COMMISSION OF INQUIRY INTO THE AIR ONTARIO CRASH AT DRYDEN, ONTARIO

Final Report

Volume I

The Honourable Virgil P. Moshansky
Commissioner


ADEN
C,3

COMMISSION OF INQUIRY INTO THE AIR ONTARIO CRASH AT DRYDEN, ONTARIO

This Final Report consists of three volumes: I (Parts One–Four), II (Part Five), and III (Parts Six–Nine and the General Appendices). The table of contents in each volume is complete for that volume and abbreviated for the other two volumes. Seven specialist studies prepared for this Commission have been published separately in a volume entitled Technical Appendices; the contents of the Technical Appendices are given at the end of this volume.

COMMISSION OF INQUIRY INTO THE AIR ONTARIO CRASH AT DRYDEN, ONTARIO

CANADA

Final Report

Volume I

Parts One–Four

The Honourable Virgil P. Moshansky
Commissioner

Printed in Canada
Cat. No. CP 32-55/1-1992E

This volume has been translated by the translation services of the Secretary of State, Canada, and is available in French.

The aerial photograph reproduced in the endpapers was taken by CASB investigators on March 11, 1989, the day following the crash of Air Ontario flight 1363. It depicts the area of the Dryden Municipal Airport (upper right), surrounding road system, and crash site. McArthur Road runs vertically up the middle of the photograph, curving to the right at about the centre of the book on the right-hand page. (The cleared straight line is a hydro right of way.) Middle Marker Road angles to the left off McArthur in the lower left-hand section. The path of Air Ontario flight 1363 through the trees begins not far from the end of runway 29, and the crash site can be seen just above Middle Marker Road. Many survivors walked out to Middle Marker Road immediately after the crash.

CANADIAN CATALOGUING IN PUBLICATION DATA

Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario (Canada)

Final report
Issued also in French under title: Rapport final.
Includes bibliographical references.
ISBN 0-660-14382-8 (Vol. 1–3)
DSS cat. no. CP32-55/1992E (Vol. 1–3)

1. Aeronautics — Ontario — Accidents — 1989.
I. Moshansky, Virgil P. II. Title.

TL553.5.C65 1992 363.12'492 C92-099547-0

Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario

CANADA

Commission d'enquête sur l'écrasement d'un avion d'Air Ontario à Dryden (Ontario)

Commissioner
The Honourable Virgil P. Moshansky
Counsel
F.R. von Veh, Q.C.
Associate Counsel
G.L. Wells
Administrator
R.J. McBey

Commissaire
L'honorable Virgil P. Moshansky
Conseiller juridique
F.R. von Veh, c.r.
Conseiller juridique associé
G.L. Wells
Administrateur
R.J. McBey

TO HIS EXCELLENCY
THE GOVERNOR GENERAL IN COUNCIL

MAY IT PLEASE YOUR EXCELLENCY

By Order in Council PC 1989-532 dated the 29th of March, 1989, I was appointed Commissioner to inquire into the contributing factors and causes of the crash of Air Ontario Flight 1363 Fokker F-28 at Dryden, Ontario, on March 10, 1989, and report thereon, including such recommendations as I may deem appropriate in the interests of aviation safety.

Having previously submitted two Interim Reports, I now beg to submit my Final Report consisting of four volumes in each official language.

Respectfully submitted.

V.P. Moshansky

Commissioner

P.O. Box/C.P. 687, Succursale Adelaide Station
Toronto, Canada M5C 2J8

(416) 973-2904 FAX: (416) 973-2908

COMMISSIONER AND COMMISSION STAFF

Commissioner
The Honourable Virgil P. Moshansky

Commission Counsel
Frederick R. von Veh, QC

Assistants to Commission Counsel
Adam S. Albright
William R. Cottick
Laurence C. Goldberg
William M. McIntosh
Douglas M. Worndl

Administrator
Robert J. McBey

Assistant to Administrator
Sylvia Cannon

Investigator in Charge
Joseph E. Jackson

Ontario Provincial Police Investigators
Detective Inspector Dennis J. Olinyk
Detective Sergeant Donald J. MacNeil
Sergeant Douglas G. Davis
Provincial Constable Gordon Leslie

Technical Advisor/Investigator
David G. Rohrer

Technical Advisors
Frank C. Black
Gerard M. Bruggink
James W. Fitzsimmons
Dr Robert Helmreich
Reg Lanthier
Captain C. Robert MacWilliam
Dr Charles O. Miller

Associate Counsel
Gregory L. Wells

Human Factors Specialist
David J. Adams

Communications Advisor
Gordon A. Haugh

Records Management
Clifford Collier
Christopher Perkins

Systems Consultant
M. Pauline Cheeks

Registrars
Norman J. Savage
Sidney B. Smith

Secretary to Commissioner
Arlene S. Walker

Secretary to Commission Counsel
Jenifer R. Williams

Secretarial Staff
Roberta Grant
Louise Madore-Payer
Margaret Mason
Elizabeth Nagata
Sonja Thomason

Support Staff
Mitchell Klein
Savita Patil

Security Staff
William Channon
Ernest Garnham
Karen Roche

Editors (English)
Daniel Liebman
Mary McDougall Maude
Rosemary Shipton
(Shipton, McDougall Maude Associates)

Legal Advisor (French)
Paul Ollivier, QC

Editor (French)
Marguerite Côté

CONTENTS

VOLUME I

VOLUME II

PART FIVE *THE AIR CARRIER – AIR ONTARIO INC.*

VOLUME III

PART SIX *TRANSPORT CANADA*

PART SEVEN *HUMAN FACTORS*

PART EIGHT *LEGAL AND OTHER ISSUES BEFORE THE COMMISSION*

PREFACE

This Report is the product of an exhaustive investigation not only of the crash of Air Ontario flight 1363, which occurred at Dryden, Ontario, on March 10, 1989, but also of the aviation system that allowed it to occur. It should be considered in conjunction with my two *Interim Reports,* which were released in December 1989 and December 1990, respectively.

My Commission staff, in the course of their investigation of the Air Ontario accident at Dryden, interviewed hundreds of potential witnesses and reviewed thousands of potential documentary exhibits. In the end the witness list was pared to 166 witnesses who were called to testify, and the exhibits were reduced to 1343 in number, most of them being documents, many containing hundreds of pages. Evidence was taken under oath in a public forum, subject to cross-examination, for a total of 168 hearing days. This Report is a synthesis of both the testimony of those 166 witnesses, contained in 168 volumes of transcript totalling some 34,000 pages, and of the contents of the documentary exhibits totalling more than 177,000 pages.

The public hearings of this Commission, held in Dryden, Thunder Bay, and Toronto over a period of 20 months, from June 1989 to January 1991 inclusive, disclosed numerous safety-related deficiencies and failings within the carrier, Air Ontario, specifically; within the aviation industry generally; and in the regulatory domain of Transport Canada. These shortcomings, their causes, and their relationship to the accident at Dryden were closely scrutinized during the hearings. They are addressed in detail in this Report, and, in accordance with the mandate given to me, recommendations for change are made.

Pursuant to an agreement reached with the chief coroner for the Province of Ontario, I conducted an investigation, during the hearings of my Commission, into matters that would normally fall within the jurisdiction of the chief coroner for Ontario. As a result of this arrangement, a substantial duplication of effort was avoided. The chief coroner for Ontario at the time,Dr Ross Bennett, and his successor, Dr James Young, shared my concern that there be an in-depth analysis of the human performance aspects of the accident at Dryden. In lieu of holding a coroner's inquest, the chief coroner for Ontario was granted full participant status in the Inquiry. I am grateful for the chief coroner's unreserved cooperation and assistance in this endeavour and for his written advice that the goals of the Office of the Chief Coroner for the Province of Ontario have been fully met by this Commission (attached as appendix F).

The Inquiry process afforded a good opportunity for the identification in a public forum of aviation safety problems within the aviation industry generally and within Air Ontario specifically. Accordingly, with respect to the air carrier, a searching investigation was conducted, not only into Air Ontario's F-28 program but also into virtually every aspect of the operations of Air Ontario, beginning with its corporate history and culminating with its management policies and practices and its relationship with its parent company, Air Canada.

In the case of the regulator, Transport Canada, this Inquiry was the vehicle for a constructive public examination of the inner workings of the Aviation Group of that department. This examination was described by the current assistant deputy minister of transport, aviation, Mr David Wightman, as probably "the most in-depth look at the operations of Transport Canada, the Aviation Group, and the Regulatory side of it specifically, that we've ever had." He further commented on the witness stand with respect to the process of this Inquiry that: "It has been an exceptionally valuable learning experience for me. I assure you." Similar sentiments, which were expressed by numerous other witnesses and by the many members of the Canadian public who communicated directly with me, have reinforced my strong belief in the value of a public Inquiry under the *Inquiries Act*. As a means of conducting an investigation – in this case, that of a major aviation accident – such an Inquiry under the *Inquiries Act* has the great advantages of virtually unlimited power to subpoena witnesses and the testing of their evidence in the crucible of cross-examination. I am convinced that, as an instrument in the search for truth, a public Inquiry, judiciously and fairly conducted, has no peer.

This Report is based exclusively on the extensive evidentiary record that has been assembled. The integrity of the evidentiary record was dependent upon the procedures that were adopted for the conduct of this Inquiry.

As discussed in my first *Interim Report*, on the first day of the public hearings of this Commission, May 26, 1989, I granted full participant status, special participant status, and observer status, respectively, to various parties. Subsequently during the hearings, other parties were granted status for limited purposes only. All parties granted status are listed in appendix C. On May 26, 1989, I stated my intention that the concept of procedural fairness would be the basic tenet of this Inquiry, and I made the following statement with respect to the rights which would be accorded to all parties granted full participant status before the Commission:

> Parties who are granted the status of a full participant will be permitted representation by counsel. Their counsel will be able to

> cross-examine Commission witnesses, submit written briefs to the Commission and, if necessary, to recommend to the Commissioner the calling of certain witnesses.
>
> In the course of any commission of inquiry, allegations will be made at public hearings which will reflect adversely on certain parties. It is my position that any party adversely implicated by testimony at the public hearings of the Commission shall be given a full opportunity to be heard.
>
> (Transcript, vol. 1, p. 9)

Similar rights were accorded the representative counsel granted special participant status on behalf of the survivors and the families of victims of the crash of flight 1363. It was my intention from the outset that the process of this Inquiry would, in the interests of fairness to those who might be affected by the process, mirror as closely as possible the proceedings of a court of law.

On the second day of the public hearings I elaborated upon the procedures that would govern the conduct of the proceedings of this Commission as follows:

> I will now deal with the question of the procedures which I propose to be followed during the hearings of this Commission. It is intended that the procedures will be those already outlined by me at the status hearings and as amplified by correspondence from Commission counsel, Mr von Veh, to the interested parties dated June 2, 1989.

In addition, I propose that the following rules of procedure will apply:

- Firstly, with respect to **Opinion Evidence**, the Commission will only receive opinion evidence of a witness where it is indicated that the witness possesses a special skill by reason of experience or study in respect of the particular subjects on which he or she intends to express an opinion.
- Secondly, with respect to **Rebuttal Evidence**, the Commission at its discretion may allow reply evidence to rebut evidence given by another witness or witnesses, such evidence to be limited exclusively to rebuttal.
- Thirdly, Commission counsel shall have discretion to select one or more persons from among a group of persons who have similar evidence to give on a matter under consideration, to give such evidence for the benefit of the persons having similar evidence.
- Fourthly, while recognizing that a commission of inquiry has a somewhat different role than a court of law and that evidentiary and procedural rules applicable in a court of law are not necessarily automatically applicable to a commission of inquiry,

it is my intention, in the interests of fairness, that the inquiry hearings shall be conducted in such a manner so as to adhere as closely as possible to the commonly accepted evidentiary rules as to relevance, to the admission of hearsay evidence, and as to the putting of leading questions to witnesses.

- Fifthly, every party shall have the right to cross-examine any witness whom he or she believes to be in error or to be suppressing facts. This right is not to be abused by irrelevant or repetitive questioning.
- Sixthly, the Commissioner, in the absence of agreement between counsel, will determine the order in which counsel for the participants will be entitled to cross-examine witnesses.

(Transcript, vol. 2, pp. 51–53)

In addition to the adoption of these procedures (which were outlined previously in my first *Interim Report*), the following specific procedures were implemented to give practical effect to the proposition that any individual who might be adversely implicated before this Commission had the full right to be heard:

- Virtually all interviews undertaken by Commission staff of potential witnesses who were affiliated with any of the parties granted full participant status were conducted in the presence of counsel. In all cases when a prospective witness or his or her counsel requested copies of interview transcripts, such were promptly provided by Commission staff.
- Before any witness testified, synopses of the anticipated testimony of all witnesses intended to be called, based on preliminary witness interviews by Commission staff, were forwarded to all participating parties.
- Before any witness testified, photocopies of all exhibits proposed to be introduced through a given witness were forwarded to all participating parties.
- All counsel appearing before the Commission were afforded broad rights of cross-examination of all witnesses.
- All participating parties were afforded the right to file written briefs as they saw fit, for my consideration.
- All hearings were conducted in such a manner so as to adhere as closely as possible to commonly accepted evidentiary rules.
- All counsel appearing before me were afforded the opportunity to call such further evidence as they saw fit.
- All counsel appearing before me were afforded the opportunity to present closing arguments.

To the extent that any party perceived that there were any inaccuracies or misstatements by any witness on the record, that party, directly or through counsel, was able to take steps to clarify the record – by cross-examining a witness, by adducing new evidence, or by submitting oral or written argument to me. Throughout this process, all parties availed themselves of these rights from time to time as they saw fit.

The mandate of this Commission was to investigate a specific air crash and to make recommendations in the interests of aviation safety. In carrying out this mandate, it was necessary to conduct a critical analysis of the aircraft crew, of Air Ontario Inc., of Transport Canada, and of the environment in which these elements interacted. As will be explained in the Introduction, I have adopted a system-analysis approach, with emphasis on an examination of human performance.

Following the completion of the hearings of this Inquiry, in late January 1991, my staff and I began reviewing both the voluminous transcripts of evidence and the great mass of documentary exhibits, prior to commencement of the task of writing this Report. This preliminary work was completed in March 1991. At that time my counsel staff and technical advisers were assigned to several research teams charged with the responsibility of preparing draft material in specific areas, according to their expertise and interests. I was personally involved with each such team, meeting regularly with team members and directing the course that I wished to be taken by the researchers. The enormous amount of evidentiary material that had to be reviewed and distilled into this Report, and the severe time constraints imposed for its production, required a dedicated team effort. The various drafts of every chapter of this Report were subjected by me to numerous reviews and revisions. My writing of this Report was basically completed in early November 1991, approximately seven months after the initial drafting began.

This Final Report consists of nine Parts (divided into 44 chapters) and general appendices in volumes I, II, and III, and a separate volume of seven Technical Appendices. Part One sets out the terms of reference for this Commission and includes a description of the duties imposed upon me by Order in Council and a description of the system-analysis approach of accident investigation utilized by this Commission of Inquiry. This Part includes a brief description of the air transportation system components pertinent to the crash of Air Ontario flight 1363, namely:

- the aircraft, C-FONF
- the aircraft crew of C-FONF
- the operational environment affecting the flight crew
- the air carrier, Air Ontario
- the regulator, Transport Canada.

Part Two of the Report includes synopses of the facts leading to the crash of Air Ontario flight 1363, of the crash itself, and of the Dryden area response to the crash. Part Three deals with an important area in the context of airline passenger safety: the airport crash, fire-fighting, and rescue services. This issue was thoroughly examined during the hearings.

Part Four describes the technical investigation of the accident and deals with the issue of crash survivability and the highly technical areas of aircraft performance and flight dynamics.

Part Five represents an in-depth examination of Air Ontario's history: the carrier's corporate mergers and management organization, and its program for the acquisition, implementation, and operation of F-28 aircraft. Numerous shortcomings in the F-28 program, discovered during this Inquiry, are dealt with in detail in the eight chapters devoted to this subject. This Part concludes with an assessment of Air Ontario management performance and of the role of the parent corporation, Air Canada.

Part Six of this Report is the product of an intensive examination by this Commission of the role of the regulator, Transport Canada, in assuring a safe air transportation system generally and a safe operation by Air Ontario specifically. The results of this examination were such that Transport Canada was found wanting in a number of areas critical to aviation safety. I thought it insufficient simply to expose regulatory shortcomings without discovering the reason for their existence. In this Part, I examine in considerable detail the effects upon aviation safety of the policy of economic regulatory reform (ERR), which was put in place in conjunction with a concurrent governmental policy of fiscal restraint. As well, the performance of senior Transport Canada management in responding to the resource needs of its front-line air carrier inspectors is critically assessed. This Part also specifically assesses how Transport Canada discharges its responsibilities in the areas of aviation regulation and legislation, air carrier audits, monitoring and surveillance, operating rules and legislation, company check pilots, spot-checks, and safety management, to list a few.

Part Seven contains a systemic analysis of the human performance aspects of this accident. The flight crew of Air Ontario flight 1363 erred in deciding to commence the takeoff at Dryden with contaminated wings. The finding of human error on the part of the flight crew is the reason for an analysis of the human performance aspects of this crash. If effective preventive measures are to be found, then the reasons for and the underlying causes of the human error must be fully understood. This Part, which represents a synthesis of the findings of the entire investigation of this accident, is a departure from the usual format for aviation accident investigations in that the role of air carrier management in the events leading to a breakdown in the air transportation system is closely scrutinized. I was greatly assisted in this area by those internationally recognized experts in the field of human performance who were special advisers to this Commission.

Part Eight represents my analysis, views, and recommendations with respect to certain legal and other issues concerning the aviation accident investigation process in Canada; the reporting of aviation incidents and accidents and the issue of pilot confidentiality; the matter of the objection to production of documents based on a confidence of the Queen's Privy Council, pursuant to section 39 of the *Canada Evidence Act*, R.S.C. 1985, c.C-5; and the matter of section 13 of the *Inquiries Act*, R.S.C. 1985, c.I-11.

In the later stages of the preparation of my Final Report it became clear that I would be making comments which might be perceived to be adverse to certain individuals. Section 13 of the *Inquiries Act* requires that reasonable notice be given to a person against whom a charge of misconduct is alleged in a report and that the person be allowed full opportunity to be heard in person or by counsel. Although my intended comments did not, in my view, constitute a "charge of misconduct" against any individual within the meaning of section 13 of the *Inquiries Act*, in the interests of fairness I instructed Commission counsel to send written notice to all of these individuals, advising of the substance of the intended adverse findings and inviting them to make written or oral submissions to me in response thereto. Such notices were delivered in the latter part of August 1991. In a number of instances individuals responded to the notice given to them under section 13. In all instances, the responses were carefully considered by me. The procedures adopted by this Commission with respect to section 13 of the *Inquiries Act*, the provisions of section 13 itself, and the proceedings brought by Air Ontario and certain unnamed individuals in the Federal Court of Appeal, after receipt of notice under section 13, and the subsequent withdrawal of those proceedings are discussed in Part 8 of this Report.

I have made numerous recommendations in my first and second *Interim Reports* and throughout the body of this Final Report. All these recommendations are consolidated in Part Nine for the convenience of readers. During the course of the Inquiry I was called upon to make a number of rulings involving points of law or procedure. These rulings are reproduced as appendix M among the general appendices to this Report. The volume of Technical Appendices is published to disseminate specialized research gathered by the Commission.

This Report is, in certain instances, critical of individuals and institutions where criticism, in my view, is warranted. Such criticism is an unavoidable result flowing from the nature of this Inquiry and the evidence. It is intended to be constructive, the objective being the prevention of similar accidents in the future. At the same time, acknowledgement is made in the Report of aviation safety–related improvements that have already been made by the air carriers and by the regulator, Transport Canada, to the aviation system, in response to deficiencies discovered in the course of the hearings. In particular, the air carriers and Transport Canada are commended for the implementation of new inspection and de-icing procedures at Pearson International Airport in Toronto during weather conditions when aircraft surface contamination due to freezing rain, snow, and ice is likely. The recently announced intention of Transport Canada to construct at Pearson a remote touch-up de-icing spray facility and a major de-icing/anti-icing facility with provision for fluid recycling, estimated to cost $45 million, is a welcome response to the safety concerns and recommendations outlined in my *Second Interim Report*.

What was also discovered during the hearings was the fact that, generally speaking, Transport Canada is staffed at all levels by competent and dedicated persons who are sincerely doing their best to ensure a safe air transportation system for the public, at times under trying and frustrating circumstances.

The many air carrier pilots and others involved in the aviation industry who testified before this Inquiry impressed me with their general professionalism and with their commitment to aviation safety. I must mention in particular the valuable contribution of the Canadian Air Line Pilots Association throughout the investigative stage and the hearings of this Inquiry.

It is my hope that the work of this Commission will have served as a catalyst for change. In my view, one of the lasting benefits from this Inquiry is to be found in the greatly heightened awareness that has been generated not only among those involved in the aviation industry, but also among the members of the public, in matters of aviation safety generally, and particularly as to the dangers presented by aircraft surface contamination and the need to ensure clean wings on takeoff. The Canadian media deserve a great deal of credit for this heightened public awareness. There can be no doubt that the widespread and responsible coverage of the public hearings of this Commission by members of the media has had a beneficial effect.

I am confident that, if the contents of this Report are carefully considered and the recommendations made herein are accepted and implemented in a timely manner, an important contribution to aviation safety in Canada will have been made.

The readers of this Final Report should view the critical nature of the analysis contained in it as this Commission's contribution towards enhancing the safety of the travelling public. Transport Canada and the Canadian aviation industry will ultimately have to strike the delicate balance between maintaining an adequate level of aviation safety and dealing with realistic economic considerations.

ACKNOWLEDGEMENTS

This Report could not have been written without the help of a great many people. I am grateful to all of my counsel and my technical staff for joining me in working, without respite, through the summer and fall of 1991 to complete an enormous task in the shortest time possible. They have earned my deep respect.

I believe it to have been a distinct advantage that virtually everyone involved in an official capacity with this Commission had an aviation background, either in the military or in civil aviation, or in both. The result was a compatible working group, knowledgeable in aviation matters, possessing an understanding of the principles of flight and a command of the terminology and the language of aviation.

No Commission can function effectively without the assistance of a highly competent, dedicated, and motivated Commission counsel. I was most fortunate to have such a counsel in the person of Mr Frederick von Veh, QC, of Toronto. A veteran of several Commissions of Inquiry, Mr von Veh's previous Commission experience and his background in administrative and transportation law proved invaluable to me not only in the initial organization and staffing of this Commission, in the assembly of my Commission team of investigators and technical experts, and in the prompt startup of the Commission process, but also throughout the conduct of this Inquiry. In addition to being deeply involved in the planning of the basic direction that the Inquiry was to take, Mr von Veh had the heavy responsibility of organizing and overseeing the work of my entire Commission staff throughout the life of this Commission. He also very ably served as counsel during a number of important phases of the hearings of this Inquiry. Upon the conclusion of the hearings he assisted me greatly in the onerous day-to-day management of the research, drafting, and revision activities for this Final Report. His drive and perseverance contributed much to its timely production. He was also responsible for all matters pertaining to section 13 of the *Inquiries Act*. Mr von Veh has discharged his multiple and weighty responsibilities as Commission counsel in a most professional manner. I am greatly indebted to him.

I was very well served also by my associate Commission counsel, Mr Gregory L. Wells of Calgary. His experience and unique background as a former military pilot, as an air carrier pilot, and as a counsel involved in aviation law enabled him to make a very important contribution to this Inquiry. Mr Wells did much of the counsel work at the Inquiry hearings, acquitting himself admirably. He was heavily involved in the

research and draft writing of the highly technical sections of this Report, and he participated in the numerous reviews of its various sections. I am most appreciative of the total commitment that he made to the work of this Commission and for the thorough and professional job that he has done.

The other members of my counsel staff, Mr Adam Albright, Mr William Cottick, Mr Laurence Goldberg, Mr William McIntosh, and Mr Douglas Worndl, all worked very hard throughout the investigative phase, the hearings phase – during which they appeared as counsel – and the research and report-writing phase of this Inquiry. I thank them for their dedication and tireless efforts. Mr Worndl, who has been a member of my counsel staff from the inception of this Commission, was my director of research. He assisted me in the drafting, revising, and refining of many of the sections of this Report and has rendered exemplary service to this Commission.

I wish to express my appreciation also to my outside counsel, Mr Ian Binnie and Mr Peter Griffin of Toronto, for their advice and counsel at various times and for so capably representing me in the Federal Court of Appeal proceedings taken under section 13 of the *Inquiries Act*.

The investigation of an aviation accident requires specialized investigation teams under the direction of an experienced and knowledgeable team leader. It was my good fortune to obtain the secondment to my Commission, from the Canadian Aviation Safety Board (now the Transportation Safety Board of Canada), of an outstanding aviation accident investigator, Mr Joseph Jackson of Ottawa, for the position of investigator in charge. I express my deep appreciation to him and to his corps of investigators for their total dedication to this investigation. Mr Jackson, a skilled writer, was also involved in the research and preparation of drafts of several highly technical sections of this Report and made important contributions to other areas of this Report.

My senior technical adviser, Mr Frank Black of Manotick, Ontario, a private aviation consultant and the former chief of aeronautical licensing for Transport Canada, was the driving force behind the complex and difficult Transport Canada phase of the Inquiry. As well, Mr Black assisted me greatly in the aircraft ground de-icing/anti-icing phase that culminated in my *Second Interim Report*. He was ably assisted by Mr James Fitzsimmons, a former regional director of aviation regulation, Ontario Region, for Transport Canada, and both were instrumental in the research and preparation of drafts of the Transport Canada sections of this Report. In addition, Mr Black, along with Mr Jackson and Mr Worndl, assisted me greatly in the drafting of the Human Performance chapter of this Report. I am grateful to Mr Black for his sage advice and counsel.

My technical advisers, Captain Robert MacWilliam, Mr David Rohrer, Mr David Adams, and Mr Reg Lanthier, made important contributions throughout the investigative and hearing phases of the Inquiry, with Captain MacWilliam also being involved in research and drafting of the various operational chapters and the Human Performance chapter of this Report and as a valued adviser during the Final Report review committee meetings.

My special advisers, internationally known in the field of aviation accident investigation, Dr Charles O. Miller, Mr Gerard Bruggink, and Dr Robert Helmreich, gave me the benefit of their expert knowledge and experience in aviation accident investigation both throughout the investigative and the hearing stages of this Commission and in their critiques of various drafts of this Report. It was a great privilege to associate and work with such outstanding individuals.

My thanks go to Detective Inspector Dennis Olinyk and Detective Sergeant Donald MacNeil of the Ontario Provincial Police and to those other members of the force who were seconded to this Commission as full-time investigators and served so diligently and professionally. My thanks also to the communications adviser for the Commission, Mr Gordon Haugh, for his ongoing rapport with all branches of the media and for his research and contributions to the section on the Dryden area response to the crash.

On the administrative side I wish to express my appreciation to Commission administrator Mr Robert McBey, also a veteran of previous Commissions and a former military pilot, who assumed the position early in the life of this Commission and has skilfully guided the administrative and financial side of the Commission to an under-budget conclusion. He has been ably assisted by Mrs Sylvia Cannon, assistant administrator to the Commission. My thanks also to Mr William Pratt, assistant deputy minister of management services; to Ms Hélène Langlois, Commission coordinator; and to Mr Peter Brennae of the Inquiries Secretariat, Transport Canada, for their valued advice and assistance so willingly given.

The Commission registrars, Mr Norman Savage and his successor Mr Sidney Smith, and the hearing room officers, Mrs Karen Roche, Mr William Channon, and Mr Ernest Garnham, contributed much to the decorum and orderly conduct of the hearings. For their dedication and valuable service beyond the call of duty I express my sincere appreciation to the Commission records and exhibits manager, Mr Clifford Collier, to his assistant, Mr Christopher Perkins, and to the secretarial, clerical, and computer operations members of the Commission office staff: Pauline Cheeks, Roberta Grant, Mitchell Klein, Louise Madore-Payer, Margaret Mason, Elizabeth Nagata, Savita Patil, Sonja Thomason, Jenifer Williams, and my personal secretary Arlene Walker. I also

express my appreciation to other members of my secretarial and clerical staff who served the Commission most diligently for shorter periods of time: Joe Anile, Sheila Brown, Lisa Buxton, Florence Guttierez, Janet Hinton, Debbie McBurnie, Patricia McIntosh, Sheila Moore, and Diane Risteen.

I wish also to acknowledge the outstanding contribution made to the Inquiry by all of the counsel who represented interested parties throughout the hearings of this Commission. A large number of these counsel also had backgrounds in aviation. All of them acquitted themselves in an exemplary manner, and I hesitate to single out any one of them for specific mention. However, I feel that I should acknowledge the outstanding service rendered by Mr Paul Bailey, counsel to the chief coroner for Ontario. Mr Bailey bore the brunt of the cross-examination of witnesses, and his efforts have in fact been acknowledged by his own peers. He also made an important contribution in his reviewing, on behalf of the chief coroner, of certain draft sections of this Report, for which I offer my thanks. In addition, I will also mention Mr Kristopher H. Knutsen and Mr S. Alexander Zaitzeff, who ably represented the survivors and the families of victims of the Dryden crash as a result of my decision to grant to this group unprecedented special participant status.

Those parties who were granted full participant status, and who seconded to the various investigative groups of this Commission highly experienced experts as participants, are to be commended for the valuable contributions that they made to the process of this Inquiry. I acknowledge the cooperation of the counsel for and the officials of Transport Canada with the officials of my Commission, and I express my appreciation to the assistant deputy minister of transport for his direction to all Transport Canada officials who appeared before this Commission that they were to do so freely and with no sense of inhibition.

Crucial to the writing of a report of this nature are the services of professional editors. It has been my good fortune to have secured the services of three of the best, Mary McDougall Maude, Rosemary Shipton, and Daniel Liebman. They have been involved since the early stages of the writing of this Report and have given to me and my staff the benefit of their valuable advice and guidance. Besides carrying out their editorial work, they have also acted as the liaison between the Commission and the translators and printers, and they have looked after the myriad of details involved in the publication of this Report. I express to them my thanks for the total dedication that they have brought to this task and for their consummate professionalism. My appreciation and thanks are extended as well to the editors of the French edition, Mrs Margot Côté and Mr Paul Ollivier, QC.

Finally, I wish to thank all of the witnesses who testified, including the many expert witnesses, for their valuable contribution to this Inquiry. To the many pilots from across the country and the numerous members of the public who have personally contacted me or who have written to me with expressions of interest, suggestions, and encouragement during the life of this Commission, I express my sincere appreciation for their interest. On a personal note, to my wife June, for her understanding and tolerance of my prolonged absences from home, my thanks.

GLOSSARY OF TERMS AND ACRONYMS

Symbols and Units of Measure

°	degree(s) – applies to latitude and longitude
′	minute(s) – applies to latitude and longitude
″	second(s) – applies to latitude and longitude
BTU	British Thermal Unit
fpm	feet per minute
G *or* g	a symbol used to denote the force of gravity (load factor)
in Hg	inches of mercury
KHz	kilohertz
knot	a nautical mile per hour or 1.15 statute miles per hour
°M	degrees magnetic
mb	millibar(s)
MHz	megahertz
pph	pounds per hour
psi	pounds per square inch
rpm	revolutions per minute
°T	degrees true

Glossary of Terms and Acronyms

The terms and acronyms contained herein are general in nature and are not intended to provide complete and/or technical definitions. Rather, they are included as references to assist the reader. Many of the terms and acronyms are more completely defined and described in specific sections of this Report.

AAG	Transport Canada Airports Authority Group
A-base review	A systemic review of the Canadian Air Transport Administration, initiated in November 1982 for the purpose of determining an appropriate level of resources
above ground level	Height measured from the surface of the earth
AC	Air Canada
ACA	Aircraft certification authority
ACC	Area control centre (air traffic control)
accelerate stop distance available	The length of takeoff run available plus the length of stopway if provided
accident	An aviation occurrence in which: (a) a person sustains a serious or fatal injury; (b) the aircraft sustains damage or failure normally requiring major repair (with exceptions); or (c) the aircraft is missing or completely inaccessible
ACM	Air cycle machine
ACN	Aircraft classification number (ICAO)
AD	*See* airworthiness directive
ADF	Automatic direction finder
adiabatic cooling	The process by which air is cooled solely through expansion as it ascends

ADM	Assistant deputy minister
ADMA	Assistant deputy minister, aviation
ADMR	Assistant deputy minister, review
AEA	Association of European Airlines
aerodrome	Any area of land or water designed, prepared, and equipped for use in arrival and departure or servicing of aircraft. The aerodrome includes all runways and taxiways and any buildings and fixed equipment.
Aeronautical Information Publication	A document produced by Transport Canada to provide pilots with a single source of information concerning rules of the air and procedures for aircraft operations in Canada
AES	Atmospheric Environment Service
AFM	*See* aircraft flight manual
A/G	Air/ground
agl	*See* above ground level
AIC	Aeronautical information circular
ailerons	Pairs of control surfaces, normally hinged along the wing span, designed to control an aircraft in roll
A.I.P.	*See* Aeronautical Information Publication
air bottle	A device used to store air under pressure for use in producing rotation in a jet engine for starting

air brake	A device attached to an aircraft for the purpose of reducing lift and/or increasing drag while the aircraft is airborne. It is normally controlled by the pilot and used in flight to reduce air speed or increase the rate of descent. Also referred to as speed brake.
air carrier	Any person or organization operating a commercial air service
Aircraft Flight Manual	Sometimes referred to as flight manual/flight handbook. It sets out operating limitations, emergency procedures, abnormal procedures, normal operating procedures, and flight and ground-handling and performance data. Produced by the aircraft manufacturer, the Aircraft Flight Manual forms part of the type certification of the aircraft.
Aircraft Operating Manual	Sometimes referred to as a flight manual or standard operating procedures (SOPs) manual. It is developed by the carrier to set out standard operating procedures for a specific aircraft type. It is based on and is no less restrictive than the approved Aircraft Flight Manual. Examples are the Piedmont Airlines F-28 Operations Manual and the USAir F-28 Pilot's Handbook.
Aircraft Operations Groups Association	The bargaining agent that represents Transport Canada civil aviation inspectors
airflow	Movement of air around a moving object. Airflow generally refers to a moving aircraft.
airfoil	A structure designed to produce a useful reaction of itself in its motion through the air. It generally refers to an aircraft wing.
airframe	The assembled structural and aerodynamic components of an aircraft

airline transport rating	A certificate of competency issued by Transport Canada to a pilot meeting the requirements. This is the highest rating available in Canada to a commercial pilot.
Air Navigation Order	An order having the force of law that finds its origins in the *Aeronautics Act* and the Air Regulations
airport	An aerodrome that has been inspected by Transport Canada inspectors, has met specific standards, and has been issued an aerodrome certificate
airport surveillance radar	A relatively short-range radar intended primarily for surveillance of airport and terminal areas
air route	A prescribed track between specified radio aids to navigation, along which air traffic control service is not provided
air traffic control clearance	Authorization by an air traffic control unit for an aircraft to proceed within controlled airspace under specified conditions
air traffic control instruction	A directive issued by an air traffic control unit for air traffic control purposes
air start unit	A machine that provides pressurized air to a jet engine for the purpose of starting it
airway	A prescribed track between specified radio aids to navigation in controlled airspace
airworthiness	In respect of an aeronautical product, being in a fit and safe state for flight and in conformity with applicable standards
airworthiness directive	Instruction that specifies the modification, replacement, or special inspection required to preserve the continuing airworthiness of an aircraft

alternate airport	An aerodrome specified in an IFR flight plan to which a flight may proceed when a landing at the intended destination becomes inadvisable
altimeter	An instrument that uses barometric pressure to measure height above a reference datum
AME	Aircraft maintenance engineer
AMO	Approved maintenance organization
angle of attack	The angle between the chord line of an airfoil and the relative airflow
ANO	*See* Air Navigation Order
ANS	The national Air Navigation System
anti-ice	Prevention of the buildup of ice
anti-skid	With reference to braking, a system that provides for maximum brake effectiveness by not allowing the wheels to stop turning completely
AOGA	*See* Aircraft Operations Groups Association
AOM	*See* Aircraft Operating Manual
APM	Airport manager
APU	*See* auxiliary power unit
aquaplane	*See* hydroplane
ARASS	*See* aviation regulation activity standards system
ASDA	*See* accelerate stop distance available
ASE	Aviation safety engineering
asl	Above sea level, height in feet measured from sea level

ASP	Aviation safety programs
ASR	*See* airport surveillance radar
ATAC	Air Transport Association of Canada
ATC	Air traffic control
ATF	Aerodrome traffic frequency
ATIS	Automatic terminal information service
ATPL	Airline transport pilot licence (replaces ATR)
ATR	Airline transport rating
ATS	Air traffic services
ATZ	Aerodrome traffic zone
audit (regulatory)	An in-depth review of the activities and facilities of an organization such as an air carrier or a manufacturing, repair, or overhaul facility to verify conformance with regulatory standards and practices
audit manager	An individual, designated by the convening authority, who is responsible for planning and overall conduct of the audit, up to and including the production of the final audit report
automatic direction finder	A radio direction finder that automatically and continuously provides an indication of the direction to a tuned radio beacon
automatic terminal information service	The continuous broadcast of recorded non-control information in selected busy terminal areas
autopilot	Equipment that automatically controls an aircraft as directed by the pilot(s)
autothrottle	Equipment that automatically adjusts aircraft power to maintain a selected airspeed

auxiliary power unit	A small turbine engine installed in some aircraft to provide pressurized air and electrical power
aviation regulation activity standards system	A staffing standard developed by and used within Transport Canada's Aviation Group
AWIS	Aviation weather information service
BASI	Australian Bureau of Aviation Safety Investigation
bleed air	Air taken from the compressor section of a turbine engine, used to operate some aircraft systems
button	The point on a runway in the immediate vicinity of the threshold from which takeoff normally begins
C	The symbol added to designators of Canadian airports for international flights
CA	*See* convening authority
CADORS	Civil aviation daily occurrence reporting system
CAF	Canadian Armed Forces
CAI	Civil aviation inspector
CALDA	Canadian Air Line Dispatchers Association
CALPA	Canadian Air Line Pilots Association
CAMU	Civil aviation medical unit
CAP	*Canada Air Pilot*, a Transport Canada publication depicting instrument approach procedure at Canadian airports. Operating weather minima are given for each airport.

CASB	Canadian Aviation Safety Board
CAT	Clear air turbulence
CATCA	Canadian Air Traffic Controllers Association
CCFR	Chief, crash, fire-fighting, and rescue services
CCI	Condition conformity inspection
CCP	*See* company (carrier) check pilot
CDL	(1) Central datum line; (2) configuration deviation list
ceiling	The lowest height above ground at which a broken or overcast sky condition exists
centre line	A line running the length of a runway, depicting the centre
certificate of airworthiness	A conditional certificate of fitness for flight, issued in respect of a particular aircraft under the Air Regulations or under the laws of the state in which the aircraft is registered
certificate of registration	A certificate issued to an aircraft owner when the aircraft is registered under the Air Regulations
certification	The process of determining competence, qualification, or quality on which issuance of a Canadian aviation document is based, in accordance with the procedures approved by the minister. This process includes original issuance, denial renewal, or revision of that document.
C/F	Carried forward
CFB	Canadian Forces Base
CFR	Crash, fire-fighting, and rescue (services); crash fire rescue (services)

CFS	*Canada Flight Supplement*, a Transport Canada publication that provides aerodrome and related information for use during flight planning and in flight
checklist	A consolidation, in checklist form for ready reference, of the procedures and limited essential information set out in the Aircraft Operating Manual
checkout	Attaining individual competency in a specific aircraft
check pilot	A pilot appointed by an airline to carry out competency evaluations on company pilots
chief pilot	In the case of Air Navigation Order Series VII, No. 2, a management position required of an air carrier. Air carriers operating a number of large aircraft may have a chief pilot for each aircraft type.
chord	A datum line connecting the leading and trailing edges of an airfoil, and from which the angles of the airfoil are measured
circuit	A rectangular pattern flown by an aircraft from takeoff to landing
clearance (air traffic control)	Authorization by an air traffic control unit for an aircraft to proceed within controlled airspace under specified conditions
clearway	A defined rectangular area over the ground, selected or prepared as a suitable area over which an aircraft may make a portion of its initial climb to a specified height
cockpit (or crew) resource management	The enhancement of air crew knowledge, management skills, and attitudes to promote effective management of all available resources, both human and technical, to maintain a safe flying operation

cockpit voice recorder — A recording device used to record all sounds in the cockpit during flight, including all transmissions and receptions on the radios

coefficient of lift (C_L) — Dimensionless measure of aerodynamic lift, where lift is the aerodynamic force generated perpendicular to the relative airflow. Expressed as aerodynamic lift force divided by the product of the free stream dynamic pressure and the surface area.

$$C_L = \frac{L}{\frac{1}{2}\rho V^2 S}$$

$$\text{Free stream dynamic pressure} = \frac{1}{2}\rho V^2$$

where L = lift, ρ = air density, V = velocity, S = surface area

C of A — *See* certificate of airworthiness

C of G — Centre of gravity

C of R — *See* certificate of registration

cold soaking — The process which occurs when an aircraft is subjected to cold temperatures so that all or part of the aircraft is cooled to ambient temperature

company (carrier) check pilot — A check pilot employed by an air carrier who has delegated authority to carry out certain check pilot functions on behalf of Transport Canada

confirmation request form — The form issued to the auditee by a TCAG inspector requesting information that was not readily available. The auditee must respond within a specified time period.

conformance — The state of meeting the requirements of a standard, a specification, or a regulation

controlled airspace	Airspace of defined dimensions within which air traffic control service is provided
controlled VFR (CVFR) flight	A flight conducted under the visual flight rules within Class B airspace surrounding an airport and in accordance with an air traffic control clearance
control zone	Controlled airspace of defined dimensions extending upwards from the surface of the earth up to 3000 feet above the airport elevation, unless otherwise specified
convening authority	The manager within Transport Canada Aviation Regulation responsible for authorizing a regulatory audit
COPA	Canadian Owners and Pilots Association
Corrective Action Plan	A plan submitted to the convening authority or his or her delegate by the auditee, following receipt of the audit report. This plan details the action to be taken to correct the deficiencies identified by the audit findings. It is intended to bring the auditee into full conformance with regulatory standards.
CRFAA (CRFFAA)	Critical rescue and fire-fighting access area
CRM	*See* cockpit (or crew) resource management
cross-country (flight)	Flying an aircraft from one geographical location to another over a distance great enough to require some form of navigation
cross-feed	A system by which fuel may be fed from fuel tanks to the engines in a non-standard manner, often required in situations where a fuel-pump or aircraft engine is inoperative or when a fuel imbalance occurs
cross-wind	A wind that is blowing from any direction except directly down a runway

CSD	Constant speed drive
CSN	Cycles since new
CTAISB	Canadian Transportation Accident Investigation and Safety Board. *See* Transportation Safety Board of Canada (TSB)
CUPE	Canadian Union of Public Employees. Flight attendants of Air Ontario belong to this union.
CVFR	Controlled VFR
CVR	*See* cockpit voice recorder
CZ	Control zone
decision height	A specified height at which a missed approach must be initiated during a precision instrument approach, if the required visual reference to continue the approach to land has not been established
deferral	Postponing the rectification of a malfunction or unserviceability noted in an aircraft journey log, normally with reference to the aircraft's minimum equipment list
de-ice	The removal of ice, snow, or frost (from an aircraft)
de-icing pad	Designated area on an aerodrome where aircraft de-icing and anti-icing are carried out
DFC	Dryden Flight Centre
DFDR	Digital flight data recorder
DFO	Director of flight operations
DFTE	Designated flight test examiner
DH	Decision height

digital flight data recorder	A device that automatically records, in digital form, certain elements related to the performance of an aircraft such as engine performance and flight control position. It is used as a tool for accident investigation and, recently, aircraft maintenance
distance measuring equipment	On-board electronic equipment that provides continuous readout of the distance of an aircraft from a selected ground radio station
DM	Deputy minister
DME	*See* distance measuring equipment
DND	Department of National Defence
DOT	Department of Transport
downdraft	A localized area of descending air
E&I	Engineering and Inspection Manual
ECC	Emergency Coordination Centre
Elephant Beta	A vehicle developed in Sweden for the de-icing and anti-icing of an aircraft
elevation	The vertical distance of a point on the earth surface, measured from mean sea level
elevator	A hinged horizontal control surface connected to the horizontal stabilizer and connected to the control column to allow the pilot to control the pitch attitude of the aircraft
ELT	Emergency locator transmitter

emergency locator transmitter	A radio transmitter, attached to the aircraft structure, that operates from its own power source. It is designed to commence transmitting, without human action, following an accident. It transmits a distinctive signal on emergency frequencies for homing purposes.
empennage	An arrangement of stabilizing surfaces at the tail of an aircraft
ERR	Economic regulatory reform
ETA	Estimated time of arrival
ETD	Estimated time of departure
ETE	Estimated time en route
EWD	Equivalent water depth
FA	Flight attendant, described in the Air Navigation Orders as a cabin attendant, who is a member of the aircraft crew
FA	Area (weather) forecast
FAA	Federal Aviation Administration, the U.S. government agency responsible for safety regulations pertaining to aircraft
FACN	Area forecasts (Canadian)
FAR	Federal Aviation Regulation
FDR	Flight data recorder
final approach	The segment of the approach from the final approach fix to the point where the aircraft touches down on the runway or commences a missed approach. The final approach fix is normally three to four miles from the runway end.

FIR	Flight information region
FL	Flight level
flame-out	To cease burning in the combustion chamber of a turbine engine from a cause other than deliberate shutdown
flaps	Appendages to the wing of an aircraft that change its lift characteristics to permit slower landing and takeoff speeds
flare	Decreasing the rate of descent and airspeed by raising the nose of the aircraft just prior to landing
flashover	The spontaneous combustion of heated gases
flight data recorder	A device that automatically records certain elements related to the performance of an aircraft, such as engine performance and flight control position. It is used as a tool for accident investigation and, recently, aircraft maintenance.
flight following	A system, described in the Flight Operations Manual of an air carrier, for monitoring the progress of each flight from its point of origin to final destination, including intermediate stops and diversions. Also referred to as flight watch.
flight handbook	The title used by the aircraft manufacturer, Fokker Aircraft B.V., to describe the F-28 Mk1000 Aircraft Flight Manual; in this case, it is set out in three volumes
Flight Operations Manual	A manual produced by an air carrier for its own use and approved by the regulatory agency. It sets out the air carrier's flight operation's organization, operating policies, and practices.

flight plan	Specified information related to the intended flight of an aircraft and filed with an air traffic control facility
flight release	Documentation produced by an air carrier that authorizes a given flight, including specific circumstances of such flight
flight service station	A facility operated by Transport Canada to provide information and assistance to flights. This is an advisory service only, and no traffic control is provided except as may be relayed from an air traffic control unit.
flight simulator	A flight-training device that simulates most modes of flight of a specific aircraft. It is used by air carriers to train and requalify flight crews to fly a specific aircraft.
flight watch	*See* flight following
flow control	An air traffic procedure designed to restrict the flow of aircraft during periods of excessive traffic congestion
FO *or* F/O	First officer
FOD	Foreign object damage (to an aircraft)
FOM	*See* Flight Operations Manual
forced landing	A landing that is made when it is impossible for an aircraft to remain airborne as a result of mechanical failure, such as loss of propulsion
FSO	Flight safety officer
FSS	*See* flight service station
FT	Terminal forecast
FTCN	Terminal forecast (Canadian)

GCA	Ground controlled approach
gearbox	A system of gears that transfers power from an engine to drive specific systems
GEN	Generator
g forces	Acceleration forces acting on an aircraft in flight expressed in multiples of the force of gravity
glide path (glide slope)	The vertical flight path followed by an aircraft on final approach; at times it is electronically generated by an instrument landing system
glycol	Chemical used in anti-freeze. Forms of glycol are used to de-ice and anti-ice aircraft.
GPU	*See* ground-power unit
GPWS	Ground proximity warning system
ground effect	The temporary increase in lift at very low altitudes due to compression of the air between the aircraft's wings and the ground
ground-power unit	A unit that is used to provide electrical power to an aircraft while it is on the ground
ground speed	The rate of motion of an aircraft over the ground, usually expressed in nautical miles per hour. It is the sum of the true airspeed plus or minus the effect of wind.
GS	Glide slope
Gx	International designation for Air Ontario
hard wing	A wing that has no high lift devices on the leading edge
head wind	That portion of the wind that acts to reduce the ground speed of an aircraft

holdover chart	A chart setting out guidance information as to the length of time de-icing and anti-icing fluids will protect an aircraft from contamination due to precipitation
holdover time	The time during which a de-icing or anti-icing fluid is considered to offer protection against the formation or accumulation of contaminants (frost, ice, etc.) on an aircraft
hot de-icing	De-icing of an aircraft while one or more of its main engines is running
hot refuelling	Refuelling of an aircraft while one or more of its main engines is running
HP	High pressure
HS	Hawker Siddeley (aircraft manufacturer)
HYD	Hydraulic
hydroplane	A condition in which moving aircraft tires are separated from the runway surface by a film of water, resulting in almost complete loss of brake effectiveness. Also referred to as aquaplane.
IAS	Indicated airspeed
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IFALPA	International Federation of Air Line Pilots Associations
IFR	*See* instrument flight rules
IIC	*See* investigator in charge
ILS	*See* instrument landing system

IMC	*See* instrument meteorological conditions
incident	An aviation occurrence, other than an accident, that affects or could affect the safe operation of an aircraft
instrument flight rules	Rules for the conduct of a flight in weather conditions below those required for visual flight
instrument landing system	A ground-based electronic system designed to provide guidance in both the horizontal and vertical planes for an aircraft to follow to a runway
instrument meteorological conditions	Weather conditions expressed in terms of visibility and distance from cloud and ceiling less than the minimum required to maintain visual flight
investigator in charge	An investigator appointed by the TSB to investigate or to lead the investigation into the circumstances surrounding an aviation occurrence
ISA	International standard atmosphere
JAA	Joint Aviation Authorities
JAR	Joint Aviation Requirement
JBI	James Brake Index. It is used in indicating the coefficient of friction of a runway surface.
Jet A fuel	Jet fuel with a relatively low volatility
Jet B fuel	Jet fuel with a relatively high volatility
journey log	A log required to be carried in an aircraft. Specified information on each flight, including crew names, flying times, defects, and rectification, must be entered in this log.

Kallax De-icing System — A computer-controlled gantry-type structure, developed in Sweden and similar to a giant automobile car wash, that has the capability to de-ice and anti-ice aircraft quickly. It is normally located near the departure end of a runway.

landing gear — The components of an aircraft that support and provide mobility for an aircraft on the ground. It consists of wheels and all supporting structures.

landing roll — The segment of a landing from touchdown until the aircraft either stops or taxis off the runway

LDA — Landing distance available

leading edge — The forward edge of an airfoil

leg — A single flight from one airport to another that is part of a series of flights by the same aircraft/crew combination

LF — Low frequency

lift-dumpers — Mechanical devices installed on the wings of some aircraft, including the F-28, that, when deployed, reduce lift and increase drag on the ground in order to reduce the stopping distance

liftoff — The time during the takeoff when the wheels of an aircraft leave the runway

line indoctrination — That portion of pilot training which is carried out during normal flying operations

line pilot — An airline pilot who has no supervisory or management status

load factor — The ratio of the acceleration load on an aircraft to the weight of the aircraft

LOC	Localizer (for non-precision approach procedures predicated on a localizer facility)
localizer	An electronic component of an instrument landing system that provides the pilot with guidance to the runway centre line
logbook	*See* journey log
LP	Low pressure
M *or* **Mag**	Magnetic
MAC	*See* mean aerodynamic chord
Mach	Mach number: speed relative to the speed of sound, with the speed of sound being designated as 1
master caution (or warning) light(s)	A light or lights, normally on the instrument panel of an aircraft, designed to draw the pilot's attention to a malfunction in one of a number of systems connected to the warning system
master minimum equipment list	A document, produced by the manufacturer and approved by the certification authority, that establishes the essential aircraft equipment allowed to be inoperative, under specified conditions, for a specific type of aircraft
MCM	Maintenance control manual
MEA	*See* minimum en route altitude
Mean aerodynamic chord	Chord of imaginary wing of constant section having same force vectors under all conditions as those of actual wing
MEC	Master Executive Council (CALPA)

MEDEVAC	Medical evacuation, a term used to request air traffic services priority handling based on a medical emergency in the air transport of patients, organ donors, or organs or other urgently needed life-saving medical material. The term is to be used on flight plans and in radio-telephony communications if a pilot determines that a priority is required.
MEL	*See* minimum equipment list
MEL	Multi-engine land (endorsement of pilot's licence, referring to land-based, multi-engined aircraft)
minima, minimums	A short form for minimum descent altitude or decision height
minimum en route altitude	The published minimum altitude above sea level between specified fixes on airways or air routes which assures acceptable navigational signal coverage and meets the IFR obstruction clearance requirements
minimum equipment list	An approved document that authorizes an air carrier to operate a specific type of aircraft with essential equipment inoperative under the conditions specified
MM	(1) Middle Marker; (2) maintenance manual
MMEL	*See* master minimum equipment list
MNR	Ministry of Natural Resources
MRA	Manual of regulatory audits
msg	Message
msl	Mean sea level
MTC	Maintenance

NACIS	National Air Carrier Information System
NAMEO	Notice to Aircraft Maintenance Engineers
NASA	National Aeronautics and Space Administration (U.S.)
National Audit Program	The program of activities that measures the level of an organization's regulatory compliance with current legislation
nautical mile	A term used in navigation; it is equal to 6076 feet or 1.15 statute miles
NCATS	National Civil Air Transportation System
NDB	*See* non-directional beacon
non-compliance	The state of not meeting regulatory requirements
non-conformance	A deficiency in characteristics, documentation, or procedure that renders the quality of a product or service unacceptable or indeterminate
non-directional beacon	A low frequency radio beacon that transmits non-directional radio signals which a pilot of an aircraft with compatible receivers can use to determine his or her relative bearing
NOTAM	Notice to airmen
notice to airmen	A notice disseminated throughout the air traffic control system containing information concerning the establishment, condition, or change in any component of the National Airspace System
NTA	National Transportation Agency

NTSB	National Transport Safety Board, the United States government agency responsible for investigating and reporting on aircraft accidents
OAT	Outside air temperature
OC	*See* operating certificate
occurrence (aviation)	Any accident or incident associated with the operation of an aircraft; and/or any situation or condition that the Transportation Safety Board of Canada has reasonable grounds to believe could, if left unattended, induce an accident or incident
OFP	*See* operational flight plan
O/H	Overhaul
ojt	On-the-job training
ONF	C-FONF
ONG	C-FONG
operating certificate	A certificate issued by Transport Canada, certifying that the holder is adequately equipped and able to conduct a safe operation as an air carrier
operational flight plan	The operator's plan for the safe conduct of a flight, based on consideration of aircraft performance, other operating limitations, and relevant expected conditions on the route and at the aerodromes concerned
OPI	Office (or officer) of primary interest
OPP	Ontario Provincial Police
Ops	Operations

OSC	Onsite coordinator
out-of-trim	A situation in which the trimming devices on aircraft flight controls are not synchronized with the aircraft attitude
outside air temperature	Temperature of the air surrounding an aircraft at a distance far enough from the aircraft so as not to be affected by temperature rise due to aircraft speed
overshoot	To go beyond a designated mark or area. The term is often used to mean "missed approach."
participant	An individual representing an interested party, selected to take part in an accident investigation as a member of the investigating team
participant status	Status given to individuals or parties allowing full participation in an accident investigation
PATWAS	Pilot Automatic Telephone Weather Answering Service
PAX	Passenger
PCB	Program Control Board (subsequently, Resource Management Board)
pilot-in-command	A pilot who meets the requirements of the Air Navigation Orders and is designated as being in command of a flight
pilot-not-flying duties	Actions set out in the Aircraft Operating Manual or established through standard practice that are to be carried out by the pilot not flying the aircraft

pilot proficiency check	An annual check conducted on air carrier and other specified pilots to evaluate continuing competency on a specific aircraft type. This check is conducted to standards set out in Air Navigation Orders and may be conducted by an approved company check pilot or a Transport Canada inspector.
pilot's handbook	*See* Aircraft Operating Manual
PIP	Preliminary investigation procedures
PIREP	Pilot report of weather conditions in flight
pitch	The rotation of an aircraft around its horizontal axis. Pitch is controlled by elevators and often refers to the attitude of the aircraft in relation to the horizontal plane.
PNF	Pilot-not-flying
PPC	*See* pilot proficiency check
Program Control Board	An agency set up within Transport Canada to examine resource requests from within the department and to allocate resources to the highest-priority tasks
purser	A title often used to refer to the flight attendant who has been designated as being in charge of the cabin crew; sometimes referred to as the "in-charge"
pushback	The moving back of an aircraft from a gate by a ground vehicle
P/Y *or* **PY**	Person years
QRH	Quick reference handbook; same as checklist. It may have more or less information than a checklist, depending on the operating philosophy of the carrier.

Quality Assurance Review	A review of regional compliance with national policies, standards, and procedures in either operations or airworthiness
ramp	A defined area on an airport used by aircraft for loading and unloading passengers or cargo, for refuelling, for parking, or for maintenance
RASO	Transport Canada regional aviation safety officer
RCAF	Royal Canadian Air Force
RCC	Rescue Coordination Centre
RCMP	Royal Canadian Mounted Police
RCR	Runway condition report
RDAR	Transport Canada regional director, aviation regulation
Red 1, 2, and 3	Radio call signs of the three CFR vehicles at Dryden Airport
RLD	Rijksluchtvaartdienst (Netherlands equivalent to Transport Canada)
RMAS	Transport Canada regional manager, aviation safety programs
roll	The rotation of an aircraft around its longitudinal axis. Roll is controlled through use of ailerons or control-spoilers on the wings.
rotables	Aircraft parts that can be repaired or overhauled for re-use
rotation	During takeoff, the act of rotating the aircraft by a rearward movement of the control column in order to position the aircraft in the takeoff attitude

route bulletins	Information placed in bulletin books by Air Ontario flight operations management in order to keep pilots apprised of changes in policy or standard operating procedures
route manual	A manual provided by Air Ontario to its pilots that contains information on specific routes and aerodromes
rpm	Revolutions per minute
RSC	Runway surface condition
runup	Operation of an aircraft's engine prior to takeoff to confirm engine condition
runway designations	Runways are designated according to their orientation to the nearest 5° magnetic (or true). Where two parallel runways exist, they are further designated left and right.
runway threshold	The beginning of that portion of the runway which is usable for takeoff or landing
runway visual range	An instrumentally derived value, expressed in hundreds of feet, which represents the horizontal distance the pilot would be able to see down the runway at the point where the instrument is located
RVR	Runway visual range
SA	Station actual weather (weather report)
SAE	Society of Automotive Engineers
SAR	Search and rescue
self-dispatch	The planning and execution of a flight or series of flights, being the sole responsibility of the captain
SID	Standard instrument departure

side-slip	The controlled flight of an aircraft in a direction not in line with its longitudinal axis. It requires cross controlling by the pilot; that is, application of aileron in one direction and rudder in the opposite direction.
SIGMET	Significant meteorological report
simulator	*See* flight simulator
slats	Devices that can be extended from the leading edge of an airfoil in order to increase lift at low speeds
slipstream	The stream of air discharged aft of a revolving propeller
slot time	A time assigned to a pilot by air traffic control at which a departure clearance may be expected
SMOH	Since major overhaul
snag	A system or component malfunction or unserviceability entered in a journey log
SOC	System operations control
SOPs	Standard operating procedures
speed brake	*See* air brake
Spey engines	The common name for the Rolls-Royce engines installed on the F-28
spoilers	*See* lift-dumpers
stall	The sudden loss of lift of an airfoil when it exceeds its critical angle of attack (maximum lift coefficient)
stall fence	A fence on an airfoil, its primary purpose being to improve behaviour at stall

standard operating procedures (SOPs) — The procedures reflected in a flight operations manual, an aircraft operating manual, or even a route manual that could be, and sometimes are, referred to as standard operating procedures. *See* Aircraft Operating Manual.

stick-shaker — A device that will induce rapid control column movement to warn the pilot that the airfoil is approaching the stall

STOC — Station operations control

STOL — Short takeoff and landing

stopway — A prepared surface at the end of a runway, to be used as required when stopping an aircraft. It is not built to the specifications of the runway and is not used during takeoff.

SVFR — Special VFR

swept wing — An aircraft wing that slopes in plan form so that the wing tip is further aft than the wing root. The angle formed by the fuselage and the wing leading edge is the degree of sweep.

system operations control — A group designated by an air carrier to carry out operations planning and economical utilization of aircraft and personnel. Note that operations control is distinct from operational control.

TACAN — Tactical air navigation aid (UHF omni range)

tail plane — An airfoil, located aft of the main airfoils, contributing to longitudinal control and/or stability

takeoff	(1) Procedure in which aircraft becomes airborne; (2) moment or place at which aircraft leaves ground or water; (3) net flight path from brake-release to screen height. (Note: Screen height is the height above ground of the top of screen on takeoff, normally 35 feet, which is measured at the end of the takeoff distance.)
takeoff alternate	An airport, designated as the landing airport in case of an emergency, where a takeoff is conducted in weather conditions that do not allow a landing at the airport of departure
takeoff distance available	The length of the takeoff run available plus the length of clearway, if provided
takeoff run available	The length of runway declared available and suitable for the ground run of an aircraft taking off
TAS	True airspeed
taxi	To operate an aircraft under its own power on the ground, except for takeoff or landing
taxiway	A specially prepared or designated path on an aerodrome, for use by taxiing aircraft
TBO	Time between overhaul
TC	Transport Canada
TCA	Terminal control area
TCAG	Transport Canada Aviation Group
TCU	Terminal control unit
TDZ	Touchdown zone
team leader	An individual designated by the audit manager to conduct a specific part of the audit
TGT	Turbine gas temperature

threshold	*See* runway threshold
thrust	The propulsive force developed by a jet engine, usually expressed in pounds
thrust-reverser	A device used on the ground to deflect the airflow from a turbojet engine forward in order to assist in slowing the aircraft
TI	Technical inspector
TL	Technical log
TODA	Takeoff distance available
TORA	Takeoff run available
touch-and-go	Where an aircraft touches down on the runway and the pilot deliberately takes off again. It is usually carried out in order for pilots to practise approaches and landings.
touchdown	The point where the wheels first touch the runway during a landing
touchdown zone	The first 3000 feet of runway from the threshold in the direction of landing
TP	Indicates a Transport Canada publication
transmissometer	A device used for the determination of runway visual range
trim	The positioning of flight controls and/or trim tabs so the aircraft will maintain a desired attitude in steady flight
true airspeed	Speed of the aircraft through the air corrected for air density (altitude and temperature)
trunk-feed (feeder-trunk)	Refers to the relationship between a national or international air carrier and its regional affiliate

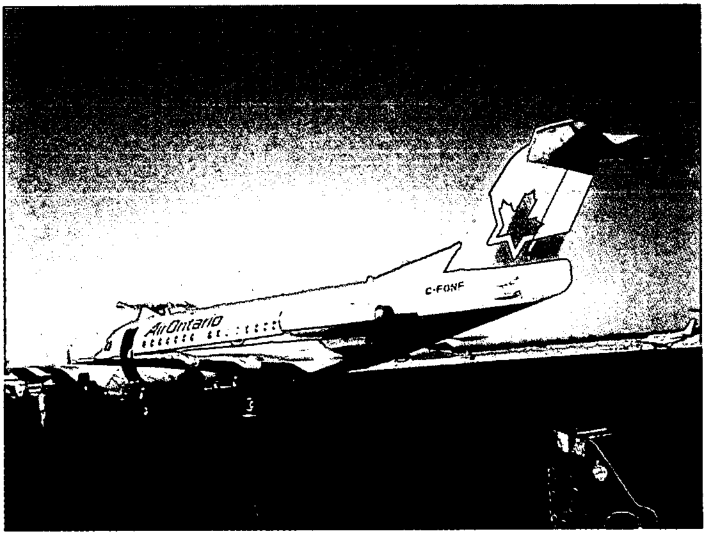
TSB	Transportation Safety Board of Canada, the Canadian government agency responsible for investigating and reporting on transportation occurrences
TSN	Time since new
TSO	Time since overhaul
turbofan (engine)	A turbojet engine in which thrust is produced both by jet propulsion and by a fan (propeller) contained within the engine cowlings
turbojet (engine)	An engine using jet propulsion to provide forward thrust
turboprop aircraft	An aircraft driven by propellers that are powered by a turbojet engine
turn-and-bank indicator	A gyroscopic instrument for indicating the rate of turning and the degree of coordination or yaw
TWB	Transcribed weather broadcast
TWR	Control tower
Type I fluid	A de-icing fluid composed of a mixture of glycol, water, and anti-corrosive and wetting agents that is heated and sprayed on aircraft. The fluid removes contaminants and offers limited protection against icing.
Type II fluid	A glycol-based anti-icing fluid containing corrosion inhibitors, wetting agents, and polymeric thickeners. This pseudo-plastic fluid, applied at ambient temperatures, provides protection against the accumulation of ice and snow on aircraft; it is not used as a de-icing fluid.

UNICOM	A radio facility operated by agencies, other than Transport Canada, at an uncontrolled aerodrome to provide information to aircraft operating in the area. No air traffic control is provided.
unserviceable	The state of a system or component where that system or component is not capable of carrying out the function for which it is designed
updraft	A localized area of rising air
u/s	Unserviceable
UT of O	Unorganized Territories of Ontario (fire-fighters)
UTC	Coordinated Universal Time
V_1	Takeoff decision speed: the aircraft speed during takeoff at which the pilot, having recognized the failure of the critical engine, decides whether to continue with the flight or stop the aircraft
V_2	Takeoff safety speed: the minimum speed at which an aircraft is allowed to climb after reaching a height of 35 feet on takeoff
V_R	Takeoff rotation speed: the speed during takeoff at which the pilot initiates rotation of the aircraft to cause the aircraft to become airborne
VASIS	Visual approach slope indicating system. VASIS consists of a series of lights used to provide vertical visual guidance to pilots on final approach to a runway.
vector	A magnetic heading maintained by an aircraft at the request of air traffic control
VFR	*See* visual flight rules

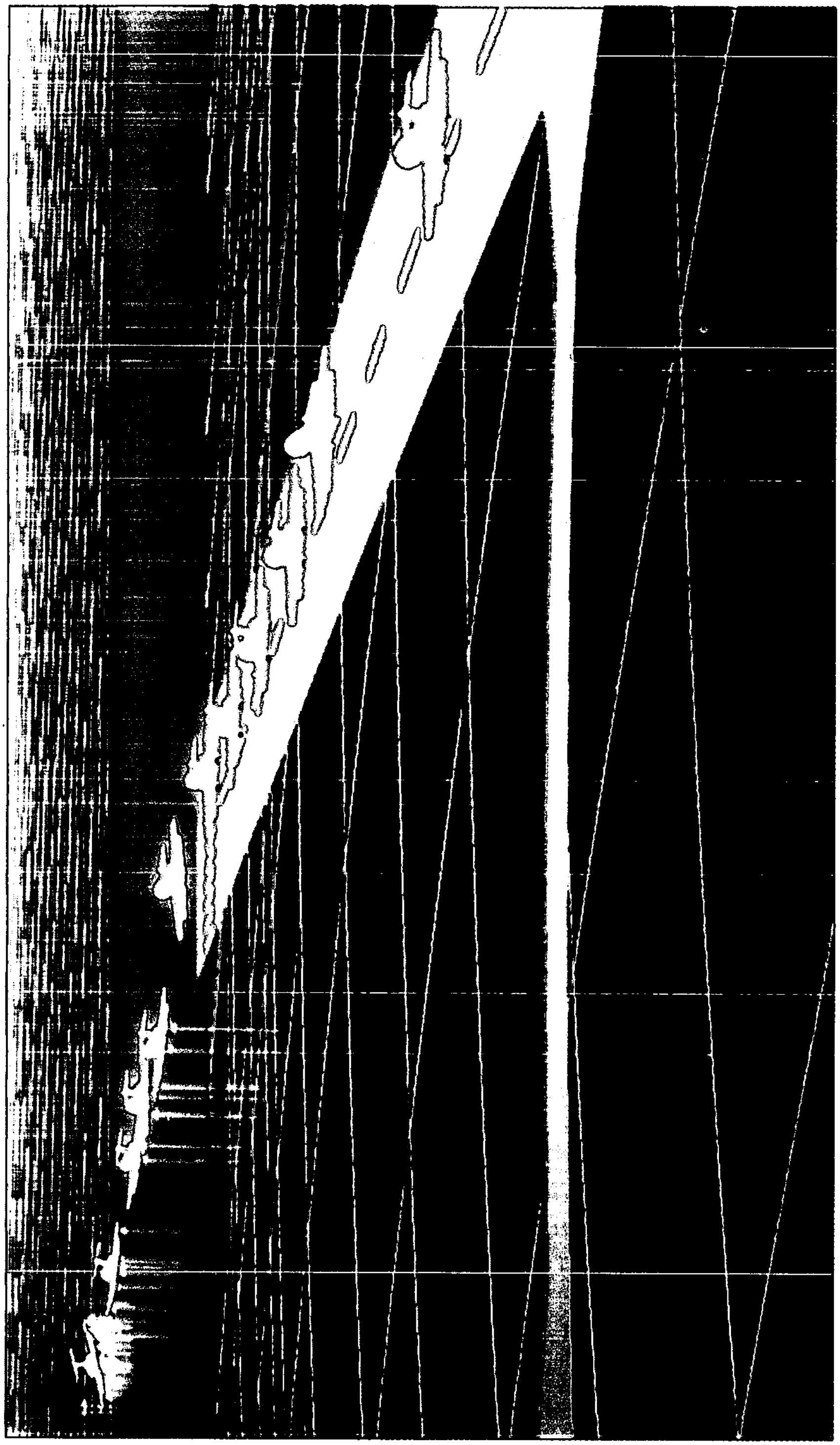
visual approach	A normal visual approach or an approach where an aircraft on an IFR flight plan, operating in VFR weather conditions and having ATC authorization, may proceed to an airport using visual references only
visual flight rules	Rules that provide for flight having continuous visual reference to the ground or water and requiring specified minimum weather conditions
visual meteorological conditions	Weather conditions expressed in terms of visibility and distance from cloud and ceiling equal to or greater than specified minima for VFR flight
VMC	Visual meteorological conditions
VNC	VFR navigation chart
VOLMET	In-flight meteorological information
VOR	Very high frequency (VHF) omni-directional range
walkaround	An external visual examination of an aircraft carried out prior to a flight
whiteout	Loss of orientation with respect to the horizon, caused by uniform light conditions from sky and snow
wind shear	A change in wind velocity along an axis at right angles to the general wind direction; usually specified as vertical or horizontal
wind sock	A cloth sleeve mounted aloft at an airport, for use in estimating wind direction and speed
WX	Weather
YAM	Sault Ste Marie airport

yaw	The rotation of an aircraft around its vertical axis. Yaw can be induced or corrected by use of the rudder on the vertical stabilizer.
YHD	Dryden airport
YQK	Kenora airport
YQT	Thunder Bay airport
YWG	Winnipeg airport
YXU	London airport
YYZ	Toronto/Lester B. Pearson International airport
Z	Zulu time (UTC)

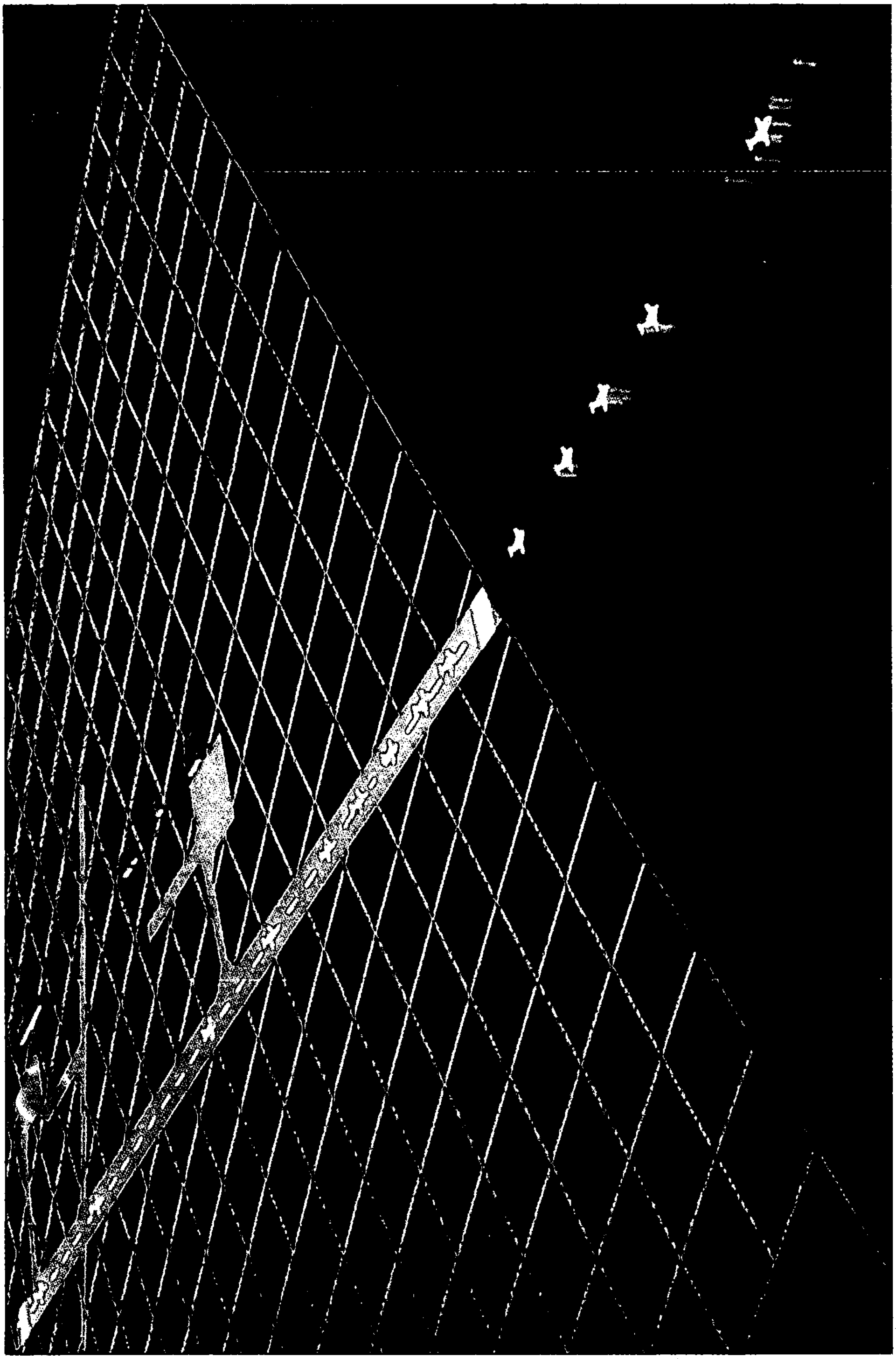
Air Ontario C-FONF on the ground in Thunder Bay on February 21, 1989; this photograph was taken by a passenger boarding flight 1363 for Dryden that day.



These views of Air Ontario's other F-28, C-FONG, show the exits available on this aircraft.



Computer-generated reconstructions of the takeoff were prepared for the Commission of Inquiry by the Canadian Aviation Safety Board (CASB) as part of the investigation of the crash. The first shows the aircraft from the perspective of the terminal: passing taxiway Alpha, attempting liftoff, settling back onto the runway, lifting off again towards the end of the runway, and contacting trees.



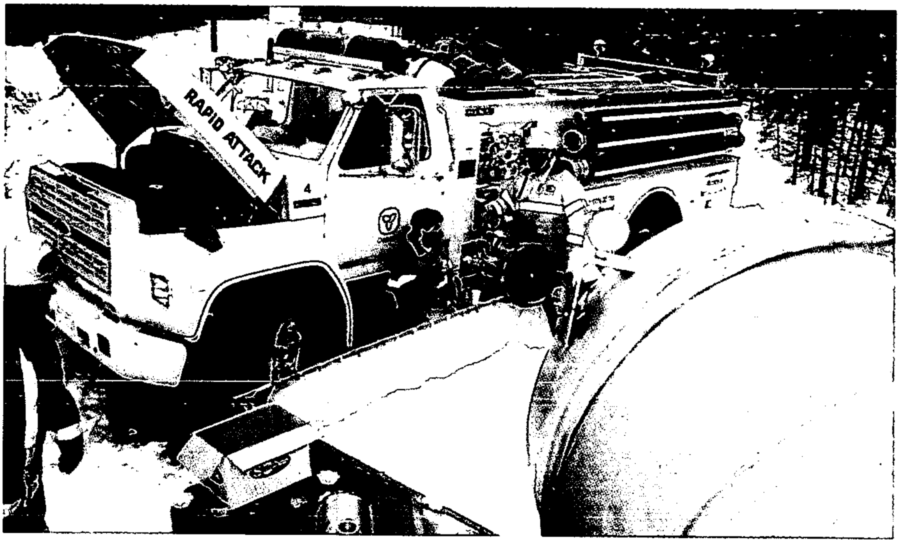
This reconstruction gives an aerial view of Dryden Municipal Airport and the takeoff attempt of flight 1363 on runway 29 on March 10, 1989.

An aerial view, showing the flight path of C-FONF on March 10, 1989.

An aerial view of the wreckage of C-FONF, showing the aircraft in three pieces. The Air Ontario designator is clearly visible on the tail section.

This infrared photograph shows the extent of the fire damage to trees along the flight path.

These photographs, taken by one of the fire-fighters in mid-afternoon March 10, 1989, convey the intensity of the fire which, by this time, is nearly extinguished.



By 2:00 p.m. the port-a-pond was set up on Middle Marker Road, filled from the tanker truck in the foreground, and foam was available to fight the fire.

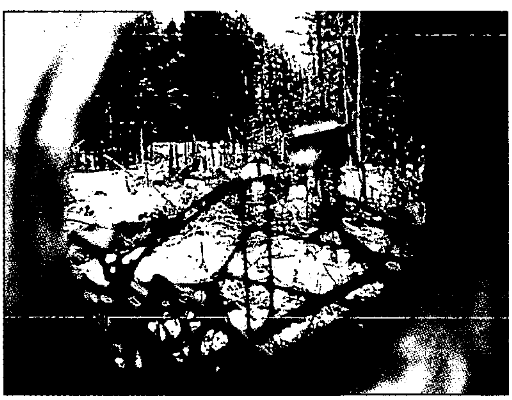
An emergency road was bulldozed in to give access to the crash site.

Investigators from the Canadian Aviation Safety Board (CASB) arrived at the site about noon on March 11, 1989.

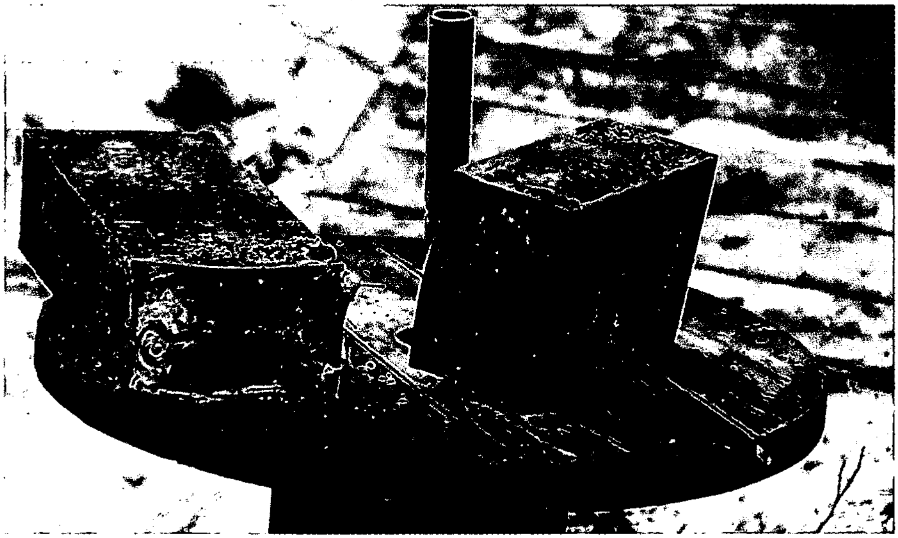
The path of flight 1363 is clear in this photograph taken by CASB investigators, looking west from runway 29 of Dryden airport.

The wreckage trail looking east from the site of the crash

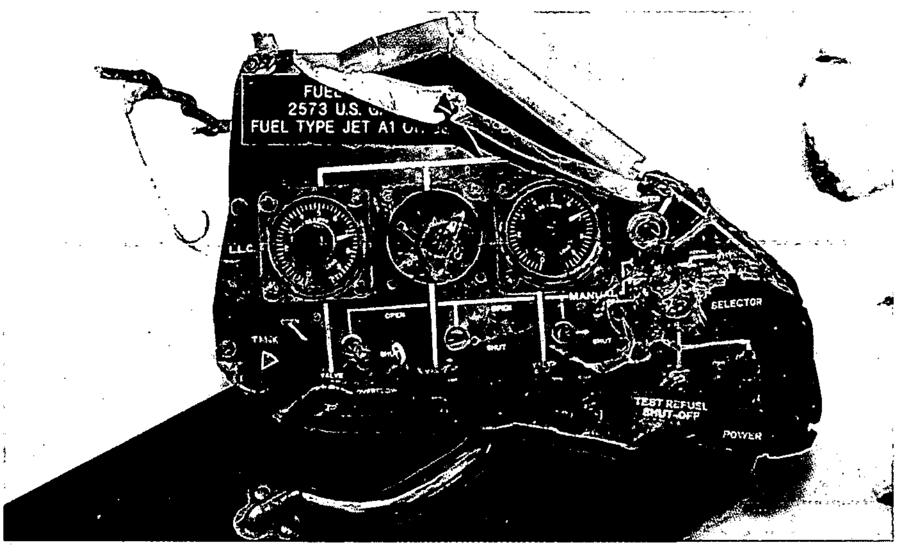
The wreckage trail looking west towards the wreckage from part way along the trail



The wreckage trail shot through the fuselage of the aircraft

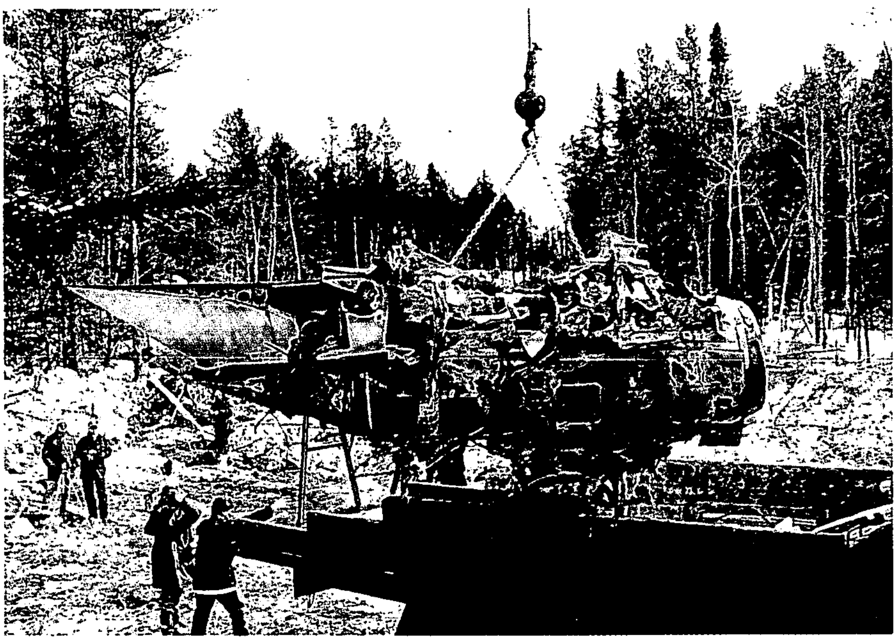


The cockpit voice recorder and flight data recorder were recovered, buried in debris, approximately 24 hours after the crash. On disassembly, it was discovered that the recording medium of both recorders had been destroyed by severe heat damage.

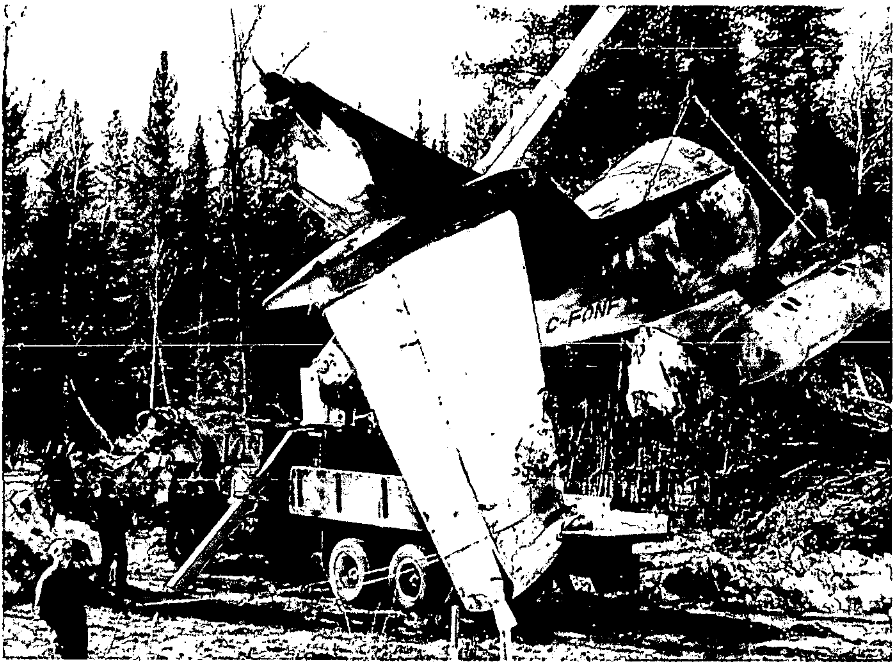


The refuelling panel, located in the wing, shows a fuel load of approximately 14,000 lbs.

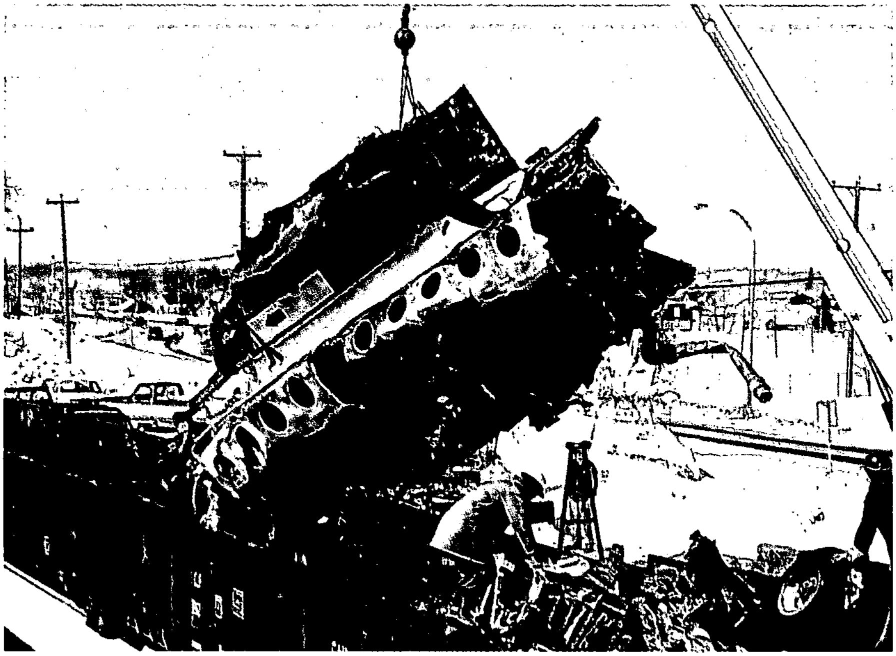
The wreckage was carefully photographed in situ at the crash site by the investigators: top, right engine; bottom, rear section of the right side of the fuselage.

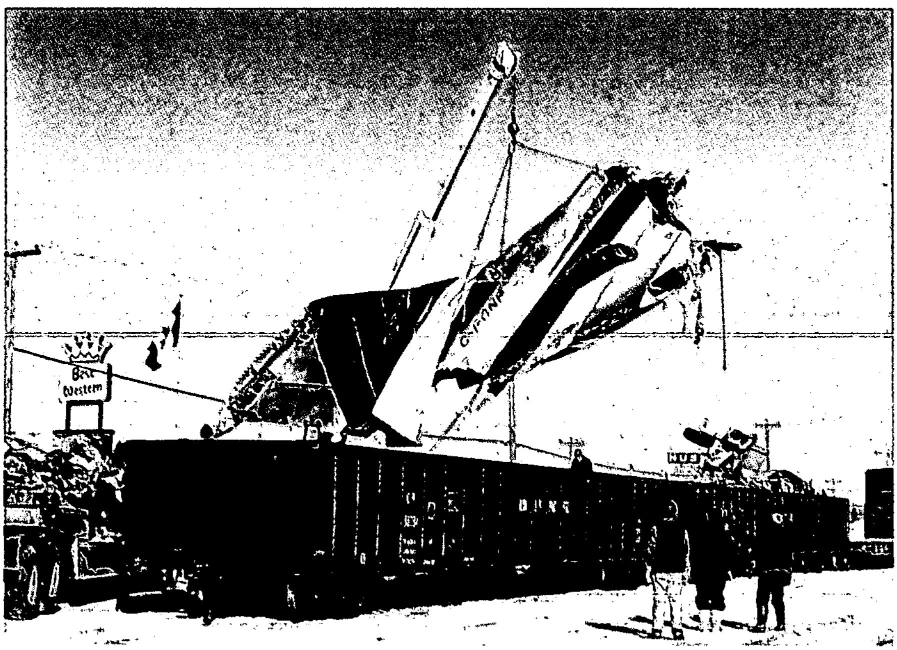


The aircraft was dismantled and transported to Ottawa for examination. These photographs show the left engine being removed and loaded onto a truck.

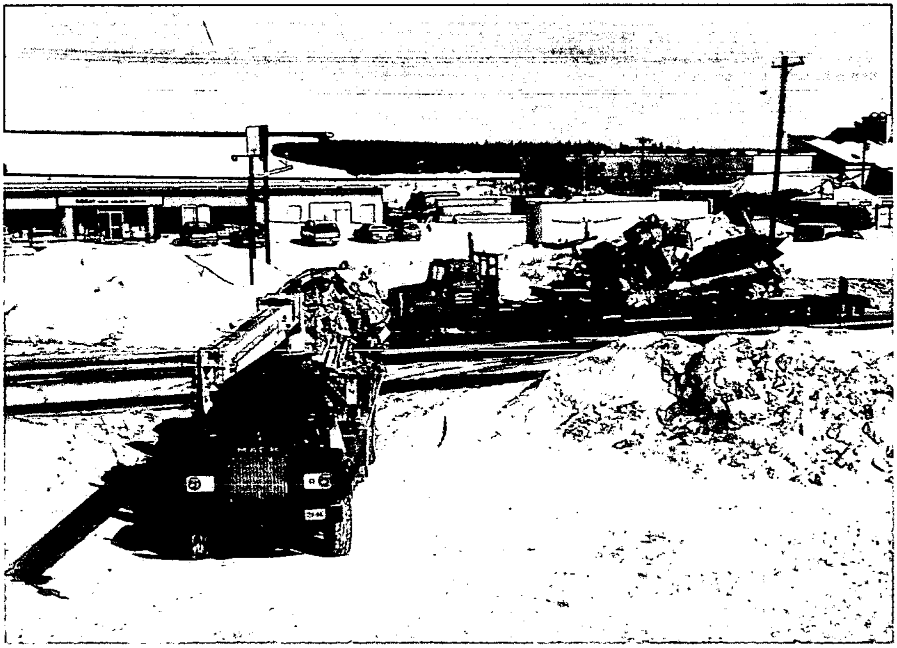


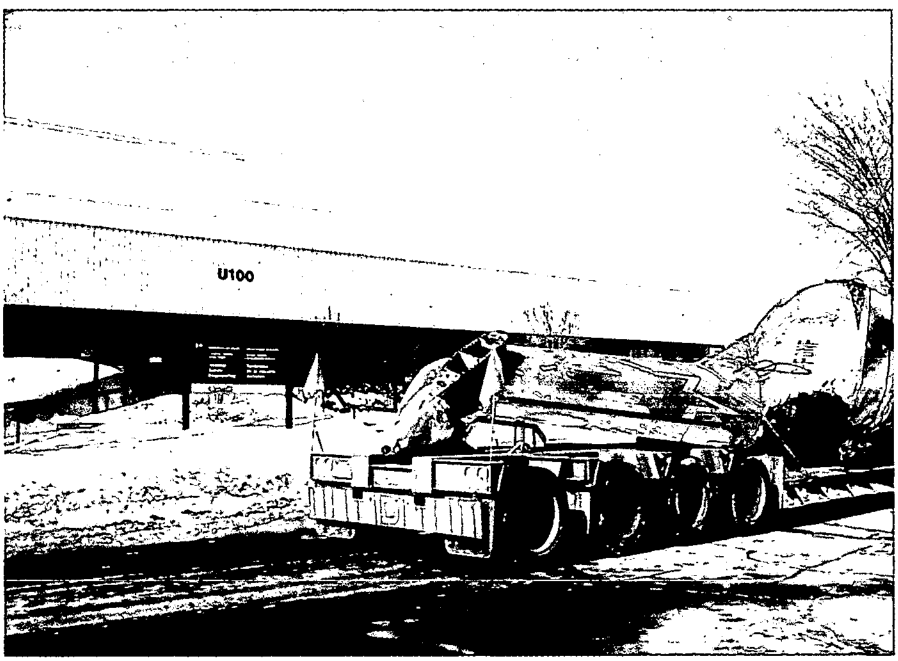
The tail section and part of the nose cone and fuselage centre section were moved from the crash site.





The aircraft sections were loaded onto gondola railway cars for transportation to Ottawa.





The aircraft wreckage was delivered to CASB's Engineering Branch in Ottawa for examination and analysis.

PART ONE

INTRODUCTION


RED LAKE
MANITOBA
ONTARIO
PICKLE LAKE
N
W
E
S
WINNIPEG
SIOUX LOOKOUT
KENORA
DRYDEN
VERMILION BAY
CANADA
FT. FRANCES
THUNDER BAY
RAINY RIVER
INT'L FALLS
LAKE SUPERIOR
SAULT
STE
MARIE
N. DAKOTA
MINNESOTA
DULUTH
MICHIGAN
U. S. A.
LAKE MICHIGAN
MINNEAPOLIS
WISCONSIN
MICHIGAN
MILWAUKEE
IOWA

1 INTRODUCTION

The Accident

On Friday, March 10, 1989, at approximately 12:11 p.m. Central Standard Time (CST),[1] Air Ontario flight 1363 crashed approximately 962 metres off the end of runway 29 after takeoff from the Dryden Municipal Airport. Air Ontario flight 1363 was a scheduled flight from Thunder Bay to Winnipeg via Dryden. The aircraft was a Fokker F-28 Mk1000 bearing Canadian registration C-FONF.

There were 65 passengers and a crew of four on board. The aircraft failed to gain altitude after its attempted takeoff from runway 29 and continued on a flat flight path, barely clearing a bluff approximately 700 metres from the end of the runway and crashing into a densely wooded area. In all, 21 passengers and three crew members, including the captain, the first officer, and one of the two flight attendants, died as a result of the crash and the accompanying fire.

There was extensive physical and fire damage to the aircraft, which resulted in the destruction of the flight data recorder (FDR) and the cockpit voice recorder (CVR) tapes. The loss of the FDR and the CVR data necessitated a detailed reconstruction of the crash sequence.

The Initial Investigation

An investigation into the crash of flight 1363 was immediately undertaken by the Canadian Aviation Safety Board (CASB) pursuant to the *Canadian Aviation Safety Board Act*, R.S.C. 1985, c.C-12 (the *CASB Act*). The investigator in charge (IIC), Mr Joseph Jackson of Ottawa, attended at Dryden on March 11, 1989, with a team of 21 CASB investigators. The CASB team carried on with its investigation as it would in any major accident investigation, interviewing witnesses and analysing the aircraft wreckage.

---

[1] Local time will be used throughout this Report unless otherwise indicated. It should be noted that Dryden and Winnipeg are located within the Central time zone while Thunder Bay is located within the Eastern time zone. Thunder Bay time is one hour ahead of time in Dryden and Winnipeg.

On March 29, 1989, the CASB investigation was suspended and this Commission of Inquiry was established to inquire into the contributing factors and causes of the crash. I, as Commissioner, was authorized to make such recommendations as I may deem appropriate in the interests of aviation safety.

Following the formal establishment of the Commission, I took immediate steps to reactivate the accident investigation. I contacted the then chairman of CASB, Mr Ken Thorneycroft, and requested that certain CASB aviation accident investigators, including the IIC, be seconded to this Commission to assist in the conduct of the inquiry. This was done and, with the complete cooperation of CASB, the investigation of the crash of flight 1363 was transferred to this Commission.

Interpretation of Terms of Reference

In my opening statement on June 16, 1989, I commented upon my interpretation of the terms of reference of this Inquiry:

> I interpret the terms of reference to provide a broad mandate to inquire not only into the Air Ontario crash but also into any derivative matters which affect aviation safety, with respect to which I am directed to make such recommendations as I may deem appropriate. The Commission may, from time to time, enlarge, consolidate, delete, and/or modify any of the said areas of inquiry as the evidence unfolds.
>
> (Transcript, vol. 2, p. 51)

My interpretation has remained consistent throughout the life of the Commission.

I have interpreted the terms of reference to provide a broad mandate to inquire not only into the Air Ontario crash but also into any derivative matters that affect aviation safety. Essentially, the Commission was to conduct a thorough investigation in order to allow an assessment of the contributing factors and causes of the crash of flight 1363. This included the necessity to identify persons or organizations that may have contributed to the accident.

Aviation Accident Investigation: The System Approach

Modern air transportation is a complex enterprise. Similarly complex are the causes of aircraft accidents. Previous aircraft accident investigations have demonstrated that an accident or serious incident is not normally the result of a single cause, but rather the cumulative result of oversights, shortcuts, and miscues which, considered in isolation, might have had minimal causal significance.

To assess all of the contributing factors and causes of this accident and to make recommendations in the interest of future accident prevention, this Commission adopted an analytical and a "system" approach to facilitate a methodical and thorough investigation of the accident. The system approach identifies the main components of the air transportation system and calls for an assessment of the performance of each of these components.

The components of the air transportation system are generally categorized as follows:

- the aircraft crew (including the pilots and the cabin crew)
- the aircraft
- the immediate operational infrastructure (including airport facilities, navigation aids, weather, and other communications facilities)
- the air carrier
- the regulator.

The aircraft crew, being immediately responsible for the safe carriage of the passengers, is the focal point of the entire air transportation system. The aircraft crew members must contend with the total operating environment of a given flight and any constraints placed upon them by their aircraft, their air carrier, the immediate operational infrastructure, and the regulator. The serviceability of the aircraft, the operational control of a particular flight, and the overall operational and flight safety ethic within which the crew functions are the products of air carrier management. The air carrier, in turn, operates in a highly regulated environment where the regulator is expected to establish and monitor standards for the aviation industry.

The evidence arising out of the Dryden crash has convinced me of one point above all: because of the potentially catastrophic consequences of a failure in the air transportation system, the aviation industry must operate within a regime of clearly defined and well-enforced standards. In Canada the standards of the air transportation system should be of the highest order that current technology permits.

A properly functioning air transportation system with appropriate standards operates as an ongoing check against the circumstances that can give rise to an accident. It became clear from the evidence that, when one or more of the components in the system breaks down, the probability of an accident or serious incident is increased. The accident at Dryden on March 10, 1989, was not the result of one cause but of a combination of several related factors. Had the system operated effectively, each of the factors might have been identified and corrected before it took on significance. It will be shown that this accident was the result of a failure in the air transportation system.

The ultimate goal of this Inquiry, like that of all accident investigations, is to prevent future accidents. To this end I am of the view that a review of certain aspects of the air transportation system is most important. Accordingly, my approach has been to examine the relevant facts surrounding the accident and to assess whether the existing system reacted, or was capable of reacting, as it should have. After more than two years of intensive investigation and public hearings, I believe that this accident did not just happen by chance – it was allowed to happen.

The Components of the Commercial Air Transportation System

Having accepted an analytical framework for the investigation of this accident, I am of the view that my mandate required me to examine the components of the air transportation system and to assess reasons for the various failures in the system that, together, caused the crash of the aircraft on March 10, 1989. Accidents are, of course, often the result of several complex factors.

The Aircraft Crew

The aircraft crew is a significant component in the air transportation system. Pilots and flight attendants are trained professionals, and the travelling public has a right to expect that crew members will carry out their duties in a professional, competent manner.

As the performance of the regulator and the air carrier will be scrutinized, so too will there be an assessment of the conduct of the four crew members on flight 1363.

Captain George Morwood

Captain George Morwood, age 52, was an experienced pilot with approximately 24,100 flying hours. He received his commercial pilot's licence in 1955 and worked in a variety of flying jobs until 1973, when he joined Great Lakes Airlines, a predecessor to Air Ontario. He was employed by Air Ontario until his death in the crash on March 10, 1989.

During his career, Captain Morwood gained qualification on a number of aircraft types, including the Convair 440, a 55-passenger piston-engine propeller aircraft; the Convair 580, a 55-passenger turboprop aircraft; and the Grumman Gulfstream II, an executive jet. He received his qualification on the F-28 in January 1989 and, by the date of the accident, had acquired 81.63 hours on that aircraft type. The F-28 was the largest jet aircraft he had flown, and the only jet aircraft he had flown in scheduled commercial service. Captain Morwood was described by his peers as a conscientious and competent pilot, who, to use the vernacular, "flew by the book."

Because Captain Morwood had fewer than 100 hours as pilot-in-command on the F-28 aircraft by March 10, 1989, he was under certain operational restrictions with regard to takeoff and landing weather limits. The determination of these limits is discussed in chapter 38 of this Report, Crew Information.

First Officer Keith Mills

First Officer Keith Mills, age 35, became a commercial pilot in 1975. In 1979 he joined Austin Airways Limited, another predecessor of Air Ontario Inc.

While at Austin Airways, he gained qualification on the Cessna 402, a seven-passenger piston aircraft; the de Havilland Twin Otter, a 19-passenger turboprop aircraft; the Hawker Siddeley HS-748, a 43-passenger turboprop aircraft; and the Cessna Citation, an executive jet.

First Officer Mills received his qualification on the F-28 in February 1989 and, by the date of the accident, he had acquired 65.7 flying hours on that aircraft type. He was described by his colleagues as an assertive pilot, and he had a satisfactory record with Transport Canada.

In spite of their considerable flying experience, neither Captain Morwood nor First Officer Mills had much experience on the F-28. "Low-time on type" crew pairings have been the subject of investigation and have been identified as causal factors in other aviation accidents, as will be discussed in chapter 40 of this Report, Human Performance.

Flight Attendant Katherine Say

Katherine Say, age 31, was a flight attendant with 10 years' experience and had been employed by Austin Airways and Air Ontario Inc. throughout that time. She was promoted to in-flight coordinator in February 1989. Mrs Say was considered by her colleagues to be an excellent crew member with a professional approach to her duties.

Flight Attendant Sonia Hartwick

Sonia Hartwick, the sole surviving crew member, was 26 years old on the day of the accident. She had two-and-a-half years' experience as a flight attendant, all with Austin Airways and Air Ontario. Along with Mrs Say, she had received the F-28 flight attendant training course offered at Air Ontario, and was considered competent and professional in her work.

The Aircraft

The F-28 Mk1000 aircraft, C-FONF, was manufactured by Fokker Aircraft B.V. of the Netherlands. Its design and construction met the American certification criteria stated in Civil Air Regulation 4(b). It began flying in 1967 and was authorized for Canadian operation in 1972, when it received aircraft type approval from the Department of Transport.

The F-28 Mk1000 aircraft was last manufactured in 1976. It was designed for the short- to medium-range jet transport market and a brisk resale market exists for the model. A typical configuration of this aircraft will accommodate 65 passengers, requiring a crew of two pilots and two flight attendants.

The manufacture of aircraft C-FONF was completed on November 2, 1972, and from 1973 to 1987 it was part of the fleet of Turk Hava Yollari (THY), the Turkish national airline. It was powered by two Rolls-Royce Spey Model 555-15 engines manufactured in Great Britain. In 1987, after having been "mothballed" by THY in Turkey for two years, the aircraft was sold to Transport Aérien Transrégional of France and subsequently leased to Air Ontario in November 1987. It received a Canadian certificate of airworthiness on May 30, 1988, and its Canadian registration as C-FONF on June 13, 1988. Air Ontario was given a temporary amendment to its operating certificate on May 31, 1988, authorizing F-28 operations. Its operating certificate was formally amended to include the F-28 on June 10, 1988.

At the time of the accident Air Ontario was operating two F-28 Mk1000 aircraft: C-FONF and C-FONG.

The Carrier: Air Ontario Inc.

Air Ontario Inc. (Air Ontario) is the product of a functional merger[2] between Austin Airways Limited (Austin Airways) and Air Ontario Limited that occurred in June 1987. Before the merger, Austin Airways was the largest regional air carrier in Northern Ontario, with its main base of operations in Timmins. Between 1974 and the 1987 merger, this

[2] Though the terms "merger" or "functional merger" were used in testimony to describe the June 1987 union of Austin Airways Limited and Air Ontario Limited, there was never a formal amalgamation of the two companies. What actually occurred was an acquisition of the assets of Air Ontario Limited by Austin Airways. Austin Airways then changed its name to Air Ontario Inc., while Air Ontario Limited, having been stripped of its assets, was wound up. The terms "merger" and "functional merger" will be used in this Report as they were used by the witnesses who appeared before me.

largely charter and cargo operation prospered under the ownership and management of the Deluce family of Timmins, Ontario. At the time of the merger, Austin Airways had a fleet of 30 aircraft of seven different types. These aircraft ranged in size from the seven-passenger Cessna 402 to the 43-passenger Hawker Siddeley HS-748.

Air Ontario Limited, based in London, Ontario, provided scheduled service primarily in southern Ontario. At the time of the merger, Air Ontario Limited operated the 55-passenger Convair 580 aircraft exclusively.

In January 1987 Air Canada purchased a 75 per cent voting interest in both Air Ontario Limited and Austin Airways, with the Deluce family retaining a 25 per cent voting interest in the companies. In June 1987, after operating separately for five months, Air Ontario Limited and Austin Airways were functionally merged under the name Air Ontario Inc. After the merger, Air Canada and the Deluce family retained the same 75:25 ownership interests in the new Air Ontario Inc.

Air Ontario Inc. functioned as a regional "feeder" airline to Air Canada's national transportation network. Because of a common marketing, ticketing, and scheduling arrangement, Air Ontario passengers were able to benefit from the coordinated connection of their Air Ontario regional flight to a national or international Air Canada flight.

Air Ontario was one of several regional airlines across Canada that fed into Air Canada "hubs" at major airports. Air Ontario was the primary regional feeder for Air Canada at Lester B. Pearson International Airport. To a lesser extent, Air Ontario provided a regional feed into Winnipeg International Airport.

By the date of the accident, Air Ontario Inc. was a different airline from the one that existed at the time of the merger in June 1987. It had divested itself of most of its old Austin Airways northern routes and had become primarily a scheduled carrier based in London, Ontario, operating Convair 580, Dash-8, and F-28 aircraft.

The Regulator: Transport Canada

Transport Canada is the body charged with the responsibility for the promulgation and enforcement of aviation regulations and standards in Canada. Furthermore, Canada is a signatory to a number of international conventions that define additional standards under which passengers are carried by air.

The reason for this degree of regulatory involvement is straightforward. A safe and reliable air transportation industry is important to the economic well-being of Canada. Equally obvious is the proposition that the regulator owes a duty to the travelling public to keep the industry as safe as practicable. The regulatory duty arises from the fact, which is often overlooked, that the public has given the regulator its trust.

The *Aeronautics Act*, R.S. 1985, c.A-2, and the Air Regulations, C.R.C. 1978, c.2 (Air Regulations), together with the Air Navigation Orders (ANOs), are the legislative instruments governing Canadian aviation. Operating standards for air carriers, like Air Ontario, using large aircraft[3] are set out in Air Navigation Order Series VII, No. 2, C.R.C. c.21 (ANO Series VII, No. 2).

Pursuant to section 4.2 of the *Aeronautics Act*, the minister of transport "is responsible for the development and regulation of aeronautics and the supervision of all matters connected with aeronautics" in Canada. Transport Canada is the federal department that gives effect to the minister's statutory mandate.

There are two groups within Transport Canada responsible for aviation: the Airports Authority Group and the Aviation Group. The Airports Authority Group is responsible for the development, maintenance, and operation of essential airport services throughout Canada. The Aviation Group is divided into two significant branches:

- the Air Navigation Systems Branch, which is responsible for, among other things, air traffic control and navigation and communication systems; and
- the Aviation Regulation Branch, which is responsible for the development and promulgation of regulations and standards; the certification and monitoring of aviation personnel, airlines, aircraft, and aeronautical products; and the enforcement of the *Aeronautics Act*, Air Regulations, and ANOs.

The Aviation Group is divided administratively into a national headquarters and six regions: Atlantic, Quebec, Ontario, Central, Western, and Pacific regions. Each is responsible for the regulation of aviation in Canada. The ongoing regulation of Air Ontario Inc., as a commercial air carrier based in London, Ontario, was the responsibility of the Ontario regional office.

Carriers' Obligation and Regulator's Duty

As will become clear throughout the Report, the regulator – Transport Canada – has imposed significant responsibilities in the area of flight safety on individual Canadian air carriers.

---

3 "Large aircraft" means an aircraft of more than 12,500 pounds maximum certificated takeoff weight (ANO Series VII, No. 2, s.2).

The provision of an acceptable level of flight safety is an obligation owed by both the air carrier and the regulator to the Canadian travelling public. The regulator, as an arm of government, has a duty to the public to fulfil its role in the promulgation and enforcement of legislative standards within the air transportation system. A licensed air carrier has an obligation to comply with the standards set out in the applicable legislation. As discussed in later chapters of this Report, the legislation governing Canadian commercial air carriage is not universally comprehensive or exhaustive. While in some areas the legislative requirements are detailed and well developed, in other areas the legislation is broadly worded and indefinite.

For example, air carriers are directed by the ANOs to conduct their operations "in a proper manner," leaving it up to an individual carrier and regulator to come to an agreement as to what is "proper" under the circumstances. If there is scope for interpretation, it must be emphasized that air carriers cannot simply rely on legislation to define the limits of their flight safety obligations. As is the case with any business enterprise, air carriers must conduct their affairs in a reasonable and prudent manner.

The fulfilment of flight safety obligations is part of the operating costs for air carriers. Again, as is the case with any commercial enterprise, success will be the result of the prudent balancing of commercial considerations with legislated and civil obligations.

The duty owed by a carrier to its passengers is not mitigated by inadequate or absent legislation, but rather it is independent of the regulator's obligations within the safety system. Throughout this Report, certain deficiencies within Transport Canada will receive comment. Air Ontario's corporate role in this accident is assessed against what I view to be its independent obligation to its passengers. Air Ontario, independent of regulatory requirements, is obliged to its passengers to provide the highest standard of flight safety reasonably available.

Within a regulated industry, legislation that is perceived as commercially threatening will be resisted by that industry. The Canadian air transportation industry is no different. The regulatory process in Canada, in fact, allows for discourse between the regulator and industry when such issues arise. This process ensures that the regulator will consider the economic viability of proposed legislation as well as its implications on flight safety.

When the regulator is faced with the choice between the commercial viability of an individual operator and the highest level of safety reasonably available to the travelling public, I am of the view that, for the reasons previously stated and later elaborated upon, the duty to the public must take priority.

It is against the propositions of the corporate obligation and the legislator's public duty that I have weighed the actions of Air Ontario and Transport Canada in determining their effectiveness as components of the air transportation system.

PART TWO

FACTS SURROUNDING THE CRASH OF FLIGHT 1363

2 AIR ONTARIO FLIGHTS 1362 AND 1363

Winnipeg

The four Air Ontario crew members, Captain George Morwood, First Officer Keith Mills, and flight attendants Katherine Say and Sonia Hartwick, arrived at the Air Canada counter of Winnipeg International Airport at 6:40 a.m. on March 10, 1989, to prepare for the day's flying.[1] Their scheduled flights consisted of a Winnipeg to Thunder Bay return trip, with intermediate stops at Dryden (flights 1362 and 1363), followed by another Winnipeg to Thunder Bay return trip without the Dryden station stop (flights 1364 and 1365). In all, there were six legs to their scheduled flying on March 10. Their first departure from Winnipeg was scheduled for 7:25 a.m., with the final landing at Winnipeg scheduled for 3:30 p.m. As was normal before the first flight of any day, the crew checked on the weather and the condition of the aircraft, and received the company flight authorization (flight release).

The Weather, Fuel and Passenger Loads, Aircraft Weight

The area weather forecasts for the day's operations showed generally unsettled and deteriorating weather, including lowering cloud ceilings and freezing precipitation as the day progressed. Terminal weather forecasts for Thunder Bay and Winnipeg were available to the crew before their departure. These forecasts indicated conditions that could potentially deteriorate to below the captain's landing limits at their scheduled arrival times. There was no terminal weather forecast for Dryden available at this time.

Because of these forecasts of unsettled weather, the crew had to accommodate deviations from normal flight planning. Air Regulations

[1] Air Ontario utilized Air Canada station facilities at Winnipeg and Thunder Bay. These Air Canada Station Operations Control (STOC) centres often provided communication links between Air Ontario pilots and their own System Operations Control (SOC) facilities in London. Air Ontario aircraft had no direct radio communications link with Air Ontario SOC. Air Ontario pilots could communicate with their SOC by a radio call to an Air Canada STOC, which would in turn relay messages via telephone to Air Ontario SOC.

require that an aircraft carry fuel sufficient to fly to an alternate airport (alternate) in case the crew is unable to land the aircraft at its planned destination. The crew of C-FONF had to plan for Sault Ste Marie as an alternate, and because it was a more distant alternate than usual, they had to carry a greater fuel load. Fuel and passenger loads are two significant variables in the calculation of total aircraft weight. The F-28, like all commercial aircraft, is limited by maximum takeoff and landing weights.

As it happened, March 10, 1989, was the Friday before the Ontario spring school break. A heavy passenger load from Thunder Bay to Winnipeg, which included many families commencing their vacations, combined with the extra fuel required to accommodate the longer alternate, necessitated a refuelling on the second Dryden station stop. Normally, fuel would not be taken on in Dryden.

The Flight Release

Each Air Ontario revenue flight must, in accordance with Air Regulations and the company's Flight Operations Manual, be specifically authorized before departure. Normally this is done through the issuance of a flight release by Air Ontario System Operations Control (SOC) in London. The flight release is then sent by telex to the point of departure, where it is picked up by the captain of the planned flight, and to all online stations.

The flight release contains significant operational information that governs the conduct of all flights. It is typically planned and prepared by the SOC in London before the intended flights. The flight release specifies the planned alternates, aircraft weights, fuel consumption, passenger loads, and other operational information necessary for the crew to conduct its flights in a safe and orderly manner. The flight release is a document used by Air Ontario to fulfil its fundamental obligation to exercise operational control over its aircraft (see chapter 23, Operational Control).

The flight release made available to Captain Morwood on the morning of March 10, 1989, at Air Canada Station Operations Control (STOC) in Winnipeg contained numerous errors. It was prepared and issued by an Air Ontario SOC dispatcher who was untrained and unfamiliar with the operational characteristics of the F-28 aircraft. The errors in the flight release should have been manifest to a pilot of Captain Morwood's experience and reputation and to First Officer Mills. Somewhat uncharacteristically, Captain Morwood did not contact Air Ontario SOC on the morning of March 10 to rectify the errors and have a new flight release issued.

The Unserviceable Auxiliary Power Unit

When Captain Morwood reviewed the operational state of his aircraft, he would have discovered that the auxiliary power unit (APU) was unserviceable. The APU normally provides compressed air and electrical power to various aircraft systems while the aircraft is on the ground. A flow of compressed air is required to start the F-28 main engines, and this flow is usually supplied by the APU. After one main engine is started with the APU, that engine can generate its own compressed air to start the other engine via a cross-bleed start. An independent source of compressed air such as an air compressor or an "air bottle"can be used to start the aircraft's main engines whether or not an APU is functioning.

The APU on C-FONF had not been functioning normally for the five days preceding the accident. On occasion, it was not producing enough air pressure, a deficiency that caused high engine temperatures during startup. On several occasions while in flight, an oily mist or smoke was observed in the passenger cabin and was detected by the cabin smoke alarm. Although never confirmed, this smoke was believed by maintenance personnel to have been caused by problems with the APU or the air conditioning air cycle machine.

Throughout the week preceding March 10, Air Ontario maintenance attempted, with limited success, to cure the APU problems. On the morning of March 9, the aircraft was in Toronto and was expected to be operational for a full day's flying. However, that morning Air Ontario maintenance was again trying to rectify the persistent APU problems. After several attempts, maintenance was unable to repair completely the APU, and the aircraft missed its originally scheduled morning flights. In the late afternoon, the pilot-in-command, the maintenance inspector on duty, Air Ontario SOC, and Air Ontario Maintenance Control collectively decided to dispatch the aircraft to Winnipeg and to defer the repair of the APU until the aircraft returned to Toronto on the night of March 10.

This maintenance deferral was carried out pursuant to the company's minimum equipment list (MEL), a document approved by Transport Canada that allows operators to dispatch aircraft with certain items unserviceable (see chapter 16, F-28 Program: APU, MEL, and Dilemma Facing the Crew). Because of the maintenance deferral, the APU would not be used until the problems were rectified.

On March 9, the aircraft was flown from Toronto to Winnipeg via Sault Ste Marie, Thunder Bay, and Dryden. It was parked in Winnipeg overnight, where it received a routine daily inspection by Air Ontario maintenance personnel.

A problem facing Captain Morwood on the morning of March 10 in Winnipeg was that Dryden did not have the ground-start equipment needed to start the F-28's engines when the APU was unserviceable. As a result, Air Ontario SOC in London notified Captain Morwood in the flight release that he would have to leave one engine running during his Dryden station stops. If for any reason both engines had been shut down in Dryden, they could not have been restarted unless the APU had been started in accordance with the procedures set out in the MEL; a mechanic had been able to repair the APU; or an independent source of compressed air (such as an air bottle) had been transported to Dryden and used for engine startup.

The inability to restart the engines once they were shut down resulted in two significant operational considerations. First, since it was necessary to take on fuel in Dryden, the refuelling had to be carried out with one engine running. This procedure is described as "hot refuelling." Second, the aircraft could not be de-iced at Dryden because a proscription had been published in both a Fokker aircraft winter operations bulletin and an Air Ontario operational directive against de-icing the F-28 aircraft with one or both engine(s) running. It should be noted that Captain Morwood did not request nor was he given any dispensation from this proscription.

Departure from Winnipeg

After his weather briefing on the morning of March 10, 1989, and his receipt of the flight release and other pertinent operational information, Captain Morwood prepared for departure on flight 1362 to Thunder Bay via Dryden.

The flight attendants had noted several deficiencies in the cabin equipment throughout the week preceding the accident. On March 10 the persisting deficiencies or "snags" on C-FONF included missing oxygen equipment, a passenger door that was difficult to close properly, and emergency exit lighting that was not serviceable. The flight crew was aware of these deficiencies in the cabin equipment, and flight attendant Hartwick testified that Captain Morwood expressed frustration that the snags had not been repaired.

In addition to the usual pre-flight checks, Captain Morwood requested that Air Canada ground personnel de-ice C-FONF. The aircraft had been sitting outside overnight and there may have been some frost on the wings.

Air Ontario flight 1362 departed Winnipeg for Dryden at 7:49 a.m. with 11 passengers on board. Although the weather at Dryden was acceptable for the flight, the weather at Thunder Bay was below the captain's landing limits and did not improve during the flight from Winnipeg to Dryden.

Air Ontario SOC requested the Dryden passenger agent[2] to ask Captain Morwood to call SOC when Air Ontario 1362 arrived. The aircraft landed in Dryden at 8:19 a.m., approximately 13 minutes late. The delay was partially attributable to the de-icing in Winnipeg.

First Dryden Station Stop

After landing at Dryden, Captain Morwood left the aircraft to telephone Air Ontario SOC. First Officer Mills remained in the aircraft and, because of the unserviceable APU, the right main engine was left running. The aircraft was not refuelled during this station stop.

At about 8:30 a.m. CST the London SOC duty manager, Mr Martin Kothbauer, advised Captain Morwood by telephone that he was going to hold the aircraft in Dryden pending an improvement in the Thunder Bay weather. The captain reminded Mr Kothbauer that the aircraft engine was running and that they were consuming fuel while they waited. Mr Kothbauer instructed Captain Morwood to call back at 8:45 a.m. CST for further consultation.

At 8:00 a.m. CST Thunder Bay was reported to have an overcast cloud ceiling of 100 feet with a visibility of three-eighths of a mile in fog. When Captain Morwood telephoned Air Ontario SOC a second time, the weather at Thunder Bay was still below his landing limits. Nevertheless, based on an observed trend towards improved weather conditions, alternate fuel requirements, and the aircraft fuel consumption with one engine running, SOC agreed to have Air Ontario flight 1362 depart Dryden for Thunder Bay. It was hoped that the Thunder Bay weather would improve while the aircraft was en route. SOC notified Sault Ste Marie of a possible diversion of the flight, should the weather not improve.

Air Ontario flight 1362 with its 30 passengers departed the ramp at Dryden at 8:50 a.m. CST, 20 minutes late. While en route, the Thunder Bay weather improved, and Air Ontario flight 1362 landed uneventfully in Thunder Bay at 10:32 a.m. EST, approximately 20 minutes late. This concluded the Air Ontario 1362 flight segment. The flight number then changed to Air Ontario flight 1363 for the return trip to Winnipeg via Dryden.

[2] Air Ontario aircraft and passenger handling in Dryden was carried out by their contract agent, the Dryden Flight Centre.

Thunder Bay Station Stop

The flight release issued by Air Ontario SOC indicated passenger loads of 55 from Thunder Bay to Dryden and 52 from Dryden to Winnipeg. The planned alternate was again Sault Ste Marie via Thunder Bay and, in accordance with the flight release, the aircraft was to be refuelled to 15,800 pounds of fuel on board (FOB) prior to departure from Thunder Bay. Altogether, 3310 litres, or about 6190 pounds, of fuel were added. At approximately 11:00 a.m., after the aircraft was refuelled, Air Canada STOC in Thunder Bay advised Air Ontario SOC in London that Air Ontario flight 1363 was overweight. The overweight resulted from Air Canada's STOC having booked 10 passengers from a Canadian Partner flight that had been cancelled earlier in the day onto flight 1363, in addition to the 55 already booked. It appears that Air Canada STOC in Thunder Bay did not inform Air Ontario SOC in London about the change in passenger load in time to allow SOC to inform the flight crew and amend the flight release for flight 1363 with regard to the passenger load and the maximum fuel load.

When faced with this overweight situation, Captain Morwood informed Air Canada STOC in Thunder Bay that he would off-load the additional 10 passengers and their baggage. However, when Air Canada STOC advised the Air Ontario SOC duty manager in London of Captain Morwood's intentions, the SOC duty manager elected to keep the extra passengers on the flight and to make the appropriate weight reduction by off-loading fuel. This defuelling procedure imposed an additional 35-minute delay on the departure of flight 1363 from Thunder Bay. The flight crew was informed of and agreed to the defuelling, and 1510 litres of fuel, or about 2823 pounds, were downloaded from the aircraft, leaving approximately 13,000 pounds FOB.

A number of the passengers on flight 1363 were to make connections out of Winnipeg. During the period from the boarding in Thunder Bay through the station stop in Dryden, many passengers were making inquiries of the flight attendants regarding their connecting flights in Winnipeg. The flight attendants made the flight crew aware of these passenger concerns. Mr Peter Shewchuk, the Air Canada radio operator in Thunder Bay through whom the flight crew was relaying its messages, testified that the flight crew expressed concern regarding the passenger connections. Flight attendant Hartwick also stated that, because of the apparent misunderstanding over passenger and fuel loads and the resulting delay during the Thunder Bay station stop, both Captain Morwood and First Officer Mills expressed anger and frustration. Mr Warren Brown, an off-duty Air Ontario dispatcher, sat in the observer's jump seat in C-FONF and spoke with Captain Morwood and First Officer Mills during the Dryden-to-Thunder Bay leg. Although Mr

Brown described the crew as having been in good spirits prior to landing in Thunder Bay and looking forward to their days off after the flying segment, it is clear from the evidence that their mood changed while they were on the ground at Thunder Bay.

Although Dryden was not a normal refuelling stop, the flight release for flight 1362/1363 anticipated a refuelling in Dryden to 15,000 pounds FOB[3], again with one engine running. This was the so-called hot refuelling procedure.

During the Thunder Bay station stop an amended terminal weather forecast for Dryden, calling for freezing precipitation, was issued. The previous Dryden terminal weather forecast did not. It is normal and prudent procedure that, prior to departure, flight crews operating in instrument meteorological conditions (IMC)[4] check the weather of their destination; and it is mandatory that they check the weather of their alternate. The crew of flight 1363 had access to the Dryden weather forecast via the Air Canada Reservac computer terminal in the Thunder Bay crew room, and they were seen in the crew room during their station stop. It is not known, however, whether in fact they checked the amended forecast.

At 11:55 a.m. EST Air Ontario flight 1363, with 65 passengers and one infant on board, departed Thunder Bay, approximately one hour late. As they approached Dryden, the crew were informed that the runways were bare and dry and that light snow grains had been reported in the previous hour to the west of Dryden. The aircraft landed in Dryden on runway 29 at 11:39 a.m. CST. The flight was approximately one hour behind schedule.

The weather conditions at Dryden on the arrival of flight 1363 were suitable for visual flight rules (VFR) flight. It began to snow lightly when the aircraft landed.

---

3 This refuelling in Dryden was planned. The defuelling which occurred in Thunder Bay had no effect on this aspect of the flight planning.

4 Instrument meterological conditions (IMC) are cloud and visibility conditions that are lower than required to maintain visual flight. Instrument flight rules (IFR) are rules for the conduct of a flight in weather conditions below those required for visual flight. Visual flight rules (VFR) are rules that provide for flight having continuous visual reference to the ground or water and requiring specified minimum flight visibility. Both IFR and VFR are set out in the Air Regulations.

3 DRYDEN MUNICIPAL AIRPORT AND AIR ONTARIO FACILITIES MARCH 10, 1989

Dryden Municipal Airport

The Dryden Municipal Airport is owned by Transport Canada and is operated by the Dryden Airport Commission on behalf of the Town of Dryden, pursuant to a lease agreement. It is located approximately 6.5 km northeast of the town and is used by scheduled air carriers, a small number of resident aircraft, and one fixed-base operator, Dryden Flight Centre. The Dryden Municipal Airport is also a base for the Ontario Ministry of Natural Resources (MNR). The relationship among the Dryden Airport Commission, Transport Canada, and the various parties operating at the Dryden Municipal Airport will be discussed in chapter 9 of this Report, Dryden Municipal Airport Crash, Fire-fighting, and Rescue Services. A diagram of the airport appears as figure 5-1 in chapter 5, Events and Circumstances Preceding Takeoff.

The aerodrome certificate for the airport was renewed by Transport Canada on March 23, 1988. The last formal Transport Canada inspection of the airport prior to March 10, 1989, was conducted on August 25, 1987. An informal inspection was conducted by Transport Canada on October 19, 1988, and no discrepancies were noted with reference to the department's standards and recommended practices.

Equipment and On-Duty Personnel

The airport maintenance equipment available on March 10, 1989, included two half-ton trucks (one strictly for airport maintenance and one for the airport manager); two snowblower trucks; one front-end loader; two small snowblowers; two runway sweepers; one sand truck; and one chemical spreader (for urea, a chemical used to melt snow and ice on manoeuvring surfaces).

Airport crash fire rescue (CFR) vehicles available on March 10, 1989, included Red 1, a rapid intervention vehicle equipped to deliver water, foam, and dry chemical; Red 2, a crash response vehicle equipped to deliver foam; and Red 3, the fire chief's van, which contained communication radios and limited emergency equipment.

When Air Ontario flight 1363 landed in Dryden on March 10, 1989, on-duty personnel at the Dryden Municipal Airport included the airport manager, Mr Peter Louttit; the CFR chief, Mr Ernest Parry; a CFR crew chief, Mr Stanley Kruger; a fire-fighter, Mr Gary Rivard; the maintenance lead-hand, Mr Christopher Pike; and a mechanic, Mr Allan Haw.

Runways

Runway 11/29 at Dryden Municipal Airport is aligned in a general east/west direction. It is 6000 feet long and 150 feet wide with an asphalt surface. The runway has no appreciable slope. The runway elevation is approximately 1354 feet above sea level (asl). On runway 29 there is a takeoff run available (TORA) of 6000 feet and a takeoff distance available (TODA) of 6200 feet. Air Ontario flight 1363 took off in a westerly direction using runway 29.

In addition to the main runway 11/29, there is a secondary runway, 05/23. This second runway is aligned in a northeast/southwest direction, intersecting runway 11/29 approximately 1250 feet from its eastern end. It has a sand surface and is 2000 feet long and 75 feet wide. Runway 05/23 is not maintained in the winter months.

A single taxiway from the terminal ramp area (taxiway Alpha) enters runway 11/29 approximately 3500 feet from its east end. The airport's two other taxiways are designated taxiways Bravo and Charlie. Prior to March 10, 1989, runway 11/29, which was constructed in 1969, had last been resurfaced in the summer of 1988. It was informally inspected by Transport Canada on October 19, 1988.

On the day of the accident, March 10, 1989, Dryden airport field maintenance staff completed an official daily runway inspection at 4:17 a.m. The runway at that time was reported to be 100 per cent bare and dry. Maintenance was being completed on the runway lights, and various inspections were conducted throughout the morning as workers finished their tasks. The runway condition remained constant. A runway-condition report was passed to the crew of the F-28, inbound from Winnipeg, before their first arrival at Dryden on the morning of March 10.

Approved Runway Lighting

Runway lighting on runway 11/29 consisted of standard runway-identification lights (flashing strobe lights), medium-intensity threshold lights, and runway-edge lights with three intensity-level settings. In addition, runway 29 had 3000 feet of low-intensity centre-row approach lights.

Aerodrome lighting at Dryden is available on request from the Kenora Flight Service Station (FSS). The lights are remotely controlled by Kenora FSS and were available and operable at the time of the accident.

Weather Minima

Canadian domestic airspace is divided into six classes, designated by a single letter A, B, C, D, E, or F, each governed by specific rules. The airspace around the Dryden airport extending five nautical miles from the centre of the airport in every direction to a height of 3000 feet above ground level is designated Class D controlled airspace. As such, aircraft operating under both instrument flight rules (IFR) and visual flight rules (VFR) are permitted to fly in the airspace. On March 10, 1989, the VFR weather minima for the Class D airspace over and around the Dryden airport were visibility of not less than three miles; distance from cloud at least one mile horizontally and 500 feet vertically; and distance above ground level at least 500 feet (except when taking off or landing).

Navigation Aids and Landing Limits

Runway 11 is serviced by a non-directional beacon (NDB) and an instrument landing system (ILS). The NDB minimum descent altitude for runway 11 is 1760 feet above sea level (asl), which is 406 feet above the airport elevation of 1354 asl. The ILS decision height for runway 11 is 1554 feet asl.

Runway 29 is serviced by a localizer back course (LOC(BC)), which has no glide slope, and by an NDB. The LOC(BC) minimum descent altitude for runway 29 is 1780 feet asl. The NDB minimum descent altitude for runway 29 is 1820 feet asl.

Dryden Flight Centre

On December 7, 1987, Dryden Flight Centre Limited entered into an agreement with Air Ontario to provide aircraft, baggage, and passenger-handling services to Air Ontario at the Dryden Municipal Airport. This agreement, which was in effect on March 10, 1989, is silent with regard to the de-icing of aircraft.

Dryden Flight Centre provided the following services and facilities for Air Ontario's aircraft, including the F-28: aircraft marshalling; aircraft refuelling; a ticket counter; a direct-line telephone to Air Ontario System Operations Control (SOC) in London, Ontario; a reservations computer (linked with the Air Canada Reservac computer system); four baggage carts; and a VHF radio capable of communicating with company aircraft and the Kenora Flight Service Station (FSS). For each Air Ontario flight, Dryden Flight Centre provided one ticket agent and two baggage handlers.

Dryden Flight Centre was also under contract with Imperial Oil Limited as an aviation fuel dealer, and, accordingly, it provided ESSO aviation petroleum products to all aircraft – both general and commercial aviation aircraft – at the Dryden Municipal Airport. As a term of its agreement with Imperial Oil, Dryden Flight Centre agreed to provide training to all personnel involved in fuel handling in order that they be proficient in safe operating procedures. Among the fuelling procedure manuals that Imperial Oil provided to Dryden Flight Centre were ESSO's Aviation Fuelling Guide and ESSO's Aviation Operations Standards Manual.

Mr Lawrence Beeler was the majority shareholder and president of Dryden Flight Centre, and Mr Vaughan Cochrane, a minority shareholder, was the general manager and the fuelling agent.

On March 10, 1989, Mr Cochrane was in charge of the ramp crew. The other member of the ramp crew was Mr Jerry Fillier. The ticket agent on duty was Ms Jill Brannan.

According to the evidence before this Commission, Mr Cochrane received minimal training on F-28 fuelling procedures in the autumn of 1987. Although aircraft-fuelling manuals in the possession of Dryden Flight Centre included instruction on the operation of F-28 main engines and its auxiliary power unit (APU) during fuelling, Messrs Beeler, Cochrane, and Fillier testified that they had no knowledge of such provisions until after the accident.

Further details of the aviation services agreement, particularly with reference to training and procedures related to the fuelling operation, appear in chapter 9 of this Report, Crash, Fire-fighting, and Rescue Services, and in chapter 20, F-28 Program: Flight Operations Training.

Other Services

De-icing

On March 10, 1989, de-icing at Dryden airport was available from Dryden Air Services for any aircraft. Dryden Air Services, a company owned and operated by Mrs Diane Beasant and Mr Mark Beasant, was under contract to provide passenger- and aircraft-handling services for Ontario Express[1] Airlines in much the same way that Dryden Flight ntre

[1] Ontario Express Airlines, which carried on business as Canadian Partner Airlines and was partially owned by PWA Corporation, was a regional feeder to Canadian Airlines International.

Centre serviced Air Ontario. Ontario Express owned the de-icing equipment and provided the de-icing fluid, while Dryden Air Services employees performed the de-icing.

Dryden Flight Centre did not itself have any de-icing facilities. If an Air Ontario aircraft needed to be de-iced, an employee of Dryden Flight Centre would relay the request to an employee of Dryden Air Services, who in turn would telephone Canadian Partner operations in Toronto to receive permission to de-ice the Air Ontario aircraft. Such permission was never denied. It was understood by the employees of Dryden Flight Centre and Dryden Air Services that, should an Air Ontario and a Canadian Partner aircraft both require de-icing at the same time, Canadian Partner would be given priority. There appears to have been a good working relationship between Dryden Flight Centre and Dryden Air Services, and de-icing was available on short notice.

The de-icing equipment used by Dryden Air Services was manufactured by Mid-Canada Equipment of Winnipeg, Manitoba. The equipment, an "Old Faithful" model, consisted of a spraying mechanism attached to a "bucket" suspended by an articulating arm mounted above a mobile, self-propelled, three-wheeled vehicle. An operator de-icing an aircraft would stand in the bucket and use a control panel to control the movements of the vehicle and the bucket. The spraying nozzle was manually operated.

On March 10, 1989, the average cost of de-icing an aircraft was about $360 but varied according to the amount of de-icing fluid required. Only type 1 fluid was available for de-icing at Dryden.

No one employed by Dryden Flight Centre or Dryden Air Services had ever received any advice or instruction from Air Ontario on procedures for the de-icing of the F-28 aircraft. The training of personnel handling the F-28 aircraft at Dryden is discussed in chapter 20 of this Report, F-28 Program: Flight Operations Training.

Weather Services

Until July 31, 1988, weather information was available through a weather observation facility provided by the Dryden Airport Commission, the authority set up by the town to oversee airport operations. The facility was staffed by trained observers who, in addition to making hourly and special weather observations, maintained a watch of airport activities, communicated with surface vehicles and aircraft on a two-way radio, collected landing fees, and acted as contact persons for pilots of itinerant aircraft. An approved crash alarm system was operated through this facility. Funding for these services was provided by Transport Canada through an annual renewable contract.

In 1988, a public tender was called for the provision of the weather observation services at the Dryden airport. The contract was awarded to Cloud Nine Contracting, which began service on July 31, 1988. Environment Canada's Atmospheric Environment Service personnel provided training for the owners and operators of Cloud Nine, which offered weather-related services only.

Air Traffic Control

Flight Service Station service for the Dryden aerodrome was provided by Kenora FSS via a remote communications outlet. Instrument flight rules (IFR) flights departing Dryden receive their IFR clearance through Kenora FSS. (IFR clearances originate in Winnipeg, the area control centre.) After takeoff, aircraft contact Kenora's en-route radar and other controlling agencies as directed.

In subsequent chapters I will discuss in greater detail the facilities, operations, and services in place at the Dryden Municipal Airport and their significance to the events of March 10, 1989.

4 METEOROLOGICAL INFORMATION

Aviation Weather Information

Canadian aviation weather information is gathered, produced, and distributed by the Atmospheric Environment Service (AES) of Environment Canada with the assistance of contract personnel trained to make weather observations and prepare reports. The weather information is available from a variety of sources to those who require it, primarily aviation planners and flight crew.[1]

Aviation weather information is available from 60 AES weather offices and more than 100 flight service stations (FSS), which are normally located at airports across Canada. Access to this information is available in person, by telephone, and by two-way radio. As well, organizations such as flying schools, corporate aviation departments, air charter companies, and air carriers have computer and facsimile equipment that allows easy gathering of the required weather information.

Types of Weather Information Available

Aviation weather reports (SA), based on hourly weather observations, are issued each hour from over 300 airport and en route stations in Canada. In addition, observations are made and special reports (SP) are issued when weather conditions are fluctuating, or as requested.

Aviation area forecasts (FA) are issued for Canadian domestic airspace and are distributed on a routine basis or when requested. These forecasts are prepared four times a day for 90 regions across the country.

Airport forecasts (FT) are prepared by nine weather forecast offices for 160 airports across Canada. Airport forecasts are limited to airports for which routine hourly (SA) reports are available, as well as special reports that meet AES standards for observations representative for the

[1] Weather systems are generally large and cover areas in different time zones. As well, because a person can be in one time zone discussing weather in another time zone, the time reference can be confusing. For these reasons, times in this meteorology chapter are in Coordinated Universal Time, which is abbreviated UTC or Z. Z is used in this chapter. Thunder Bay is in the Eastern time zone; EST = Z - 5 hours. Dryden is in the Central time zone; CST = Z - 6 hours. For example: 1800Z is 1:00 p.m. EST at Thunder Bay and 12:00 noon CST at Dryden. The accident occurred at approximately 1811Z.

airport. The forecasts are prepared four times a day and are valid for 12 to 24 hours.

Upper-level wind and temperature forecasts (FD) are prepared for 115 locations in Canada twice a day for three valid periods. Other aviation charts, reports, and forecasts, including weather warnings (significant in-flight weather warning messages or SIGMETS), upper-level prognostic charts, significant weather prognostic charts, radar reports, pilot reports (PIREPS), surface weather charts, and upper level analysis charts are disseminated as required for flight planning purposes.

Significance of Weather Information

All persons who plan flights require weather information for a number of reasons: to make takeoff calculations such as aircraft weight and takeoff speeds and distances; to determine if the visibility is within limits for takeoff; to determine ground speed and time estimates for the flight; to be prepared for en route weather, including turbulence, icing conditions, and storms; to determine if the destination weather is suitable; and to allow the selection of alternate airports where the weather meets regulatory requirements.

When the flight crew of a transport aircraft on a short domestic flight receives a weather package from either its operations centre or a meteorological office, the package will normally contain the following information:

- hourly reports (SA) and special reports (SP) for each en route stop and alternate and, if required, intermediate station;
- forecasts (FT) for each en route airport and alternate and other airports that could be used for an emergency landing;
- upper-level wind and temperature forecasts (FD);
- area forecasts (FA) for the area of the flight(s);
- SIGMETS, PIREPS, and radar reports if applicable; and
- other desired weather information as required or requested by individuals or organizations.

During flight and at en route stops, flight crew continually update their knowledge of the weather that is of significance to them – primarily en route, destination, and alternate weather.

Weather Information for March 10, 1989

Synopsis

The weather surface analysis (figure 4-1) for the area that included Dryden for 1200Z on March 10, 1989, indicated that an arctic cold front extended from central Manitoba to northern Ontario, with a warm front extending south to Duluth, Minnesota. An ill-defined maritime frontal system was also situated over southwestern North Dakota, with a weak centre of low pressure in southeastern Alberta. By 1800Z the arctic cold front had moved southeastward from southern Saskatchewan to the top of James Bay, with the centre of low pressure situated in southwestern Saskatchewan (figure 4-2). The maritime frontal system had moved eastward and was situated over central North Dakota, where a second centre of low pressure was located. Moist air was present over northwestern Ontario, with mid-level instability increasing owing to the overrunning maritime polar air from the northern United States.

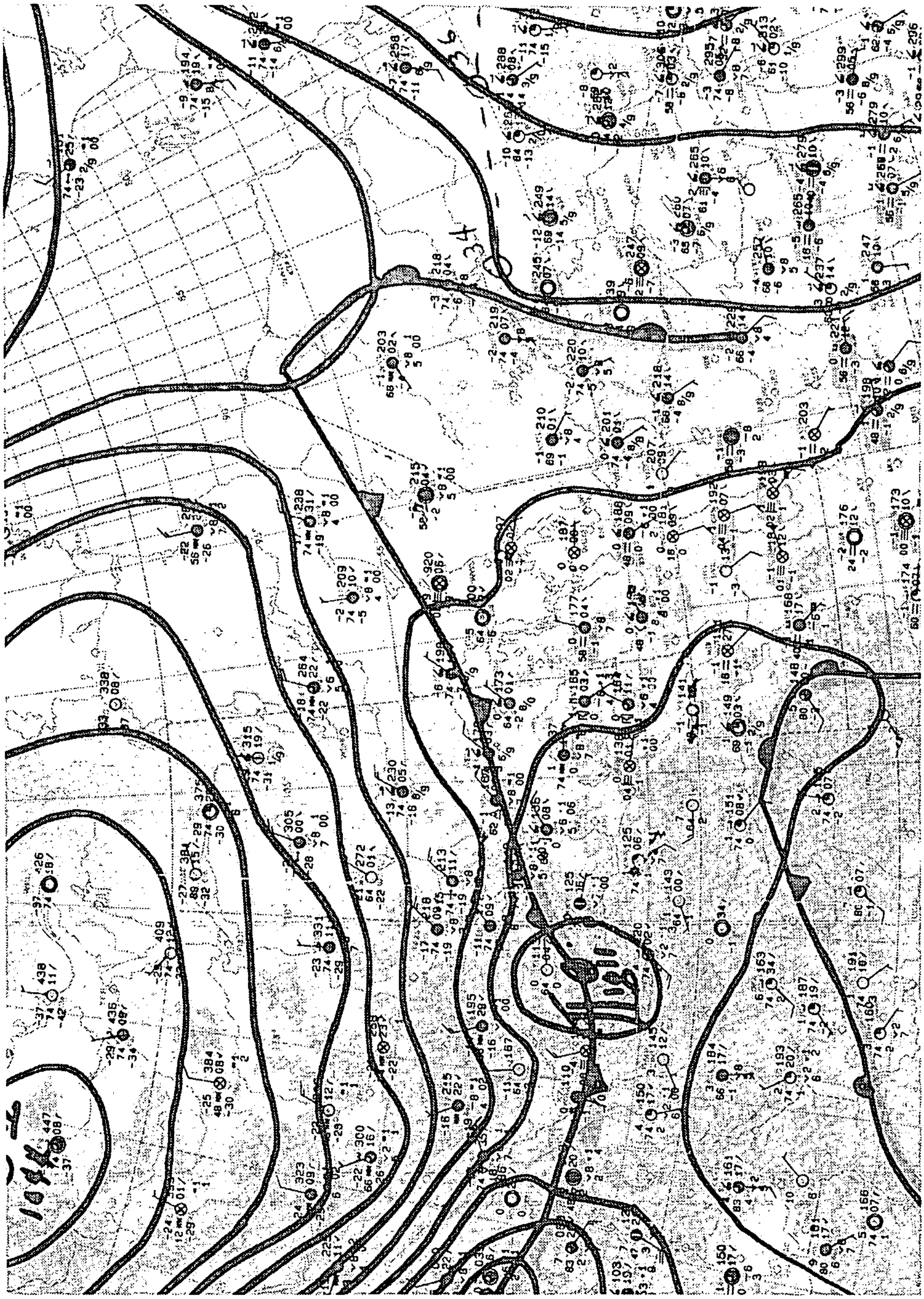
General Weather

Broken stratocumulus and altocumulus clouds were present over northwestern Ontario when the accident occurred, at 1811Z, with areas of low cloud and fog producing isolated instrument meteorological conditions (IMC). At 1200Z on March 10, 1989, there were isolated rain showers over southern Manitoba, with a line of scattered thunderstorms over southwestern Manitoba that were moving eastward at 45 knots. At 1700Z radar plots from Vivian, Manitoba, and Upsala, Ontario, showed scattered weak echoes, indicating small storm centres, moving into the Dryden, Ontario, area. SIGMETS were issued by the Winnipeg Weather Office from between 1200Z and 1605Z, valid until 2005Z, based on the radar information about the scattered line of thunderstorms. At 1805Z the Winnipeg Weather Office cancelled the last Sigmet affecting the Dryden area when the radar information indicated that the line of thunderstorms had dissipated into scattered altocumulus castellanus and towering cumulus clouds.

Area Forecast

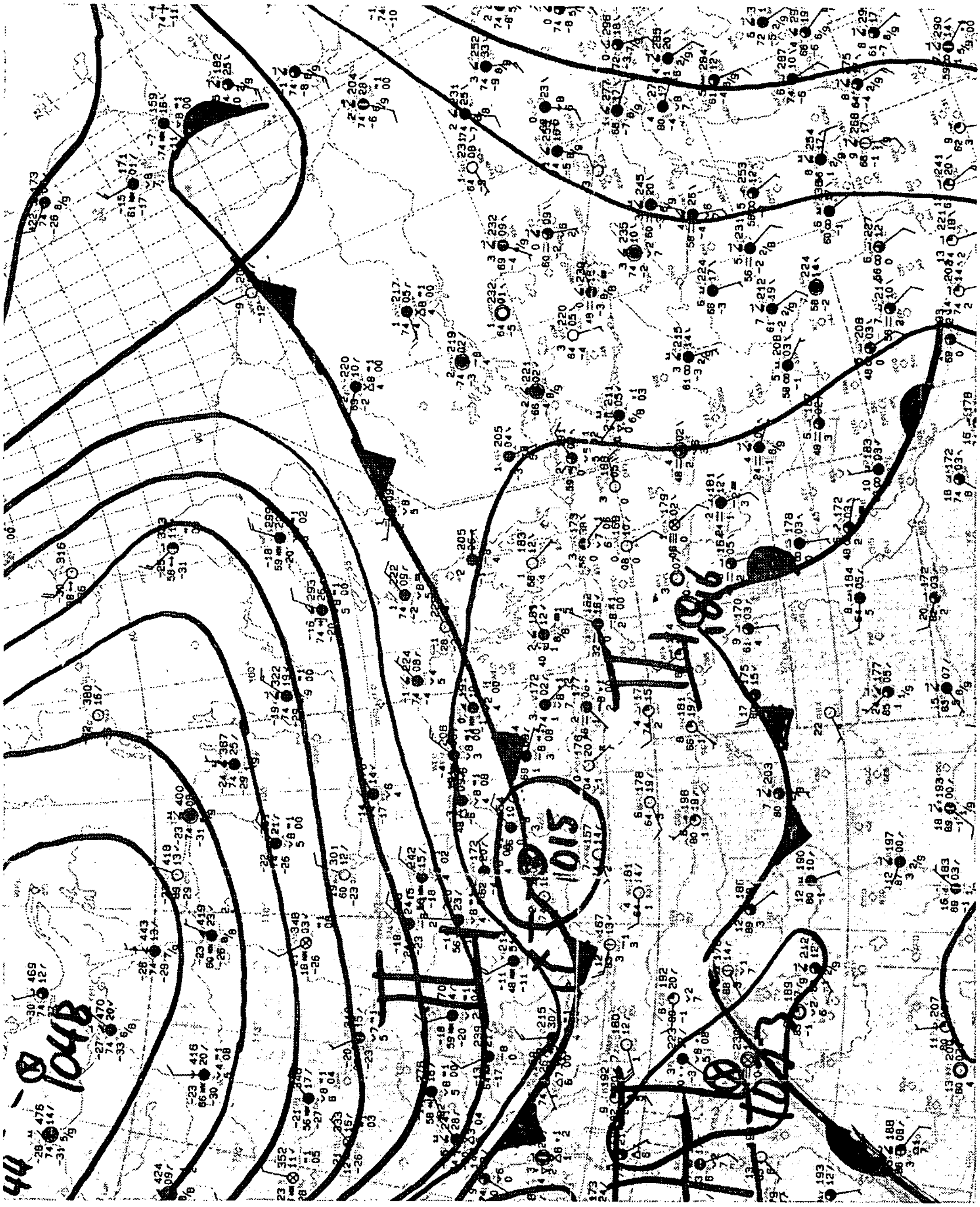
The area forecast for the area designated as FACN3, which includes Dryden along the southern edge and which was issued at 1130Z and was valid from 1200Z to 2400Z on March 10, 1989, gave the following forecast (not verbatim):

Figure 4-1 Environment Canada, Surface Analysis, March 10, 1989, 1200Z, Prairie Weather Centre



Source: Exhibit 508

Figure 4-2 Environment Canada, Surface Analysis, March 10, 1989, 1800Z, Prairie Weather Centre



Source: Exhibit 509

> Two broken variable to scattered cloud layers based at 3000 feet above sea level (asl) and 8000 feet asl are forecast. Isolated altocumulus castellanus embedded in the layer cloud are expected to give visibilities as low as 3 miles in light rain with a risk of freezing rain. There is a risk of embedded cumulo-nimbus cloud giving visibilities as low as 3 miles in thunder and light rain showers near the end of the period. A few ceilings as low as 300 feet and visibilities down to 1/2 mile are forecast due to patchy drizzle and fog. The freezing level is forecast to be near the surface with an above freezing layer from 2000 feet asl to 6000 feet asl. Light to moderate rime icing is forecast in the cloud above 6000 feet and severe clear icing is forecast in freezing rain. Moderate turbulence is expected near the altocumulus castellanus cloud.

Mr David Patrick, a meteorologist employed by Atmospheric Environment Service of Environment Canada in the Prairie Weather Centre in Winnipeg, prepared a report (Exhibit 313) on weather conditions that existed along the flight path of Air Ontario flights 1362 and 1363 on March 10, 1989. Mr Patrick was also the shift supervisor on duty at the Prairie Weather Centre on that day.

When asked during his testimony about the forecasts for March 10, 1989, in relation to typical March weather in that area, Mr Patrick stated the following:

> A. Well, each March is different, but from my experience, in almost every March if not every March in northwestern Ontario, you can expect to have weather of this nature from time to time, so it is certainly not an everyday occurrence, but in March, there is melting snow and that generates moisture and it forms stratus clouds and fog, so low stratus and fog is – it occurs fairly often in northwestern Ontario in March in the springtime, and low visibilities and ceilings and snowshowers do occur from time to time.
>
> The only thing that was really unusual that day was – really not freakish but unusual – was that there were thundershowers over southern Manitoba that were moving towards northwestern Ontario. That's unusually early in the season to be getting thundershowers.
>
> (Transcript, vol. 49, p. 11)

Winnipeg (YWG) Weather

Winnipeg Forecasts (FT)

The Winnipeg forecast issued at 1045Z on March 10, 1989, and valid from 1100Z on March 10 to 1100Z on March 11 read as follows:

> Ceiling 200 feet, sky obscured, visibility 1/2 mile in fog, occasional sky partially obscured, ceiling 5000 feet overcast, visibility 6 miles in light rain and fog. After 1800Z 600 feet scattered cloud, ceiling 5000 feet overcast, occasional ceiling 600 feet overcast, visibility 2 miles in light rain and fog. After 0200Z [March 11] ceiling 4000 feet broken, 8000 feet broken, occasional sky partially obscured, ceiling 2000 feet overcast, visibility 2 miles in light freezing rain, light snow and fog after 0700Z [March 11].

The amended Winnipeg forecast issued at 1412Z on March 10, 1989, and valid from 1400Z on March 10 to 1100Z on March 11 read:

> Ceiling 500 feet, sky obscured, visibility 1 mile in fog, occasional sky partially obscured, ceiling 5000 feet overcast, visibility 6 miles in thunder and light rain showers. After 1800Z 600 feet scattered cloud, ceiling 5000 feet overcast, occasional ceiling 600 feet overcast, visibility 2 miles in light rain and fog. After 0200Z [March 11] ceiling 4000 feet broken, 8000 feet broken, occasional sky partially obscured, ceiling 2000 feet overcast, visibility 2 miles in light freezing rain, light snow and fog after 0700Z [March 11].

The Winnipeg forecast issued at 1630Z on March 10, 1989, and valid from 1700Z on March 10 to 1700Z on March 11 read:

> Sky partially obscured, ceiling 500 feet broken, visibility 1 mile in fog, variable to 500 feet scattered, ceiling 4000 feet broken, visibility 5 miles in fog. After 2000Z 800 feet scattered, ceiling 4000 feet broken, occasional sky partially obscured, ceiling 800 feet broken, visibility 3 miles in fog. After 0200Z [March 11] ceiling 1000 feet broken, 4000 feet broken, wind 040°T at 10 knots, occasional 5 miles visibility in light snow showers, with a risk of light freezing drizzle. After 1200Z [March 11] ceiling 1500 feet broken wind 360°T at 10 knots.

Winnipeg Reports (SA)

The Winnipeg regular special report (RS)[2] issued at 1200Z read:

> Sky partially obscured, measured ceiling 400 feet broken, 10,000 feet overcast, visibility 3 miles in fog, temperature and dew 0°C, wind 160°T at 7 knots.

---

[2] RS is a regular special (an observation taken on the hour, as is normal, but that reports a significant weather change).

The Winnipeg aviation weather report (SA) issued at 1300Z read:

> Sky partially obscured, 500 feet thin scattered, estimated ceiling 10,000 feet overcast, visibility 2 miles in fog, temperature 0°C, dew point -1°C, wind 160°T at 7 knots.

When Air Ontario flight 1362 departed Winnipeg eastbound at 1349Z (7:49 a.m. CST), the weather at Winnipeg was as indicated at 1300Z.

The Winnipeg SA issued at 1400Z read:

> Sky partially obscured, 500 feet scattered, estimated ceiling 10,000 feet overcast, visibility 2 miles in fog, temperature 0°C, dew point -1°C, wind 150°T at 6 knots.

The Winnipeg SA issued at 1500Z read:

> Sky partially obscured, measured ceiling 700 feet broken, 4300 feet overcast, visibility 1 mile in light rain showers and fog, temperature 1°C, dew point -1°C, wind 300°T at 4 knots.

The Winnipeg SA issued at 1600Z read:

> Sky partially obscured, measured ceiling 500 feet broken, 4500 feet overcast, visibility 3/4 mile in fog, temperature 1°C, dew point 0°C, wind 090°T at 9 knots.

The Winnipeg SA issued at 1700Z read:

> Sky partially obscured, 500 feet thin scattered, 12,000 feet thin broken, visibility 3 miles in fog, temperature 2°C, dew point 0°C, wind 120°T at 10 knots.

The Winnipeg SA issued at 1800Z read:

> Sky partially obscured, estimated ceiling 3500 feet broken, visibility 4 miles in fog, temperature 3°C, dew point 0°C, wind 140°T at 8 knots.

The Winnipeg SA issued at 1812Z read:

> Sky partially obscured, estimated ceiling 1500 feet overcast, visibility 4 miles in light rain showers and fog, wind 120°T at 5 knots.

Between 1812Z and 2200Z the weather at Winnipeg did not deteriorate below sky partially obscured, estimated ceiling 1500 feet overcast, and visibility 3 miles in fog.

Dryden (YHD) Weather

Dryden Forecasts (FT)

The Dryden forecast issued at 1330Z on March 10, 1989, and valid from 1400Z to 2300Z on March 10 read:

> 4000 feet scattered, ceiling 8000 feet broken, occasional sky partially obscured, ceiling 700 feet broken, 4000 feet overcast, visibility 2 miles in light rain and fog.

The amended Dryden forecast issued at 1502Z on March 10, 1989, and valid from 1500Z to 2300Z on March 10 read:

> 4000 feet scattered, ceiling 8000 feet broken, occasional sky partially obscured, ceiling 700 feet broken, 4000 feet overcast, visibility 2 miles in light rain, light freezing rain, and fog.

This was the first forecast specifically calling for freezing rain at Dryden. Aircraft C-FONF was, at the time this forecast was issued, en route from Dryden to Thunder Bay. The aircraft arrived at Thunder Bay at 1532Z.

The Dryden forecast issued at 1630Z on March 10, 1989, and valid from 1700Z on March 10 to 0300Z on March 11 read:

> 3000 feet scattered, ceiling 10,000 feet overcast, occasional ceiling 3000 feet broken, 10,000 feet overcast, visibility 5 miles in light rain, light freezing rain, and fog. After 1900Z 800 scattered, ceiling 4000 feet overcast, occasional sky partially obscured, ceiling 800 feet overcast, visibility 2 miles in light rain and fog, with a risk of thunder and rain showers until 2100Z. After 2100Z ceiling 1500 feet broken, 4000 feet overcast.

This second forecast calling for freezing rain at Dryden was issued while the aircraft was at its Thunder Bay station stop. It departed for Dryden as flight 1363 at 1655Z, 25 minutes after this forecast.

Dryden Reports (SA)

The actual weather reports for Dryden indicated that on March 10, 1989, from 1200Z until 1742Z, the ceiling and visibility did not go below 4000 feet and 12 miles, respectively. Light snow started falling at 1742Z. Aircraft C-FONF landed in Dryden at 1739Z (11:39 a.m. CST).

The Dryden special report (SP)[3] issued at 1748Z read:

> Sky partially obscured, estimated ceiling 4000 feet overcast, visibility 2½ miles in light snow, wind 260°T at 3 knots.

The Dryden SA issued at 1800Z read:

> Sky partially obscured, estimated ceiling 4000 feet overcast, visibility 2½ miles in light snow, barometric pressure 1022.5 hPa (hectopascals), temperature 1°C, dew point -3°C, wind 190° at 3 knots, altimeter setting 30.12" Hg. (Actual recorded temperature before rounding off was 0.7°C.)

The Dryden SP issued at 1806Z read:

> Precipitation ceiling 300 feet, sky obscured, visibility 3/8 mile in snow, wind 170° at 4 knots.

This was the last weather report issued before aircraft C-FONF commenced its takeoff roll at Dryden at 1809Z (12:09 p.m. CST).

The Dryden SP issued at 1811Z read:

> Precipitation ceiling 1000 feet, sky obscured, visibility 3/4 mile in light snow, wind 170° at 4 knots.

The Dryden accident observation report issued at 1812Z read:

> Precipitation ceiling 1000 feet, sky obscured, visibility 3/4 mile in light snow, wind 170° at 4 knots, barometric pressure 1021.8, temperature -0.3°C, dew point 2.1°C, wind 170° at 4 knots, altimeter setting 30.10" Hg.

From the above observations, it is apparent that during the 30 minutes that flight 1363 was on the ground in Dryden, the weather deteriorated significantly. By 1806Z (12:06 p.m.), approximately three minutes prior to takeoff, the weather had dropped to a precipitation ceiling of 300 feet, with visibility three-eighths of a mile in snow.

---

[3] SP denotes a "special observation." SPs are made when there are specific changes in the observed weather conditions, such as the commencement or cessation of snow, or when requested.

Eyewitness Weather Information for Dryden

A number of witnesses testified about the weather conditions at the Dryden Municipal Airport at the approximate time of the takeoff roll of flight 1363. The evidence shows that, at such time, a heavy snow squall affected the eastern part of the airport, more particularly the area surrounding the button[4] of runway 29.

Observations made by two commercial pilots, Mr Roscoe Hodgins and Mr Craig Brown, and a private pilot, Mr Robert McGogy, all of whom had been flying in the area that day, confirm the above observations. Mr Hodgins is an experienced pilot with about 8000 hours' flight time, and Mr Brown had 1250 hours. Mr McGogy had about 80 hours' flying time.

Mr Hodgins landed at the Dryden airport at 1710Z (11:10 a.m.). During his testimony, he stated that the weather at that time was "good VFR," with no precipitation and very little wind (Transcript, vol. 22, p. 124).

Mr Hodgins taxied to the Ministry of Natural Resources building, located south of the runway, approximately midway between the button of runway 29 and taxiway Alpha. He shut down his aircraft, put the engine heater and cover on, and started to fill up the seed-spraying hopper of his aircraft. These combined tasks took about 10 minutes. While he was filling the hopper, snow began to fall, interrupting his work and prompting him to put wing covers on the aircraft.

Mr Hodgins heard the engines of flight 1363 at 1801Z (12:01 p.m.) and recalled that "[i]t was snowing quite heavy" at that time (Transcript, vol. 22, p. 136). He also saw the Cessna 150, registration C-FHJC, piloted by Mr McGogy, land on runway 29 at 1806Z (12:06 p.m.). He stated that at that time "[i]t was snowing quite heavy" (Transcript, vol. 22, p. 138). Three minutes later, at 1809Z (12:09 p.m.), flight 1363 was at the eastern end of runway 29. Mr Hodgins described the weather and visibility as he observed them when the aircraft began its takeoff roll:

> A. It was snowing quite heavily. I would say the visibility was half to three-quarters of a mile with large, fluffy flakes fluttering down like leaves; you know, they weren't falling straight, they were in a fluttering motion.
>
> (Transcript, vol. 22, p. 140)

[4] The term "button" is often used by pilots when referring to the threshold area of a runway. "Threshold" in general terms defines the beginning of the runway surface which is of sufficient load-bearing strength to allow continual flight operation by aircraft that the runway is intended to serve. In this Report, the terms "button" and "threshold" are both used from time to time when referring to the east end of Runway 29 at the Dryden Municipal Airport.

At approximately 1743Z (11:43 a.m.), Mr Brown reported to Kenora Flight Service Station that he was "down and clear in Dryden." He was questioned on his observations of the weather upon landing:

Q. ... What was the weather like, more particularly, what was the precipitation like, if any, during your taxi down Alpha and over to the refuelling area?
A. It – the snow had increased from the snow grains reported earlier to a – more of a heavy snowfall and I am estimating the visibility to be approximately five or six miles.

(Transcript, vol. 5, p. 218)

Mr Brown stated that after landing he proceeded to the fuel pumps located on the Dryden ramp, west of the terminal building, and proceeded to refuel. He estimated he was at the fuel pumps at 11:44 a.m.:

Q. ... I take it then that you, in fact, commenced to refuel your aircraft, is that correct?
A. That is correct.
Q. And how long would that have taken?
A. Approximately 15 minutes, about 5 minutes before we got the fuelling started and another 10 minutes to finish the fuelling.
Q. ... If I could take you back to that 15-minute period, I take it you were near your aircraft at all times?
A. Yes, sir.
Q. Could you describe the weather, particularly, any precipitation phenomena such as snow and visibility during that 10- to 15-minute period?
A. As I was saying before, it started to increase, the snowfall, and by that time – by that 15 minutes, it snowed very heavily. With visibility going down to about half a mile at its worst time.

(Transcript, vol. 5, p. 220)

After refuelling, Mr Brown taxied his aircraft to the eastern side of the terminal building to park. He taxied by the F-28:

Q. ... could you describe the snowfall at that point.
A. It was still heavy, heavy wet snow. Visibility, again, I think was around a mile to a half a mile.

(Transcript, vol. 5, p. 223)

Mr Robert McGogy, a private pilot, took off about 1720Z (11:20 a.m. CST) on a recreational flight in his light aircraft, a Cessna 150, and flew to the north and west of Dryden, returning to Dryden about 1800Z (12:00 noon). The visibility throughout the flight was poor. On his return leg and close to the Dryden airport, "it was almost a whiteout." As he approached the airport, the snow increased in intensity and the flakes "were approximately the size of 50-cent pieces, and they were very wet" (Transcript, vol. 22, pp. 25, 40).

Mr McGogy testified that in order to maintain visual reference with the ground, his height above ground level varied from a high of 1000 feet while en route to 150 to 200 feet while approaching runway 29.

At 18:04:03Z Mr McGogy radioed Kenora Flight Service Station and asked: "There any chance that plane [C-FONF] can hold, I'm having real bad weather problems here." At 18:04:07Z, First Officer Mills on flight 1363 transmitted:

> Okay three sixty three's, holding short of the active, be advised you are down to a half a mile or less in snow here.
>
> (Exhibit 7A, p. 31)

Mr Brown heard the Cessna 150's transmissions to Kenora Flight Service Station both on its approach to and after landing at the Dryden airport. He also observed the Cessna 150 taxiing down Alpha taxiway towards the Dryden ramp area. The Cessna 150 reported down at 1806Z (12:06 p.m.) and off the runway onto the taxiway at 1808Z (12:08 p.m.). Mr Brown provided the following observations concerning the weather:

> Q. Could you describe the weather again at the point in time that you saw this 150 taxi in down Alpha?
>
> A. Again, it was still snowing heavily. I'm estimating it to be about half a mile visibility.
>
> (Transcript, vol. 5, p. 225)

Mr Keith Fox, an experienced pilot and F-28 first officer with Air Ontario, was a passenger on flight 1363 from Thunder Bay to Dryden. He testified that at approximately 1804Z (12:04 p.m.) he was driving south from the Dryden airport on Airport Road and saw a Cessna 150 flying north to the airport at an "extremely low altitude" of "no more than 200 feet" (Transcript, vol. 51, p. 189). To be driving south on Airport Road and to see the Cessna 150 flying northward, Mr Fox must have been at least a mile southwest of the button of runway 29. He gave the following evidence regarding the visibility when he observed the Cessna 150 overhead:

> A. I would estimate quarter mile, but it's hard to estimate because it was freezing on my windshield. It was very bad conditions at the time.
>
> (Transcript, vol. 51, pp. 189–90)

Approximately three minutes before the F-28 took off, the airport CFR chief, Ernest Parry, who was located in his vehicle on taxiway Charlie, described a "heavy curtain of snow" and poor visibility when looking towards the east end of runway 29:

> A. ... I realized that I was not even seeing the end of the runway. I was not getting – I could not see the M.N.R. [Ministry of Natural Resources] buildings or towers that were down at that end. I was not seeing that end of the runway.
>
> ...
>
> ...it appeared to be, you know, like a very heavy curtain of snow at that end.
>
> (Transcript, vol. 6, p. 219)

The distance from taxiway Charlie to the MNR buildings is approximately 2000 feet.

Some witnesses in the vicinity of the airport terminal saw smoke from the crash which occurred to the west of the airport. If the smoke they saw was from the fire that started when the aircraft struck the trees on top of the knoll, the distance was about 4500 feet or about seven-eighths of a mile. If the smoke they saw emanated from the crash site, the distance was about one mile. It must be recalled, however, that the heavy snow squall occurred on the east half of the airport, the direction from which flight 1363 commenced its attempted takeoff.

Thunder Bay (YQT) Weather

Thunder Bay Forecasts (FT)

The Thunder Bay forecast issued at 1030Z on March 10, 1989, and valid from 1100Z to 2300Z on March 10 read as follows:

> 600 feet scattered, ceiling 8000 feet broken, occasional sky partially obscured, ceiling 600 feet overcast, visibility 1/2 mile in fog. After 1700Z ceiling 4000 overcast, occasional sky partially obscured, ceiling 1000 feet overcast, visibility 2 miles in light rain and fog, with a risk of light freezing rain.

The Thunder Bay amended forecast issued at 1040Z on March 10, 1989, and valid from 1100Z to 2300Z on March 10 read:

> 600 feet scattered, ceiling 8000 feet broken, visibility 4 miles in fog, occasional sky partially obscured, ceiling 300 feet overcast, visibility 1/4 mile in fog. After 1700Z ceiling 4000 feet overcast, occasional sky partially obscured, ceiling 1000 feet overcast, visibility 2 miles in light rain and fog, with a risk of light freezing rain.

The Thunder Bay amended forecast issued at 1041Z on March 10, 1989, and valid from 1100Z to 2300Z on March 10 read:

> 600 feet scattered, ceiling 8000 feet broken, visibility 4 miles in fog, occasional sky partially obscured, ceiling 600 feet overcast, visibility 1/2 mile in fog. After 1700Z ceiling 4000 feet overcast, occasional sky partially obscured, ceiling 1000 feet overcast, visibility 2 miles in light rain and fog, with a risk of light freezing rain.

The Thunder Bay amended forecast issued at 1043Z on March 10, 1989, and valid from 1100Z to 2300Z on March 10 read:

> 600 feet scattered, ceiling 8000 feet broken, visibility 4 miles in fog, occasional sky partially obscured, ceiling 300 feet overcast, visibility 1/4 mile in fog. After 1700Z ceiling 4000 feet overcast, occasional sky partially obscured, ceiling 1000 feet overcast, visibility 2 miles in light rain and fog, with a risk of light freezing rain.

The Thunder Bay amended forecast issued at 1444Z on March 10, 1989, and valid from 1400Z to 2300Z on March 10 read:

> 100 feet scattered, ceiling 800 feet overcast, visibility 5 miles in fog, occasional ceiling 100 feet sky obscured, visibility 1/4 mile in fog. After 1700Z ceiling 4000 feet overcast, occasional sky partially obscured, ceiling 1000 feet overcast, visibility 2 miles in light rain and fog, with a risk of light freezing rain.

The Thunder Bay amended forecast issued at 1616Z on March 10, 1989, and valid from 1600Z to 2300Z on March 10 read:

> 500 feet scattered, ceiling 10,000 feet broken, occasional sky partially obscured, ceiling 500 feet broken, visibility 1 mile in fog. After 2100Z 2000 feet scattered, ceiling 8000 feet broken, occasional ceiling 2000 feet overcast, visibility 5 miles in light rain, light freezing rain, and fog.

The Thunder Bay forecast issued at 1630Z on March 10, 1989, and valid from 1700Z March 10 to 0500Z on March 11 read:

> 500 feet scattered, ceiling 10,000 feet broken, occasional sky partially obscured, ceiling 500 feet broken, 10,000 feet overcast, visibility 1 mile in fog. After 2100Z 800 feet scattered, ceiling 4000 feet broken, occasional ceiling 800 feet broken, visibility 5 miles in light rain showers and fog, with a risk of freezing rain until 0000Z.

Thunder Bay Reports (SA)

The Thunder Bay SA issued at 1200Z read:

> Indefinite ceiling 400 feet, sky obscured, visibility 1/8 mile in fog, temperature -6°C, dew point -7°C, wind 230°T at 2 knots.

The Thunder Bay SA issued at 1300Z read:

> Sky partially obscured, measured ceiling 400 feet broken, 4500 feet overcast, visibility 1/8 mile in fog, temperature -6°C, dew point -7°C, wind calm.

The Thunder Bay SA issued at 1400Z read:

> Measured ceiling 100 feet overcast, visibility 3/8 mile in fog, temperature -5°C, dew point -6°C, wind 260°T at 2 knots.

The Thunder Bay SA issued at 1500Z read:

> Sky partially obscured, measured ceiling 100 feet broken, 5000 feet overcast, visibility 1/2 mile in fog, temperature -4°C, dew point -5°C, wind 270°T at 2 knots.

The Thunder Bay SP issued at 1521Z read:

> Sky partially obscured, estimated ceiling 300 feet broken, 11,000 feet overcast, visibility 1 mile in fog, wind calm.

The Thunder Bay SP issued at 1547Z read:

> Sky partially obscured, 500 feet thin broken, estimated ceiling 11,000 feet broken, 25,000 feet overcast, visibility 1½ miles in fog, wind 240°T at 2 knots.

The Thunder Bay SA issued at 1600Z read:

> Sky partially obscured, 500 feet thin broken, estimated ceiling 11,000 feet broken, 25,000 feet overcast, visibility 1½ miles in fog, temperature -3°C, dew point -4°C, wind calm.

The Thunder Bay SA issued at 1700Z read:

> Sky partially obscured, 4500 feet scattered, measured ceiling 7000 feet broken, 9000 feet overcast, visibility 1½ miles in fog, temperature -2°C, dew point -3°C, wind calm.

The Thunder Bay regular special (RS) issued at 1800Z read:

> Measured ceiling 8000 feet overcast, visibility 3 miles in fog, temperature 0°C, dew point -3°C, wind 090°T at 3 knots.

Sault Ste Marie (YAM) Weather

Sault Ste Marie Forecasts (FT)
The Sault Ste Marie forecast issued at 0445Z on March 10, 1989, and valid from 0500Z to 1700Z on March 10 read:

> 10,000 feet scattered, high broken. After 0800Z 10,000 feet scattered, high broken, variable ceiling 10,000 feet overcast until 1500Z.

The Sault Ste Marie forecast issued at 1045Z on March 10, 1989, and valid from 1100Z to 2300Z on March 10 read:

> 10,000 feet scattered, high scattered, occasional visibility 3/4 mile in fog. After 1400Z 10,000 feet scattered, high broken. After 1800Z ceiling 10,000 feet broken.

Sault Ste Marie Reports (SA)
Between 1200Z and 2300Z on March 10, 1989, the lowest weather observed at Sault Ste Marie was at 1200Z, when scattered cloud was reported at 600 feet and 10,000 feet, with 10 miles visibility.

Runway Visual Range

General Description
Runway visual range (RVR)[5] in respect of a runway means the maximum horizontal distance, as measured by an automated visual landing distance system and reported by air traffic services (ATS), for the direction of takeoff or landing at which the runway, or the lights or markers delineating it, can be seen from a point above its centre line at a height corresponding to the average eye level of pilots at touchdown.

To compute RVR, three factors must be known: first, the transmissivity of the atmosphere as provided by a visibility sensor; second, the brightness of the runway lights, which is controlled on request by the air traffic control (ATC) controller; and third, whether it is day or night, since the eye can detect lights more easily at night than during the day. During twilight there is a problem, similar to that with prevailing visibility, when neither day nor night conditions prevail.

---

[5] Exhibit 607: A.I.P. Canada: Aeronautical Information Publication, section RAC 9.21.1

RVR is measured by a visibility sensor, such as a transmissometer, located near the runway threshold. A light emitted from a source is attenuated in the atmosphere because of snow, fog, rain, and other conditions. The amount of this attenuation, or the transmissivity of the atmosphere, can be obtained by measuring the amount of light reaching a detector after being transmitted by a projector. The visibility sensor samples the atmosphere at a height that best represents the slant transmittance from the pilot's eye at cockpit level to the runway.

Operational Use of RVR

RVR information is available from ATC controllers, control towers, and flight service station (FSS) operators:

> When applicable, RVR information will be passed to the pilot as a matter of routine and may only be used in the determination or application of visibility minima if the active runway is the one served by the transmissometer.
>
> ...
>
> NOTE: RVR reports are intended to provide an indication of how far the pilot will be able to see along the runway in the touchdown zone; however, the actual visibility at other points along the runway may differ due to the siting of the transmissometer. This should be taken into account when decisions based on reported RVR must be made.[6]

In periods of low visibility, large fluctuations can occur during extremely short periods of time. In accordance with International Civil Aviation Organization (ICAO) recommendations, the RVR computer automatically averages the readings over the last minute.

RVR Equipment at the Dryden Airport

The Dryden airport has one set of RVR equipment, consisting of a transmissometer and a sensor, positioned near the threshold of runway 11. The equipment is remotely connected to the Kenora Flight Service Station and is normally controlled from there. The readout is made only in Kenora, not in Dryden. The transmissometer samples a 250-foot path-length parallel to the runway at its west end.

The readout from the RVR equipment is recorded on paper, and only a trained person is able to interpret and calibrate the readout. Mr Brian Sheppard, a senior instrument meteorologist with Environment Canada's Atmospheric Environment Service at Downsview, Ontario, assisted the Commission in interpreting and calibrating the Dryden RVR record. In

---

[6] Ibid., section 9.21.3

support of his work, he prepared a report (Exhibit 498) and an amendment (Exhibit 499) to it, and testified at the Commission hearings.

During his testimony, Mr Sheppard provided detailed explanation and support for his calculations of visibility. He also stated that the agreement between the visibility from the meteorological observations at Dryden and the visibility calculated from the RVR information is "well within my experience of such comparisons" (Transcript, vol. 65, p. 114). It must be remembered that the RVR equipment measures the visibility only in the space between the transmissometer and the sensor, while the meteorological observer looks at the entire horizon circle and finds a value that represents the average visibility for that horizon circle.

Visibility Comparisons: RVR and Meteorological Observations
Mr Sheppard provided a chart (Exhibit 499, p. 2) to show the comparison of the visibilities from the RVR and the meteorological observer:

		Observer	
Time	**RVR (Feet)**	**Miles**	**Feet**
1800Z	5000	2 1/2	
1805Z	1400	—	
1806Z	1600	3/8	1980
1811Z	2600	3/4	3960

At the request of the Commission, Mr Sheppard estimated the RVR-derived visibility for 1809Z (12:09 p.m.), the time the attempted takeoff commenced. He estimated that at 1809Z the visibility at the west end of the runway was 2200 feet; however, in making his estimate, he assumed that "some change did not take place in the atmosphere," and that there was continuity in the RVR trace (Transcript, vol. 65, pp. 111–12).

Visibility at Dryden, 1809Z (12:09 p.m.)

Summary of the Evidence
Based on the radio transmission made by First Officer Mills at 1804Z, the visibility in the area of taxiway Alpha at that time was one-half of a mile or less. Based on the testimony of Mr Fox, the visibility south of the airport at about 1804Z was about one-quarter of a mile.

The weather reports indicate that the visibility at the Dryden airport at 1800Z was two-and-a-half miles, at 1806Z was three-eighths of a mile, at 1811Z was three-quarters of a mile, and at 1812Z was three-quarters of a mile. From his vantage point at the airport terminal, Mr Brown estimated that at 1808Z the visibility was about one-half of a mile. The testimony of Mr Hodgins indicates that the visibility at the button of runway 29 at 1809Z was one-half to three-quarters of a mile, and that as he looked down the runway to the west as the F-28 was taking off, the visibility was about three-quarters of a mile.

Based on the RVR data, Mr Patrick said in evidence that at 1809Z the visibility at the west end of runway 11/29, near the threshold of runway 11, was approximately 2200 feet (between three-eighths and one-half of a mile). At 1812Z the visibility from the terminal to the west, as evidenced by those who saw the smoke, was about one mile.

These close estimates of visibility made by witnesses in the vicinity of the Dryden airport, and the close agreement between witness estimates and the visibilities reported by the meteorology observer and the RVR equipment, are conclusive evidence of the visibility at the time the F-28 started its takeoff roll. The fact that some witnesses saw smoke from the crash fire, about one mile west of the terminal, is not conflicting evidence; their observations were made about two minutes after the F-28 started its takeoff roll, and there is a great deal of evidence that the heaviest snowfall, and hence the lowest visibility, was at the east end of the runway. The position from which the F-28 commenced its takeoff run – the east end of the runway – was approximately 6000 feet from the RVR equipment.

Findings

- The visibility at the button of runway 29 at the Dryden airport at the time the F-28 aircraft, C-FONF, began its takeoff roll, at approximately 1809Z (12:09 p.m. CST), was between three-eighths and three-quarters of a mile.

- The forecast for the area FACN3, which included the Dryden airport, issued at 1130Z on March 10, 1989, and valid from 1200Z to 2400Z, included a risk of freezing rain, with severe clear icing in the freezing rain.

- The Winnipeg terminal forecast issued at 1045Z on March 10, 1989, and valid from 1100Z on March 10 to 1100Z on March 11, as well as the Winnipeg terminal amended forecast issued at 1412Z on March 10, 1989, and valid from 1400Z on March 10 to 1100Z on March 11, forecast occasional light freezing rain.

- The Dryden terminal amended forecast issued at 1502Z on March 10, 1989, and valid from 1500Z to 2300Z, as well as the Dryden terminal forecast issued at 1630Z on March 10, 1989, and valid from 1700Z on March 10 to 0300Z on March 11, forecast occasional light freezing rain.

- All of the Thunder Bay terminal forecasts covering the period on March 10, 1989, from 1100Z on March 10 to 0500Z on March 11, forecast a risk of light freezing rain, occasional light freezing rain, or a risk of freezing rain.

- Based on this weather information and its availability to the flight crew of Air Ontario flight 1362/1363 and the Air Ontario system operations control (SOC) personnel, I find that the flight crew and SOC personnel should have been aware of the fact that the aircraft could be exposed to airframe icing during the station stops at Winnipeg, Dryden, and Thunder Bay on March 10, 1989.

5 EVENTS AND CIRCUMSTANCES AT THE DRYDEN MUNICIPAL AIRPORT PRECEDING TAKEOFF

Air Ontario flight 1363 landed at Dryden on runway 29 at 11:39 a.m. CST. It taxied down taxiway Alpha to the terminal and was marshalled to the front of the terminal by Mr Vaughan Cochrane, the refuelling agent and general manager of Dryden Flight Centre. The aircraft came to a stop, facing west, at the Dryden airport terminal at 11:40 a.m. The centre line of the parked aircraft was approximately 90 feet from the terminal, and the left wing tip was approximately 60 feet from the terminal (figure 5-1).

Between 11:40 a.m. and 12:01 p.m., Air Ontario 1363 was refuelled with the right engine operating and with the passengers remaining on board the aircraft. Eight passengers deplaned in Dryden and seven passengers, two of whom were children, boarded the aircraft.

Condition of Runway on Landing

It was acknowledged by all witnesses that, when the aircraft landed, the runway was bare and wet. Flight attendant Sonia Hartwick described the snow on landing as "big, wet, fluffy snowflakes falling very lightly ... they were drifting down at a little bit of an angle" (Transcript, vol. 10, p. 203).

Mr Richard Waller, a passenger seated in aisle seat 3D (figure 5-2), testified that, on landing in Dryden, it was snowing "big ... very wet snowflakes which melted upon contact with the ground" (Transcript, vol. 18, p. 114). As the aircraft taxied towards the terminal, the snow was light and the weather gloomy and overcast.

Figure 5-1 Dryden Municipal Airport

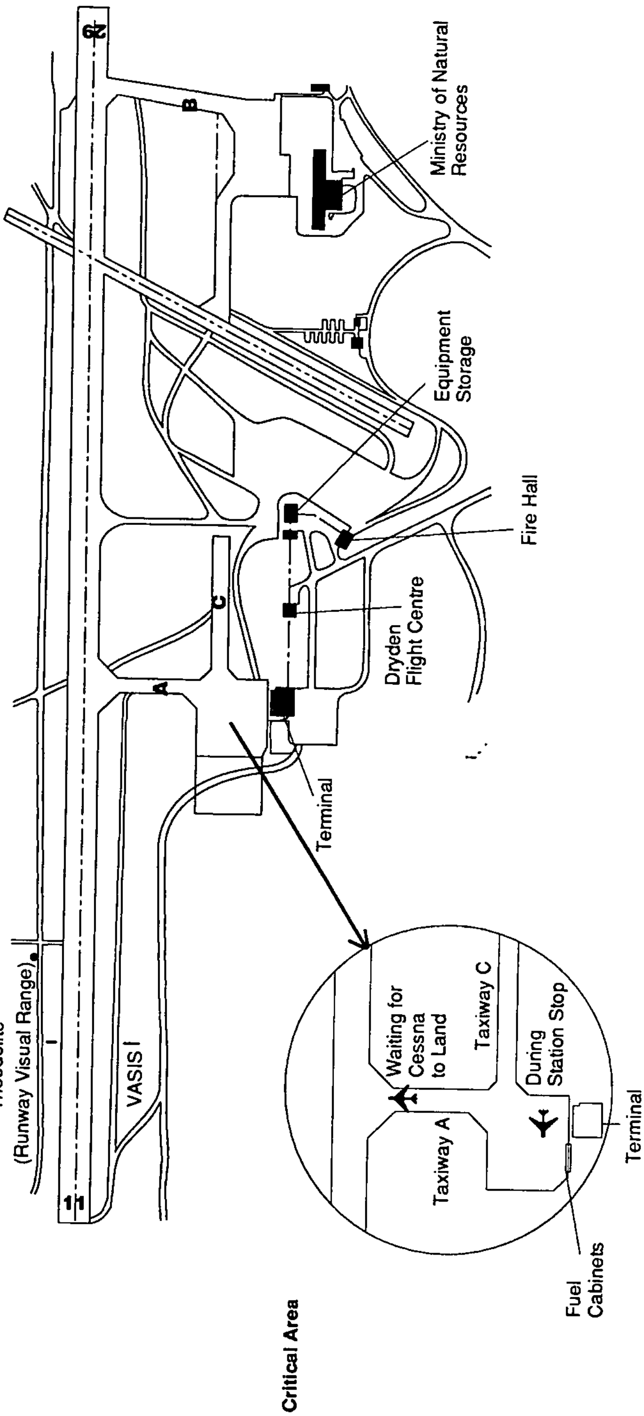
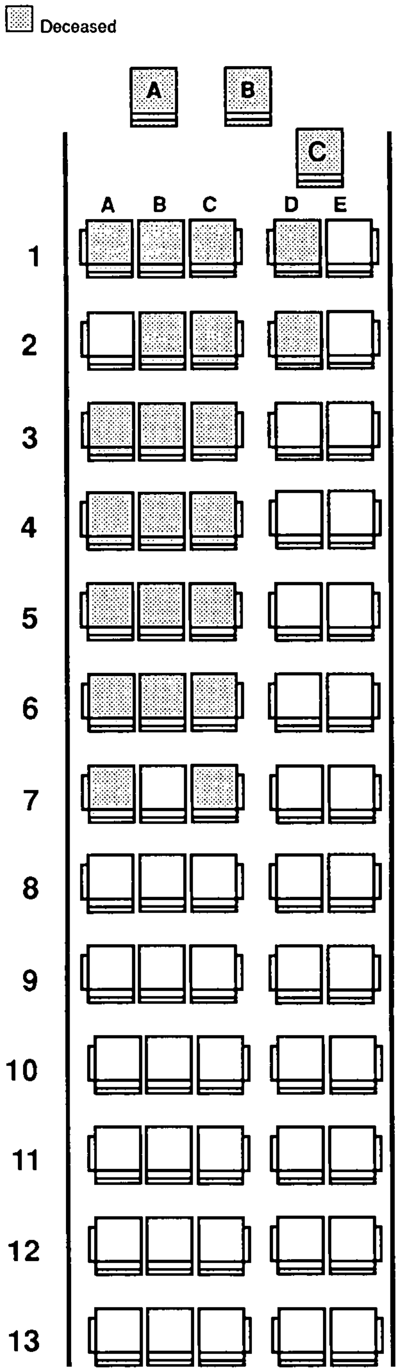


Figure 5-2 Seating Plan of Flight 1363



A Capt. George Morwood
B F/O Keith Mills
C Purser Katherine Say

	A B C	D E
1	Donald Allcorn Pamela Kliewer Brian Kliewer	Steve Syme Karen Syme
2	Uwe Teubert Lisa Kliewer Michael Kliewer	Hilda Rabb Jack Phibbs
3	Ryan Kozak George Kozak Kenneth John McLeod	Richard Waller Clyde Ditmars
4	Wilfred P. McColeman Geraldine McColeman Fred Gallinger	Brian Adams Brian Perozak
5	Mark Monroe William Schweitzer Alvin Rossaasen	Shannon Haines John Archer
6	Donald Finlayson Wendy Fortier Greg Fortier	Gordon Tucker Tina Maronese
7	Rudy Barton Allan MacDougall Nancy Ayer	Ricardo Campbell Shelley Podiluk/ Megan Podiluk
8	Tom Harris Byron Knott Ron Mandich	Flight Attendant Sonia Hartwick Paul Taggert
9	Lori Godin Dan Godin Alfred Bertram	Susan Godin Danielle Godin
10	Donna Menzies Kelly Mackenzie James Mackenzie	Susan Ferguson Michael Ferguson
11	Michael Gatto Ryan Gatto Lois Haines	Violet Woods John Biro
12	David Berezuk Michael Berezuk Sandra Berezuk	Douglas McFarlane Gary Scott McFarlane
13	Gary Jackson Donald Crawshaw Dennis Swift	Murray Haines Jessi Haines

Hot Refuelling

Because the auxiliary power unit (APU) on the F-28 was unserviceable and there was no F-28 ground-start equipment at Dryden, there was no way to restart the main aircraft engines if both were shut down. Therefore, refuelling had to be done while one of the main aircraft engines remained running. This practice, which is commonly referred to as a "hot refuelling," was performed while the passengers remained in the aircraft. Hot refuelling with passengers on board is a highly questionable and unsafe practice. My recommendation that this procedure be prohibited, as contained in my *Interim Report* of November 30, 1989, was accepted and implemented by Transport Canada.

Immediately after the aircraft stopped, Mr Jerry Fillier, an employee of Dryden Flight Centre, brought a baggage cart close to the right side of the aircraft to unload and load baggage. Mr Cochrane assisted him, and then boarded the aircraft at approximately 11:43 a.m. to advise the crew of the baggage count. At this time Mr Fillier was told by a crew member that fuel was required, but he was not advised that it would be a hot refuelling or that any precautions or special steps were necessary to perform the procedure safely. (For a discussion of hot refuelling, see my first *Interim Report*, pp. 23–24, and in this Report chapter 17, F-28 Program: Ground-Start Facilities, and chapter 21, F-28 Program: Hot Refuelling and Ground De-icing.

Mr Cochrane left the aircraft, asked Mr Fillier to bring the fuel truck to the plane, and then went inside the terminal to the Air Ontario desk to call the crash fire rescue (CFR) service unit. According to the Air Ontario Flight Attendant Manual and the ESSO Aviation Operations Standards Manual, the CFR unit was to stand by while any hot refuelling was in progress. The Air Ontario Flight Operations Manual, which was used by pilots and other operational personnel, was silent on the issue of hot refuelling.

At 11:48 Mr Fillier returned with the fuel truck and positioned it near the right side of the aircraft. He then proceeded to the cockpit of the F-28 to find out how much fuel was required. He was told by the captain to bring the fuel up to a total of 13,000 pounds, being 6500 pounds per wing.

Mr Fillier then returned to the fuel truck and hooked up the anti-static bonding cable to the aircraft. He was about to make the connection between the hose and the underside of the right wing when Mr Cochrane instructed him to fuel another aircraft. Mr Fillier advised Mr Cochrane of the amount of fuel uplift required, and Mr Cochrane took over the fuelling of the F-28. He made the single-point connection of the two-inch fuel hose to the underside of the right wing and set the gauges at the aircraft control panel at the wing root to the amount of fuel requested by the captain.

Mr Cochrane then turned on the fuel flow at the control panel located at the wing root, walked to the fuel truck to open the controls to permit the flow of fuel, and then walked back to the control panel to observe the fuelling operation. From that position he could observe the fuel truck, the single-point fuel entry underneath the right wing, and the aircraft fuel control panel.

It was Mr Cochrane's evidence that he recalled seeing the fire trucks coming along taxiway Bravo to stand by for the hot refuelling; by that time, all the necessary hookups had been completed. From the evidence presented, it is my conclusion that the fuelling process began before the fire trucks actually had arrived and were positioned near the aircraft.

The fuelling was completed at approximately 11:59 a.m. Once the aircraft had received the required amount of fuel, the fuelling process automatically shut itself off at the aircraft. When Mr Cochrane returned to the aircraft to disconnect the hose, a valve in the wing did not close as required, and approximately 5 litres of fuel spilled onto the ramp from the wing-refuelling receptacle.

Mr Cochrane moved the fuel truck away from the aircraft, went into the cockpit to advise the crew that fuelling was completed, and walked towards the terminal, stopping to speak with Mr Stanley Kruger, crew chief of the airport's CFR unit. Mr Cochrane advised Mr Kruger of the fuel spill and was asked if he wanted it washed down by a booster line from one of the rescue vehicles. Mr Cochrane indicated that in his opinion this was not required, and that it would be better to move the aircraft and then clean up the spilled fuel. The fuel spill was washed down by Mr Gary Rivard of the CFR unit after the F-28 left the ramp.

Concurrent Events

At Dryden, Captain Morwood initially stayed in the cockpit while First Officer Mills went to the lavatory in the rear of the aircraft. When the first officer returned to the cockpit, the captain went into the terminal and telephoned Air Ontario System Operations Control (SOC) in London. Mr Wayne Copeland of SOC informed him of the 11 a.m. Winnipeg weather (sky partially obscured, three miles visibility in fog). The captain informed SOC that a short delay would be needed for refuelling and that, if required to proceed to his alternate of Sault Ste Marie, he would proceed directly to it, rather than via Thunder Bay. While the captain was inside the terminal, First Officer Mills, seated in the aircraft, obtained, via radio, updated en-route and Winnipeg weather from the Kenora Flight Service Station (FSS).

The first officer received the 11 a.m. hourly weather observation as well as updated terminal forecasts at approximately 11:58 CST. During his conversation, at approximately 180030Z (12:00:30 CST), he advised the FSS operator on duty at Kenora that the visibility at Dryden was about one and one-half miles and described the precipitation as "quite puffy, snow ... looks like it's going to be a heavy one" (Kenora FSS taped log, Exhibit 7A, p. 29). Meanwhile, snow was accumulating on the wings. At approximately 12 noon, the captain returned to the aircraft. He walked quickly from the terminal to C-FONF. One witness described his walk as being "in somewhat expedient fashion" (Transcript, vol. 28, p. 21). On boarding the aircraft, the captain, as described by a passenger, "rather looked disgusted ... just not a happy expression" (Transcript, vol. 17, p. 45). No one among the 45 survivors of the crash or the witnesses on the ground observed either pilot do an inspection of the exterior of the aircraft (a walkaround inspection).

Prior to the start of the left engine, Mr Cochrane boarded the aircraft briefly to give the crew the fuel slip. According to Mr Cochrane, Captain Morwood asked if de-icing was available and was told that it was; however, the captain did not request de-icing.

At 12:03 p.m., as Air Ontario flight 1363 taxied for runway 29, the first officer radioed a request to Kenora FSS for instrument flight rules (IFR) clearance to Winnipeg. Immediately after this request, the pilot of a Cessna 150 reported to Kenora FSS that he was four miles south of the airport and inbound for landing. The Dryden weather at 12:04 was below visual flight rules (VFR) limits, and Kenora FSS advised the Cessna pilot that special visual flight rules (SVFR) would be required to land at Dryden. The Cessna pilot requested that Air Ontario 1363 hold while he landed and reported that he was having "real bad weather problems" (Exhibit 7A, p. 31).

Captain Morwood's Call to System Operations Control

As noted in chapter 3, Dryden Municipal Airport and Air Ontario Facilities, on March 10, 1989, Dryden Flight Centre, operating under a contractual arrangement with Air Ontario, provided aircraft and passenger-handling services for Air Ontario at the Dryden Municipal Airport.

The Air Ontario counter was located in the southwest corner of the terminal. The public counter space was equipped with a Reservac computer linked with the Air Canada system, a boarding pass printer, one telephone for normal use, and one direct line telephone to the security counter in the airport boarding lounge. There was also a VHF two-way communications radio with three dials, to control volume, tuning, and squelch.

On March 10, the first flight to be serviced by Dryden Flight Centre was Air Ontario 1362 during its morning stop between Winnipeg and Thunder Bay. The next Air Ontario flight to be serviced was flight 1363, arriving from Thunder Bay on its return trip to Winnipeg.

The actions of Captain Morwood during the final moments before he boarded C-FONF for the last time were significant to the Commission's investigation into the human performance aspects of this aviation accident. In the course of the investigation, my staff became aware of information that suggested Captain Morwood had a heated conversation over the telephone while he was at the Dryden Airport terminal prior to the departure of flight 1363. A thorough inquiry was conducted into this potentially critical information, and sworn evidence on the subject was elicited from all relevant witnesses. Although there was some inconsistency in the evidence on this subject, I am able to draw some conclusions regarding the demeanour of Captain Morwood during the period immediately preceding the crash. It is, however, necessary to review carefully all the evidence on the subject. I will begin with the evidence of the two individuals who spoke with Captain Morwood on the telephone at the material time.

Evidence of Ms Mary Ward and Mr Wayne Copeland

Ms Mary Ward, the crew scheduler on duty at Air Ontario SOC in London, confirmed that on March 10, 1989, some time between mid-morning and afternoon, she took a telephone call from Captain Morwood, who was at the Dryden terminal. Ms Ward testified that she spoke with Captain Morwood for only a moment and noticed nothing unusual or abnormal about his tone of voice or his telephone demeanour. She stated:

> A. Captain Morwood mentioned the weather had gone down, and as soon as he mentioned that, I put him over to the dispatcher, Wayne Copeland.
>
> (Transcript, vol. 56, p. 118)

Mr Copeland, a dispatcher at Air Ontario SOC, testified that, at about midday on March 10, 1989, he spoke to Captain Morwood for approximately one minute. Mr Copeland stated that they discussed the payload, passenger load, and IFR alternate, and that the captain did not seem upset, in a hurry, or in any way abnormal. Mr Copeland emphatically stated that there was no heated exchange between him and Captain Morwood. Following the accident, at approximately 2 to 3 p.m. on March 10, Mr Copeland made the following note detailing the content of his conversation with Captain Morwood:

> At approx 1200L (Dryden time) received call from Capt Morwood from Dryden. Morwood and I discussed the fuel load, pax [passenger] load and IFR alternate. At this time I relayed the YWG [Winnipeg] 1700Z wx [weather] which was "-X 5 -SCT 120 -BKN 3F" Morwood then seemed content with the wx and advised that because of the load he would be holding YAM [Sault Ste Marie] direct as the alternate due to load, not YAM via YQT [Thunder Bay] as originally planned. Also mentioned there would be a short delay due fuel being uplifted.
>
> (Exhibit 350)

Mr Copeland, in referring to this note, explained that he had advised Captain Morwood that the Winnipeg weather was as follows: sky partially obscured, a thin scattered cloud layer based at 500 feet, a thin broken cloud layer based at 12,000 feet, with three miles of visibility in fog. This was the extent of Mr Copeland's evidence on the subject of his telephone conversation with Captain Morwood.

Telephone toll records indicate that a telephone call, 1.9 minutes in duration, was placed from the Air Ontario counter at the Dryden airport to Air Ontario SOC at 11:58 a.m. CST. In my view this corresponds with the telephone call described by Ms Ward and Mr Copeland.

Evidence of and Related to Ms Jill Brannan

Ms Jill Brannan, a ticket agent employed by Air Ontario's passenger handler, Dryden Flight Centre, was on duty at the Air Ontario counter at the Dryden airport terminal on March 10, 1989. Ms Brannan testified that she observed Captain Morwood come over to the Air Ontario counter during both station stops on March 10. She testified that she observed and overheard him in telephone conversation with London operations during the morning station stop (i.e., the stop of flight 1362 from Winnipeg to Thunder Bay), but that she had no recollection of his making a telephone call during the second station stop (flight 1363).

Ms Brannan testified that Captain Morwood came into the terminal immediately following the arrival of flight 1363 and that he was on the inside of the counter at the same time she was processing the lost-baggage claims of some passengers who had just deplaned from flight 1363. Ms Brannan testified that she and Captain Morwood discussed the fact that during the captain's telephone conversation with London SOC on the morning station stop, Captain Morwood had turned off the Dryden Flight Centre VHF radio.

Although Ms Brannan testified that she did not remember Captain Morwood's making any telephone call during the flight 1363 station stop, a number of witnesses gave evidence that Ms Brannan told them that Captain Morwood did make such a call.

Mr Christopher Pike, who worked for the maintenance department at the Dryden airport, testified that Ms Brannan told him that Captain Morwood "had been on the phone and ... was late" (Transcript, vol. 28, p. 52).

Mr Trevor Northcott and Mr Allan Hymers, both of Dryden, testified that they had a conversation with Ms Brannan at the Dryden airport terminal approximately one hour after the crash of C-FONF and that Ms Brannan told them about Captain Morwood's telephone conversation during the station stop. Mr Northcott stated in evidence that Ms Brannan advised both him and Mr Hymers that:

> A. ... when he [Captain Morwood] slammed up the phone, he was certainly upset or disturbed about something.
> Q. And she referred to the phone being slammed?
> A. Yes, she did.
> Q. And did she say anything else about that phone call, sir?
> A. No. She – not that I can recall, that – just assumed that he was – would be talking to Dispatch or Flight Ops or whoever, in the main office, I suppose, in London or –
> Q. Okay. Subsequent to her relating this telephone call to you, did she refer to receiving some radio communication from the pilot of that aircraft?
> A. Yes.
> Q. And would you tell the Commissioner about that, please.
> A. She said it was very unusual but he was talking on the radio. I don't know if she said the captain was talking on the radio, but the – there was two or three calls, and that he still appeared upset or disturbed about something.
> (Transcript, vol. 21, p. 113)

Mr Hymers's evidence on his conversation with Mr Northcott and Ms Brannan is as follows:

> A. ... she had told us that he had come in from the flight and he had made a phone call. And her words on the phone call were – she said – she said, I don't know what was said but he was really upset about something.
>
> And then she said he had left and that was about the only thing that he had said to her.

> And I actually don't know what was said to make her get that opinion and he went back to the aircraft.
>
> (Transcript, vol. 21, p. 79)

A final account of the Morwood telephone call came in the testimony of Ms Tara Barton. Ms Barton, a customer-service agent for Canadian Partner Airlines at the Dryden Municipal Airport, testified that at approximately 2:30 p.m., following the crash on March 10, 1989, she spoke with Ms Brannan in the Dryden airport terminal.

> A. ... I had first asked her if she wanted anything and she had said the cup of tea and ... I went over and talked to her for a while at that point.
> Q. And what else did you talk about?
> A. I had asked her how she was doing, how she was holding up. And she had said that she was worried.
>
> And the word "worried" struck me funny and I asked her, I said, why are you worried. I said, you wouldn't have done anything else for that flight that you wouldn't have done for any other flight, would you. And she said, no.
>
> She explained how the – the day had been unusual or the morning had been unusual from the beginning. She saw the captain come in both off 1362 and again off 1363 and made a phone call.
> Q. He made a phone call on just 1362?
> A. No, off of both flights.
> ...
> Q. Did she say anything else?
> A. She said that the second phone call had upset him and I told her not to worry about it. I said they can't fault – they are not going to fault you for anything that you have done as long as you have done your job.
>
> (Transcript, vol. 25, pp. 207–208)

Evidence of Captain Keith Fox and Ms Carol Petrocovich

In addition to hearing this "second-hand" evidence regarding Captain Morwood's demeanour in the Dryden terminal, I did hear from two individuals who spoke with Captain Morwood at the material time. Captain Keith Fox, an Air Ontario pilot, and Ms Carol Petrocovich, a court clerk in Kenora, Ontario, were both passengers who had departed from Air Ontario flight 1363 at Dryden. While standing adjacent to the Air Ontario counter at the Dryden terminal, they both spoke with Captain Morwood.

Captain Fox, after returning to the terminal from the airport parking lot, observed Captain Morwood on the telephone. Captain Fox testified:

A. ... I noticed George Morwood was standing at the Air Ontario counter. He was talking on the telephone.
Q. Now, when you say at, was he in front of the counter or behind the counter?
A. He was in front of the counter.
Q. Yes? And what was he doing again?
A. He was on the telephone. And I waved to him, sort of to say goodbye, and he motioned me over, he wanted to talk to me.
And he put his hand over the receiver, and he apologized to me for the delay. He said, sorry about the delay ... but they had us going out of Thunder Bay at – and he named a weight.
And I just did a quick calculation in my head, and I realized that, you know, going out at that weight that he gave me, that would put them over their landing weight in Dryden.
Q. You don't recall what weight he told you?
A. It was – thinking about it, I recall he used something and change. He did say that. But it was well over, you know, the limit. It was obvious from what – the figure he gave me.
...
Q. Do you recall it putting [him] over the maximum takeoff weight?
A. I don't recall that. I just recall – I had other things on my mind, but I recall it was definitely much over the landing weight.
Q. Do you recall the mood of Captain Morwood?
A. At that time, he just seemed more apologetic to me about the delay. And he also – on his P.A. announcement, he apologized for the delay as well on the way up to Dryden.

(Transcript, vol. 51, pp. 184–85)

Ms Petrocovich was at the Air Ontario counter, processing her lost-baggage claim. She testified that an off-duty pilot [Keith Fox] was ahead of her in the line, processing his own claim. She observed the pilot behind the counter [Captain Morwood] initiate a conversation with Captain Fox. Ms Petrocovich testified:

A. The gentleman ahead of me, it became apparent ... because of the conversation that took place that he was an off-duty pilot travelling as a passenger. He was quite concerned about some missing flight bags.
The pilot on the opposite side of the Air Ontario counter initiated some conversation with the gentleman ahead of me. He made a comment to him to the effect, You wouldn't have believed my [weight] in Thunder Bay before we took the fuel off; it was sixty-six and change.

Q. And was there any reply from the other individual in front of you?
A. Just acknowledgement of the comment.
Q. Now, what happened next?
A. The gentleman ahead of me, as I said, was extremely concerned about his missing flight bags. He was pressing the ticket agent to let him go out onto the tarmac and check the baggage compartment of the plane.
She replied with, as long as he had his identification card and put it on, he could go out and look in the baggage compartment. And he left.
Q. Can you describe the pilot standing behind the Air Ontario ticket counter.
A. He was about five-foot-ten, medium build, approximately 180 pounds, dark hair, slightly greying at the temples, dark-skinned, glasses. He wore a white shirt with dark pants ... dark tie, epaulets, approximately early fifties.
Q. Did you notice the demeanour of the pilot behind the counter when he was having his conversation with the individual in front of you?
A. As he was having this conversation with the gentleman ahead of me, he had his ear to the receiver of a telephone the entire time. He was dialling, and it appeared as if he was not getting a response from the other end. He continued dialling –
Q. Before that, what was his demeanour when he was talking to the other individual in front of you?
A. With regard to the comment about sixty-six and change, it was sort of disbelief.
Q. Now, was he on the telephone while he was talking to this individual in front of you?
A. Yes, he – well, he had the receiver up to his ear.
Q. Now, once the person in front of you left the counter, describe what happened then.
A. I started to make my claim with the ticket agent for the missing baggage. As we did so, the pilot spoke to me. He initiated a conversation. He said something to the effect, Oh, don't tell me we have lost your luggage too.
And I said it wasn't really important. He said they had thrown off approximately 10 to 12 bags in Thunder Bay, so, hopefully, it would come that same day.

(Transcript, vol. 26, pp. 10–12)

Ms Petrocovich went on to identify the Air Canada missing baggage report that she and Ms Brannan completed at the Air Ontario counter. Ms Petrocovich, who confirmed that the form was completed at approximately noon, testified that while she and Ms Brannan were completing the form, the pilot behind the counter tried unsuccessfully four or five times to complete a telephone call. She observed the pilot asking Ms Brannan to confirm the number he was dialling. Ms Petrocovich testified that she recognized the telephone as a local "Oxdrift exchange" number, beginning with the three digits "937." The Dryden airport is included within the Oxdrift exchange, but the Town of Dryden is not. Ms Petrocovich, who did not recall the final four digits of the number, was certain that the pilot dialled a local Oxdrift number and not a Dryden number or a long-distance 1-800 number.

Ms Petrocovich confirmed that the pilot was still behind the Air Ontario counter when she completed her baggage claim and left the terminal. She provided the following evidence on the pilot's demeanour while she was at the counter:

> A. ... there was an element of frustration because he could not complete his telephone call. Other than that ... he initiated a conversation with me and apologized for losing my luggage, and I don't think that falls into the category of a pilot's specifics, handling baggage, and ... I thought that was extremely kind of him, and he was extremely pleasant to me. But, as I said, he was frustrated because he could not complete his telephone call.
> (Transcript, vol. 26, p. 18)

When the evidence of Ms Petrocovich is considered, it is apparent that Captain Morwood was attempting to place two telephone calls, one local and one to Air Ontario SOC at London. Although he was unsuccessful in placing the local call, he obviously was successful in placing the call to Mr Copeland of Air Ontario in London. (The confirmed telephone call between Captain Morwood and Mr Copeland of Air Ontario SOC was a 1-800 long-distance telephone number.) It is evident that Captain Morwood attempted to place the local call prior to the call to London. In all likelihood, the 11:58 a.m. call to Air Ontario SOC occurred after Mr Fox and Ms Petrocovich left the Dryden terminal.

It was not possible to determine the party within the Oxdrift exchange whom Captain Morwood unsuccessfully tried to reach. It may have been he was attempting to call the CFR fire hall regarding the hot refuelling and was unsuccessful because the CFR personnel were already en route. (The Dryden CFR fire hall is in the 937 Oxdrift exchange.) Such a theory would, however, be speculation.

Having considered all the evidence regarding Captain Morwood's actions in the Dryden terminal during the flight 1363 station stop, I accept as fact that Ms Brannan did speak with the four witnesses – Pike, Northcott, Hymers, and Barton – about the noon-hour Morwood/SOC telephone call. The next step in assessing the evidence is to determine what weight, if any, can be attached to the substance of the comments Ms Brannan made to these individuals.

I note that much of what Ms Brannan told these four individuals was consistent with other evidence: Captain Morwood did make a telephone call, he was late, two subsequent radio communications were made to the Air Ontario counter by flight 1363, and the first radio communication was a hurried complaint about the additional wait for the Cessna 150. Because of the accuracy of the verifiable portion of what Ms Brannan told witnesses Pike, Northcott, Hymers, and Barton, and the fact that her comments to these individuals were consistent with the overall scenario at the Dryden terminal during the noon-hour station stop of flight 1363, I am prepared to attach some weight to the substance of the four indirect accounts of Captain Morwood's demeanour; and I am satisfied that Captain Morwood was exhibiting signs of frustration while he was in the Dryden airport terminal.

Later Events at the Terminal

Ms Brannan specifically recalled speaking with airport employee Christopher Pike before flight 1363 departed, a conversation corroborated by Mr Pike. Mr Pike testified that before going to the Air Ontario counter to speak with Ms Brannan, he had seen the captain "on his way out the arrival doors in somewhat expedient fashion" (Transcript, vol. 28, p. 21). Since Captain Morwood was on the telephone at the counter until about 12 noon, Mr Pike would have had to arrive at the Air Ontario counter shortly after 12 noon.

While Mr Pike was at the Air Ontario counter with Ms Brannan, two radio transmissions were received from flight 1363. The first transmission was to the effect that flight 1363 would have to wait for an incoming aircraft. Ms Brannan was questioned regarding this first radio transmission:

Q. And what conversation with the pilot were you referring to?
A. When he had called me on the radio just before he had taxied out.
Q. And that was the conversation about having to hold because of the small aircraft; is that right?
A. Yes.
Q. That's the conversation where you felt he sounded – describe how you thought he sounded.
A. I thought he sounded upset.
Q. And, again, would you tell me why you concluded that this man sounded upset.
A. Because he was talking really fast, and like, I couldn't really understand exactly what he was saying, just that he was saying

something about an incoming plane and God knows how long we're going to have to wait now.

And I didn't answer back because I didn't know what to say to him. And then, like not even two minutes later, he called back and said that he was going to taxi out now. And I said okay.

Q. He said something like, God knows how long we're going to have to wait now, right?
A. Yes.
Q. And he said that quickly, did he?
A. Yes.
Q. So quickly that you had trouble understanding him?
A. Yes.

(Transcript, vol. 20, pp. 170–71)

The following testimony by Mr Pike regarding the radio transmissions supports the evidence of Ms Brannan:

A. The first radio transmission was to the effect, Looks like we are going to have to wait. I can't believe there is a small aircraft coming in.
The second transmission –
Q. No, let's talk about the first for a moment. Did you gather anything about the way the pilot felt from what you heard on that radio transmission?
A. Yes, I did.
Q. Could you tell us about it.
A. He was very impatient, anxious ... Pissed off.
...
Q. You also heard a second transmission, sir?
A. Yes, I did. He had called in and said that, I see the small plane is down and we are taxiing out.

(Transcript, vol. 28, pp. 22–23)

On the evening of March 10, Mr Pike reduced to writing his recollection of the content of the radio transmission from flight 1363. His written recollection is repeated verbatim as follows:

Looks like we're going to have to sit a while. I can't believe there's a small plane coming in God knows how long we're going to sit here. I see the small plane is down now and we're going to taxi now. I can't believe there's a small plane coming in God knows how long we're going to have to stay here now. (Talking real fast. Impatient, Pissed off.) I see the small plane's down and we're going to taxi now.

(Exhibit 189)

Mr Pike elaborated upon the content of this note:

> Q. Now, Mr. Pike, the original which I have before me reads, and I quote,
> "I can't believe there is a small plane coming in. God knows how long we are going to have to stay here."
> And then you write,
> "Now talking real fast."
> What did you mean by that?
> A. It was the manner in which he was speaking. It was very quick. It was fast enough that Jill Brannan could not understand what he was saying and I had to repeat it to her.
> Q. And the next two words are "impatient, pissed off."
> A. Right.
> Q. That was the way you sensed –
> A. His feeling.
>
> (Transcript, vol. 28, pp. 24–25)

Very soon after the first transmission, a crew member of flight 1363 called back on the radio and said "okay, we're going to taxi out now." Ms Brannan stated that "the second time, he seemed a little calmer" (Transcript, vol. 20, p. 107).

It must be noted that Ms Brannan could not positively identify which crew member was speaking during these two radio communications. Mr Pike, however, expressed a view that it was the captain of the aircraft.[1] Given that it was apparently the task of First Officer Mills to perform the required operational radio communications while the aircraft was on the ground, and that he was in continuous contact with Kenora FSS and the pilot of the Cessna 150 when the Cessna made its final approach and landing, it seems likely that Mr Pike was correct in his assessment that it was Captain Morwood who twice radioed the Air Ontario counter at the Dryden terminal immediately before takeoff.

Role of the Cessna 150 Aircraft

As previously noted, while Air Ontario flight 1363 was preparing to depart from Dryden, a Cessna 150, registration C-FHJS, piloted by Mr Robert McGogy, was inbound to the airport. Mr McGogy, a low-time pilot with a private pilot's licence, had on March 10, 1989, a total of approximately 80 VFR flight hours.

---

[1] Because it was not Air Ontario's practice to record aircraft/station radio communications, there was no record of the two communications in question.

On March 10 Mr McGogy had decided to do some recreational flying. He drove from his home in Vermilion Bay to Dryden airport, where his aircraft was parked. Mr McGogy testified that the weather looked "a little bit iffy" (Transcript, vol. 22, p. 14), so he spoke to Mr Cochrane, who advised that "the weather would stay approximately the way it was and within about an hour would probably get worse" (Transcript, vol. 22, p. 17). Following this discussion and after having Dryden Flight Centre refuel his aircraft, Mr McGogy went flying. Figure 5-3 represents the course of his flight, as recalled by him in testimony. The visibility throughout the flight was poor. On his return leg and close to the Dryden airport, "it was almost a whiteout" (Transcript, vol. 22, p. 25). As he approached the airport, the snow increased in intensity, and the flakes "were approximately the size of 50-cent pieces, and they were very wet" (Transcript, vol. 22, p. 40).

In the first of two conversations with Kenora FSS, at 12:03:08, Mr McGogy reported that he was four miles south of the airport, inbound for landing. The FSS operator advised the pilot that the Dryden airport weather was below VFR minima and that he would require a special VFR clearance to enter the zone.[2] Mr McGogy responded that he would be using runway 29, but he did not request special VFR.

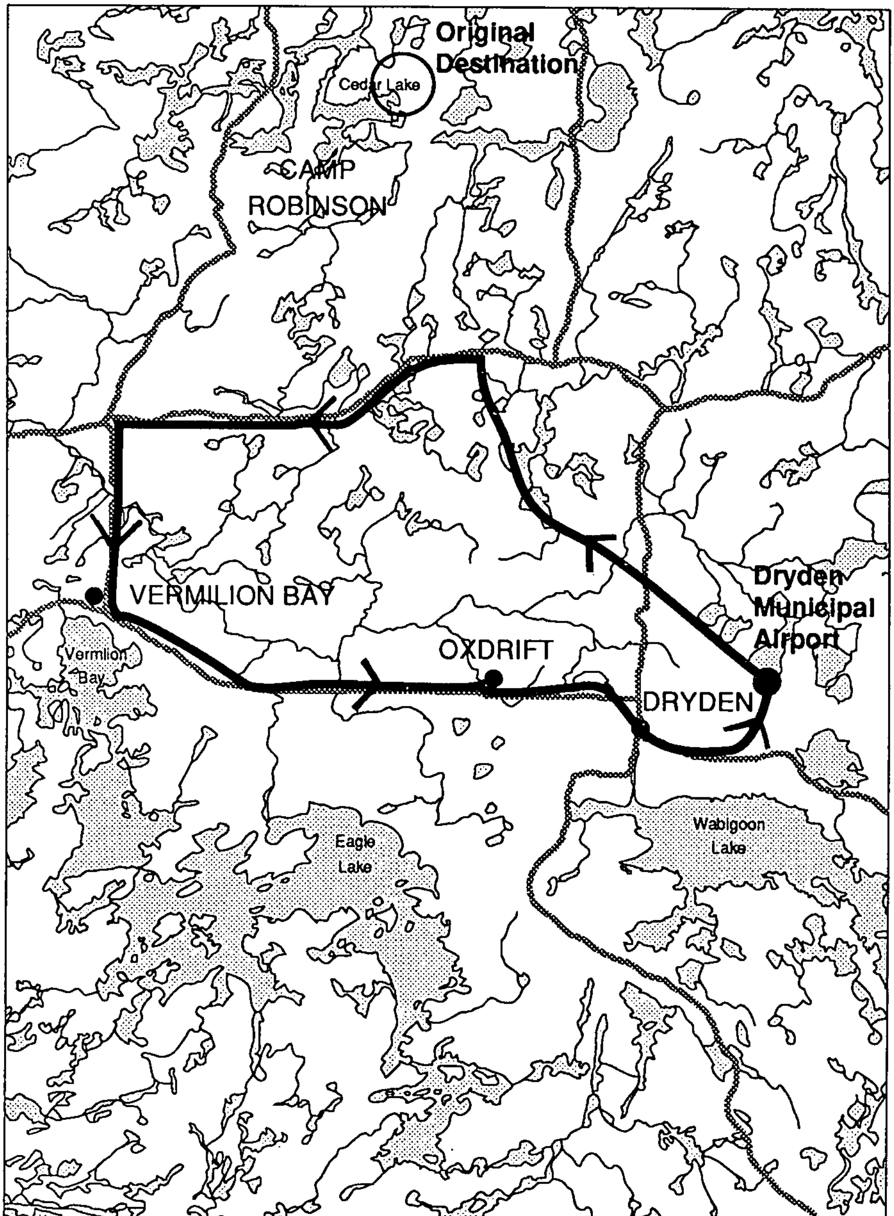
Mr McGogy testified that in order to maintain visual reference with the ground, his height above ground level varied, from a high of 1000 feet while en route to 150–200 feet while approaching runway 29.

Based on the evidence of Mr McGogy and his taped radio conversations with Kenora FSS, it is clear that he was a low-time pilot who was in serious trouble. Mr McGogy was already within the five-mile radius of the control zone surrounding the Dryden airport when he contacted Kenora FSS at 12:03. From the evidence it would appear that, when he made this initial communication, the weather was below VFR minima and any SVFR minima.

At 12:04:03 Mr McGogy asked: "There any chance that plane can hold, I'm having real bad weather problems here" (Kenora FSS taped log, Exhibit 7A, p. 31). Flight 1363 then indicated that it would hold.

[2] For an explanation of VFR minima, see chapter 3, Dryden Municipal Airport and Air Ontario Facilities. When weather minima are below VFR minima, special VFR flight (SVFR flight) may be authorized by the appropriate air traffic control unit subject to current and anticipated IFR traffic. This authorization is normally obtained through the local tower or FSS and must be obtained before SVFR flight is attempted within a control zone. On March 10, 1989, the applicable SVFR weather minima were as follows: (a) ceiling of not less than 500 feet and ground visibility of not less than 3 miles; (b) ceiling of not less than 600 feet and ground visibility of not less than 2 miles; or (c) ceiling of not less than 700 feet and ground visibility of not less than 1 mile.

Figure 5-3 Flight Path of the Cessna 150



The crew of flight 1363 informed the passengers of the additional delay caused by the Cessna, and at approximately 12:04 a crew member, probably Captain Morwood, called Ms Brannan on the radio to advise that the F-28 would have to hold for a light aircraft.

At 12:04:07, First Officer Mills made the following radio transmission:

> Okay three sixty three's, holding short of the active, be advised you are down to a half a mile or less in snow here.
>
> (Exhibit 7A, p. 31)

Since the crew of the F-28 were aware of what was transpiring in relation to the Cessna, there are several possible explanations of the purpose of First Officer Mills's transmission. In addition to advising both Kenora FSS and the pilot of the Cessna 150 that Air Ontario 1363 would hold and would not proceed onto the active runway, its purpose may have been the following:

- to warn the pilot of the Cessna 150 of the weather at the airport;
- to advise either Kenora FSS or the Cessna 150 pilot, or both, that the weather was below special VFR limits; and/or
- to inform Captain Morwood, indirectly, of the deteriorating weather and the fact that Captain Morwood was below his takeoff limitation.

Mr Keith Fox, a passenger who departed flight 1363 at Dryden and himself an Air Ontario F-28 pilot, testified that when he was driving south from the airport on Airport Road he saw Mr McGogy's Cessna 150 flying north to the airport at an "extremely low altitude ... [of] no more than 200 feet" (Transcript, vol. 51, p. 189). Mr Fox gave the following evidence regarding the estimated visibility at the time he observed the Cessna 150 overhead:

> A. I would estimate quarter mile, but it's hard to estimate because it was freezing on my windshield. It was very bad conditions at the time.
>
> (Transcript, vol. 51, pp. 189–90)

Mr McGogy estimated that he landed approximately 200 feet beyond the button of runway 29. He testified that the runway had approximately one-quarter inch of slush at its centre, with a greater accumulation of slush on the north side of the runway.

After landing at 12:06:42, Mr McGogy contacted Air Ontario 1363 on the radio, asking, "Are you using Runway one one or two nine?" Air Ontario 1363 replied, "We'll go for 29" (Exhibit 7A, p. 33). Having confirmed that the F-28 would be using runway 29, Mr McGogy taxied west, beyond taxiway Alpha, allowing the F-28 to proceed from taxiway

Alpha onto the active runway and to turn right (east) towards the button of runway 29. Mr McGogy then taxied off the runway onto taxiway Alpha and subsequently onto taxiway Charlie, in order to bring his aircraft to its parking location near Dryden Flight Centre.

Five minutes and 53 seconds passed between the time Air Ontario 1363 commenced to hold at the intersection of taxiway Alpha and the ramp and the time it advised Kenora FSS that it was "about to roll" (Exhibit 7A, p. 35). The total time that elapsed up to the actual commencement of the takeoff roll was estimated to be 6 minutes and 4 seconds. A delay of approximately 2 minutes and 45 seconds is attributable to flight 1363 waiting for the Cessna 150 to land.

At 12:07, as flight 1363 taxied for the button of runway 29, the flight crew received their instrument flight rules (IFR) clearance for their flight to Winnipeg. Meanwhile, the snow was continuing to fall heavily, becoming increasingly thick on the wings. When flight 1363 was backtracking towards the button of runway 29, the flight crew lowered the flaps to 18° for takeoff. After turning the aircraft around at the east end of runway 29 they powered up the engine for about 15 seconds before beginning the takeoff roll. The last transmission received from the flight crew, at 12:09:29, was the call, "about to roll twenty-nine at Dryden" (Exhibit 7A, p. 35). The aircraft then started the takeoff roll, approximately one hour and 10 minutes behind schedule.

Eyewitness Observations of Precipitation

Ramp Area

It was acknowledged by every witness who testified on the subject that, during the station stop at Dryden, the ramp area in front of the terminal and where the F-28 waited for Robert McGogy's Cessna 150 to land was, at the very least, wet at all times from falling precipitation.

The ramp area in front of the terminal was black and wet, and, as 12 noon approached, the snowfall's intensity increased and a film of slush began to cover the ramp.

Mr Alfred Bertram, a survivor of the crash and himself a flight service specialist with Transport Canada, was seated in aisle seat 9C and had a reasonable line of vision to the ramp area. Referring to the period when the aircraft initially parked at the terminal, he stated that he "was marvelling at the fact that snowflakes this size (indicating) were actually melting" (Transcript, vol. 18, p. 12).

Mr Ronald Mandich was one of the surviving passengers who boarded flight 1363 in Dryden. He testified as to his observations while boarding the aircraft:[3]

Q. Now describe boarding the aircraft.
A. Well, as we left the security area after going through security, I would say that the airplane was approximately 50 to 80 feet from the doorway.
And as I proceeded with my briefcase in one hand and I flipped my hood on my jacket up over my head because the snow was intense enough so that I figured by the time I got to the airplane, I was going to have a head full of snow and then I would have to deal with that after I got on the airplane ...
Q. Did you observe any snow or precipitation on the tarmac areas as you walked up?
A. My recollection is that the tarmac had been scraped from previous snow such that there were bare spots and there were hard packed covered areas. And the snow was sticking to the hard pack snow areas and it was melting on the pavement areas.

(Transcript, vol. 17, pp. 351–52)

Mr Daniel Godin, seated in 9B, made some critical observations of the ramp on the left side of the aircraft, the area between the aircraft and the terminal. Mr Godin testified that he observed an emergency vehicle standing by during the refuelling and noted that, because of the intensity of the snowfall, the only reason the vehicle could be seen was that it had its headlights and flashing roof lights illuminated. As well, he testified that he saw the refuellers pulling down their toques and pulling up their collars because they were getting covered in wet snow.

In his testimony, Mr Godin stated:

A. We – as we were sitting there, a dead-style snowstorm hit us, no wind. It started snowing quite heavily.
I watched the snow hit the side windows of the airplane, immediately turn to water and run down to give us the effect of raining.
Outside, I had watched the tarmac, and, at all times, you could see asphalt on the tarmac, but it was covered by a layer of thin slush.

(Transcript, vol. 17, pp. 174–75)

[3] It must be noted that refuelling began at approximately 11:50 a.m., and the passengers who boarded at Dryden embarked before the refuelling commenced.

Two passenger/pilots on board the F-28, Air Ontario Captain David Berezuk and Air Canada Captain Murray Haines, testified about the ramp area in front of the terminal. Captain Berezuk described the area as black and wet. Captain Haines testified that the flakes "melted when they hit the tarmac" (Transcript, vol. 19, p. 15). Captain Haines did not believe it to be snowing at the time he boarded the aircraft at Dryden.

As the aircraft moved away from the front of the terminal to the intersection of the ramp and taxiway Alpha, where it waited for the Cessna 150 to land, the snowfall increased in intensity. According to Mr McGogy's testimony, there was up to one-quarter inch of slush at the intersection by the time the Cessna 150 had passed through taxiway Alpha, this being seconds after the F-28 progressed through taxiway Alpha onto the active runway.

Wings

With the exception of Mr Vaughan Cochrane, every witness who had observed the aircraft wings while the aircraft was parked in front of the terminal testified that the wings were, to some extent, covered with snow, wet snow, or ice.[4] Those who observed the wings while the aircraft was waiting at the intersection of the ramp and taxiway Alpha also testified that the wings were, to some extent, covered with snow.

While the F-28 was standing in front of the terminal, a number of revealing observations were made. Mr Michael Ferguson was seated in 10E, a window seat with a direct unobstructed view of the right wing. He stated that the amount of snow covering the wing was such that he "couldn't see ... the line of rivets on the wing" (Transcript, vol. 13, p. 15).

Mr Gary Jackson was seated in 13A, a window seat with a direct line of vision to the left wing. He recalled that during the time the aircraft was at the terminal, the snow was "slowly but steadily increasing." He stated that snow was collecting on the wing and that "[a]t the terminal, between 5 and 10 per cent of the wing would have been covered" (Transcript, vol. 16, pp. 125, 126). He was able to see the metal on the wing through the snow.

Mr Ricardo Campbell was seated in 7D, an aisle seat directly over the wing. He stated that, while waiting at the terminal prior to the aircraft taxiing for the first time, he observed "straight ice" on the right wing. "There was a glaze," he said (Transcript, vol. 17, pp. 46, 47). Air Ontario Captain David Berezuk was seated in 12A, a window seat with a direct line of vision over the left wing. He stated that, just before the aircraft taxied out, he looked at the wing and saw a trace of snow covering all of the wing. He estimated that this trace of snow, at the highest point,

[4] See my first *Interim Report*, pp. 24-25.

was approximately one-quarter inch thick. Referring to the distribution of snow over the wing, Captain Berezuk said that at its highest point the snow "was sort of a texture of a sculptured carpet" (Transcript, vol. 14, p. 55).

Mr John Biro was seated in 11E, a window seat directly overlooking the wing. He stated that the snow on the wing was melting, but not as rapidly as it was falling, and that there was an accumulation of snow on the wing. At the time the fuel truck was by the aircraft the accumulation was, he believed:

> A. ... about between an eighth and a quarter of an inch accumulation. And it seemed to stay about that way throughout the refuelling process because it was melting next to the wing and the new snow was landing on top of the wet, melting snow.
> (Transcript, vol. 21, p. 9)

Air Canada Captain Murray Haines, who was seated in 13D, testified that he had a good view of the right wing:

> A. ... the first large snowflakes fell and they fairly adhered themselves to the wing. As they touched the wing, they melted a bit and adhered to the wing.
> (Transcript, vol. 19, p. 15)

Flight attendant Sonia Hartwick stated that she looked at the wing while the aircraft was parked in front of the terminal, and that there was "a fluffy layer of snow on the wing" (Transcript, vol. 10, p. 218).

Similar observations of snow accumulation on the wings, while the aircraft was standing in front of the terminal, were also made by firefighter Gary Rivard, who was attending to the hot refuelling, and by Ms Cherry Wolframe, an employee of Dryden Air Services, who was inside the terminal.

Observations of Mr Vaughan Cochrane

The only eyewitness to testify that he did not see any snow on the wings while the aircraft was in front of the terminal was Mr Vaughan Cochrane. Mr Cochrane had initially boarded the F-28 to give the baggage count to the crew. It will be recalled that he refuelled the aircraft, and then spoke with Mr Stanley Kruger about the fuel spill.

At approximately 12:01, Mr Cochrane boarded the aircraft for a second time, to advise that the fuelling was complete. His observations of the events surrounding the crash were recorded by him in a prepared statement, drawn up at approximately 3 p.m. on the afternoon of the crash. This statement contains in my view three noteworthy items:

- On start up commenced snowing heavy wet snow ...
- A/C was taxiing before any build-up on wings ...
- My impression are undecided however I do not feel icing was heavy or sustained to be a major factor ...

(Exhibit 415)

As noted earlier, while Captain Morwood was in the terminal, First Officer Mills was checking the weather with Kenora FSS. First Officer Mills made the following transmission from the aircraft to Kenora FSS at 12:00:30:

> Okay we check that, we're down to about a mile and a half in Dryden in snow right now, quite puffy, snow, looks like it's going to be a heavy one. Uh, okay and go ahead the rest.
>
> (Exhibit 7A, p. 29)

This radio transmission was apparently made by First Officer Mills before Mr Cochrane boarded the F-28 for the second time to give the crew the fuel slip.

In view of this radio transmission, Mr Cochrane was asked to recall the snowfall at that time:

Q. ... would you like to reconsider your own recollection of what the snowfall was like when you boarded the aircraft which would have been, in all probability, after that point in time?
A. No, I think that's consistent with a light to moderate snowfall. He [Keith Mills] of course, from his perspective, was looking out to the west and could see the approaching weather.
Q. So you would not disagree that it was puffy snow that was falling at that time?
A. No, I wouldn't disagree with that.

(Transcript, vol. 53, pp. 159–60)

Following the crash, Mr Cochrane gave two interviews to Mr Guy Dutil of the Canadian Aviation Safety Board (CASB). In his first interview, on the morning of March 11, 1989, Mr Cochrane recalled what he observed when he was in the aircraft to advise that fuelling was complete:

- ... I gave the pilot his final uplift ... at that point it had started to snow fairly heavy wet snow.

- ... we gave him the O.K. to depart because it was snowing heavy they closed the door right off quick.

- Marshalled them off the gate and he departed the gate. There was no significant accumulation of snow on it.

- When it was sitting on the ramp during the turn around that – that airplane was clean. It started to snow on it about the time we started closing it up.

(Exhibit 414[a], pp. 3, 8)

In his second interview with Mr Dutil, on March 14, 1989, Mr Cochrane described coming out of the cockpit after the fuel uplift was given:

- I marshalled the aircraft off the gate, toward the taxiway. The question is about snowing, or was about snowing. It had started very, very light snowfall as I was coming down from out of the cockpit. As the aircraft turned to taxi, it was snowing very, very lightly.

- In my mind there was no question at that point about de-icing the aircraft, there was just no significant accumulation of snow on the airplane.

- ... when that airplane left the ramp, it was ready to go flying. It hadn't snowed enough to create an accumulation.

- The snow had not started when he had marshalled off the ramp or was so light as to be insignificant ...

(Exhibit 414[b], pp. 3, 7, 9)

Mr Cochrane, when questioned on the obvious discrepancy in the two statements that he gave CASB regarding the intensity of the snowfall, explained:

A. I would have to say that the first interview with Mr Dutil was probably the most current and would probably represent the best information.

(Transcript, vol. 54, p. 173)

When he was questioned before the Commission, Mr Cochrane was presented with the observations of witnesses describing the snowfall and condition of the wings while the aircraft was parked in front of the terminal. In view of the consistent nature of the observations made by other eyewitnesses, Mr Cochrane's contrary evidence was challenged. He stated that his observations of the aircraft wings were restricted to those made from the stairs of the aircraft, and he conceded that the other witnesses, who were sitting in the aircraft, looking out at the wings, would have had a better view. I have no hesitation in concluding that the evidence of the other witnesses correctly reflects the condition of the wings of the aircraft while it was on the ramp.

Waiting for the Cessna 150

When the aircraft departed from in front of the terminal, it moved to the intersection of the ramp area and taxiway Alpha, where it waited for the Cessna 150 to land and clear the active runway. A number of observations made by witnesses aboard the aircraft reveal the effect of the deteriorating weather conditions on the wings.

Air Ontario Captain David Berezuk, who from his vantage point in seat 12A was able to see the left wing, acknowledged that the snow was accumulating and staying on the wing.

> Q. And what did you see?
> A. I saw snow accumulation on the left-hand wing wet in texture and, again, like a sculptured carpet.
> Q. And how much snow was accumulating?
> A. At what time?
> Q. When the aircraft was parked on the taxiway just prior to Alpha.
> A. Approximately quarter of an inch.
> Q. It was a quarter of an inch. Now, you said it was a quarter of an inch by the terminal approximately?
> A. That is correct.
> Q. Now when it taxied out and stopped just prior to entering taxiway Alpha, how much – how thick was the snow?
> A. It was more than one quarter of an inch at that time due to the increasing snow.
> Q. And was it adhering; was it staying on the wing?
> A. Yes.
>
> (Transcript, vol. 14, pp. 59–60)

In response to further questioning, Captain Berezuk provided evidence of his additional observations to the effect that up to one-half inch of snow had accumulated on the wings while flight 1363 waited at the intersection for the Cessna 150 to land:

> Q. And at the end of the five minutes as the aircraft was sitting there, did you observe the left wing?
> A. Yes.
> Q. And did you observe the right wing?
> A. Yes.
> Q. And can you tell me what the weather conditions were like at the end of the approximate five minutes?

> A. At the end of the five minutes, the portion of the left wing, of which I stated I could see, was varying in amounts up to one half an inch at that time.
>
> (Transcript, vol. 14, pp. 61–62)

Mr Michael Ferguson, from his vantage point in seat 10E, made the following observation:

> A. ... The wing was covered with snow. I remember saying to my wife to look at the wing ...
>
> (Transcript, vol. 13, p. 17)

Mrs Susan Ferguson corroborated the evidence of her husband, Mr Michael Ferguson.

Ms Kelly Mackenzie, seated in 10B, a vantage point close to the centre of the wing, described what she saw on the wing of the aircraft:

> A. ... I was noticing that white was starting to cover the wings at this point ... it was just building up to a white colour. That's what I saw.
>
> (Transcript, vol. 19, pp. 185–86)

Mr Brian Perozak was seated in window seat 4E. Looking over his right shoulder while the aircraft waited for the Cessna to land, he observed "up to a half an inch of fluffy snow on the wings" (Transcript, vol. 16, p. 229).

Flight attendant Sonia Hartwick also testified that, while waiting for the Cessna 150 to land, "there was a layer of fluffy snow on the wing" (Transcript, vol. 10, p. 228).

Findings

Landing at Dryden

- Air Ontario flight 1363 landed in Dryden on March 10, 1989, in visual meteorological conditions. When the aircraft landed, the runway was bare and wet. Light snowflakes that melted upon contact with the tarmac were falling when the aircraft taxied to the Dryden terminal.

At the Dryden Terminal

- While passengers were leaving and boarding the aircraft, the snowfall was steadily increasing in intensity. Initially, snowflakes were melting on contact with the tarmac, but, by the time the aircraft was about to leave the terminal, at approximately 12:01 p.m., a thin film of slush was covering the ramp.

- While at the Dryden terminal, the aircraft was refuelled. Because the auxiliary power unit on the F-28 was unserviceable, it was necessary to keep one engine running during the refuelling. This practice, which is commonly referred to as a "hot refuelling," was performed while the passengers remained in the aircraft and in all probability commenced before the required fire trucks were in place.

- Hot refuelling with passengers on board is a highly questionable and unsafe practice that was contrary to the provisions of the ESSO Aviation Operations Standards Manual and the Air Ontario Flight Attendant Manual.

- During the refuelling procedure, Captain Morwood went into the airport terminal while First Officer Mills remained in the aircraft.

- Captain Morwood unsuccessfully attempted to place a local telephone call from the Air Ontario counter at the Dryden airport terminal. While he attempted to place this telephone call, Captain Morwood spoke with Captain Keith Fox and Ms Carol Petrocovich. Captain Morwood apologized to Captain Fox for the delay of flight 1363 and explained that, in Thunder Bay, "they" (presumably Air Ontario System Operations Control (SOC)) had put the flight well over its maximum landing weight at Dryden. Captain Morwood apologized to Ms Petrocovich regarding her lost baggage.

- Captain Morwood showed signs of frustration when he was unable to complete his local telephone call.

- After failing in his attempt to place the local call, at 11:58 a.m., Captain Morwood telephoned Air Ontario SOC, speaking with Ms Mary Ward and then Mr Wayne Copeland. Captain Morwood advised Ms Ward that the weather at Dryden had deteriorated, and he discussed fuel and passenger loads and the Winnipeg weather with Mr Copeland.

- Ms Brannan of Dryden Flight Centre was in a position to observe and/or overhear Captain Morwood making this telephone call. Although Ms Brannan stated that she had no recollection of speaking with anyone about the telephone call, I am satisfied by the evidence of witnesses Pike, Northcott, Hymers, and Barton that she did advise them of such a telephone call.

- Although Mr Copeland and Ms Ward stated that Captain Morwood was not upset when they spoke with him, they were not in a position to observe his demeanour following his telephone conversation. I am satisfied that, in the Dryden terminal before and after the SOC telephone call, Captain Morwood was exhibiting signs of frustration and of being in a hurry.

- Captain Morwood left the terminal in a hurried fashion after he completed his telephone call to Air Ontario SOC.

- On boarding C-FONF at approximately 12 noon, Captain Morwood seemed troubled and did not have a "happy expression."

Accumulation of Snow on the Wings while Aircraft at Gate

- Snow continuously accumulated on the wings of the aircraft throughout the station stop. When the aircraft was about to leave the terminal area, at approximately 12 noon, its wings were covered in snow to depths varying from one-eighth to one-quarter of an inch.

- Ground handler Vaughan Cochrane was in a position to observe the wings prior to the aircraft's leaving the terminal area, and he knew, or ought to have known, that the wings were covered in snow. Captain Morwood asked Mr Cochrane whether de-icing was available, and Mr Cochrane indicated that it was. There was no follow-up to this inquiry by either Captain Morwood or Mr Cochrane.

Waiting for the Cessna 150

- As the F-28 was about to proceed onto the runway, it was unexpectedly subject to a delay, of approximately 2 minutes and 45 seconds, while, in heavy snow and poor visibility, a Cessna 150 aircraft landed.

- The pilot of the Cessna 150, Mr Robert McGogy, was not instrument rated. He was already within the five-mile radius of the control zone surrounding the Dryden airport when he first contacted Kenora FSS at 12:03:08 p.m. It would appear that, when he made this initial communication, the weather was below VFR minima and any SVFR minima.

- During this delay, a pilot from flight 1363, in all likelihood Captain Morwood, radioed back to the Air Ontario counter at the Dryden airport and, in a hurried, impatient manner, said to the Air Ontario ticket agent something like: "I can't believe there is a small plane coming in. God knows how long we are going to have to stay here."

- At approximately the same time, Captain Morwood made a public address announcement to the passengers, explaining the reason for the delay.

- A short time later, Captain Morwood radioed back to the Air Ontario counter and, in a calmer tone, advised the Air Ontario ticket agent that the small plane had landed and that flight 1363 was about to taxi out.

- During the delay created by the Cessna 150, the snowfall increased in intensity such that visibility was reported by First Officer Mills at 12:04:07 p.m. to be one-half mile or less.

- During the delay, the accumulation of snow on the aircraft wings increased to an uneven depth of one-quarter to one-half inch.

- At the time the F-28 entered the runway and began back-tracking to the button of runway 29 (approximately 12:07:00 p.m.), there was an accumulation of approximately one-quarter to one-half inch of slush on that portion of the runway.

6 CIRCUMSTANCES RELATED TO THE TAKEOFF AND CRASH OF FLIGHT 1363

The Takeoff Roll – Condition of Aircraft

At 12:09:29 p.m., a flight crew member of flight 1363 advised Kenora Flight Service Station (FSS) that they were "ready to roll." The estimated time of commencement of the takeoff roll is 12:09:40 p.m.

A number of telling observations regarding weather conditions just prior to takeoff and during the takeoff roll were made by surviving passengers. Flight attendant Sonia Hartwick testified that the snowfall intensified, particularly from the time the aircraft left the terminal to the time it arrived at the end of the runway in preparation for takeoff. Her observations as to the transformation of snow to ice during the takeoff roll were vivid:

> Q. Now, you're rolling down that runway, and what are you looking at?
> A. I'm staring at the wing.
> ...
> Because, at this time, as we rolled down the runway, the snow was now turning to ice on this wing, it was freezing to the wing.
> Q. Now, let's stop there and go over this in some detail. If you're rolling down the runway, you, up to that point in time, have observed this layered, fluffy buildup of snow, and what happened to that layered, fluffy buildup of snow as you were rolling down the runway?
> A. It crystallized and turned to ice.
> Q. Describe to me what you saw.
> A. At first, it was frosty, and then it turned clear, and then it was now the color of the wing and you could see a sheen on it, that it was actually ice on the wing.
> Q. So you could see the transformation?
> A. Yes, you could definitely see the transformation. It happens very quickly.
>
> (Transcript, vol. 10, pp. 239–40)

Mrs Hartwick's evidence on the witness stand, as to the condition of the wing on takeoff, was consistent with a tape recording of her telephone conversation with Mr Clifford Sykes, then the director of flight operations at Air Ontario, which took place between 1:15 and 1:30 p.m. on March 10, 1989, approximately one hour after the crash. Mrs Hartwick was not aware that her telephone conversation with Mr Sykes had been tape recorded by him, and the existence of the tape was discovered by Commission staff only by chance in early August 1989 and the tape itself was eventually obtained by Commission investigators in September 1989. The relevant portion of the transcript of this tape recording reads as follows:

> Sonia: And uhm, the wings were icing up.
> Cliff: They were? After take off or before?
> Sonia: Uhm, before take off there was quite a bit of wet snow on them, as we were taking off it was freezing.
>
> (Exhibit 126)

Mr John Biro, from his observation point in seat 11E, directly above the wing, stated:

> A. We started to roll down the runway and at this stage I was looking at the wing rather closely, hoping that as we gained speed this wet snow would slide off.
>
> We reached flying speed at seemingly about the same time as previously. And as the nose of the aircraft lifted, the snow on the back part of the wing, about halfway up across the wing, came off with a puff, almost an explosive-type puff.
>
> And the snow on the forward part of the wing seemed to freeze to an opaque, dull opaque ice, almost a flash freezing type thing. And it had a rough surface, not – not coarsely rough but definitely a rough surface.
>
> (Transcript, vol. 21, p. 12)

David Berezuk, an Air Ontario Dash-8 captain, from his window seat in row 12, observed a half-inch "wet snow accumulation" on the left wing as the aircraft was taxiing towards the button. He described the snowfall as "increasing in intensity from the time we arrived at the terminal until the whole takeoff phase" (Transcript, vol. 14, pp. 79–80).

As the aircraft was on its takeoff roll, Captain Berezuk noted the snow on the wing changed in colour from white to an opaque grey, dissipated in thickness, and took on a sculptured carpet texture:

> A. ... As we gained forward speed approximately 10 to 20 percent, in my best assumption, 10 to 20 percent of the snow had blown off the wing.

Q. Did you see that snow blow off?
A. It is not really a question of seeing it blow off, I saw it dissipate.
Q. When you say "dissipate," did the thickness of the snow on the wing just decrease?
A. Yes.
Q. Did it change in colour at all?
A. Yes.
Q. Can you tell me what that colour was?
A. The parts where it was sculptured, again, I explained that it was a sculptured carpet texture, the parts that were white in colour got more of a greyish opaque colour and the parts that were greyish got more grey in intensity.

(Transcript, vol. 14, p. 84)

As the F-28 was taxiing towards the button in preparation for takeoff, Captain Murray Haines, an Air Canada pilot seated in an aisle seat in row 13, described what he could see of the wing as "thoroughly covered in wet snow" with a rough texture.

He further specified:

Well, I could see the root of the wing. I couldn't see the leading edge. But, as much as I could see, it was covered in snow.
Q. And was it a very smooth cover that you observed or was it –
A. No, it was a rough texture.
Q. Rough texture, okay. And was it – while you were taxiing, was it blowing off or falling off?
A. No, it wasn't.

(Transcript, vol. 19, pp. 34–35)

Captain Haines then testified that, on the plane's final takeoff roll, he observed that the snow on the wings was not moving off and he saw it crystallize to ice:

A. ... as the speed got up, the snow crystallized into ice, and it wasn't moving off the wings.
Q. You saw the snow crystallize to ice?
A. Yes, I was watching it all the time.

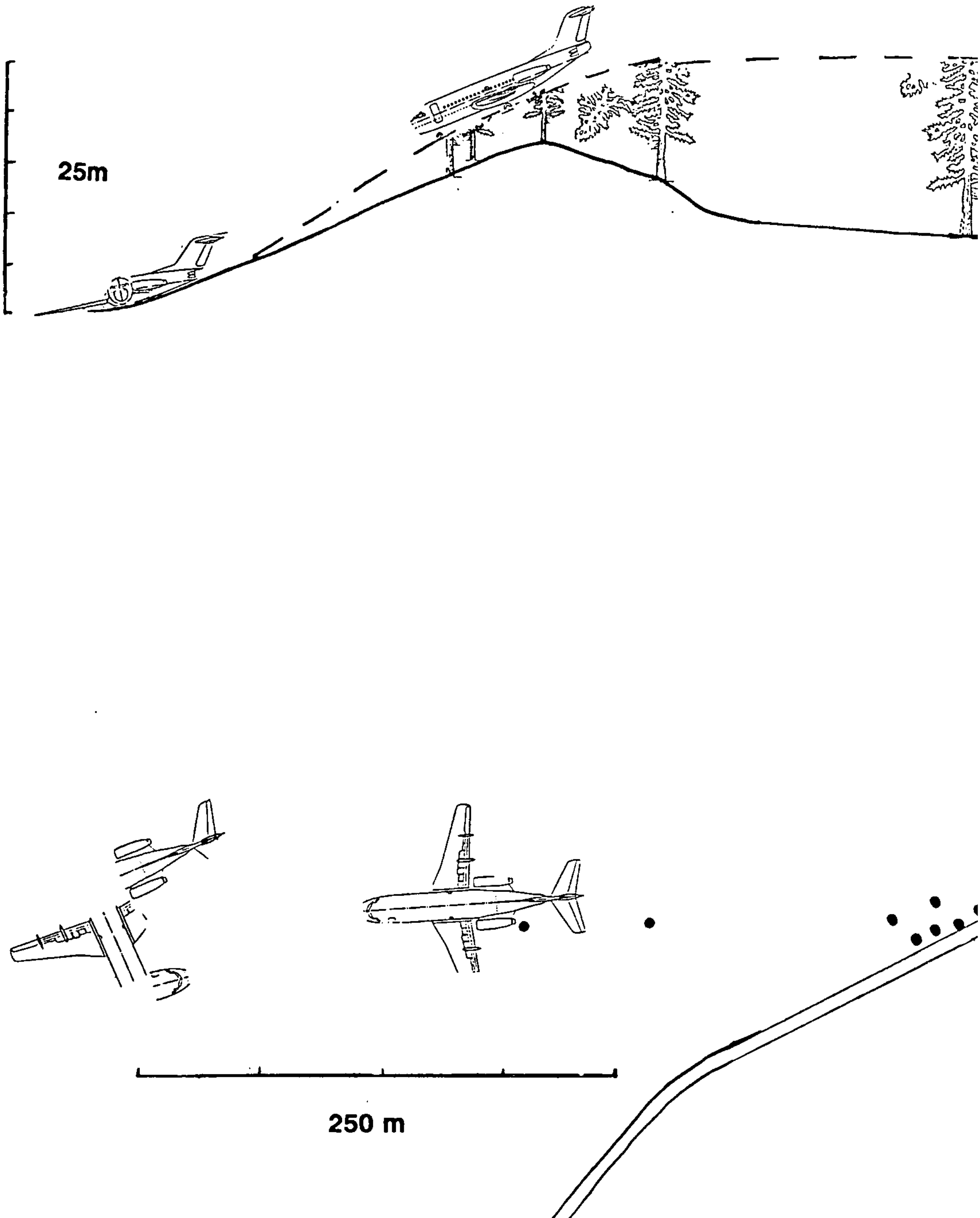
(Transcript, vol. 19, p. 37)

In testimony, passenger Brian Perozak, seated in 4E, described the front edge of the wing on the takeoff roll as looking like "a glazed donut." He described the rest of the wing as crystallized:

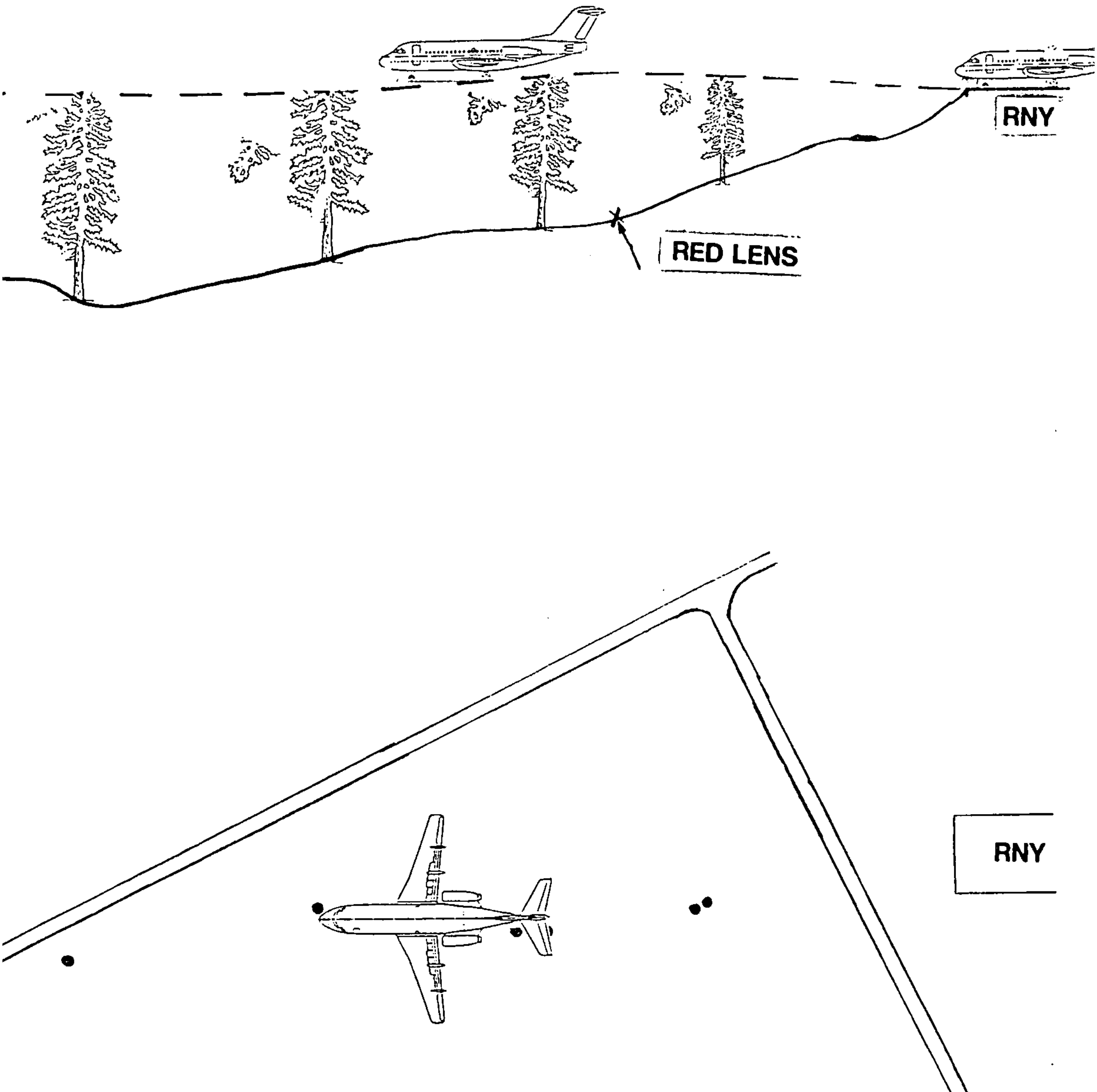
A. ... It was not as it was before. It was not just snow on the rest of the wing, it seemed like it had crystallized on what I could see of the rest.

(Transcript, vol. 16, pp. 234, 236)

Figure 6-1 Aircraft Flight Plan Profile



Source: Exhibit 484



AIR ONTARIO FOKKER F-28, C-FONF
DRYDEN MUNICIPAL AIRPORT
DRYDEN, ONTARIO
CASB ENGINEERING
PRELIMINARY PLOTS

●●● TREE STRIKES

AIRCRAFT AND TREES NTS

The Takeoff – Eyewitness Observations

The destruction by fire of the flight data recorder and the cockpit voice recorder resulted in heavy reliance being placed upon eyewitness observations of the takeoff. Many persons were interviewed, and evidence was adduced from ten witnesses on the ground who observed all or a portion of the takeoff roll and the takeoff itself. These witnesses were all asked to describe their observations and to note on a sketch of the runway where they recalled specific occurrences, such as the point of rotation of the aircraft and the point of liftoff, to have taken place. As well, a number of passengers on board flight 1363 made observations concerning the takeoff.

All the witness observations were carefully reviewed by the Commission counsel and investigators, and subsequently by experts working with CASB and its successor the Transportation Safety Board of Canada (TSB). The observed locations on the runway of specific occurrences were plotted onto a scale drawing of runway 29 and then converted into distances along the runway, thereby providing a reconstruction of the takeoff roll, rotation, and liftoff of flight 1363 (see figure 6-1). Further, in support of the investigation, Mr Michael Poole of the TSB laboratory analysed the eyewitness testimony and provided the Commission with a computer-generated video flight-path reconstruction. Mr Poole's flight-path reconstruction report and the computer video reconstruction were entered as exhibits and were considered by me as evidence.

Mr Roscoe Hodgins, an experienced pilot, had observed the F-28 aircraft take off some 12 to 15 times in Dryden. On March 10, from a location at the Ministry of Natural Resources building adjacent to the button of runway 29, he heard the F-28 engines power up and saw the aircraft accelerate. It was his testimony that the acceleration of the F-28 was not as rapid as he had observed on the previous occasions. Mr Hodgins did not see the nose of the F-28 lift but stated that he saw the tail go down, at approximately the 3400-foot mark of the runway. He did not see the F-28 lift off.

Mr Stanley Kruger of the Dryden airport crash, fire-fighting, and rescue (CFR) service was in his fire truck parked on taxiway Charlie adjacent to the wind-sock when he observed the takeoff roll of flight 1363. He testified that he saw the aircraft as it accelerated from the button of runway 29 up to a point just east of taxiway Alpha. At that point, approximately the 3100-foot mark of the runway, the F-28 had not rotated.

Mr Craig Brown, a commercial pilot with Terraquest Ltd, with approximately 1250 hours of flying experience, was on the eastern side of the main ramp area when he observed the F-28. He first saw the F-28 when it was at approximately the 2300-foot mark of runway 29. He saw the nose of the aircraft lift just west of taxiway Alpha. Mr Brown testified that the main wheels of the F-28 stayed on the ground for a considerable time thereafter until the aircraft was observed to leave the runway at approximately the 4900-foot mark.

Mr Allan Haw, who was working as a mechanic at the Dryden airport on March 10, testified that he had previously observed F-28 aircraft land and take off at least 100 times. He first observed flight 1363 when he was working outside a maintenance equipment shed located east of the terminal and south of the runway. He testified that, at approximately the 2700-foot mark of the runway, the F-28 was going considerably slower than it should have been at that point on the runway. Mr Haw expected the F-28 to abort its takeoff, and he therefore continued to watch what was transpiring closely. At approximately the 5700-foot mark of the runway, he observed the F-28 in the air: "I could see sky between the underpart of the airplane and the tree tops" (Transcript, vol. 24, p. 140). He described the takeoff as being very shallow and slightly nose up.

Mr Gary Rivard, also of the airport CFR services, was on the eastern side of the ramp area in front of the terminal when he observed the F-28 on its takeoff roll. He testified that, at approximately the 3200-foot mark of the runway, just east of taxiway Alpha, all wheels of the aircraft were on the ground.

Mr James Esh was working as a ground handler for Dryden Air Services and, as of March 10, had approximately 140 hours of flying experience as a pilot. He was walking west on the tarmac just to the west of the terminal building when he heard the F-28 throttling up. He glanced over and first observed the F-28 at about the 3600-foot mark of the runway with all wheels on the ground. Mr Esh then continued to observe the takeoff roll:

> A. ... from that point, I watched the rest of his ground run there. And he went to approximately the 11 numbers[1] on the west side of the runway before he rotated, and it looked like he really reefed on the controls, just, you know, hauled back.
>
> He had an extremely high angle of attack, and the right wing dropped just a bit, and it looked like he corrected, and it also looked like he overcorrected just – just a bit. And the left wing dropped just a bit, and he corrected that.

---

[1] The term "11 numbers" refers to the markings on the west end of the runway. approximately 350 feet from the end.

> And it just looked like he was mushing along there in a high angle of attack, not gaining any altitude, and he disappeared behind the trees in the snow.
>
> (Transcript, vol. 24, pp. 203–204)

Mr Martin Gibbs was the co-pilot of a NorOntair Twin Otter, which was the first plane to take off after flight 1363 had crashed on March 10, 1989. He had approximately 1760 hours of flying experience. While the F-28 was on its takeoff roll, he was in the airport manager's office in the terminal building looking out towards the runway; he observed the F-28 to have a "positive attitude" with the nose wheel apparently off the ground at approximately the 3800-foot mark (Transcript, vol. 23, p. 23). He testified that the aircraft was airborne at taxiway Alpha, with all wheels off the runway. Once the aircraft was past taxiway Alpha, the right wing appeared to dip, the right main gear appeared to contact the runway, and the F-28 appeared to level out.

Mr Jerry Fillier, a ground handler with Dryden Flight Centre, was standing on the ramp outside the terminal building when he first observed the F-28. He testified that, just east of taxiway Alpha, the F-28 had all wheels on the ground. He next observed it just west of taxiway Alpha when the nose wheel was off the ground and the aircraft was rotating.

Mr Christopher Pike, a maintenance employee at the airport, was also in the airport manager's office when the F-28 was taking off. He first observed the F-28 at the intersection of the runway and taxiway Alpha. He stated that it had all wheels on the ground and appeared to be going slower than it should have been at that point on the runway. At approximately the 4400-foot mark Mr Pike observed the F-28 take a "skip and hop" with the left wing coming up and the right wing dropping. Then he observed the F-28 to lift off at the 5700-foot mark of the runway. He was very certain of this observation since his line of sight of the aircraft was lined up with the first set of VASIS (visual approach slope-indicator system) lights. Mr Pike testified that the aircraft did not seem to want to fly but rather "kind of waddled through the air" (Transcript, vol. 28, p. 36).

Mr Norbert Altmann, captain of the NorOntair Twin Otter and with approximately 5000 hours' flying experience, was in the weather office located at the northwest corner of the terminal building on March 10 while the F-28 was on its takeoff roll. He observed it at approximately the 5000-foot mark of the 6000-foot runway. He noted that it had a nose-high attitude and that it was low for being so far down the runway.

Observations by passengers on board flight 1363 were of assistance in determining the movements of the aircraft during the takeoff roll and, by and large, were consistent with the observations made by people on the ground.

Captain Berezuk testified that approximately 500 to 1000 feet past taxiway Alpha (at approximately the 4000-foot mark of the runway) the aircraft attempted to rotate and began to shudder; the nose of the aircraft was then lowered to one-half of the initial rotation angle (from an estimated 10° to 4° or 5°). Captain Berezuk testified that there was a second rotation but was unclear as to where it occurred.

Flight attendant Hartwick also recalled the aircraft initially attempting to rotate, not succeeding, and then rotating a second time. She was not able to specify where these rotations occurred, but stated that on the first attempt it felt like the aircraft bounced, came back down onto the runway, continued down the runway, bounced again, and stayed in the air. At the time of the second bounce, the aircraft jerked to the left with the left wing coming down.

Passenger Ronald Mandich, a professional engineer with aviation experience in the management of flight test programs and vibration testing for Hughes Aircraft Corporation, described the takeoff roll. Mr Mandich testified that, as the aircraft gained speed during the takeoff roll and the nose pulled up, "it didn't appear to me that the plane wanted to leave the runway as easy or as quickly as it had on the previous flights" (Transcript, vol. 17, p. 357). Mr Mandich also recalled that the aircraft left the runway for approximately two seconds and came back down onto the runway. Then there was an increase in the pitch of the engines and the aircraft left the runway. He estimated that the aircraft, as it flew over the end of the runway, was 15 feet off the ground.

Runway Conditions before and after Takeoff

A number of witnesses testified as to the condition of the runway immediately before and after takeoff. Mr McGogy, the Cessna 150 pilot, described the condition of the eastern end of the runway at about 12:06:30, the time of his landing:

> A. The runway where I landed, there was approximately a quarter inch of slush on the centre of the runway and onto the north side ... had accumulated a bit more. I would say it would be 3/8 to half an inch range of slush.
>
> (Transcript, vol. 22, p. 54)

He also testified about the condition of taxiway Alpha:

> A. Taxiway Alpha, my recollection was exactly the same as the runway was. It was approximately a quarter inch of wet slush on the taxiway.
>
> (Transcript, vol. 22, p. 59)

It is important to note that it was continuing to snow heavily and with increasing intensity after Mr McGogy left the runway in his Cessna 150 and that the slush accumulation on the eastern portion of the runway would have continued to increase during the entire period up to and including the time of the F-28 takeoff roll.

Captain Murray Haines, a passenger on flight 1363 and an experienced Air Canada pilot, described the runway as being covered in slush, with the black of the tarmac visible through it in the centre and with the slush accumulation being more "yellowish" along the edges of the runway.

After the takeoff, personnel at the airport quickly learned that the F-28 appeared to have crashed. Gary Rivard in Red 2 noticed the F-28 on its takeoff roll, almost at taxiway Alpha, just after he finished hosing down the fuel spill in front of the terminal. He was backing up Red 2 when an employee at the airport, James Esh, ran towards him waving his arms while slipping and sliding on the slush-covered surface. Mr Rivard testified that Mr Esh was hollering: "the plane went down, the plane went down, get going ... I looked behind me and I could see all this grey, white smoke in the air" (Transcript, vol. 28, p. 219). Mr Rivard then immediately drove down taxiway Alpha onto runway 29 and proceeded to its western end. He described the condition of the runway to the west of taxiway Alpha:

> A. ... the portion of the runway that I ran on going and coming was a hundred percent bare and wet.
>
> And I made my turn at the end with no problem and that is – when I did that, I noticed Ernie Parry was right behind me.
>
> (Transcript, vol. 28, p. 220)

Mr Rivard further testified that he saw no tracks after he turned his vehicle around at the west end of the runway and doubled back towards the maintenance road.

Chief Ernest Parry had observed Red 2 proceeding at a high rate of speed from the ramp in front of the terminal area up taxiway Alpha. He immediately followed, staying 50 to 75 feet behind it and to the left of the centre line of the runway. He too described that portion of the runway as bare and wet going west and testified that a "very light spray" was coming from the wheels of Red 2 (Transcript, vol. 6, p. 229).

In cross-examination, Chief Parry was asked whether he saw any tracks on the runway after turning around at the west end:

Q. And when Red 2 and yourself turned around and proceeded back, in an eastbound direction, did you see ribbons of tracks?
A. No, sir, I didn't see any trace of any tracks at all. It was just wet pavement.
Q. Not even your own tracks?
A. Not even our own tracks.

(Transcript, vol. 7, p. 16)

Mr Kruger also proceeded onto the active runway in Red 1 moments after the F-28 had taken off. His observations of the runway condition to the west of taxiway Alpha support the observations of Chief Parry and Gary Rivard:

A. Trying to look back and visualize it, I can only describe it as black and wet.

(Transcript, vol. 26, p. 110)

Observations Shortly after the F-28 Takeoff

Mr Norbert Altmann, the NorOntair captain, testified that at approximately 12:30, only 20 minutes after the takeoff of flight 1363, he observed the ramp area in front of the terminal to be clear, black, and covered with wet slush which was one-half inch deep. Mr Altmann's Twin Otter departed Dryden at 12:50 p.m. bound for Red Lake, with Martin Gibbs as the co-pilot. The Altmann/Gibbs aircraft was the first aircraft to taxi to the east end of the runway after the departure of Air Ontario 1363.

First Officer Gibbs described the ramp and easterly portion of the runway, that is, between taxiway Alpha and the button of runway 29, as then having "about a half inch of slush on them." He testified that he was able to see the tracks created in the slush by the F-28 when it backtracked to the threshold of runway 29:

A. ... About halfway down on the backtrack on runway 29, I noticed the F-28 tracks from his backtracking. At that point, I decided to take note of them to see how far down the runway they went, and they went right to the threshold of runway 29.
Q. Now, how thick do you estimate the slush to be?
A. Still, it was about a half inch, a quarter to a half inch of slush.
Q. And was it white or could you see the tarmac or the runway?
A. It was – it was melting. You could see the darkness of the tarmac through it. It was not white.

(Transcript, vol. 23, pp. 30–31)

In cross-examination, Mr Gibbs reiterated as follows:

> Q. You indicated that you saw what you thought were the tracks of the F-28 on 29 about halfway down 29.
> Can you tell me if those tracks were continuous to what you described as the threshold of 29 or were they intermittent ...
> A. They were – from the point that I first observed them, they were continuous, and I believe it was the taxi portion of his departure there. I noticed them right to the threshold where they turned around. Once we straightened out, lined up for takeoff, could see his tracks and our tracks at the same time.
> Q. And were these tracks straight or was there any differential to them?
> A. As I recall, they were straight.
> Q. Were there three tracks or two?
> A. I recall three tracks.
>
> (Transcript, vol. 23, pp. 42–43)

Captain Altmann, testifying as to the condition of the runway at this time, corroborated First Officer Gibbs's evidence and stated that there was one-half inch of slush on the runway between taxiway Alpha and the threshold of runway 29:

> A. Taxiing out, we back-taxied for departure off of runway 29, which would be going westbound. On the taxi out, I taxied down the middle of the runway. I was looking for foreign objects that might have come off the jet, pieces of shrapnel, whatever, you know, the – having realized that the airplane had crashed, there might be pieces of metal and shrapnel laying on the runway, and I was looking for that.
> Q. Did you observe any contamination on the runway, slush or snow?
> A. No snow. I would say a thin layer of slush, half an inch thick. That's not a problem for the Twin Otter. I didn't notice the tracks of the other aircraft, the F-28. My co-pilot did notice that. However, my main concern was looking for debris on the runway so that I wouldn't run over it.
>
> (Transcript, vol. 22, pp. 200–201)

The evidence of various witnesses clearly establishes that at the time of the takeoff of flight 1363 there was a buildup of slush, approximately one-half inch in depth, on the eastern half of runway 29 up to the vicinity of taxiway Alpha, and that the western end of the runway was bare of slush but wet.

Findings

- A heavy snow squall covered the entire eastern half of the Dryden airport, extending from taxiway Alpha eastward, between the time flight 1363 departed the terminal area and its takeoff on March 10, 1989.

- The snowfall increased in intensity and continued to fall heavily during the entire period from the time that the F-28 entered the runway and taxied eastward to the threshold of runway 29, at approximately 12:07:00 p.m., until after its takeoff, which commenced at approximately 12:09:40 p.m.

- There was an accumulation of at least one-half inch of wet, layered snow on the wings of the F-28 as it began its takeoff roll.

- The snow on the forward part of the wings of the F-28 aircraft, the area most critical to aircraft lift, froze and crystallized to form dull, greyish opaque ice, of a rough sculptured-carpet texture, during the takeoff roll, while some of the snow on the back part of the wings was blown off.

- The usual point of rotation of the F-28 aircraft during routine takeoffs, observed on other occasions, from runway 29, was at a location prior to taxiway Alpha, some 3100 feet to the west of the threshold of runway 29.

- After a longer than normal takeoff roll, the F-28 aircraft, C-FONF, was rotated near taxiway Alpha, at approximately the 3500 foot mark. The aircraft lifted off slightly, began to shudder, and then settled back down onto the runway.

- The takeoff roll then continued and the aircraft was rotated a second time, finally lifting off at approximately the 5700 mark of the 6000 foot runway. It flew over the end of the runway approximately 15 feet above the ground. It thereafter failed to gain altitude and mushed through the air in a nose-high attitude, before commencing to strike trees.

- There was an accumulation of between one-quarter inch and one-half inch of wet slush on the runway as the F-28 aircraft entered the runway at approximately 12:07:00 p.m. and commenced back-tracking to the button of runway 29.

- At the time of commencement of the takeoff roll by C-FONF, 12:09:40 p.m., there was a runway surface accumulation of slush between one-quarter and one-half inch in depth extending from the threshold of runway 29 to taxiway Alpha. The remainder of the runway, being in the airport area to the west of taxiway Alpha, and not affected by the snow squall, was bare of slush but wet.

7 THE CRASH AND THE RESPONSE

The Crash

Air Ontario flight 1363, after a longer than normal takeoff run, rotated and struggled into the air about 4000 feet down the runway. It settled back onto the runway and continued its takeoff run before lifting a few feet into the air virtually at the end of the runway. The aircraft was unable to gain any altitude. It began contacting trees 127 metres from the runway end and then barely cleared a treed rocky bluff some 700 metres west of the runway, before going down into a wooded area, coming to rest 962 metres from the end of the runway.

Standing on the tarmac outside the terminal building, Mr James Esh, who described the events in his testimony to the Commission, continued to watch after the aircraft left the ground:

> Q. Did the aircraft climb at all?
> A. No, it didn't.
> Q. And what happened next?
> A. Then I could remember hearing the engines still screaming away, and then there was a – about half a second of – or a second of just silence. Then there was a big orange or red fireball with a mushroom cloud of black smoke.
>
> (Transcript, vol. 24, p. 204)

Mr Craig Brown of Terraquest Ltd saw the aircraft disappear behind trees:

> A. After one- or two-second delay, there was smoke and a fireball.

He described the smoke as "very black and with orange glowing flames in it" (Transcript, vol. 5, p. 234).

After contacting the first treetop, the aircraft continued another half kilometre, striking more treetops and leaving a trail of wreckage before hitting a substantial number of trees while clearing the top of a wooded knoll. Fire broke out on the left side of the aircraft as it descended beyond the knoll, and its left side struck the ground first. It came to a stop against a stand of trees, breaking into three pieces (see figure 6-1 in the preceding chapter, Takeoff and Crash of Flight 1363). The tail section faced forward, the main section of the fuselage turned to the left of the tail section, and the cockpit section rotated further to the left of the fuselage, so that the main wreckage formed an approximate u-shape.

The fire followed the aircraft path until the aircraft finally came to rest. After the crash, fire was confined to the crash site and to the trees along and beside the trail of wreckage. Infrared photography reveals the charring of trees that occurred during the crash fire. The fire gutted the fuselage from the interior of the cockpit back to the rear pressure bulkhead, but left part of the right side of the fuselage in place, with the exterior paint scheme charred but recognizable (see colour plates).

Crash Fire Rescue Response at the Terminal

The primary objective of crash, fire-fighting, and rescue (CFR) services is to save lives in the event of an aircraft accident or an aircraft or airport fire, and the emphasis is on CFR personnel providing a fire-free escape route for passengers and crew. A secondary objective is to preserve property by containing, or extinguishing where practical, any fire resulting from an aircraft accident or incident.

As of March 10, 1989, the airport at Dryden, Ontario, was equipped and staffed according to Transport Canada's requirements for CFR services. The complement of CFR unit staff at the Dryden airport was as follows: Ernest Parry, chief of the unit, with six years' service; crew chiefs Stanley Kruger and Bernard Richter and fire-fighter Gary Galvin, each with six years' experience; and two other fire-fighters, Kenneth Peterson and Gary Rivard, each with one year's service. Three CFR vehicles were involved in the events of that day: Red 1, a rapid intervention vehicle, driven by Mr Kruger; Red 2, a tanker truck, driven by Mr Rivard; and Red 3, a utility van, driven by Chief Parry.

Red 1 had returned to the fire hall, and Mr Rivard had just finished washing down the fuel spill by the terminal building when he was told that flight 1363 had probably gone down. He immediately drove Red 2 to the end of the runway. Chief Parry noticed Red 2 proceeding at speed towards the active runway, realized that something was wrong, and drove out onto the runway behind Red 2.

Both Red 2 and Red 3 drove west at a high rate of speed on the active runway. When it became obvious that they could not reach the location of the smoke from the runway, both vehicles turned around and proceeded back towards the terminal area. Chief Parry testified that while he was still on the runway he was fairly certain that the aircraft had crashed. He left the active runway in Red 3 at taxiway Alpha. Red 2, turning at high speed, skidded off a service road, got stuck in a snow bank, and had to be pulled out by airport employee Christopher Pike using a front-end loader. Mr Rivard then topped up Red 2 with water to replace what had been used washing down the fuel spill.

Between 12:09:29, when Air Ontario flight 1363 advised the Kenora Flight Service Station that it was about to roll, and 12:12:47, there were a number of radio communications questioning the whereabouts of the flight and involving Chief Parry in Red 3, Kenora FSS, and air traffic control out of Winnipeg. At 12:12:47 Chief Parry advised that the aircraft might have gone down west of the airport, since smoke could be seen in the distance, and further advised that he was proceeding in that direction. At 12:14:00, Chief Parry advised the Town of Dryden police dispatch that he suspected the F-28 jet had gone down approximately three or four miles west of the runway and requested that the mutual aid and emergency plan be activated.

At the Air Ontario Counter

After the crash of flight 1363, Mr Vaughan Cochrane, the Dryden Flight Centre general manager, went to the Air Ontario counter and called London SOC. He also told Ms Jill Brannan to "lock everything up, we just had a crash" (Transcript, vol. 20, p. 121). She testified that she gathered all papers relating to the crash, such as flight manifests and passenger lists, and locked them in a drawer at the counter. Later that afternoon, the contents of the drawer were given to Mr Cochrane, who took them to the Dryden Flight Centre office. Ms Linda Harder, the senior Dryden Flight Centre passenger agent, testified that when she arrived at the airport at about 2:00 p.m. she sealed the documents in an envelope:

> Q. And the documents which we were talking about, Mrs Harder, generally what did they constitute?
> A. The passenger manifest, the lifted ticket coupons, the messages that had been received pertaining to the flight from previous downline stations.
>
> (Transcript, vol. 25, p. 116)

Despite the best efforts of Commission staff, these documents were never located.

At the Scene

Chief Parry in Red 3, joined by Stanley Kruger in Red 1, left the airport property via the airport's public access road and thereafter travelled westward by public highways to McArthur Road and Middle Marker Road. Chief Parry positioned Red 3 at the intersection of the two roads, unlocked the gate leading into Middle Marker Road, and waved Red 1 down that road. It was estimated that Chief Parry arrived at the intersection at approximately 12:18 p.m. He established a command post there.

The aircraft had crashed in Wainwright Township, an area under the overall command of the Ontario Provincial Police. The fire-fighting responsibility for this location was held by the Unorganized Territories of Ontario (UT of O) Fire Department under the direction of Chief Roger Nordlund. Chief Parry, however, was the first responsible fire-fighting official to arrive near the crash site. He testified that, when he established the command post, he in fact had "no official jurisdiction" at the site, but was simply responding to the situation.

The first OPP officer to arrive at the site was Sergeant Douglas Davis, who testified that he arrived at the intersection at approximately 12:30 and assumed control of site access, egress, and security.

Two civilians, Mr Craig Brown and Mr Brett Morry, were the first persons to actually reach the crashed aircraft, making a path through the deep snow. Mr Brown and Mr Morry had left the terminal immediately on seeing the orange fireball and had driven towards Middle Marker Road. Finding the gate closed, they climbed over the fence and hurried down the road until they reached a point that seemed to be near the aircraft. They then made a trail through the waist-deep snow towards the smoke and sounds of fire. Arriving at the aircraft, they saw a number of survivors, some in quite good condition and others seriously injured.

Crew chief Kruger drove Red 1 nearly to the end of Middle Marker Road and parked. He then followed on foot the path made by Mr Brown and Mr Morry, carrying with him a portable radio and a first-aid kit weighing 11.5 kilograms. He initially estimated the distance from the road to the aircraft at 150 yards. As he came close to the crash site he encountered about 20 survivors, whom he directed to walk out to the road. These 20 to 25 survivors reached Middle Marker Road at approximately 12:32 p.m., just after Sergeant Davis arrived at the intersection. Sergeant Davis testified that he first saw them after speaking to Chief Parry, and that some of them appeared burned and had other injuries.

By the time Mr Kruger arrived at the aircraft, all but one of the surviving passengers had gotten out of the crashed aircraft. Mr Uwe Teubert and Mr Michael Kliewer, who had not yet been discovered, were trapped outside on the left side of the aircraft until approximately 1:10 p.m., when they were freed from the wreckage and attended to by rescuers including Dr Gregory Martin and Dr Alan Hamilton, both of Dryden. They were carried from the crash site and transported by ambulance to the Dryden hospital at 1:45 p.m. Mr Kliewer subsequently died.

During the hour and a half from 12:15 to 1:45, all other surviving passengers either made their own way to Middle Marker Road or were assisted by various persons from the Dryden airport CFR unit, the UT of O fire-fighting unit, the Town of Dryden fire-fighting unit, officers from the OPP, civilians, and by medical personnel from the Dryden Municipal Hospital.

Handlines from UT of O fire vehicles positioned on Middle Marker Road were not brought into the crash site until between 1:50 and 2:00 p.m. At approximately 2:00 p.m., one hour and 50 minutes after the crash occurred, foam was first applied to the fire, using the handlines. Mr Raymond Godfrey, a volunteer member of the UT of O Fire Department, was one of those who took the hose in from UT of O firetruck No. 4. He testified that about 10 or 12 people were involved in taking the hose into the crash site and that the operation took 5 or 10 minutes.

Crew and Passenger Injuries

Twenty-one passengers and three crew members died as a result of the crash. Forty-four passengers and one crew member survived. Most of the passengers who died were seated in the left and front portion of the aircraft. The majority of the bodies recovered at the crash site were badly burned in the subsequent aircraft fire, which made it difficult to determine the various injuries and specific causes of death. All the fatalities were investigated and their body shift, major injuries, suspected cause of death, and gross estimate of survival time were documented. Twenty-two people died at the site and two died in hospital – Mr Kliewer approximately three hours after the crash, and Mrs Nancy Ayer approximately 11 hours after the crash. Of the 45 people who survived the crash, 18 required hospitalization. Appendix H at the end of this Report is a summary of the information on the fatalities and survivor injuries.

The Afternoon of March 10

Two matters of significance occurred in relation to the Dryden airport on the afternoon of March 10. The evidence is that Red 1, 2, and 3, being all of the Dryden CFR fire-fighting equipment, left the airport to attend at the crash site. The last vehicle to depart the airport was Red 2, which left at approximately 12:30 p.m. It was not until 3:46 p.m. that a notice to airmen (NOTAM) was issued by the Kenora FSS to advise that CFR coverage was not available at the Dryden airport. At 4:30 p.m., after a Town of Dryden firetruck arrived at the airport CFR fire hall, a further

NOTAM was issued by Kenora FSS, advising that CFR coverage was again available at Dryden. From approximately 12:30 p.m. until 4:30 p.m., there was no CFR coverage available at the Dryden airport, and from 12:30 p.m. to 3:46 p.m. there was no notification of this lack of coverage. There were landings and takeoffs at Dryden airport during these hours, as was shown by the evidence of several witnesses and by notations made in the daily air traffic record for that day. Mr Peter Louttit, the airport general manager, testified that the failure to issue the NOTAM in a timely manner was a technical error that should not have occurred.

At approximately 2:00 p.m. Mr Louttit asked Mr Arthur Bourre to look for debris on the runway. Mr Bourre had worked for the Town of Dryden for approximately ten years, nine years as a weather observer and most recently as an equipment operator. He drove out the maintenance road east of taxiway Alpha and onto the active runway. He travelled along the north side of the centre line to the button of runway 29, turned around, and drove back on the south side of the centre line to the button of runway 11. He testified that the runway was covered with slush, which was deeper and whiter towards the east. He estimated that the slush was from three-quarters to one and one-half inches deep. His evidence leaves no doubt that the snowfall over the eastern half of runway 29/11 did not abate until some time after the takeoff of flight 1363.

As he proceeded to the button of runway 11, the slush diminished, and he estimated that the slush at that end was at least three-quarters of an inch deep. Although Mr Bourre did not perform a James Brake Index test, it was his assessment that "it [the runway] was very slippery, and, in my estimation, the braking action was nil" (Transcript, vol. 28, p. 133). The slippery condition of the runway was reported to Mr Louttit at approximately 2:30 p.m. He took no immediate action to have the runway cleaned but simply told Mr Bourre "to stand by" (Transcript, vol. 28, p. 134).

Mr Bourre observed pieces of ice sticking out of the slush on the runway between the maintenance access road and taxiway Alpha. Although he was not certain of the origin of this ice, it was his opinion that it had come from the CFR vehicles that had driven on the runway. Evidence as to the origin of the ice was inconclusive.

Removal of the Bodies

Sergeant Paul Miller of the OPP Technical Identification Services Unit in Kenora, Ontario, was assigned as the identification officer responsible for the Dryden crash. He arrived at the Dryden OPP detachment at approximately 6:00 p.m. on March 10, and reported to the crash site at approximately 7:30 p.m. After touring the crash scene, he formulated a plan for recording and examining the site and removing the bodies from the aircraft wreckage.

Before Sergeant Miller arrived, another OPP officer had marked the locations of 21 individual bodies in the aircraft, with another subsequently identified for a total of 22. On Saturday, March 11, Sergeant Miller initially viewed the site by air and prepared a video of his observations. He and other OPP officers arrived at the crash site at approximately 11:00 a.m. No remains were removed from the aircraft until after the Canadian Aviation Safety Board (CASB) investigators attended at the site and, in conjunction with the police investigation on March 11, photographed and documented the position of the bodies. Measurements of the wreckage were taken, and the locations of bodies were identified and marked precisely. Removal of the bodies commenced in the early afternoon. The bodies of 11 people had been removed by the time hazardous working conditions caused by darkness stopped the work on Saturday. The remaining bodies were removed from the aircraft wreckage on Sunday, March 12. All the bodies were taken to a temporary morgue set up at the Dryden arena under the security of the OPP. Because of poor weather conditions, the remains were transferred from Dryden to Thunder Bay by ground transport rather than by air. They were then transported from Thunder Bay to Toronto via an Air Ontario Convair aircraft. Sergeant Miller accompanied the remains from Dryden to Thunder Bay and Toronto.

Upon arrival at Toronto the bodies were transported to the Forensic Pathology Branch of the Ministry of the Solicitor General on Grenville Street, arriving at approximately 8:15 p.m. on March 13. It should be noted that, in addition to the bodies removed from the aircraft, the body of Michael Kliewer, who died at the Dryden hospital, was also transported from Dryden to Toronto.

Post-mortem examinations were performed in Toronto between March 14 and March 22, 1989. Mrs Nancy Ayer, who survived the crash, subsequently died at Winnipeg Memorial Hospital and a post-mortem was performed in Winnipeg, Manitoba, on the morning of March 14, 1989.

Finding

- The F-28 aircraft failed to gain altitude after takeoff, maintaining a flat, nose-high flight path until it began impacting trees 127 metres from the runway end. It barely cleared a treed rocky bluff 700 metres west of the runway before going down into a wooded area where it broke up into three sections, coming to rest 962 metres from the end of the runway.

8 DRYDEN AREA RESPONSE

Emergency Services

At 12:14 p.m. on March 10, 1989, while en route to the crash scene, CFR Fire Chief Ernest Parry made the following transmission to the Town of Dryden police dispatch:

> This is Airport Red 3. We suspect we have an F-28 jet down approximately 3 or 4 miles west of the runway. Please activate the mutual aid and emergency plan.
>
> (Dryden Dispatch Fire Tape)

In so doing he initiated the mobilization of all the emergency assistance available in the area. This one radio call resulted in the notification of the emergency to three fire departments, the Dryden Police Department, the Dryden hospital, the Dryden Ambulance Service, and the Ontario Provincial Police (OPP).

Mutual Aid

There are three fire departments in the Dryden area, the Dryden airport crash, fire-fighting, and rescue (CFR) unit, the Town of Dryden Fire Department, and the Unorganized Territories of Ontario (UT of O) Fire Department. On March 10, 1989, the CFR unit at the Dryden airport was the only full-time, professional fire-fighting team in the area. The Town of Dryden's Fire Department is a volunteer unit and only the chief is a full-time fire-fighter. The UT of O Fire Department, which responds to fires in the townships of Aubrey, Van Horne, Wainwright, Britton, Eton, Rugby, and part of Zealand, is an entirely volunteer force. The crash site was in Wainwright Township, west of the airport and north of the town limits of Dryden, and therefore within the fire response area of the UT of O Fire Department.

The UT of O Fire Department was established in 1981 with some equipment and funds provided by the Ontario Ministry of Northern Affairs and the Office of the Ontario Fire Marshall in addition to local funds. At the present time, each landowner in the area pays a small levy to support the operation of the department.

The department has two fire halls and a complement of 23 men. Fire hall number 1, located on Highway 7 in Wainwright Township, contains a rapid attack truck, a tanker truck that carries 1000 gallons of water and a port-a-pond, and an equipment van. The port-a-pond consists of a collapsible steel framework and a canvas liner. When set up, it forms a pond into which the tanker, or other water-carrying vehicle, can quickly dump water. The attack truck can draw water from this pond and pump it onto the fire while the tanker returns to a supply point to refill. Fire hall number 2, on Highway 502 south of Dryden, contains another rapid attack truck and a pumper that carries 750 gallons of water.

At the time of the crash, agreements for mutual aid were in force between the Town of Dryden and the airport CFR unit, and between the Town of Dryden and the UT of O Fire Department. As part of the mutual aid agreement, the Town of Dryden provides dispatch services for the UT of O Fire Department. All calls from the UT of O area are received by the Dryden police dispatch, which then sounds the alarm via pagers carried by all the UT of O volunteer fire-fighters.

These three fire-fighting units, all of which responded to the crash site, were also members of the Kenora District Mutual Fire Aid System. The document describing this system outlines its purpose as follows:

> The role of the fire service ... is to develop plans to improve the effectiveness of fire protection facilities within the District of Kenora, to cope with large scale fires and emergencies which are beyond the ability of a single fire department or fire protection team to control.
> (Exhibit 39, p. 1)

The Emergency Plan

In his radio call on the way to the crash site, Chief Parry not only called for mutual aid to fight the fire, but also asked that the Town of Dryden Peacetime Emergency Plan be activated.

Dryden had had a rudimentary emergency plan for a number of years. In 1979 the town council decided that, because both the Trans-Canada Highway and the main line of the CPR run through town and many chemicals are used in the large pulp and paper mill that is the town's major employer, the plan should be formally reviewed, updated, and approved by the council.

Dryden Fire Chief Louis Maltais undertook this task and the Peacetime Emergency Plan was adopted by council in January 1980. The aim of the plan is as follows:

> To lay down a plan of action for the efficient employment of all services required in order that the following be assured:

(a) The earliest possible response to an emergency call by all services that may be required.
(b) An operations control facility be established at the scene and/or elsewhere according to the nature of the emergency.
(c) Crowd control be imposed so that operations are not impeded and that additional casualties are avoided.
(d) The rescue of trapped persons with the minimum of delay and the provision of first aid at the site.
(e) Provisions of controlled evacuation and balanced distribution of casualties to hospitals.
(f) Immediate action taken to eliminate all sources of potential danger in the area of the incident.
(g) The evacuation of buildings considered to be in a hazardous situation.
(h) Provision of such social services as may be required for personnel.
(i) Restoration of normal services.
(j) Factual official information be available at the earliest time to:
    (i) officials involved in the emergency operation
    (ii) the news media to allay anxiety and to reduce the number of onlookers at the scene
    (iii) concerned individuals seeking personal information

(Exhibit 3, p. 2)

The Peacetime Emergency Plan outlines how it can be activated, how the control facility should be established, and who has authority over various areas within the plan. It was tested a number of times through the running of mock disasters, and amended as problems were discovered.

The emergency plan outlines the composition and responsibilities of the emergency operations control group in a section that begins as follows:

> All emergency operations will be directed and controlled by a group of officials responsible for providing the essential services needed to minimized [sic] the effects of the emergency.
>
> This is known as the emergency operations control group and is made up of the following:
>
> 1. Mayor or alternate
> 2. Police Chief or alternate
> 3. Clerk-Administrator or alternate
> 4. Fire Chief or alternate
> 5. Town Engineer or alternate
> 6. Hydro Manager or alternate
> 7. Telephone Manager or alternate
> 8. Building Inspector or alternate

9. Medical Office of Health, Northwestern Health Unit or representative
10. Administrator, Social and Family Services or alternate
11. Emergency Planning Officer

(Exhibit 31, pp. 2–3)

Mr Maltais was designated the emergency planning officer under the plan and was responsible for ensuring that the control centre equipment was in place and ready for any emergency.

Town of Dryden Police Dispatch

The Dryden police dispatch is located in the Dryden police station and serves not only the town police, but also the ambulance and fire services of the area, including the UT of O Fire Department. When a call is received, an alert tone is transmitted, followed by an announcement of the type of emergency and its location. This announcement is repeated three times. All the volunteer fire-fighters of Dryden and the UT of O departments carry pagers that can pick up the tone and the announcement.

Dryden Ambulance Service

The Dryden hospital holds a licence from the Ontario Ministry of Health to operate two ambulances that provide service to the Dryden area. The ambulance attendants are hired and paid by the hospital, which is funded by the ministry for these services.

The ambulance service uses both full-time and volunteer ambulance attendants. The full-time attendants require an emergency medical care attendant certificate from a community college. The volunteer attendants must have knowledge of basic first aid and cardiopulmonary resuscitation (CPR).

When necessary, the Dryden police dispatch alerts the ambulance service by telephoning the hospital emergency desk. The on-duty emergency nurse takes the call and then dispatches the ambulance, either by telephone if the attendants are in the hospital or by radio if they are on the road. There is no one assigned full time to answer ambulance calls and dispatch the vehicles.

Preparing for an Emergency

The Dryden Airport

At the time of the air crash on March 10, 1989, the Dryden Municipal Airport Emergency Procedures Manual had not been approved by Transport Canada. The manual had been submitted to Transport Canada for approval, but changes to the manual suggested by the regulator were disputed by the airport manager at Dryden. These disagreements had still not been resolved by 1989.

On January 29, 1988, Chief Parry of the Dryden airport CFR unit sent a copy of the revised emergency manual for the Dryden airport to H.J. Bell, regional director-general, Airports Authority Group, Transport Canada. The manual was reviewed by Mr Desmond Risto, regional airports disaster planning and protective services officer, who responded to it on February 12, 1988, in a memorandum addressed to the airport manager, Mr Peter Louttit. Mr Risto pointed out a number of concerns regarding the manual, including the lack of specific instructions for Kenora Flight Service Station (FSS) in case of an emergency. He also noted that Kenora should be sent a copy of the existing manual, which could then be updated as revisions took place. Mr Risto testified before me that, to his knowledge, the manual was never sent to Kenora. During an exercise in November 1988, CFR was not called out by Kenora FSS for eight minutes because a new controller was not aware of the responsibility to do so. In spite of this, the unapproved manual had not been sent to the Kenora FSS as of the time of the crash.

In his memorandum of February 12, 1988, Mr Risto had indicated that a number of required items were missing from the draft manual:

> 7) There are eleven (11) sections that the AK identifies that *must* be included in the manual as a minimum. There does not appear to be any thing covering the headings Medical Emergency, Natural Disasters, Hazardous Material Handling or Persons of Authority.
>
> (Exhibit 209, p. 2)

In his testimony, Mr Risto was asked about the missing items referred to in his memorandum:

> Q. ... Were these matters all lacking in the existing Dryden manual?
> A. They were nonexistent.
> Q. All right. And when we talk about persons of authority, what does that mean, sir?
> A. The persons of authority identifies who, for example, would be responsibilities of the airport manager, the responsibilities in authority of the Town of Dryden Fire Department or the Fire Chief of the Unorganized Territory of Ontario, the responsibilities – there – of the head of the Ontario Provincial Police.
>
> (Transcript, vol. 30, p. 79)

At the end of the letter, Mr Risto informed Mr Louttit that a generic manual had been developed for Red Lake that might assist him in developing a final manual for Dryden. He promised to forward this sample manual to Dryden for their information.

On May 3, 1988, Mr Louttit acknowledged receipt of the approved Red Lake manual and advised Mr Risto as follows:

> While there appear to be advantages to both approaches, we prefer our own format for the time being. We are returning the Red Lake manual to you and shall make the necessary changes in our manual, as noted by Mr Risto, and forward it for approval.
>
> (Exhibit 212)

Throughout the correspondence between Dryden and Transport Canada, there are references to, among other things, matters of nomenclature. Transport Canada continued to request the use of nationally accepted acronyms, while the Dryden airport manager preferred to use local terms. On March 1, 1989, just 10 days before the crash, another revision was forwarded to Transport Canada. Again, Transport Canada noted problems with terminology. It appears as though this preoccupation over nomenclature overshadowed the resolution of the more important problems with the plan, and, on March 10, 1989, there was no approved emergency plan for the Dryden airport. Whatever the disputes, Transport Canada had the authority and the power, through lease and subsidy agreements, to insist that the plan be written in an acceptable manner, including the use of nationally accepted acronyms. As well, there is no logical reason why the Dryden airport management could not have agreed to the request of Transport Canada in view of the fact that it is Transport Canada that sets the standards and assesses the completeness of emergency plans.

Exercises Involving Crash, Fire-fighting, and Rescue

It is the policy of Transport Canada that each airport CFR unit should test the readiness of personnel and equipment to respond to an emergency. Every two years, each airport is expected to run a full-scale exercise involving a simulated aircraft crash with response by off-airport agencies, such as police, ambulance, and local fire departments; this exercise is evaluated by Transport Canada representatives. In the alternate years, a locally evaluated exercise should be run to test individual parts of the response mechanism.

Full-scale exercises were held at Dryden in 1985 and 1988. In both cases, all responding agencies were involved in the planning and execution of the exercise. The 1985 exercise was originally scheduled for December 18, 1984. Unfortunately, the day before the planned exercise, "torrential rainfall fell throughout the whole area" rendering some roads impassable, and the exercise was postponed. Because of a reluctance on the part of the CFR unit to carry out a training exercise in winter weather conditions, the exercise was rescheduled, finally taking place on November 23, 1985. While one can understand the reluctance to carry out training exercises in winter, the failure to do so ignores the fact that aircraft crashes can and do occur in winter weather conditions.

The November 1985 exercise was code-named Bravo Two and the scenario involved an aircraft that had problems on takeoff, came back down on the runway, and skidded to a stop at the west end of the runway, where it broke up. The exercise was organized by crew chief Stanley Kruger, and the on-site coordinator (OSC) was the senior CFR member on duty, Mr Bernard Richter. The exercise involved all of the major emergency agencies in the area, including the UT of O Fire Department, Dryden Fire Department, Dryden hospital, OPP, Dryden ambulance, the Red Cross, and the Dryden police. Chief Parry was one of the evaluators of the exercise.

Overall, Bravo Two was a beneficial exercise. Certain major problems were identified in the evaluator's report. The OSC moved from place to place and it was difficult for him to be found and identified during the emergency. It was emphasized that the OSC should remain in one place for easy identification and communication. In addition, the response of the OPP was thought to be slow. From the time of the original alarm, 40 minutes elapsed before an OPP officer was observed at the scene. He apparently had initially been sent to the wrong location. The report also noted that no body count, protection of property, photography, or identification work was undertaken or simulated.

In 1986, a local communications exercise was held. While a number of elements were tested, the most important involved the communications equipment and procedures. Significantly, the exercise critique noted that a common radio frequency was needed on which all agencies involved could be contacted. In this exercise, the airport manager was the OSC, and Chief Parry again was an evaluator.

The final report for the 1986 exercise was submitted to Transport Canada on January 14, 1987. In his covering letter to Mr Risto, Chief Parry remarked:

> I see from your "Schedule of Exercises" that we are due for a full-scale exercise in 1987. With the present trend in funding this may not be possible. I'm sure your [sic] are working on the problem as it is not unique to Dryden but affects all airports. However, a policy statement on the status of exercises would be appreciated at this time, so it can be properly dealt with in the funding negotiations.
> (Exhibit 229, p. 1)

No documentation was presented to the Inquiry to indicate that any planning whatsoever was done for a full-scale exercise in 1987, as mandated by the Transport Canada schedule. I am convinced that no such exercise was planned for 1987, and only a real incident allowed for any testing of the emergency systems in Dryden that year.

On November 9, 1987, the crew of an Air Ontario HS-748 cargo flight had problems lowering the undercarriage and diverted to Dryden, because of the presence of a CFR unit there, to make a wheels-up landing. This emergency was responded to by the UT of O Fire Department, Dryden ambulance, the OPP, and the airport CFR unit. Just before landing, the crew was able to lower the landing gear and a safe landing was made. This incident was then written up as a "Report on Emergency Exercise" and submitted to Transport Canada to fulfil the full-scale exercise requirement for 1987.[1]

Since Transport Canada did not evaluate the 1987 emergency, another full-scale exercise was scheduled for Dryden in 1988, and, on this occasion, advance planning included all the major agencies in the Dryden area. Again, the scenario involved an aircraft crash on airport property. Code-named Delta Four, the exercise was conducted on November 1, 1988, just four months before the Air Ontario crash of March 10, 1989. Ironically, because of a problem with an oil-pumping mechanism, Chief Parry was unable to fuel or ignite the fire at the practice site. As a result, the exercise did not include any fire suppression activities.

Again, in this exercise, there was a problem with identifying the OSC. He was wearing a vest that identified him as the OSC, but his vehicle carried no such marking. Mr Stanley Kruger, the OSC, spent much of his time moving about to control and coordinate, rather than having responding agencies report to him. The Transport Canada evaluator's report, prepared by Mr Risto, commented on one of the deficiencies noted:

> Having two fire trucks at the scene and as a member was required to take on the duties as OSC and the fact that there was no fire, OSC

---

[1] Exhibit 50, Transport Canada AK-13-01-002, Policy, Standards, and Guidelines for the Development of an Airport Disaster/Emergency Plan and the Conduct of Exercises at Transport Canada Airports, states as a Note to section 2.02 (b): "Should a real emergency situation occur at a Transport Canada airport (such as a real crash or an actual highjacking), which necessitates a full response to the airport from all participants included in the airport's emergency plan (i.e., police, hospitals, fire departments, coroner, etc.), the yearly requirement to hold that specific exercise will be considered to have been met."

> should have relocated his vehicle closer to the only access road. This would have given him immediate identification and control.
> (Exhibit 236, p. 2)

Both of the full-scale exercise reports which were put in evidence identified problems with the role of the OSC. It is unfortunate that a fire was not lit in the course of this exercise. If it had been, the problems and responsibilities of the OSC would have been identified in a much more realistic and effective manner. On the day of the crash of flight 1363, Chief Parry positioned himself at the only access road to the crash site to direct and control, as the exercise reports suggested, but, unlike the exercise, there was a fire to fight.

In his report of the 1988 exercise, Mr Risto complimented the UT of O Fire Department for its role in the exercise:

> Good response of "numbers" of personnel. Handlines extended, maintained and manned throughout exercise, which was exceptional.
> (Exhibit 235, p. 2)

In the local debriefing that followed the November 1, 1988, exercise, communications were again identified as being the primary problem. Chief Parry was the acting airport manager at the time of this exercise and therefore responsible for setting up the control centre in the airport terminal building. In this role he called in the various agencies that were required, and coordinated the sending of them to the site upon their arrival at the control centre. Although he was able to communicate with the town dispatcher, he was not able to contact the OSC, Mr Kruger, on the same radio frequency. Some of the verbatim comments from the local debriefing with respect to this exercise are reproduced below:

> Roger Nordlund stated there [sic] biggest problem was there was no one around to direct them to the crash site and organization was lacking.
>
> The hospital had problems responding because of no clear indication of where the incident took place and there was poor communications with the site after the ambulance did arrive there was no indication of how many casualties were involved.
>
> Also there was a problem with the Red Cross registration, this was going to be resolved. There was a problem with the ambulance staff being able to identify the on scene commander with all of the emergency vehicles bunched in and around the scene of the accident.
>
> John Callan spoke regarding communication with the emergency control group and the frustration caused by not being able to keep track of what is going on. He mentioned that the most obvious solution to the problem was a common frequency which would be used by everyone.

> Larry Moore spoke for the OPP and their problems were also communication he was wondering whether one common frequency would be enough and could one operator be able to handle the traffic. The OPP new radio system will not be in place before April 1992.
>
> (Exhibit 236, attachment number 3, p. 2)

This lack of a common frequency was noted by many as the single biggest problem revealed by the exercise and it was a problem that would recur on March 10, 1989.

A review of the tasks performed by the Dryden CFR unit personnel in the three exercises discussed above shows the following:

- During exercise Bravo Two in 1985, Mr Kruger organized the exercise, Chief Parry was an exercise evaluator, and Mr Richter, the senior CFR person on duty, was the OSC.
- During the local communication exercise in 1986, the airport manager was the OSC, and Chief Parry was an evaluator.
- During exercise Delta Four in 1988, Mr Kruger was the OSC and Chief Parry was the acting airport manager.

As can be seen, Chief Parry never acted as the OSC or as the chief of the Dryden CFR unit during any reported exercise between 1985 and the time of the Air Ontario crash. There was no evidence found that showed that any Dryden airport manager or Transport Canada official was concerned about the lack of training for Chief Parry in his primary role, that of the CFR chief, although there is evidence that Transport Canada was concerned with the training, in general, of the CFR unit.

The exercises at Dryden normally involved an aircraft accident scenario, and the primary goal of such aircraft accident responses should be the preservation of life and property. On an airport, or in the immediate vicinity, this response is provided by the CFR fire-fighters, including the chief. Having the chief or one of his crew chiefs act as the OSC for an exercise does not allow the entire CFR unit to benefit, as fire-fighters, from the exercise. In the case of an emergency, it is not in the best interests of the occupants of the crashed aircraft, or in the advancement of aviation safety (preservation of evidence), to divert fire-fighters to duties other than those directly related to fire-fighting and evacuation. It is somewhat unfortunate that neither the Dryden airport supervisors, including the airport manager and the CFR chief, nor Transport Canada evaluators saw this as a problem. Had the duties and responsibilities of an OSC been defined better in the emergency plan, and those persons who could act as the OSC been named, it is unlikely that Chief Parry would have been acting as the OSC on March 10, 1989. He would have been acting as a fire-fighter and directing other fire-fighters, as required by Transport Canada CFR policy documents, to fight the fire on C-FONF.

Town of Dryden

In his testimony, the mayor of Dryden, Mr Thomas Jones, was justifiably proud of the fact that he and other members of his council had attended the Emergency Preparedness College at Arnprior, Ontario. In fact, 16 municipal employees of the Town of Dryden, in addition to the elected members, had attended at least one of the courses at the college. In order to test its emergency plan, the Town of Dryden cooperated fully in planning and executing the exercises at the airport. Its participation in the Delta Four exercise resulted in a number of changes that assisted in the town response to the crash on March 10. In his testimony, Fire Chief Louis Maltais related what was learned from their participation in that exercise:

> At the November exercise ... we used a building – a room off of the police station as Emergency Control Room. And it was found at that time it was inadequate. There was too much traffic: security was a problem and a decision was made after this exercise to move to a room in the fire hall.
>
> And it was also identified at the time of this exercise that we did not have enough telephone phones, outside lines. So, from that, we installed extra telephones in this other room.
>
> We also found that radio communications were very poor. We couldn't ... contact the airport from where they ... had a command post. So that was recognized.
>
> So, we established a communications committee who, in turn, worked with the amateur radio group and from there we established them as a group of people that we would certainly be using in the event of an emergency.
>
> (Transcript, vol. 4, pp. 100–101)

Having learned some lessons in November before the accident in March, the Town of Dryden had moved the location of their control centre to the fire-fighter's lounge in the fire hall, installed new telephone communications, and was working to improve the radio communications.

Observations

I am struck by the difference between the Town of Dryden and the CFR unit at the Dryden airport in reaction to the problems encountered in the Delta Four exercise. The town made changes based on deficiencies noted during the exercise. The CFR unit was to make many of the same mistakes again.

It seems that Transport Canada, despite the fact that it subsidizes airports such as Dryden, is reluctant to use its fiscal power to ensure that problems identified in exercises are corrected by the personnel involved. In 1988 during Delta Four, some of the same problems were identified as in the Bravo Two exercise of 1985. In an area as critical as crash, fire-fighting, and rescue, there should be no reason for professionals to make the same mistakes in two consecutive exercises.

Evidence was produced which showed that, at both Thunder Bay and Dryden, real incidents were substituted for exercises for reporting purposes. Although this substitution is permitted, in the case of the Dryden HS-748 incident there was, in fact, no accident. Emergency services were called out to deal with an anticipated problem, but the aircraft landed safely. Accordingly, there was no need for any site coordination, fire-fighting, or rescue. Based on the evidence, if this emergency had not occurred, Dryden would not have had even this limited test of its emergency response systems in 1987.

The evidence before me indicated that Chief Parry never assumed a fire-fighting role during the exercises. He usually acted as an evaluator, and on the one occasion he was a participant in an exercise, he was the acting airport manager and was therefore removed from the actual exercise "crash site." It would seem that, if an exercise is meant to simulate a real event, all personnel should play the roles that they are expected to fulfil in an emergency.

During the hearings, I heard a great deal of testimony regarding the responsibilities of various agencies within the critical rescue and fire-fighting access area (CRFAA) and I expected that, if Dryden had had an approved airport emergency manual, it would have delineated these responsibilities. However, I have reviewed the Thunder Bay Airport Emergency Procedures Manual (Exhibit 202), which has been approved by Transport Canada, and could find no reference to the CRFAA. In fact, in referring to off-airport crashes, the manual states:

> A) Airport [sic] crashes off airport will be under the authority of the Municipal Authority or the Police Force for that area.

The clear impression I received from reading this approved manual was that the airport CFR unit would only be responsible for aircraft crashes on the airport property itself. Indeed, the manual shows a series of five-mile-diameter rings around the airport and describes what equipment may be sent from the airport CFR depending on the distance. It notes that CFR will respond "if requested" to a crash in the immediate vicinity but off the airport, and only "if it has been determined that the crash site is accessible and CFR can provide a useful service."

Although Transport Canada clearly defines what a CRFAA is, that by definition there is a CRFAA at every airport, and that there are prescribed requirements regarding the responsibilities of the CFR unit within a CRFAA, it is apparent that Transport Canada has not been rigid in requiring that airport managers adhere to the principles and practices regarding CRFAAs. As well, at least in the example in evidence, Transport Canada did not require that information pertaining to the CRFAA be included in airport emergency manuals. As the basis for the CRFAA is that most aircraft accidents occur within the area so described, it is my opinion that the response to aircraft crashes that occur within the CRFAA should be clearly delineated in all related documentation, including the airport emergency response plans.

The Emergency, March 10, 1989

Implementing the Emergency Plan

The Emergency Plan for the Town of Dryden is very clear on how an emergency should be declared and by whom:

> (a) This plan will be implemented as soon as an emergency occurs or is expected which is considered to be of such magnitude as to warrant its implementation.
> (b) This decision shall be made by the member of the Emergency Operations Control Group who received the initial warning and/or arrives first on the scene of the emergency.
> (c) At this time, this official will activate the alerting system, in whole or in part, be [sic] calling the Town of Dryden Police dispatcher, identifying himself, and giving all necessary and pertinent information and requesting that Operations Control Group be alerted.
>
> (Exhibit 31, pp. 4–5)

The chief of the CFR unit at the Dryden airport is not listed in the emergency plan as one of those with authority to activate it. Chief Parry's radio transmission on March 10 was heard, however, by the Dryden fire chief, Mr Maltais, and the police chief, Mr Russell Phillips. Both of these men were members of the control group and, recognizing that the emergency was the type envisaged by the Peacetime Emergency Plan, they immediately activated the plan. Given the remoteness of the crash site from the town centre, the immediate call by Chief Parry to the Dryden police dispatch resulted in coordinated aid reaching the site in the shortest possible time. In this action, Chief Parry reacted in a responsible manner to be expected of a fire chief.

Within 10 minutes of Chief Parry's call, the police dispatch had called the Dryden and UT of O fire-fighters, the police chief had begun notifying other agencies, the emergency control room had been set up, the control group had been assembled, and the control group had made contact with Chief Parry at the crash site.

All calls by telephone or radio that are received by the Dryden police dispatch are recorded on an eight-track Dictalogue tape system. There are individual tracks, or channels, for all incoming and outgoing police telephone calls, 911 emergency calls, police radio calls, and fire department radio transmissions. The Dryden Fire Department radio frequency, called the fire channel, was the frequency to use for any mutual aid requirement. On the day of the crash, this frequency was used by the majority of the agencies that responded to the crash. The OPP, unfortunately, do not have the equipment to broadcast or receive on this frequency. A separate tape track records time, which when played against the other tracks allows the timing of events. The fire channel tape was checked against the time track and, unless otherwise noted, this record (Exhibit 1282) has been used to verify times used throughout this Report.

Chief Maltais and the Dryden Fire Department

Fire Chief Maltais testified as to his actions after he heard Chief Parry's transmission at 12:14 p.m., a time when he was at his home for lunch. On hearing the radio transmission, he drove to the fire hall and went upstairs, where he knew most of the people who would make up the control group were assembled for a lunch. He called Mr John Callan, the town administrator, out of the meeting and informed him of the emergency. Mr Maltais then proceeded to the police office and ascertained that the chief of police was also informed. Proceeding to the fire-fighter's lounge, Chief Maltais began organizing the control centre, and he called the Dryden Telephone Company to ask for delivery of the telephone hand sets.

Chief Maltais then used the radio in a fire department vehicle to make contact with Red 3 at the site. In his initial transmission, made at 12:24 p.m., just 10 minutes after the original call declaring the emergency, Chief Maltais reported: "We have the control centre set up. You can make requests if you wish" (Exhibit 1282, p. 2). The radio in the truck remained the point of radio contact between the site and the town for the balance of the day.

At 12:27 p.m. Chief Maltais, at the request of Chief Parry, dispatched the Town of Dryden pumper truck, the suburban van that was usually driven by the chief and which contained rescue equipment, and 10 men to the crash site. These two vehicles, Dryden Fire 3 and Dryden Fire 5, arrived at the McArthur Road location at 12:44 p.m.

The UT of O Fire Department

Since the crash occurred in an area serviced by the UT of O Fire Department, Dryden dispatch called out the volunteers of that department. The fire-fighters responded quickly to the announcement. The chief, Mr Roger Nordlund, was at his place of business next door to fire hall number 1 when the announcement came. He opened the hall and, shortly after, two fire-fighters left it with the rapid attack unit. Mr Gerald McCrae then arrived at the fire hall and was dispatched with the tanker truck. Other members of the department proceeded directly to the scene in their private vehicles.

Chief Nordlund testified that he heard the alerting message only once and, since it was not repeated two more times as was the procedure in an emergency, he assumed that this was an exercise. On that assumption, he returned to his place of business, where he received a telephone call from Dryden dispatch asking for confirmation that the message had been received. Now convinced that this was an emergency, he got into his private vehicle and proceeded to the scene.

Many others who responded to the scene also felt they were attending an exercise. The scenario for the exercise that had been held the previous November involved an aircraft crash at the airport. Following that exercise, there had been some discussion of holding another exercise without giving the participants advance warning.

The first of the UT of O fire trucks reached Middle Marker Road at approximately 12:34 p.m., and the tanker truck driven by Mr McCrae arrived at approximately 12:40 p.m. Leaving their trucks parked on McArthur Road, the fire-fighters of the UT of O then proceeded to the crash site, where they assisted the survivors. Mr McCrae, in fact, after helping to carry Mrs Nancy Ayer out of the bush, ended up driving the ambulance that carried her to the hospital, leaving the site at 1:05 p.m.

It was sometime after 1:30 p.m. before the UT of O trucks were driven down Middle Marker Road and set up to begin fire suppression activities. A handline was taken through the bush from the UT of O pumper and the first foam was put on the fire at approximately 2:00 p.m.

The Ontario Provincial Police

The radio log of the Dryden Detachment of the OPP for Friday, March 10, shows that the first officer dispatched to the scene was Sergeant Douglas Davis at 12:17 p.m. The detachment had been notified of the crash by a telephone call from the Dryden police dispatch.

Sergeant Davis was in his vehicle when he received the dispatch. He immediately proceeded to the airport since, during the exercise that had been held in November 1988, the OPP had established a command post at the terminal. He arrived at the airport terminal at 12:25 p.m. and went inside to speak with Mr Peter Louttit, the airport manager. After a brief conversation, Sergeant Davis proceeded to the crash site.

At 12:30 p.m., while en route to Middle Marker Road, Sergeant Davis asked his dispatch to find out if the local ham radio club had been notified. As a result of the November 1988 exercise, a demonstration of the club's capabilities to assist in such an emergency was scheduled for later in March, but Sergeant Davis decided they should be called on for this emergency. Coincidentally, the same decision was reached at the control centre and the Reverend Ken Rentz of the ham radio club was asked to gather the members.

On reaching the intersection of McArthur Road and Middle Marker Road at about 12:30 p.m., Sergeant Davis noted that injured passengers from the aircraft were arriving at the intersection. Private vehicles began to arrive and the injured were put in these cars and trucks for transport to the Dryden hospital.

At 12:34 p.m., Sergeant Davis asked that check points be established at both ends of McArthur Road to restrict vehicular access to the site. He spoke to Chief Parry while he was at the intersection, and at 1:00 p.m. he took a portable OPP radio and went into the bush to the crash site. At this point, he no longer had any method of direct communication with Chief Parry.

While at the scene, Sergeant Davis called for "CPFP [Canadian Pacific Forest Products] Ltd. personnel with chainsaws." He also radioed that "medical staff at scene require helicopter to scene asap re medical drop." At about the same time, similar requests were being made through the control centre. Because the OPP radios could not be connected to the frequency being used by Chief Parry and the Dryden control centre, there were two groups separately looking for the same kinds of resources. In addition, unknown to either Sergeant Davis or Chief Parry, a rescuer, Mr Mark Beasant, using a portable VHF aviation band radio, contacted Kenora FSS and asked them to relay his requests for certain supplies. These various independent requests resulted in more materials being requested than were actually required. Other than causing some congestion on McArthur Road, these duplicate requests did not affect the outcome of the rescue or fire-fighting efforts on the day of the crash.

Dryden Ambulance Service

When the call was received by the hospital emergency desk regarding the crash, ambulance unit 644, driven by Mr Ernest Kobelka with Mr Harold Rabb, the supervisor of the ambulance service with him, was on the road; they drove immediately to the accident area. The second Dryden ambulance, unit 645, was driven to the site by ambulance attendant Sandra Walker who, after receiving the call at her residence, proceeded to the hospital and loaded the ambulance with required supplies. She left the hospital at 12:42 p.m. with doctors Alan Hamilton and Gregory Martin, and arrived at the scene at 12:55 p.m.

All times quoted in this section are based on three sources: the tachograph charts that were taken from the ambulances at the end of the day, notes made by Mr Kobelka and by Ms Walker, and the dispatch recording of the fire channel. From a comparison of these sources, it has been concluded that the tachograph chart from ambulance 644 was approximately nine minutes fast. Applying the estimated nine-minute error, the first ambulance, unit 644, arrived at the intersection at 12:35 p.m.

While a number of injured passengers were transported to the hospital in private vehicles, the most seriously injured were transported by ambulance. In the case of the two passengers who subsequently died from their injuries, Mrs Nancy Ayer was transported in unit 645, accompanied by attendant Walker, leaving the scene at 1:05 p.m. and arriving at the hospital at 1:15 p.m. Mr Michael Kliewer was also transported in unit 645, leaving the site at 1:45 p.m. and arriving at the hospital at 2:00 p.m.

Response Times

A number of people in Dryden at first assumed that the accident was an exercise. Given their initial incredulous reaction, the response from the responding emergency agencies seems remarkable.

Within 10 minutes of the emergency being declared, all required emergency services were notified, the control centre was established, radio contact was established with the accident scene, and the chief of airport CFR and one fire-fighting vehicle were on the scene. Within 20 minutes of the emergency call, the OPP were on the scene, road blocks had been established, and the first UT of O fire truck and the first ambulance had arrived at the intersection.

At the Scene

On-Site Coordinator

At the time of the accident, the Dryden Airport Emergency Manual was unapproved by Transport Canada, but it was still the only manual available. The manual described the duties of the on-site coordinator (OSC) for an aircraft crash on the airport; however, there is no description for the duties of an OSC in the case of an off-airport crash, nor is there any mention of the position of OSC in the Town of Dryden emergency plan. The duties of the OSC as listed in the airport Emergency Procedures Manual are as follows:

> *Action of On-Site Co-ordinator (OSC)*
> 1. Assess situation and report to E.C.C. [Emergency Co-ordination Centre] via radio. Request any necessary resources.
> 2. Establish command post at suitable vantage point.
> 3. O.S.C. is responsible for overall command of site and responding agencies on site.
> 4. Direct activities of responding agencies through proper chain(s) of command.
> 5. Maintain record of all survivors and casualties leaving site and of all significant events.
> 6. Liason [sic] with O.P.P. site command post.
> 7. Turn over command of site to O.P.P. when area is secured from fire or other hazards.
>
> (Exhibit 51, p. 9)

Section 3.00 of the manual comments on jurisdiction for off-airport crashes as follows:

> Aircraft accidents/incidents outside of the airport boundaries are the responsibility of the O.P.P. and the site will be under their command.
>
> (Exhibit 51, p. 14)

When Chief Parry arrived at the intersection of McArthur Road and Middle Marker Road, he opened the gate and sent crew chief Stanley Kruger in Red 1 down Middle Marker Road towards the crash site. As the first professional fire-fighter on the scene, Chief Parry remained at the intersection, assuming the position of the OSC, with his vehicle, Red 3, serving as the command post and marker for other responding vehicles and persons. He established communications with other agencies using the radio in his vehicle, set on the mutual aid frequency. At 12:19 p.m. Chief Parry contacted Dryden police dispatch by radio and gave directions to responding agencies. He then asked dispatch to let the OPP know that the aircraft was back in the bush and that helicopters, snow machines, snowshoes, and similar equipment would be needed.

At 12:24 p.m. he made the same requests of Mr Loutitt at airport control, remarking, "We can't get in with our vehicles at all" (Exhibit 1282, p. 2). In the next few minutes, contact was made with Chief Maltais at the control centre in town and Chief Parry requested men and fire-fighting equipment. In another call to the airport control, Chief Parry asked for some of the "field maintenance guys ... and at least a [front-end] loader," as well as blankets from the emergency kit in the fire hall.

When Sergeant Douglas Davis of the OPP arrived at the intersection at about 12:30 p.m., he had a brief conversation with Chief Parry and was informed he was the first OPP officer on the scene. Sergeant Davis then assumed traffic control and began to assist with arranging transportation of the injured to the hospital. This is the traditional role assumed by the police at a fire scene until the fire is extinguished. Until that time, unless security or preservation of life is involved, the police leave the site in the control of the fire department.

At 12:34 p.m. the first UT of O fire truck arrived, followed closely by the first ambulance and the second UT of O truck. From their testimony, it seems clear that, for everyone who arrived on the scene, first aid and preservation of life was the first instinct. Chief Parry called for blankets and ambulances. Sergeant Davis put people in his car and arranged for private vehicles to take the injured to the hospital. The UT of O fire-fighters, according to the testimony of Mr Kobelka, gave first aid to the injured who gathered at their truck on McArthur Road. Mr McCrae, the driver of the second UT of O truck, took backboards and blankets into the woods and then drove an ambulance to the hospital.

A second fire chief, Mr Nordlund of the UT of O, arrived on the scene at approximately 12:45 p.m. On his arrival, Chief Nordlund had a brief conversation with Chief Parry to ascertain what had been done and then, as he related in his testimony, he went towards the crash site "to assess the fire" so his men could most efficiently combat it.

From the evidence, Chief Parry was doing an effective job as the OSC in informing others, requesting supplies, and coordinating activities at the intersection. However, he did not, at any time, direct the activities of the CFR or other fire-fighters.

Much time was spent during the hearings discussing the question of jurisdiction and the boundaries of the critical rescue and fire-fighting access area (CRFAA). It seems clear from the evidence that those persons responding to the accident saw the security of the site as an OPP responsibility. The responsibility for fire suppression rested with the UT of O Fire Department. Because an aircraft was involved and the accident was close to the airport boundaries, the airport CFR had an obligation to respond to the crash. Because they were first on the scene, the CFR chief assumed the responsibility for coordination and communication while he sent his crew chief to the crash site. On March 10 Chief Parry remained in or around Red 3 acting as the OSC, and explained that he did so based on experiences from past exercises.

Sergeant Davis testified that, when he arrived at the scene, there was no question in his mind that the accident site was "within OPP territory." As the senior officer and the first officer at the site, he was therefore in command until relieved. His first priority, in accordance with OPP policy, was the "preservation of life, [and] assistance to the injured" (Transcript, vol. 6, pp. 11, 13). Since injured passengers were coming out of the bush, he found shelter for some and arranged transportation to the hospital in private vehicles for others. At 12:34 p.m.

he called for roadblocks to be established and requested the assistance of other officers to ensure site security.Sergeant Davis did not address the issue of jurisdiction, nor did Chief Parry ask Sergeant Davis to relieve him as the OSC. In fact, the actions taken by each of these men may have been as a result of training and, in the case of the OPP, assuming the accepted role of the police at a fire scene. During each of the exercises held at the airport, a member of the CFR crew acted as on-site coordinator. In each of those exercises, the evaluator criticized the OSC for not remaining in one place, and preferably near the access road to the site.

From his testimony, we know that when Chief Parry did leave his command post at about 3:30 p.m., it was to turn over command of the site to Staff Sergeant D.O. Munn of the OPP.

The roles of Chief Parry and Sergeant Davis were accepted by all persons who responded to the crash, and, at the time, no one questioned their roles. Without criticizing what Chief Parry did as the OSC, as discussed in chapter 9 of this Report, Crash, Fire-fighting, and Rescue Services, or what Sergeant Davis did as the first OPP officer at the scene, it is my opinion that Chief Parry should have devoted his time and talents to fulfilling his responsibilities as the chief of Dryden airport CFR, as outlined in documentation pertaining to airport CFR services.

Communications

Various Transport Canada witnesses testified that one area that consistently causes problems in disaster response exercises is that of communications, and communications had been identified as a problem in the various exercises held at the Dryden airport. Following the Delta Four exercise at Dryden, a committee had been set up to improve communications. A mutual aid frequency had been designated, and all agencies were to switch to the mutual aid frequency in case of an emergency. Chief Parry switched to this mutual aid frequency on his way to the crash site. It was on this frequency that he requested Dryden dispatch to activate the mutual aid and emergency plan.

All radio communications between Chief Parry and the control centre were made through the Dryden Fire Department truck parked outside the fire hall. A runner then relayed requests between the truck and the control group. Since the crash, the Dryden Amateur Radio Club has installed permanent antennas on the fire hall, the airport terminal building, and at the hospital. Direct communications among the control group at the fire hall and the other two locations are now available.

The tape recording from Dryden dispatch shows that Chief Parry was able to communicate with the Dryden control centre, Dryden Fire Department vehicles, Dryden Fire Department portable radios at the site, and the airport control. By using another radio in his vehicle, he could also speak with Kenora Flight Services and, later in the afternoon, directly with helicopters as they arrived in the area. However, the on-scene communications can best be described as chaotic in a number of respects. Chief Parry should also have been able to speak directly with his crew chief, Stanley Kruger, but Mr Kruger was using a different radio channel (see chapter 9, Crash, Fire-Fighting, and Rescue Services) and neither Chief Parry nor Mr Kruger switched channels in an effort to make contact, vital to the orderly control of this operation.

Throughout the emergency, the OPP operated on their own radio frequency, unable to communicate on the mutual aid frequency, and therefore unaware of the decisions of the control group. This problem was not unique to this situation. In any emergency situation that might have involved cooperation between the OPP and the Dryden Police Force, there was no way for the two to coordinate their activities on one frequency. The OPP plans to install a new radio system in Dryden in 1992 that should eliminate this shortcoming.

There was no direct communication by anyone with the members of the UT of O Fire Department, or their chief, throughout the afternoon. Although the UT of O had portable radios on order, they had not yet been delivered. (The portable radios were delivered to the UT of O Fire Department the week after the crash.) When the UT of O set up its port-a-pond, brought a handline through the woods, and began to suppress the fire, they had to use OPP portable radios at each end of the line to order the flow turned on and off.

On his way to the site, Sergeant Davis asked to have the ham operators alerted to assist in communications between agencies. As the emergency developed, Chief Parry had difficulty receiving information from the crash site. His crew chief was on the wrong channel, and the UT of O fire-fighters had no radios. At 1:01 p.m. the control centre dispatched a ham operator to try to plug this communications gap. Unfortunately, as the ham operator was going into the site to establish radio contact with Chief Parry, he was turned back by an OPP officer who was not aware that the operator had been sent to assist. Since the arrangement for this operator had been made on the mutual aid frequency, the OPP had no knowledge of the arrangement and assumed the operator was not authorized to enter the scene. This misunderstanding was soon rectified, and the ham operator was allowed into the scene.

If the OPP had relieved Chief Parry as the on-site coordinator, the police would have had to use Red 3 as their command vehicle or borrow radios in order to maintain direct communications with the majority of the rescue workers, the control centre in Dryden, and the airport control.

Had Mr Kruger and Chief Parry established radio contact when Mr Kruger first arrived at the crash site, handlines may have reached the wreckage and been used on the fire earlier than they were. The plight of Messrs Kliewer and Teubert may have been eased, and perhaps the flight recorders would have been saved from destruction by the fire; certainly more of the aircraft wreckage would have been saved as evidence. This scenario, of course, presupposes that action in response to Mr Kruger's request for handlines would have been timely.

Fire Suppression

This section deals primarily with the response by fire-fighters to the crash. A detailed description of the aircraft fire and the activity of the fire-fighters regarding the fire is discussed in chapter 9, Crash, Fire-fighting, and Rescue Services, and chapter 11, Aircraft Crash Survivability.

Transport Canada CFR standards document AK-12-03-001 states:

> The primary objective of Crash Firefighting and Rescue Services (CFR) is to save lives in the event of an aircraft accident/incident or fire at an airport. This will be accomplished by providing a fire-free escape route for the safe evacuation or rescue of passengers and crew. A secondary objective is to preserve the property involved by containing or extinguishing, where practical, any fire resulting from an aircraft accident or incident.
>
> (Exhibit 243, p. 1)

The following timeline sets out when fire-fighting vehicles and fire-fighters arrived on the scene:

- 12:18 Chief Ernest Parry arrives at the corner of McArthur Road and Middle Marker Road in Red 3.
- 12:19 Red 1 arrives at end of Middle Marker Road, driven by CFR crew chief Stanley Kruger.
- 12:34 UT of O rapid attack truck arrives and parks on McArthur Road.
- 12:40 UT of O tanker truck arrives.
- 12:43 Red 2 arrives.
- 12:44 Dryden Fire 5 and Dryden Fire 3 arrive.
- 12:45 UT of O Fire Chief Roger Nordlund arrives.

Throughout the CFR portion of the hearings, the question of the timeliness of the arrival and use of handlines at the fire scene was discussed. It is important to determine the earliest time that handlines could have arrived at the scene, and whether earlier use of the handlines would have affected the fate of any of the passengers or crew.

From the evidence regarding the fire-fighting capabilities of the vehicles that responded, there is no doubt that by 12:45 p.m. there were enough equipment and personnel in the area of the crash to deal effectively with the fire. However, no one attempted to use any of the equipment until approximately 1:30 p.m., when the UT of O pumper truck was moved down Middle Marker Road.

The UT of O rapid attack vehicle (pumper truck), the first fire-fighting vehicle to reach the scene that could have had an effect on the fire, arrived at the intersection of McArthur Road and Middle Marker Road at approximately 12:34 p.m. Mr Nordlund, the UT of O fire chief, stated in testimony that it would take one fire-fighter and two or three volunteers less than five minutes to extend 500 feet of hose, in four 100-foot and two 50-foot lengths, to the crash site. Mr Stanley Kruger, in his testimony, estimated that it would have taken up to half an hour to lay such a line through the deep snow, but reduced this estimate to 15 minutes if sufficient help was available. Assuming that other fire-fighters and volunteers assisted in this task and allowing time for the vehicle to reach the site and an assessment to be made, I estimate that a handline could have reached the aircraft wreckage by about 12:50 p.m. at the earliest. This estimate may be optimistic, since the trail to the wreckage was through deep snow.

I therefore considered the evidence regarding the state of the passengers at 12:50 p.m. to determine whether, if fire suppression had begun at that time, any deaths might have been prevented.

Two persons who survived the crash died later because of their injuries. Mrs Nancy Ayer died in a Winnipeg hospital of extensive burns received in the aircraft fire, but she was out of the aircraft wreckage before the first fire-fighter even arrived at the scene. In her case, the use of a handline by 12:50 p.m. would not have affected her fate. Mr Michael Kliewer died in the Dryden hospital with his cause of death listed in his autopsy report as massive trauma, which he sustained in the crash. Again, the use of a handline would not have saved his life; however, the timely use of the handline may have reduced his burn injuries. A third person, Mr Alvin Rossaasen, died in the wreckage, his autopsy indicating that he died from smoke inhalation (carbon monoxide poisoning) and burns. The lethal level of carbon monoxide that was found in his body can be reached over a time period of 2 to 30 minutes. Mr Rossaasen was trapped beneath another passenger on the left side of the aircraft, where the fire was the most intense. As the crash occurred at 12:11 p.m., there is little doubt that Mr Rossaasen was dead before 12:50 p.m. Finally, Mr Uwe Teubert, who survived the crash and was found trapped under Mr Kliewer at about 1:10 p.m., may have suffered less had the handlines been in use earlier.

The autopsy reports for the other deceased persons indicate that, while a number of the deceased showed evidence of smoke inhalation, all of these persons were dead within minutes of impact. Therefore, the issue of handlines is not relative to their fate.

Dr Martin testified that he arrived at Middle Marker Road in ambulance unit number 645, whose tachograph indicates the arrival time to be 12:55 p.m. He then proceeded to the scene, and he testified he did not believe that there was anyone, besides Mr Kliewer and Mr Teubert, still alive in the aircraft. In their testimony, Sergeant Davis and Chief Nordlund, who arrived at the scene at approximately 12:30 p.m. and 12:45 p.m., respectively, state that besides Mr Kliewer and Mr Teubert, no other passengers were alive in the wreckage.

Although the earlier use of the handlines would not have affected the fate of the passengers who died as a result of the crash and fire, it is obvious that had the handlines been used earlier to suppress the fire, more of the important physical evidence could have been saved, including cockpit instrumentation and probably the information in the flight recorders.

To remove the recorders from the wreckage, the fire-fighters would have to have known their location. The UT of O fire-fighters who eventually did run the handline to the wreckage had no training regarding the location of various critical areas on an aircraft. Their primary responsibility in the case of a fire at the airport was fighting structural fires. CFR was to be responsible for aircraft fires. Unfortunately, even the CFR fire-fighters did not know the location of the flight recorders on the F-28 aircraft. In fact, the CFR unit did not have a crash chart for the F-28 that would have shown the location of the recorders. Even if the fire-fighters did not know the location of the recorders, simply spraying the entire aircraft to put out the fire may have cooled the recorders enough so that their tapes and the recorded information would have survived the heat.

The evidence indicates that the fire-fighters at the scene of the crash became distracted by the injured passengers to the extent that they overlooked their responsibility to fight the fire.

Crew chief Stanley Kruger, the first professional fire-fighter to reach the aircraft, gave up his fire-fighter's jacket to flight attendant Hartwick so she could keep a baby warm. This was a humanitarian act, but this jacket was an important part of his fire-fighting equipment if Mr Kruger had to approach the fire for either rescue or fire suppression.

Chief Nordlund of the UT of O Fire Department testified that he went in to the scene "to assess the fire," yet on the way to the fire he stopped to assist others. When he arrived at the wreckage, he assisted in the rescue of Mr Kliewer and Mr Teubert, even though at that time there were between 20 and 30 other fire-fighters on the scene. Chief Nordlund did not even don his fire-fighting clothing to go into the fire area.

There was a concerted effort on the part of all the fire-fighters to assist and provide comfort to the survivors. Most assumed when they arrived at the crash that anyone who was not out of the wreckage was not going to get out. As Mr Kruger testified:

> Q. Mr Kruger, from your own observations and your own professional opinion as a fire-fighter who has been doing this work for some time, would you give the Commissioner your best opinion on whether there could have been any live passengers inside that fuselage at the time that you came upon it.
>
> A. I would have to state emphatically that, when I got there, there were no survivors in that aircraft, from my visual observations.
>
> (Transcript, vol. 26, p. 133)

If Mr Kruger's conviction was shared by all who arrived on the scene, it is understandable that the fire-fighters saw no need to provide "a fire-free escape route for the safe evacuation or rescue of passengers and crew." Nevertheless, the fire-fighters, and especially the members of the CFR unit, had a responsibility to "preserve the property involved by containing or extinguishing, where practical, any fire resulting from an aircraft accident or incident." Their inaction in responding to this part of their mandate probably cost the investigators the irreplaceable evidence contained in the flight recorders that would have been of value in the aircraft accident investigation and for the prevention of future aviation accidents.

Provision of the Passenger List

The time taken to compile a list of names of both victims and survivors of the crash was a subject of controversy both at the time of the crash and during the hearings of this Commission. Initially, for the rescuers, the total number on board the flight was an important piece of information. An accurate number, 69, was given to Chief Ernest Parry by the airport manager at 12:46 p.m., 35 minutes after the crash. This number was immediately available when requested by Chief Parry.

The first list of passenger names, sent by Air Ontario to the OPP, was received at approximately 4:00 p.m. on March 10. This list contained 57 names and was not an accurate list of the passengers on board at the time of the crash. An accurate list was received by the OPP at 8:00 p.m. the same day. This list was compiled by obtaining the names of the Air Ontario and Air Canada passengers who boarded in Thunder Bay, adding the names of those from the cancelled Canadian Partner flight who joined flight 1363 in Thunder Bay, and then checking for the names of passengers who left or joined the flight in Dryden.

A more timely provision of the passenger list at Dryden would have assisted the hospital in the treatment of injuries and the Red Cross, which was dealing with family inquiries. However, since this list was also used to notify the families of the deceased prior to the removal of the bodies from the wreckage, it was important that it be accurate. Even with the care taken to ensure accuracy, the media reported that one man, who had the same name and province of residence as one of the passengers, was incorrectly notified of that passenger's death.

Given the fact that passengers from another airline were added to the flight in Thunder Bay and that some passengers left and others joined the flight in Dryden, Air Ontario clearly required time to verify the list. Since it was to be used to notify next of kin, any requirement for speedy provision of the list must be balanced by the need for accuracy before families are contacted.

Of greater concern was the length of time taken to release the passenger names to the public. There can be no argument that the next of kin must be notified before any list of the deceased is circulated. In this case, however, all next of kin had been notified by late Saturday, March 11. A partial list of passengers was published in the *Toronto Star*, on March 15, five days after the crash, but, even then, it was not released by the OPP. Inspector Frank Harvey of the OPP refused to release the names until positive identification had been made at the post-mortem. In addition, he told the media that the list was the property of Air Ontario. It appears that, in the end, the list published was inadvertently released to the media by the OPP.

In the case of any accident, the release of the names of the victims is the responsibility of the investigating police agency. Once the police have contacted the next of kin, there should be no reason for withholding the names of the victims. In this case, the unreasonable delay in releasing the names resulted in the media's publishing their own partial list before an accurate one was made available.

Other Dryden Agencies and Businesses

Evidence was heard in Dryden regarding the significant contributions that were made by the Red Cross, the Dryden Welfare Office, the staff of the Dryden hospital, many Dryden businesses, and many individuals. All were part of a coordinated town response of which the citizens of Dryden can feel proud.

Of course, as with any disaster for which there is planned response, some things happen that were not anticipated in the emergency planning. The Town of Dryden held a number of meetings after the crash to discuss the various responses to the emergency and to learn from their experience. Attached as appendix I are the minutes of the meetings held on March 13 and 16. At these meetings, the citizens of Dryden explained the problems they encountered and assessed the effectiveness of the response to the disaster. These minutes, more than any report I could write, demonstrate the involvement of the town and the problems the townspeople encountered. I recommend that officials of other Canadian towns and cities read these minutes with their own emergency plans in mind and learn from the experiences of the Town of Dryden.

Findings

- The Dryden Municipal Airport Emergency Procedures Manual, first submitted to Transport Canada on January 29, 1988, had not been approved by Transport Canada on March 10, 1989. The manual had not been approved because the Dryden airport officials had refused to implement changes to the manual suggested by Transport Canada, and Transport Canada had not insisted that the manual be prepared to Transport Canada standards.

- Because the Dryden Municipal Airport Emergency Procedures Manual had not been approved, a copy of it, even in draft form, was not in the hands of appropriate agencies, such as the Kenora Flight Service Station.

- The Dryden airport CFR unit apparently was reluctant to carry out training exercises in winter, a reluctance that ignores the fact that aircraft crashes can and do occur in winter weather conditions.

- The crash of Air Ontario F-28 C-FONF occurred within the boundaries of the Dryden airport CRFAA.

- Transport Canada defines a CRFAA. By definition there is a CRFAA at every airport and there are prescribed requirements regarding the responsibilities of the CFR unit within a CRFAA, but it is apparent that Transport Canada has not been rigid in requiring airport managers to adhere to the principles and practices regarding CRFAAs. As well, Transport Canada does not require that information pertaining to the CRFAA be included in airport emergency manuals.

- The chief of the Dryden airport CFR unit did not assume a fire-fighting role during the various exercises in which the Dryden CFR unit participated from 1985 to 1988. He acted as an evaluator, and on one occasion he was the acting airport manager. Accordingly, neither the CFR unit nor the chief himself benefited fully from the exercises. The CFR fire chief, because he acted either as an evaluator or was the airport manager at the time that a full-scale exercise took place, was neither tested nor exercised as a fire-fighter or as an on-site commander.

- Transport Canada did not ensure that during exercises the chief of the Dryden airport CFR unit occupied a role that he would be expected to fulfil in an emergency.

- During exercises in which the Dryden airport CFR unit participated, CFR crew chiefs acted in the role of on-site coordinator rather than as fire-fighters.

- The role of the on-site coordinator was not clearly defined by Transport Canada.

- Transport Canada allowed CFR unit fire-fighters to act as on-site coordinators, diverting them from their roles as fire-fighters.

- Full-scale exercises at the Dryden Municipal Airport, involving the CFR unit, were not conducted regularly.

- CFR training exercises involving the Dryden airport, although inadequate, were helpful; however, deficiencies identified in the exercises were not always corrected.

- Transport Canada did not exercise its authority over the Dryden airport management to impose its national standards in the Dryden Municipal Airport Emergency Procedures Manual.

- Transport Canada did not ensure that the matter of the Dryden airport CRFAA was clearly defined in the Dryden Airport Emergency Procedures Manual and understood by the Dryden CFR chief and personnel.

- The Dryden airport CFR access road to the CRFAA was inaccessible to CFR vehicles on March 10, 1989, owing to lack of winter maintenance.

- Two civilians, Mr Craig Brown and Mr Brett Morry, were the first persons to arrive at the crash site, having departed from the airport terminal immediately after seeing the fireball from the crash. They made a path from Middle Marker Road, through deep snow, to the aircraft.

- Dryden CFR Chief Ernest Parry arrived at the intersection of Middle Marker Road and McArthur Road at between 12:15 and 12:18 p.m. and set up a command post. Crew chief Stanley Kruger arrived in Red 1 shortly thereafter, parking at the far end of Middle Marker Road, approximately opposite to the crash site. He carried a portable radio and a first aid kit to the crash site, following the path made by Messrs Brown and Morry. He encountered some 20–25 survivors and directed them towards McArthur Road. The survivors reached McArthur Road at approximately 12:32 p.m.

- All survivors were out of the aircraft wreckage by the time Mr Kruger reached the crash site, except for Mr Uwe Teubert and Mr Michael Kliewer, who were trapped on the left side of the aircraft under wreckage until freed at approximately 1:12 p.m. under the direction of doctors Gregory Martin and Alan Hamilton, who had arrived on the scene.

- The initial response to the crash of C-FONF on March 10, 1989, by the various emergency plan agencies, Ontario Provincial Police, Town of Dryden Fire Department, Unorganized Territories of Ontario Fire Department, Dryden Ambulance Service, and Dryden CFR services unit, was timely and well executed. However, the fire-fighting activity at the scene was uncoordinated and lacking in leadership and direction.

- Although a mutual aid frequency had been designated in the Dryden Municipal Airport Emergency Procedures Manual, not all responding agencies had the equipment necessary to operate on that frequency.

- The on-scene radio equipment for communication between the fire chief, the fire-fighters, the OPP, and rescuers was either misused, incompatible, or nonexistent, clearly contributing to the lack of a coordinated and timely fire-fighting effort at the crash site.

- As was the case in previous full-scale emergency exercises, all Dryden area agencies responding to the crash on March 10, 1989, were not capable of communicating on a common frequency. The Ontario Provincial Police did not have the equipment necessary to transmit and receive on the channel designated in the Dryden Area Response Plan as the emergency fire (mutual aid) channel. Communication between CFR Chief Parry and CFR crew chief Kruger was not established in a timely manner on either the fire channel or the CFR unit working channel. The UT of O fire chief and fire-fighters had no radios for communication between themselves or anyone else.

- A substantial amount of fire-fighting equipment arrived on the scene between 12:19 and 12:44 p.m., more than sufficient to extinguish the aircraft fire.

- The obvious lack of coordination and direction of fire-fighting activity at the scene of the crash was caused at least in part by jurisdictional uncertainty, deficient training, and confusion as to who was in command.

- At the scene of the crash, all the fire-fighters, including the fire chiefs for the Dryden airport CFR unit and the UT of O Fire Department, became distracted by the plight of the survivors to the extent that they overlooked their primary responsibility to fight the aircraft fire. As a result, handlines were not brought in and fire extinguishant was not applied to the aircraft fire until approximately 2:00 p.m. on March 10, 1989, about one hour and 50 minutes after the crash.

- It is highly probable, if not virtually certain, that more timely extinguishment of the aircraft fire would have resulted in preservation of the aircraft data recorders and of more of the aircraft remains, for investigative purposes.

- Concentration by the fire-fighters at the crash site on their primary responsibility of extinguishing the aircraft fire and providing an escape route for passengers would probably have resulted in the earlier location and freeing of Mr Teubert and Mr Kliewer from the wreckage.

- The duties and responsibilities of the on-site coordinator (OSC) for an aircraft crash are not fully detailed in the Dryden Municipal Airport Emergency Procedures Manual. For example, the manual did not designate individuals holding certain positions among the various agencies involved in the emergency manual who would be expected to act as on-site coordinators. Although the manual described the duties of an OSC for an aircraft crash on the airport, the manual did not deal with a crash off the airport.

- Apart from the noted deficiencies in the fire-fighting response at the scene of the crash, the collective efforts of all persons, agencies, businesses, and officials in the Town of Dryden relating to the crash were timely and carried out in a responsible, compassionate, and meaningful manner.

RECOMMENDATIONS

It is recommended:

MCR 18[1] That Transport Canada ensure that airport crash, fire-fighting, and rescue units carry out emergency response exercises as mandated in applicable Transport Canada documentation, including exercises in winter and in off-airport conditions.

MCR 19 That Transport Canada ensure that all persons involved in crash, fire-fighting, and rescue (CFR) exercises, including CFR chiefs and on-site coordinators, fully understand and carry out their duties during such exercises, as defined in applicable Transport Canada documentation and as they would in an emergency.

MCR 20 That Transport Canada ensure that airports subsidized by Transport Canada have in place at all times up-to-date crash, fire-fighting, and rescue airport emergency response plans and airport emergency procedures manuals approved by Transport Canada.

MCR 21 That Transport Canada ensure that the necessary crash, fire-fighting, and rescue emergency response to aircraft crashes that occur within the critical rescue and fire-fighting access area (CRFAA) be clearly delineated in all relevant documentation, including airport emergency response plans and airport emergency procedures manuals.

MCR 22 That Transport Canada ensure that, as part of the emergency planning process, all responding agencies designated in an airport emergency procedures manual equip themselves with radios capable of communication on a common channel.

[1] In the course of the hearings of this Commission of Inquiry, certain facts emerged from the evidence that, in the interests of aviation safety, I felt duty-bound to report in two interim reports. For ease of reference, recommendations are numbered consecutively, beginning with those that appear in my *Interim Report* of 1989, and all are found in Consolidated Recommendations, Part Nine of this my Final Report. They are preceded by the code "MCR," in accordance with the "short title" (Moshansky Commission) of the reports.

PART THREE

CRASH, FIRE-FIGHTING, AND RESCUE SERVICES

9 DRYDEN MUNICIPAL AIRPORT CRASH, FIRE-FIGHTING, AND RESCUE SERVICES

In the introduction to my Report, I stated that in my view the involvement of the Dryden Municipal Airport Crash, Fire-fighting, and Rescue (CFR) Services was a collateral safety issue which I considered serious enough to warrant investigation.

Legislation and Policies Governing Dryden Municipal Airport and Its CFR Services

The Dryden Municipal Airport aerodrome certificate in effect on March 10, 1989, was issued on March 23, 1988, to the Town of Dryden by the minister of transport pursuant to the *Aeronautics Act* and the Air Regulations. This certificate requires the Town of Dryden to maintain an aerodrome operations manual for the Dryden Municipal Airport in accordance with the aerodrome standards contained in Air Regulations Series III, No. 2 – Airport regulations. Although aerodrome services do not form part of the aerodrome certification criteria, the aerodrome operations manual requires that aerodrome services provided be inventoried in the manual; CFR services are in this category. The Dryden Municipal Airport Aerodrome Operations Manual, approved by Transport Canada on March 23, 1988, lists CFR services as follows:

> 3.1 AERODROME EMERGENCY SERVICES – SERVICES D'URGENCE
>
> A) Crash, Fire Fighting and Rescue – Services de secours et d'incendie
>
> CFR4 – 2300 Gals of foam
> 400 Lbs dry chemical
>
> Hours of Operation – Heures d'exploitation as per CFS [Canada Flight Supplement]

B) Medical (Agreements with Other Agencies) –
Médicaux (Ententes avec d'autres organismes)

1. First aid from AES [Airport Emergency Services]

There are no further requirements regarding CFR services listed in the aerodrome certificate or in the Aerodrome Operations Manual. As well, unlike United States Federal Aviation Regulations (FARs), in particular FAR Part 139, Canadian aviation legislation, such as the *Aeronautics Act*, Air Regulations, and Air Navigation Orders, has no provisions governing the requirements of CFR services.

FAR Part 139 deals with the certification and operations of United States land airports that service scheduled or unscheduled air carrier operations conducted with aircraft having more than 30 passenger seats. Parts 139.317 and .319 set out minimum levels of CFR equipment and extinguishing agents, and operational requirements that must be maintained at these airports. By legislation, aircraft rescue and fire-fighting equipment and extinguishing agents are defined by reference to Federal Aviation Administration (FAA) advisory circulars and must be acceptable to the administrator of the FAA. Similarly, by legislation, an airport's aircraft rescue and fire-fighting vehicles and their systems must be maintained so as to be able to perform their functions, and personnel must be able to demonstrate their ability to respond adequately when requested by the FAA. As well, each airport certificate holder must ensure that all rescue and fire-fighting personnel are acceptably equipped and properly trained to perform their duties in a manner acceptable to the administrator of the FAA.

In Canada, rules and guidelines governing crash, fire-fighting, and rescue requirements and standards are set out in various policy documents issued by Transport Canada Airports Authority Group. These policy documents, given AK designations, are implemented as mandatory standards and guidelines for internal use within Transport Canada. These documents are intended to govern Transport Canada – owned and operated airports but they have no supporting legislative or statutory authority.

The principal documents used by Transport Canada Airports Authority Group for CFR services are AK-12-03-001, CFR standards document, and AK-12-06-002, 003, and 004, training and equipment standards documents. Other related policy documents are AK-12-08-002, Firefighter Code of Conduct, and AK-66-06-400, Aviation Fuelling Manual. For information not contained in these documents, CFR firefighters must refer to documents called National Fire Protection Association (NFPA) manuals, published in the United States. For example, Transport Canada document AK-66-06-400 does not provide information regarding the handling of fuel spills. NFPA manuals specifically describe and categorize sizes of fuel spills and how each spill is to be handled.

I find Transport Canada AK policy documents dealing with CFR services to be detailed and comprehensive. I also find Transport Canada training requirements to be of a high standard, with the exception of certain specific deficiencies that are dealt with in this Report.

Specific deficiencies were noted in the training and knowledge of the Dryden airport CFR personnel in a number of areas. Some of these deficiencies arose out of a lack of training requirements or policy instruction within the Transport Canada CFR documentation and training standards. I will deal with these deficiencies in the context of the activities of the Dryden CFR unit on March 10, 1989.

Unlike in the United States, no legislation in Canada compels certificate holders of airports not owned or operated by Transport Canada to comply with Transport Canada policy standards and guidelines regarding CFR services. An airport such as the Dryden Municipal Airport, which is owned by Transport Canada but leased and operated by the Town of Dryden, appears to fall into a category that is neither clearly governed by Transport Canada CFR policies and standards nor by legislation equivalent to such policies and standards. Transport Canada exercises certain control over the operation of the Dryden Municipal Airport through its lease and its financial assistance agreements. I will deal specifically with these agreements and their application to CFR services further in this chapter.

Background of Dryden Municipal Airport and CFR Services

In August 1968 the Corporation of the Town of Dryden and the minister of transport entered into an agreement for the construction, operation, and ownership of the Dryden Municipal Airport. The Town of Dryden acquired the land and constructed access roads, and Transport Canada constructed a runway, now a paved runway, 6000 feet long by 150 feet wide. In March 1974 the Town of Dryden transferred to the minister of transport all the land upon which the Dryden Municipal Airport is situated and, thereafter, has leased the airport for successive five-year periods. The most recent lease agreement is dated June 5, 1989. The relevant provisions in the agreement state as follows:

> 22. That the Lessee shall, at its own cost, before using the said land and the said facilities for airport purposes obtain a license from the Minister under the Air Regulations and amendments thereto, and

> thereafter the Lessee shall during the currency of this Lease operate the said airport as a public airport, subject to such terms and conditions as the Minister may direct and shall charge for the use of the said airport and for any services performed in connection therewith only such fees as the Minister may approve.
>
> 23. That the Lessee, its officers, employees and agents and all persons using the said airport, shall, at all times, during the currency of this Lease observe and comply with the provisions of the Aeronautics Act, as amended from time to time, the Air Regulations, and amendments thereto, all rules and regulations made from time to time pursuant to the said Act, and all local airport rules.
>
> (Exhibit 27, Lease Indenture, July 15, 1975)

The Town of Dryden views the Dryden Municipal Airport as a regional airport serving the surrounding area and northwestern Ontario. A number of flights feed into the airport from outlying areas to meet up with flights to Thunder Bay and Toronto or west to Winnipeg. There are approximately 6000 people in the Dryden community; however, up to 55,000 passengers use the airport annually.

The Dryden airport is managed by the Dryden Municipal Airport Commission on behalf of the Town of Dryden. The commission members are the mayor of the Town of Dryden, one town councillor, and two other town representatives. Mr John Callan, the chief administrative officer for the Town of Dryden, also acts as the secretary-treasurer to the commission. Day-to-day operation of the airport is the responsibility of the airport manager, who reports directly to the airport commission. Mr Peter Louttit was the airport manager from 1978 until December 15, 1989.

The airport commission enters into sublease agreements with various parties such as Dryden Flight Centre, Canadian Partner, and rental car agencies located at the airport. It is the view of the Town of Dryden and the airport commission that Dryden is not responsible for funding the airport in any way, and that operational losses are to be borne by Transport Canada. Airport revenues are primarily derived from leasing agreements and landing fees and are approximately $300,000 annually, while the total annual operating expense is approximately $900,000. The expenses (using approximate figures) are split among five centres as follows: administrative, $100,000; surface maintenance, which includes fuel maintenance, mobile equipment maintenance, and fuel and maintenance staff, $250,000; mechanical and plant maintenance, $100,000; security services, $100,000; and the CFR unit, $350,000. A large portion of the CFR cost is fire-fighters' wages. Transport Canada subsidizes the airport for the shortfall of approximately $600,000.

Each year, based on the forecast operating budget, the Town of Dryden applies to Transport Canada for financial assistance for the airport. Funding is governed by an agreement between the Town of Dryden and the minister. Clauses from the latest agreement, dated April 3, 1979, which are relevant to the operation of CFR services on the airport are as follows:

> 5. *Operating Subsidy*
>
> (1) Upon the Corporation's submission to the Minister of its forecast annual budget, Her Majesty will grant financial assistance to the Corporation by way of an annual operating subsidy to a level approved by the Minister and the maximum level of subsidy shall be determined annually in advance by the Minister.
>
> 7. *Ministerial Approval*
>
> The Corporation shall not, without the consent in writing of the Minister, being first had and obtained, assume any obligations or make any expenditures under the provisions of this Agreement which is not in accordance with annual operating budgets approved by the Minister.
>
> 9. *Air Regulations*
>
> The Corporation shall abide by the Air Regulations, including any amendments thereto, and all other regulations that may be made from time to time under the provisions of the Aeronautics Act, being Chapter A-3 of the Revised Statutes of Canada, 1970, and the Corporation shall obtain a licence from the Minister under the Air Regulations and amendments thereto, and thereafter the Corporation shall, during the currency of this Agreement, operate the Airport as a public airport, subject to the terms and conditions as the Minister may direct.
>
> 12. *Corporation Provision of Facilities*
>
> Without limiting or restricting the generality of the provisions of Clause No. 18 hereof, the Corporation shall be responsible for the operation, management and maintenance of the Airport, and all related facilities which, without limiting or restricting the generality of the foregoing, shall include airport services, runways, fences, hangars, shops, terminal and other buildings, airport lighting equipment, and like services, and the Airport shall be maintained in a serviceable condition, all to the satisfaction of the Minister.
>
> 13. *Navigational Aids, etc.*
>
> Her Majesty may supply radio navigational facilities, airway and airport traffic control and meteorological services should the Minister at any time consider that such services are necessary.
>
> (Exhibit 288)

In the early years of this arrangement, it was relatively easy for the Dryden airport to obtain subsidies from Transport Canada. Since 1984, according to Mr Louttit, fiscal restraint has led Transport Canada to require more justification for assistance. Mr Louttit testified that fiscal restraint, together with ongoing reorganization, changed the relationship between Transport Canada and the Dryden airport, and that Transport Canada expected the airport commission to operate more independently. It was this arm's-length relationship that existed on March 10, 1989, and, according to Mr Louttit, the transition to independence was a difficult one both for Transport Canada and for the Town of Dryden, particularly at Mr Louttit's level of airport manager. The relationship between Transport Canada's regional office at Winnipeg and the Dryden Municipal Airport was at times strained, especially during budget negotiations.

Mr Callan, in his testimony, spoke with some pride about the Dryden airport and the significance it has for the business community and the local residents. It is my impression that the Town of Dryden and the airport commission also took pride in the fact that the airport was manned by full-time professional CFR personnel equipped to handle aircraft such as the Boeing 737.

There are 37 airports in Transport Canada's Central Region that are either owned and operated by Transport Canada, owned and subsidized by Transport Canada, owned by Transport Canada and operated under contract, or only subsidized by Transport Canada. Transport Canada, Central Region, covers the area from Thunder Bay to the Saskatchewan/Alberta border and from the Canada/U.S. border north to the high Arctic. In the early 1970s, flying activity was increasing and carriers such as Transair started flying into the Dryden airport using Fokker F-28 aircraft. NorOntair also operated Twin Otter aircraft into Dryden. In the late 1970s, sophisticated and expensive fire-fighting equipment was being placed at various subsidized airports across Canada, and Transport Canada was attempting to staff CFR units at these subsidized airports with fire-fighters in accordance with the prescribed airport category. Emergency services specialists in Transport Canada Central Region headquarters, Winnipeg, in allocating their resources, wanted to place at each of the subsidized airports a full-time professional fire chief so there would be someone at each airport to maintain the new fire-fighting equipment and to hire and train auxiliary fire-fighters. However, Transport Canada headquarters decided to concentrate the full-time professional fire-fighters at airports, such as Dryden, into which larger aircraft types were operating.

The Dryden airport commission began employing full-time fire chiefs in 1978. The first two fire chiefs that were hired did not remain for various reasons including, in the opinion of Transport Canada emergency services specialists, frustration as a result of a perceived lack of support by the airport manager for the CFR program. Mr Ernest Parry, hired in 1982, was the third fire chief and was hired coincident with the Dryden airport CFR unit being staffed with full-time, professional fire-fighters.

Dryden Airport Category and CFR Services

Airport Categorization

Airports are categorized by Transport Canada for the purpose of determining the CFR resources required, based on length and maximum fuselage width of the longest aircraft normally using the airport. The airport category is determined from a table in Transport Canada document AK-12-03-001. The category appropriate to aircraft length is established first and, if the maximum fuselage width of the longest aircraft is greater than the maximum width for that category, the category is increased by one level. Aircraft traffic statistics for the previous 12 months are also used in determining the airport category.

Level of Protection

Transport Canada document AK-12-03-001 outlines the CFR requirements for all categories of airports. The categories range from 1 to 9, with an airport like Manning, Alberta, being a 1; Moose Jaw, Saskatchewan, a 3; Montreal/Saint-Hubert, Quebec, a 5; Winnipeg, Manitoba, a 7; and Lester B. Pearson in Toronto, Ontario, a 9. On March 10, 1989, the Dryden airport was listed as category 4.

The number, type, and characteristics of fire-fighting vehicles and minimum quantities of extinguishing agents are specified for each category. The minimum number of employees on duty is specified and related to the type and number of vehicles provided to meet the level of protection for the particular airport category. At airports of category 5 or above, the manpower response is to include one additional person as crew chief.

It is stated in document AK-12-03-001 that "Airport emergency procedures shall be developed to ensure the effective utilization of all available resources in the event of an aircraft accident/incident" (Exhibit 243, s. 4.01, p.7).

Dryden Airport CFR Services

From 1978 until March 10, 1989, the category of the Dryden airport varied from category 3 to 6. In the 1980s, Transport Canada monitored Dryden air traffic and determined that the category of the Dryden airport was too high. Transport Canada then discussed downgrading the category with the Dryden airport commission. During these discussions, the Dryden airport commission's aim was to maintain the highest airport category and the commensurate level of CFR services. Thus, CFR staff positions could be preserved.

It was the evidence of Mr Callan that Dryden area residents were thrilled when Air Ontario announced it was going to introduce its jet service to the Dryden airport. Accordingly, the Town of Dryden corresponded with Air Ontario to gain its support for maintaining the existing airport category and had discussions on the same topic with Transport Canada. The Town of Dryden and the airport commission wished, at least, to delay any reduction of CFR service.

The *Canada Flight Supplement*, in effect for the period February 9, 1989, to April 6, 1989, provided Canadian terminal and en route data for pilots in flight and for flight planning. It listed the Dryden Municipal Airport as a category 4 airport, with the appropriate level of CFR services available from 1300 to 0315 UTC (7:00 a.m. to 9:15 p.m. CST) on Monday to Saturday and from 1300 to 0300 UTC (7:00 a.m. to 9:00 p.m. CST) on Sundays. Outside these hours of operation, three hours' prior notice was required for CFR service.

Although the Dryden airport was listed in the supplement on March 10, 1989, as a category 4 airport, the CFR vehicle strength, a rapid intervention vehicle and a foam truck, was in fact commensurate with a category 5 airport. The Dryden CFR unit comprised a fire chief and five fire-fighters, all full-time professionals, two of whom were designated crew chiefs. Transport Canada AK-12-03-001 lists the CFR staff requirement for a category 4 airport as four professional fire-fighters and five auxiliary fire-fighters. Shortly before the March 10, 1989, crash, Transport Canada had advised the airport commission that the Dryden airport should be reclassified as a category 3 airport. This change, if implemented, would have effectively eliminated all full-time fire-fighters, except for the fire chief.

Nordair Ltd introduced jet service to the Dryden airport in the late 1970s, using the Boeing 737-100 aircraft. This was the largest aircraft to use the airport, and its size and the frequency of service resulted in the airport being assessed at that time, as category 6. Because of a subsequent reduction in the number of Boeing 737 flights into Dryden, the airport category was reduced to category 5. Canadian Airlines, the successor to Nordair Ltd, terminated the Boeing 737-100 service into

Dryden in February 1988. Air Ontario subsequently introduced jet service into Dryden, using the Fokker F-28 Mk1000 aircraft, in June 1988. This aircraft, which was smaller than the Boeing 737, required a category 5 airport, but, because of a lower frequency of service, the airport was then assessed as category 4. Without the operation of the F-28 aircraft, the Dryden airport could have been reduced by Transport Canada to a category 3 airport.

The chief of the Dryden airport CFR unit reports to the airport manager. The fire chief is responsible for managing the CFR unit. The evidence indicates that the chief's responsibilities include the following: ensuring that CFR employees are adequately trained and able to perform their duties; preparing annual work plans and budgets; requesting training materials through the airport manager from Transport Canada; and reporting CFR unit activities to the airport manager on a monthly basis.

Role of the Dryden CFR Unit

There were posted on the wall of the Dryden CFR unit office copies of two pages from A.I.P. Canada: Aeronautical Information Publication, TP 2300 E, dated May 13, 1982, and entitled "Airport Emergency Services," stating the following objective at Paragraph 7.1(a):

> Objective – the primary objective of the Airport Emergency Services (AES) is to save lives in the event of an aircraft accident/incident or fire at an airport. This will be accomplished by providing a fire-free escape route for the safe evacuation or rescue of passengers and crew. A secondary objective is to preserve the property involved by containing or extinguishing, where practical, any fire resulting from an aircraft accident or incident.
>
> (Exhibit 187)

This paragraph is found, unchanged, in the current edition of the A.I.P., except that the title Airport Emergency Services has been changed to Airport Crash Firefighting and Rescue Services (CFR). The statement in question is extracted from the Transport Canada Crash Firefighting and Rescue Standards, AK-12-03-001; Policy document: TP 3660. This Transport Canada document further states that:

> Specifically, the CFR will normally be the first to arrive at the scene of an aircraft emergency. Upon their arrival, action will be taken to prevent, control, or extinguish fire involving or adjacent to an aircraft for the purpose of providing fuselage integrity and an escape area for its occupants. Such efforts shall be under the direction of the senior CFR officer present.

> The CFR will participate, to the extent possible within their available resources, with the flight crew in the evacuation of passengers. If the flight crew are unable, for whatever reason, to open usable emergency exits, CFR personnel will, by whatever means necessary, force entry to the aircraft and provide assistance in the evacuation/rescue of the occupants.
>
> (Exhibit 243)

Mr Brian Boucher, an Air Canada pilot and representative of the Canadian Air Line Pilots Association (CALPA), a well-trained fire-fighter and fire professional and a trained specialist in aircraft fires, assisted this Commission with respect to fire-related issues. During his testimony, Mr Boucher was questioned about the roles of fire-fighting units in general and about the Dryden CFR unit in particular. While responding to a specific question about the use of handlines, Mr Boucher provided insight into the roles and priorities of fire services and fire-fighters. The relevant portion of his evidence pertinent to an assessment of the fire-fighting response by the Dryden CFR unit on March 10, 1989, and in particular whether handlines were brought to the site of the crash of the F-28 in a timely manner, was as follows:

> Q. All right. Given your background and given your experience in fighting fires, would you have – in that position that they were in, would you have taken a hand line into an aircraft immediately or attempted to?
>
> A. The role of the fire department, the role of the fire service is to save lives. The fire service has tactical priorities. The first priority is rescue. The second priority is fire control. Either you control the fire offensively or defensively. After you have taken care of that tactical priority, then you go into the final stage which is property conservation.
>
> When I talk rescue, we break rescue down into two areas, a primary search and a secondary search. Now, the primary search is to immediately try and rescue people that would be in immediate danger, to prevent further injury, and that's the key word there, to prevent further injury. In order to do that, especially when you have a fire burning, in order to prevent further injury from the people that you are trying to rescue and yourself, and the survivors, is no different than a structure fire. You have to take something to control the fire, something with you to help you to carry out this primary search. So it would be a mandate to take a hand line with you as soon as possible, as soon as you were able to take that hand line.
>
> It's no different than a structural fire. An airplane on the ground burns, as far as fire dynamics goes, the same as a building, a structure fire or a trailer fire that has life in it. The major difference with airplane fires is it has fuel on board. And

as I have explained earlier, you have that problem with a fuel-fed fire, and what that does is gives you only a few minutes to do your job, to carry out a primary rescue, or at least try and control the fire in order to get up, get inside to do a primary rescue. After you have completed the primary rescue and if you can't get inside an airplane or a building, you always check the surrounding area of the incident that you have responded to.

When that's been completed, you go into fire control and you put the fire out. And then, last, you go into property conservation and that's overhauling the airplane and making sure you put out all the spot fires and so you don't get any more damage by letting the fire continue to burn.

If you cannot do a primary search, get inside, because when you arrive there, the cabin is totally involved, as we call it, fully involved. Then as soon as the fire is knocked down, you then do a secondary search. And when you do a secondary search, the possibility of survival is very remote.

(Transcript, vol. 68, pp. 108–10)

CFR Response Areas

The CFR response areas delineated in the A.I.P. and Transport Canada CFR standards document AK-12-03-001 are generally followed in the Dryden Airport CFR Standard Operating Procedures manual. An insert page in this Dryden airport CFR manual titled: "Response to Aviation Emergencies Off-Airport," effective November 18, 1985, clearly requires that the Dryden CFR respond even to "off-airport" aircraft accidents:

> CFR personnel shall respond to aircraft accident/incidents off-airport in accordance with policies/procedures outlined in Transport standard AK-12-03-001 sec. (A) 3.01, 3.03, 3.04, 3.05, and the Dryden Municipal Airport Emergency Procedures Manual.
>
> (Exhibit 76)

Subsection 3.01 of the Transport Canada CFR Standards Manual sets out the responsibilities of a CFR unit as follows:

> The primary responsibility of the CFR shall be to respond to an aircraft accident/incident on the areas within the Critical Rescue and Firefighting Access Area (CRFAA) and airport boundary; the secondary responsibility shall be to respond to an aircraft accident/incident occurring beyond the CRFAA and airport boundary when it is considered that the crash site is reasonably accessible and a useful service can be rendered.
>
> (Exhibit 243)

It is noteworthy that the word "shall" is used in both the Dryden Airport CFR Standard Operating Procedures manual and in the Transport Canada CFR Standards AK-12-03-001 policy document to describe both the primary and secondary responsibility of the CFR.

Critical Rescue and Fire-fighting Access Area (CRFAA)

A CRFAA is defined in the Transport Canada Crash Firefighting and Rescue Standards AK 12-03-001 policy document as a rectangular area, 300 metres wide, centred on a runway, and extending 1000 metres past each end of the runway (see figure 9-1). The CRFAA is the area where the majority of aircraft accidents have historically occurred, and the boundaries of the CRFAA are not necessarily coincident with the airport boundary. The terrain conditions within the CRFAA are not taken into account in the definition.

Applying the criteria set out in the Dryden Airport CFR Standard Operating Procedures and in the Transport Canada CFR Standards document AK-12-03-001 policy document, the portion of the CRFAA at the west end of Dryden airport consisted of an area 300 metres wide, centred on runway 29, and extending 1000 metres west of the end of the runway.

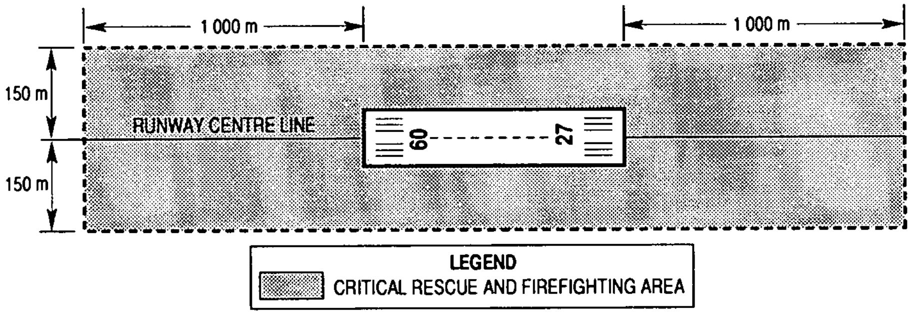
Inasmuch as flight 1363 began striking trees 127 metres to the west of the end of runway 29 before crashing and coming to a stop 962 metres to the west of the end of runway 29 at Dryden, almost in line with the runway centre line, I find that the crash occurred within the Dryden airport CRFAA.

The evidence is clear that the Dryden CFR unit never at any time conducted fire-fighting training within the CRFAA of the Dryden airport. The reason for this appears to lie, at least in part, in the lack of understanding by the Dryden CFR unit of the concept of the CRFAA, and in the failure by Transport Canada to define clearly the meaning of the CRFAA and to ensure that all CFR units understood their responsibilities with respect thereto.

During his testimony, Chief Parry discussed the responsibilities of the CFR unit at the Dryden airport. It was his opinion that the primary responsibility of the CFR unit was to perform crash, fire-fighting, and rescue operations on the airport. Chief Parry disagreed that part of the primary responsibility of the Dryden CFR unit was to respond to aircraft accidents beyond the airport boundary.

He also was of the view that the Dryden airport did not have a viable CRFAA because of the difficult terrain at the runway ends. The fact remains, however, that there was a CRFAA for the Dryden airport and that there were CFR access gates at both ends of the airport. The CFR

Figure 9-1 CRFAA



Source: Transport Canada, *A.I.P. Canada*

access gate at the west end of runway 29 led to a road that passed through the eastern portion of the CRFAA in which the crash occurred. This road provided direct access from the west end of runway 29 to McArthur Road.

As is pointed out elsewhere in this report, this access road, because of lack of winter maintenance, was not available to the CFR fire trucks that had hurriedly been driven to the west end of the runway immediately after the crash. These trucks then had to return from this point to the terminal area to get to public roads leading to the crash site, thus adding to the accident response time.

A reference contained in section 3.02 of Dryden Municipal Airport CFR Standard Operating Procedures manual to the Transport Canada CFR Standards AK-12-03-001 policy document implied that the CRFAA was part of the Dryden CFR unit's area of primary responsibility.

The Dryden Municipal Airport Emergency Procedures Manual (unapproved by Transport Canada at the time of the crash) states the following in section 3.02, in relation to the CFR response to an aircraft crash off-airport:

> 1. The primary responsibility of the CFR is to respond to aircraft accidents/incidents within the airport boundaries (CRFFAA[1]).
> 2. The Chief, CFR may dispatch CFR equipment and/or manpower to an aircraft accident/incident outside airport boundaries provided the site is reasonably accessible, a useful service can be rendered, and measures taken so the primary CFR responsibility is not jeopardized.
>
> (Exhibit 51)

1 Abbreviations of critical rescue and firefighting access area are seen, in documentation, as both CRFAA and CRFFAA.

From a reading of paragraph 1 above, it appears that the authors of the Dryden Municipal Airport Emergency Procedures Manual, by including, in brackets, the term (CRFAA) in paragraph 1, either regarded the airport boundary and the boundary of the CRFAA to be coincident or that the portion of the CRFAA that lay outside the airport fencing was to be considered as being inside the airport boundary; and therefore a CFR area of primary responsibility. The evidence shows, however, that this was not clearly understood by the Dryden CFR unit.

Transport Canada documents are not specific when discussing CFR response areas. The Transport Canada CFR Services Standards document AK-12-03-001 contains phrases that are not precise. In section 3.01 of the document, the phrase "beyond the CRFAA *and* airport boundary" is twice used, and in sections 3.02 and 3.03 the phrase "within the CRFAA *or* airport boundary" and "beyond the CRFAA *or* airport boundary" are used (emphasis added). There is more than one way to interpret the quoted phrases and this can lead to misunderstanding on the part of CFR personnel, as appears to have been the case at Dryden. Clearly, in directions about the response to aircraft crashes, there should be no ambiguity. Common sense would lead me to believe that Transport Canada would want CFR units to respond, to the best of their ability, to a crash in the entire area of a CRFAA, be it wholly inside, or partially outside, the airport boundary. Although I would interpret the provisions of AK-12-03-001 to mean in fact that a CFR unit should respond to an aircraft accident/incident that occurs even beyond the CRFAA or airport boundary, it is imperative that Transport Canada ensure that such intent be spelled out clearly in each airport's emergency plan and understood by each CFR unit.

Mr Larry O'Bray, the superintendent of CFR services, Transport Canada, Central Region, testified that fire-fighters should occasionally train in off-runway CRFAA areas and that, as most of the CRFAA area is off-runway, it is important that training with handlines be conducted in all areas of the CRFAA. He also testified that attention to training in the CRFAA and training with handlines had not been stressed or encouraged by Transport Canada. This observation is reinforced by the fact that Dryden airport training records indicate that the Dryden CFR unit there never trained off-airport and never trained for a crash inaccessible to the fire vehicles (as was the case in this accident), and requiring the use of extended handlines. Nor is there any indication in the evidence before me that Transport Canada has ever been concerned in this matter.

I agree with Mr O'Bray regarding the importance of CFR fire-fighters conducting reasonable and realistic handline training within the off-runway area of the CRFAA and not simply on the level, hard-packed airport property or hard-surface areas such as runways and taxiways. It is important that fire-fighters be able to use handline equipment when fire-fighting vehicles cannot be driven to the fire.

The evidence, however, shows that any misunderstanding of the responsibility of a CFR unit to respond to an accident within the CRFAA had no bearing on the outcome of the March 10, 1989, accident, other than the fact that such lack of understanding may have influenced the absence of CFR training by the Dryden CFR unit within the CRFAA, especially with regard to the use of handlines.

Since there are areas on and off airports, but within the CRFAA, that may be inaccessible to fire-fighting vehicles, it is clearly up to Transport Canada to ensure that airport authorities, in conjunction with their respective CFR units, determine the most appropriate ways to deal with emergencies within each airport boundary and within the CRFAA, and to conduct appropriate training. Inasmuch as the secondary responsibility of CFR units is to provide a service outside the airport boundary and CRFAA, some planning and training in this respect should be carried out as well.

Dryden Airport CFR Unit on March 10, 1989

Fuelling Procedures at Dryden

The term "hot refuelling" refers to the procedure whereby an aircraft is refuelling while one, or more, of its engines is operating. Because the running engine is an ignition source and there is the possibility of fuel spilling, precautions are normally taken to ensure the safety of the passengers, crew, fuellers, aircraft, and other facilities.

Transport Canada, Airports and Properties Branch, Winnipeg, issued, on May 8, 1978, "for the attention of all concerned" a letter outlining the procedures for refuelling a Boeing 737 with one engine running. The following passage is quoted from the letter:

> <u>Procedures:</u>
>
> (a) This procedure will be permitted only when the APU of the aeroplane is unserviceable and the necessary ground power for an engine start is not available on the airport.
>
> (b) All passengers are to be off-loaded and cleared from the area during the refuelling period.
>
> (c) Pressure refuelling permitted to a maximum volume of ninety percent of each tank capacity of the Boeing 737 and at a fuelling pressure not to exceed 30 PSI.

(d) Normal static discharge precautions taken.

(e) Fuel quantity at wing refuelling station and in cockpit to be monitored throughout procedure.

(f) A responsible company employee to be positioned at nose of aircraft to observe refuelling operation while in direct radio communications with crew member or maintenance man in the cockpit qualified to handle power plant controls.

(g) An entrance door to be open providing a satisfactory evacuation route for any crew members or company servicing personnel on board.

(h) All available fire fighting equipment shall be located within operational distance of the aeroplane.

(i) The aircraft to be positioned the maximum distance from the air terminal or other structure consistent with fixed apron or cabinet refuelling capability. Where possible this separation should be not less than 250 feet from the public terminal or passenger waiting room.

(j) The Airport Manager or his representative shall be advised before the company initiates each such refuelling procedure.
(Exhibit 273)

The testimony of Transport Canada emergency services officers indicated that this directive relating to hot refuelling of the Boeing 737 aircraft had been circulated to all airport managers in Central Region where Boeing 737 aircraft operated, including Dryden. However, it had not been passed on to the Dryden CFR unit by the airport manager. The CFR fire-fighters at Dryden had no knowledge of the directive or its contents until after March 10, 1989, when it was shown to CFR crew chief, Mr Stanley Kruger, by Mr Jack Nicholson, Transport Canada, Winnipeg.

On March 10, 1989, because the APU on C-FONF could not be used by the flight crew to start the engines, and there was no ground-start capability for the F-28 at Dryden, it was necessary to hot refuel the aircraft (see also the description in chapter 5, Events and Circumstances Preceding Takeoff). The aircraft was parked in the normal parking area with the centre line of the aircraft about 90 feet from the Dryden terminal. At approximately 11:40 a.m., after the aircraft had been parked and the pilots had discussed refuelling with Mr Vaughan Cochrane, the Dryden Flight Centre representative, Mr Cochrane called the fire hall and asked Mr Kruger to have the fire-fighters hurry to the terminal area since the F-28 was to be refuelled while one of its main engines was running. Mr Kruger relayed the information to his partner, fire-fighter Gary Rivard, and they drove two fire-fighting vehicles, Mr Kruger in Red 1 and Mr Rivard in Red 2, to the terminal area. According to Mr Kruger, the F-28 refuelling was underway when they arrived at the terminal. The fire vehicles were parked 100 to 125 feet in front of the aircraft facing downwind in an easterly direction, with Red 2 covering the refuelling operation and Red 1 to the right of Red 2 covering the aircraft exits. Once the hot refuelling was completed, Red 1 returned to the fire hall while Red 2 remained in position until C-FONF taxied away from the terminal.

During testimony, Mr Kruger stated that he was aware that hot refuelling meant refuelling with an engine running, but he had not received formal instructions on procedures to be followed. He did, however, know that he was to cover the aircraft during a hot refuelling in case of an emergency. Some time after March 10, 1989, Mr Nicholson provided a copy of the May 8, 1978, letter to Mr Kruger.

Mr Jeffrey Hamilton, an emergency services officer, Transport Canada, Airports Authority Group, Central Region, an experienced commercial bush pilot and a qualified CFR fire-fighter and fire officer, testified that the Dryden CFR personnel did not follow the correct procedures for hot refuelling as set out in the May 8, 1978, letter. Mr Hamilton also testified that, if hot refuelling is taking place and the correct procedures are not being followed by the flight crew and the fuelling agent, the CFR fire-fighters should insist, on the spot, that refuelling immediately cease and the correct procedures be complied with.

Many of the hot refuelling procedures specified in the May 8, 1978, letter were not followed. Because none of the Dryden CFR crew were aware of the correct procedures, the appropriate action was not taken by either Mr Kruger or Mr Rivard. Mr Kruger observed that the passengers stayed on the aircraft during the hot refuelling. Even if Mr Kruger was not aware that hot refuelling with passengers on board was not allowed, he was aware that the hot refuelling was taking place too close to the terminal building. During testimony, he stated it was his opinion that the aircraft was parked too close to the terminal and that, if anything happened to the aircraft, the terminal would probably have been affected. It is my view that Mr Kruger, as crew chief, should have at least stopped the fuelling because of the proximity of the aircraft to the terminal building. Chief Parry, who was in the vicinity of the aircraft at that time, was neither aware that a hot refuelling was taking place nor indeed aware of what the term meant.

As the evidence of the hot refuelling at Dryden came to my attention early in this Inquiry, I made an interim recommendation on an urgent basis to the minister of transport at the commencement of the hearings in Dryden, later formalized in my first *Interim Report* as Interim Recommendation No. 1, as follows:

> The Department of Transport prohibit the refuelling of an aircraft with an engine operating when passengers are on board, boarding, or deplaning.

Transport Canada subsequently issued a notice to all air carriers requesting voluntary compliance with the interim recommendation until the necessary legislation was drafted and passed. I am advised by representatives of the Department of Transport that such legislation will be in place by the end of 1991.

When the refuelling hose was disconnected from C-FONF after the hot refuelling at the Dryden airport was completed, about 5 litres of fuel poured out of the aircraft fuelling manifold onto the tarmac. The fuel spill was observed by the three CFR staff who were in the vicinity of the aircraft. Mr Kruger discussed its cleanup with the refueller, Mr Cochrane, and they agreed that, because the spill did not pose a significant threat, it would be cleaned up after C-FONF had departed the area. Once the aircraft taxied away, Mr Rivard used the main turret water gun on Red 2 to wash the fuel away. He estimated that 200 to 300 gallons of Red 2's approximately 1000-gallon water capacity was used.

Mr Hamilton, when asked how a CFR fire-fighter should have handled the fuel spill, stated in testimony that, a "fuel spill of that size could have been handled with absorbent material, either a speedy dry or an aquasorb or even sand could have been spread on the spill and cleaned up as opposed to using the resources from the truck" (Transcript, vol. 34, p. 4). Both Mr Kruger and Chief Parry testified that using water from the CFR vehicles to clean up a small fuel spill was a misuse of a valuable resource and that the procedures had been changed regarding cleanup of such spills. I agree with Mr Hamilton that absorbent material, not the CFR fire-fighting equipment, should be used to handle small fuel spills. The fire trucks should have been available with full water tanks in case of an emergency during aircraft operations. If, however, a fuel spill is sufficiently large, it should be cleaned up before the aircraft's engines are started.

The Dryden airport is subsidized by Transport Canada and is subject to operating guidelines issued by Transport Canada, including the guidelines regarding the fuelling of aircraft. The Dryden Flight Centre, which is the airport handling agent for ESSO Petroleum Canada, must, as well as following Transport Canada guidelines, follow the guidelines or instructions issued by ESSO for the handling of ESSO products.

Transport Canada policy documents AK-66-06-400, Aviation Fuelling Manual: Fuel Storage, Handling and Dispensing; AK-12-06-004, Airport Crash, Firefighting, and Training Manual, and TP 1297 AK-71-20, Manual of Standard of Procedures for Aircraft Fuel Servicing, set out the standards and guidelines relating to aircraft fuelling on Transport Canada–operated and Transport Canada–subsidized airports.

Transport Canada, as one the largest operators of airports in North America, created the documents noted above based on its experience in aircraft fuel handling and knowledge of previous fuelling-related accidents. The destruction of an Air Canada DC-8 aircraft in Toronto, Ontario, on June 21, 1973, to which I referred in my first *Interim Report*, is one example of such an occurrence. This aircraft caught fire during refuelling; however, the source of ignition was never determined. The boarding of passengers on the Air Canada DC-8 had just been approved but, fortunately, had not yet commenced when the first explosion took place.

ESSO Petroleum Canada's Aviation Operations Standards Manual, which describes in detail how to handle aviation fuels and other ESSO products safely, is issued to all ESSO agents, including the Dryden Flight Centre.

Transport Canada policy document AK-66-06-400 outlines the provisions relating to bonding and grounding an aircraft during fuelling to prevent the buildup of static electricity that could lead to static discharge and ignition of fuel vapours. Provisions in the document require that the aircraft and the refuelling vehicle each be grounded, the aircraft and the refuelling vehicle be bonded to each other, and the fuel nozzle be bonded to the aircraft.

Mr Jerry Fillier, an employee of Dryden Flight Centre, initially started to hook up the fuel truck to C-FONF but was sent by Mr Cochrane to refuel another aircraft at the fuel cabinets. Mr Cochrane then completed the hook-up and hot refuelling of C-FONF. During his testimony, Mr Fillier stated that he bonded the truck to the aircraft but did nothing else regarding the refuelling of C-FONF. He knew the procedures for proper bonding but did not know that the aircraft should have been grounded. It was not determined conclusively during the testimony of Mr Cochrane whether he completed the required bonding and grounding before he started to refuel the aircraft.

Transport Canada policy document AK-12-06-004 states at page 51 that:

> With Type B jet fuel, due to its relatively low vapour pressure, the vapour-air mixture above the liquid surface, under normal temperature and pressure conditions, will often be within flammability range. This means that ignition of Type B vapours either inside or outside a tank may cause violent combustion within the confined

> space if the flame enters. Type A jet fuels do not give off flammable vapours in ignitable amounts unless the fuel temperature is above 35°C.
>
> (Exhibit 244)

C-FONF was refuelled at Dryden with Jet B fuel, and the temperature during the hot refuelling was 1°C, a temperature within the fuel's flammability range.

On all refuelling vehicles, there is a dead-man switch that normally must be held continuously by the refueller in its "on" position to allow fuel to flow. This safety feature will cause refuelling to stop the moment the switch is released. The safety feature of the switch can be bypassed by, for example, taping the switch "on" or by using a switch override.

The ESSO Aviation Operations Standards Manual states at section 020-004, page 18, as follows:

> Deadman control devices must be installed on all underwing fuelling vehicles.
>
> Unless prohibited by local regulations, these devices may have an over-ride which must be sealed in the normal position. This over-ride can be used to complete a fueling in case of a faulty deadman.
>
> Corrective action must be taken to repair the deadman immediately after fueling is completed.
>
> (Exhibit 173)

Transport Canada policy document AK-66-06-400, subparagraph 8.04 at page 8, states in part: "Self-closing nozzles or deadman controls shall not be blocked open or bypassed" (Exhibit 270). Mr Cochrane testified that it was normal at Dryden to override the dead-man switch when refuelling, and, in this instance, he caused the dead-man switch to be bypassed.

The ESSO manual states in its introduction to section AOSM 202-007, page 1: "Fueling of an aircraft with one propulsion engine running is a *non-routine, emergency operation* and as such requires very strict safety precautions, in addition to those given elsewhere ... [emphasis added]" (Exhibit 173).

The ESSO manual also states that, when hot refuelling is to take place, all passengers must deplane, the customer must sign an indemnification release statement, a representative of the customer must supervise the refuelling, the operation must be reviewed beforehand by the customer and the agent, the aircraft must be positioned at least 150 feet from any building or aircraft, and all persons not directly needed for the refuelling must be at least 150 feet away. Mr Cochrane, although a representative and agent of ESSO, was not aware of these provisions and did not take any steps to ensure that they were met.

The evidence shows that there was nothing in any manuals normally used by Air Ontario F-28 pilots regarding hot refuelling, a serious omission. However, the Air Ontario Flight Attendant Manual, Section 2.31, Item 12, states as follows:

> When refuelling is required with one engine running, all passengers are to be off-loaded and cleared from the area during the refuelling period. Flight Attendants should also leave the aircraft.
>
> (Exhibit 137)

It is my view that, during the hot refuelling of aircraft C-FONF, the Dryden Flight Centre refuellers used unsafe procedures in that they did not follow any of the special precautions outlined in the ESSO manual. The failure to use the dead-man control device, the possible inadequate grounding, the fact that there were passengers and crew on board the aircraft, and the fact that the aircraft was closer to the terminal and other persons and equipment than allowed are made more dangerous by the fact that Jet B fuel, which is more volatile than Jet A fuel, was being pumped into the aircraft. The hot refuelling was completed in disregard of proven safety procedures, either because the proper procedures were not known or, if the procedures were known, the dangers involved were not appreciated.

It is also my view that the pilots of C-FONF should have been aware that extra precaution was required when hot refuelling with passengers on board.

The CFR fire-fighters were in the vicinity and monitored the hot refuelling, and they, as well, are equally responsible for ensuring that refuelling be as safe as it can be. As professionals, they should, because of their training and knowledge, be able to spot unsafe practices, and they should intervene to preclude an obvious fire hazard. The evidence is clear that the CFR unit did not intervene in any way with the refuelling other than to clean up the small fuel spill.

It is obvious from all the evidence that the flight crew were anxious to depart Dryden as soon as possible, and I am left with the impression that the fuelling agent, who was also the ground-handling agent for Air Ontario, was in a hurry to fuel C-FONF at Dryden. By so doing, he ignored many precautions that are in place to promote safe fuelling operations.

As a result of the evidence and testimony that came before me during the course of the hearings, Transport Canada, on March 22, 1990, issued an AK directive by way of a memorandum to all airport managers of Transport Canada–owned and operated airports and Transport Canada–subsidized airports dealing with airport fuelling procedures. The memorandum is as follows:

> The purpose of this memo is to reconfirm that the TC fuelling safety procedures covered in TP 2231 (AK-66-06-400) are still in force and shall be followed at Transport Canada owned and operated airports, and extended to subsidized airports in line with ADM memo of February 15, 1990. You are asked to take immediately the necessary steps to implement TP 2231 (AK-66-06-400) with emphasis on the following sections:
>
> Section 4.05
> The Airport Manager *shall* maintain a separate file for each fuel company or handling agency, which will provide a record of all inspections, document verification, and violations of the policies and standards outlined herein.
>
> Section 4.06
> The Airport Manager shall recommend that an agreement, lease, or other contract document be terminated or not renewed, if the training record of any employee engaged in the handling of fuel or fuel vehicles or equipment is not provided when requested and/or if standards or safety and security requirements are not met.
>
> Section 4.07
> The Airport Manager shall advise the fuel system operator, the airport management committee, or the airlines and the fuelling committee, if established, of any deficiencies in the fuelling area.
>
> Strict adherence to these standards are compulsory, and any deviation from them must be requested from AK – Ottawa.
> In order to ensure compliance from coast to coast, I requested that AKOB[2] personnel conduct "spot checks" at airports regardless of their size. This is a very important safety matter, and I trust that you will do your utmost to ensure its full implementation.

I commend the action taken by Transport Canada both in reaffirming that Transport Canada Fuelling Safety Procedures covered in policy document AK-66-06-400 shall continue to be in force, and in extending the mandatory fuelling safety practices and procedures to subsidized airports in Canada. I also agree with Transport Canada's decision to have its personnel conduct spot checks at airports to ensure that knowledge, training, and standards of safety are met regarding fuelling procedures. However, I see no reason why CFR personnel, upon receiving proper training regarding aviation fuels and fuelling pro-

2 AKOB is the designation for personnel in Transport Canada Airports Safety Services, Ottawa.

cedures, cannot be used to monitor fuelling procedures on a continuing basis and act as Transport Canada's representatives in ensuring compliance with the standards and procedures. Since the airport CFR unit, as an arm of Transport Canada's airport authority, has a real interest in having fuelling practices and procedures conducted in a safe manner, it seems only logical that they be mandated to ensure that standards are maintained.

Crash Gate Access Roads

At the Dryden airport, there are roads at either end of runway 11/29 leading to gates built into the airport perimeter fences in line with the runway. The roads and gates are to provide the CFR fire vehicles immediate access off the runway ends into the critical rescue and fire-fighting access area (CRFAA) beyond the airport proper in the event of an aircraft crash. On March 10, 1989, the access road to and beyond the crash gate at the west end of runway 29 could not be used by the fire vehicles because it had not been cleared of snow. During testimony, Crew Chief Kruger stated that he was of the opinion that the access roads should be kept open and accessible, and that he had communicated this view to both Chief Parry and Mr Louttit, the airport manager, on a number of occasions prior to March 10, 1989. Mr Kruger testified that the access road could have been kept open easily with the airport grader or front-end loader and that "a lot of minutes could have been saved" in reaching the crash site if this had been done (Transcript, vol. 26, p. 159). After the crash of C-FONF, Mr Kruger and Mr Garry Galvin, the other Dryden CFR crew chief, wrote a summary of observations and suggestions by the Dryden CFR crew. The summary was dated March 13, 1989, and stated in part as follows:

> Better maintain access roads to runway, road from firehall to the runway should be kept sanded on a priority basis in winter months. Access roads at the end of the runway at each end should be kept open in winter months.
>
> (Exhibit 186)

Mr Arthur Bourre has been an employee of the Dryden airport for approximately 10 years and is an experienced meteorological observer and equipment operator. During his testimony, he agreed with Mr Kruger that the access roads should be kept clear of snow, that the CFR crews had requested the same of Dryden airport management, and that it would not be difficult to keep them open using airport equipment. Mr Hamilton, a Transport Canada emergency services officer, agreed that the access roads should be kept clear.

Although Transport Canada's policy manual AK-72-40-200, Manual of Snow Removal and Ice Control Operational Requirements, does not clearly state policy on crash roads, it does establish priorities for snow and ice removal to keep an airport operating. This document establishes three levels of priority for areas to be cleared during and after a snowstorm. The airside priority I area requires, among other things, that access roads from the fire hall to the active runway be cleared at all times. The airside priority III area sets out the following requirements in section 4.02 (a)(iii):

> Priority III Area
>
> The Airside Priority III Area includes those surfaces that are cleared after a snowstorm. They are:
>
> (1) all other runways and taxiways;
> (2) airside service roads;
> (3) runway, taxiway shoulder areas;
> (4) pre-threshold areas;
> (5) glide path sites;
> (6) remaining airside areas required to permit full operational use of the airport.

While the priority III area does not expressly include crash gate access roads at runway ends, I interpret the statement in subparagraph (6), "remaining airside areas required to permit full operational use of the airport," to be broad enough to include crash gate access roads at the runway ends.

I heard no reasonable explanation as to why the management of the Dryden airport did not keep the crash gate access roads open during the winter. I find this particularly disconcerting in view of the fact that a Dryden CFR fire-fighter had repeatedly requested of airport management that this be done. I find that both the airport manager, Mr Louttit, and Chief Parry had a duty to ensure that the crash gate access roads were kept open and that they did not discharge that duty.

Transport Canada, Central Region, Emergency Services Organization, did not identify this problem. Its inattention to this area appears, in large part, to have been attributable to the lack of adequate resources, to inappropriate lines of authority, and to the lack of adequate control by Transport Canada over the Dryden airport and the CFR unit.

As a result of the evidence put before this Commission with regard to the Dryden airport crash gate access roads not being maintained during the winter months, the director-general airports operations, Transport Canada, on March 23, 1990, issued the following directive:

> SNOW REMOVAL - EMERGENCY ACCESS ROADS AND GATES
>
> During the recent Commission of Inquiry hearings concerning the Crash Fire Rescue (CFR) response to the Air Ontario crash at Dryden, Ontario, there was considerable criticism regarding the fact that emergency access roads at the ends of the active runway had not been maintained during the winter months.
>
> Pending an amendment to the "Snow Removal and Ice Control Standard," we would ask that emergency access roads and crash gates at each end of every active runway are cleared of snow as part of the after storm clean-up. In addition, these instructions extend to subsidized airports in line with AK's direction of February 15, 1990.

I endorse the action of Transport Canada in instructing airport managers to ensure that emergency access roads and crash gates at each end of every active runway are clear of snow as part of the after–storm cleanup. I also endorse the amendment to policy document AK-72-40-200 to ensure that access roads and crash gates are more clearly defined in the priority III area subsection of the document.

Activities of CFR Fire-fighters

The evidence leaves no doubt whatsoever that the CFR personnel who attended at the scene of the crash allowed themselves to become diverted from their responsibility to take action to prevent, control, or extinguish the fire involving or adjacent to the aircraft, as set out in Transport policy document AK-12-03-001. Instead, they gave in to human instinct and assisted the survivors who were already outside the aircraft.

I will not review in detail the actions and the efforts of crew chief Kruger and fire-fighter Rivard, the first CFR members to arrive at the scene, in assisting passengers who had extricated themselves from the flaming aircraft wreckage. The passengers' recollections are discussed elsewhere in this report. While it is not difficult to understand Mr Kruger's and Mr Rivard's instincts of human compassion which caused them to become absorbed in assisting the survivors, their actions demonstrate the need for adequate training of CFR crews about their primary responsibility at an aircraft accident site. At the same time, I commend Mr Kruger for making his way immediately to the crash site, assessing the situation, and directing much of the rescue activity.

I will comment later on the actions of Chief Parry as on-site coordinator. My comments and observations now will be directed at the actions of Chief Parry, crew chief Kruger, and fire-fighter Rivard in their capacity as professional CFR personnel responding to the crash of C-FONF.

The CFR unit acted in a timely manner in initially responding to the crash, except that Mr Rivard arrived at the crash site approximately 30 minutes after the arrival of Chief Parry and Mr Kruger because he got stuck in a snow bank at the airport, and because he stopped to top up Red 2 with water.

Paragraph 3.01 of the draft Dryden Emergency Procedures Manual deals with aircraft crashes off-airport and states inter alia, that: "Aircraft accidents/incidents outside the airport boundaries are the responsibility of the O.P.P. and the site will be under their command" (Exhibit 71). Paragraph 3.02 in part states: "The Chief ... [in this case, Chief Parry] may dispatch AES [Airport Emergency Services] equipment and/or manpower to an aircraft accident/incident outside airport boundaries provided the site is reasonably accessible, a useful service can be rendered, and measures taken so the primary AES responsibility is not jeopardized."

At the time, Chief Parry did not consider the ramifications of leaving the airport unattended, nor did he stop to consider the issues of jurisdiction or responsibility; his perceived requirement was to get himself, his fire-fighters, and his fire-fighting equipment to the crash site as quickly as possible. During the hearings, Chief Parry testified that his primary responsibility was the airport, that he had left it unattended, and that he would not have been able to respond to an emergency at the airport. Chief Parry explained his actions in responding to the crash by stating the following in testimony: "considering the weather conditions, and the fact that the primary aircraft was down, I did not anticipate any other aircraft of an F-28 or primary aircraft size at the airport at that time" (Transcript, vol. 6, pp. 272–73).

In my view, Chief Parry properly exercised his discretion in responding to the crash. Clearly there was a possibility that the CFR fire-fighters could render a useful service. Although the evidence demonstrated that Chief Parry lacked a full understanding of the scope of his responsibilities and duties and that his views regarding the CRFAA were questionable, these factors did not affect the initial CFR response.

The airport manager was immediately involved in the response to the crash and was aware that, once the CFR vehicles left the airport, there was no CFR service available to respond to further emergencies at the airport. He was therefore in the best position to notify all potential users and operators of the lack of availability of CFR services. It was not until 3:46 p.m. EST, however, that a notice to airmen (NOTAM) was issued by Kenora Flight Services stating that CFR services were not available at the Dryden airport. Another NOTAM was issued at 4:30 p.m. EST indicating that CFR services were again available.

Initial Response by CFR Unit to the Crash

Each of the three Dryden CFR staff who responded to the crash of C-FONF committed a number of errors that, given the evidence as to their inadequate training, are understandable. Each error or mistake, by itself, may not have been significant in the overall response; however, in assessing the collective errors of these persons, I am led to question the level of training and knowledge of the personnel of this CFR unit. Accordingly, I will deal with the activities of the each of these persons.

Fire-fighter Rivard, an experienced truck operator and previously a part-time maintenance employee for the Dryden airport, had been a fire-fighter for a few months prior to March 10, 1989, and on that day was operating vehicle Red 2. In responding to the crash, Mr Rivard, in Red 2, and Chief Parry, in Red 3, drove on to runway 11/29 and proceeded quickly to the west end of the runway. The vehicles were not able to use the crash gate access road at the end of runway 29 to reach the public roads that led to the crash site, so both vehicles turned around and proceeded back towards taxiway Alpha and the service road. As Mr Rivard had depleted some of the water from Red 2 in washing down the fuel spill, he asked Chief Parry if he should refill the truck. Chief Parry instructed Mr Rivard to top up Red 2 before proceeding to the crash site.

Chief Parry exited the runway at taxiway Alpha, and Mr Rivard proceeded east to the service road to fill up Red 2 at the fire station. Mr Rivard estimates that he was travelling at approximately 40 mph while proceeding along the runway and slowed to approximately 25 mph to negotiate the turn onto the service road. The service road, while cleared, was snow packed and not sanded. On entering the service road, Mr Rivard lost control of the vehicle, and it slid into a snow bank. Airport maintenance employee Christopher Pike, using a front-end loader, pulled Red 2 from the snow bank, and Mr Rivard proceeded to replenish Red 2 with an estimated 200 to 300 gallons of water. He then proceeded to the crash site, arriving at the junction of McArthur and Middle Marker roads at 12:43 p.m. Approximately 30 minutes had elapsed between the time that Mr Rivard got stuck and the time he arrived at the crash site.

Crew chief Kruger, in vehicle Red 1, returned to the fire hall after monitoring the refuelling and observing C-FONF take off. Immediately on his arrival at the fire hall, he received a radio call from Chief Parry asking him to "get back out here" (Transcript, vol. 26, p. 109). Mr Kruger drove Red 1 back onto the runway and proceeded westbound. On seeing Red 2 and Red 3 coming towards him, Mr Kruger turned around and waited for Red 2 and Red 3 to catch up and lead the way. Mr Kruger followed Chief Parry off the airport property and to the crash site.

En route to the crash site, Chief Parry communicated by radio with the Town of Dryden as follows:

> This is Airport Red 3 we suspect we have an F-28 jet down approximately 3 or 4 miles west of the runway, please activate the mutual aid and emergency plan.
>
> (Exhibit 1282, p. 2)

Chief Parry parked Red 3 at the intersection of McArthur Road and Middle Marker Road, unlocked the gate to Middle Marker Road, and signalled Mr Kruger to go down this road the crash site. Chief Parry and Mr Kruger arrived at the intersection at approximately 12:18 p.m.

Fire Chief Parry

Chief Parry stated that, based on his experience with the exercises he had been involved with and the location of the crash site, he made the decision to stay at the intersection and establish a command post. He believed he would be most effective in directing arriving agencies where to go. This decision is not inconsistent with the CFR and other emergency training with which Chief Parry had been involved, and had been reinforced by Transport Canada officials who oversaw or reported on the training. All such training, however, had been conducted on the airport.

Chief Parry remained at the intersection, acting, in his view, as overall coordinator. Chief Parry's jurisdiction was never challenged by other responsible persons, and he voluntarily relinquished command to the Ontario Provincial Police (OPP) at mid afternoon on March 10.

Because of its location in Wainwright Township, the crash site came under the overall command of the OPP, and the fire-fighting responsibility came under the purview of the Unorganized Territories of Ontario (UT of O) Fire Department under the direction of Fire Chief Roger Nordlund.

During his testimony, Chief Parry agreed that the control of the fire-fighting effort should have been under the UT of O Fire Department, and that the overall responsibility in the area should have rested with the OPP. When asked to explain in what context or under what jurisdiction he established his command post, Chief Parry replied as follows:

> A. Simply that it was an aircraft incident and we were the first there.
>
> (Transcript, vol. 6, p. 269)

It appears to me that the overlapping jurisdictions in place at the crash scene on March 10, 1989, caused confusion and uncertainty as to the respective roles of those involved. This is an area in need of clarification, as previously was discussed in chapter 8, Dryden Area Response. Chief Parry did not go to the crash site until approximately 3:30 p.m., some 3 hours and 20 minutes after the crash occurred, when he toured the site with Staff Sergeant D.O. Munn of the OPP. Chief Parry estimated that he was there for 10 to 20 minutes, long enough to ensure that there was no further need for the CFR unit and that he could do "an official turnover to the OPP" (Transcript, vol. 6, p. 267). It was not until later that he realized an official turnover was not required.

Crew Chief Kruger

After parking Red 1 on Middle Marker Road, Mr Kruger took a portable, two-way, two-channel FM radio and a first aid kit weighing approximately 25 pounds and walked into the site. It was Mr Kruger's intention to proceed to the crash site and assess the accident. Two civilians, Craig Brown and Brett Morry of Terraquest Ltd, who were the first persons to arrive at Middle Marker Road after the crash, had already walked through the deep snow to the crash site, and Mr Kruger followed the path they had made, catching up to them as they neared the crash site. Mr Kruger stated he could hear the fire, small explosions, and the sound of flames making an echoing noise in the bush.

As he neared the crash site, Mr Kruger met about 20 surviving passengers who presented a scene that was "hard to describe and put into words." The survivors were, in his words, "in various states of emotional distress, underdressed, and all of them coming towards me at the same time" (Transcript, vol. 26, p. 130). Mr Kruger gave them directions on how to get to Middle Marker Road and to the intersection. From his observations when he arrived at the crash site, Mr Kruger formed the opinion that there were no survivors in that aircraft.

By the time Mr Kruger arrived at the aircraft, all passengers who were to survive the accident, except two, had exited the aircraft either on their own or with the help of others. Two remaining survivors, Mr Uwe Teubert and Mr Michael Kliewer, were discovered at approximately 1:00 p.m. trapped under the left side of the aircraft. Under the direction and with the assistance of doctors Gregory Martin and Alan Hamilton, rescuers removed Mr Teubert and Mr Kliewer from the wreckage by approximately 1:10 p.m. Mr Kliewer was badly injured and incapacitated. They were both attended to by the doctors, taken out to the road on stretchers, and transported by ambulance to the Dryden hospital at approximately 1:45 p.m. Mr Kliewer died in hospital as a result of his injuries.

All other surviving passengers either made their own way out to Middle Marker Road or were assisted by other survivors, by Mr Kruger and Mr Rivard, by various UT of O and Town of Dryden fire-fighters, by OPP officers, by numerous civilians, and by medical personnel from the Dryden hospital.

Mr Kruger stated that on arriving at the aircraft site, he observed many fires around the edge of the aircraft and that the aircraft itself was burning. He inspected the right-hand side up to the nose area of the aircraft, but did not proceed around the left side of the aircraft prior to the rescue of the trapped individuals. After inspecting the right-hand side, Mr Kruger decided to go back with the remaining survivors and wait until he got help with fire-fighting apparatus.

During his testimony, Mr Kruger stated that he recognized several individuals who arrived on the scene shortly after he did. From that fact alone, he knew that the disaster plan had been activated and that there would be other fire departments responding in short order.

Mr Kruger testified that after arriving at the crash site, he called Chief Parry on channel 1 of the hand-held radio, which he stated was "our airport operating frequency for our fire department," and provided him with a quick assessment of the accident (Transcript, vol. 26, p. 125). It was Mr Kruger's opinion that channel 1 was the frequency on which he would communicate with Chief Parry. Mr Kruger further stated that he advised Chief Parry that the crash site was about 150 yards from Middle Marker Road, that there were at least 20 survivors, that "there was an awful lot of the aircraft that was burning that could be saved and to get the handlines in as quick as possible" (Transcript, vol. 26, p. 136). Mr Kruger also testified that he told Chief Parry to send in men and equipment. In Mr Kruger's view, "men and equipment" was a self-explanatory statement meaning "firefighting apparatus" (p. 136). Red 1 could not be used as a fire-fighting vehicle because its handline was only 150 feet long and would not reach the accident site from the nearest point at which it could park.

Chief Parry agreed during testimony that Mr Kruger contacted him early on when he first went into the crash site and provided him with an estimate that it was 150 yards from the crash site to Middle Marker Road. It was Mr Rivard's testimony that he heard Mr Kruger make the request for handlines, stretcher boards, and men about three times and that Chief Parry was not answering Mr Kruger's calls. Mr Rivard stated that on two occasions, once while he was refilling Red 2 with water and again while he was driving to the crash site, he answered Mr Kruger's calls on his own radio but did not receive a reply. Mr Rivard stated that Mr Kruger's requests were made on channel 1, the CFR unit's emergency channel.

Mr Kruger testified that his call for handlines shortly after he got into the woods was acknowledged by Chief Parry. Since the tape recording of the fire channel at Dryden dispatch shows that Chief Parry began operating on the mutual aid channel before he arrived at the scene, any such conversation and acknowledgement would have to appear on the same tape recording, unless Chief Parry had switched momentarily to channel 1. At 1:04 p.m. airport control radioed Red 3 (Chief Parry) that Red 1 had been talking to Kenora on VHF frequency 122.6. Chief Parry replied that he had lost contact with Red 1 and had sent a Dryden fire-fighter with a radio to try to re-establish contact. The first tape-recorded transmission from Red 1 occurs at 1:10 p.m., on channel 2, the mutual aid channel. This transmission was a request from Red 1 for handlines, which was acknowledged by Chief Parry. The evidence shows that, subsequent to his initial radio contact with Chief Parry, shortly after arriving at the crash site, Mr Kruger transmitted other information by radio, but these messages did not get to Chief Parry, probably because Chief Parry was then on the mutual aid frequency.

Fire-fighter Rivard, Mr Kruger's partner, also stayed on channel 1. In the minutes ofthe staff debriefing, held at the airport on March 14, the following recommendation appears:

> A better procedure is needed for CFR to know when to change from the CFR frequency to the Mutual Aid frequency on the FM radios.
>
> (Exhibit 37(e))

It would appear from all of the evidence that, after Mr Kruger's initial radio contact with Chief Parry after reaching the crash site, there was no further two-way radio communication between them until about 1:10 p.m. I conclude that Mr Kruger did not change his radio from channel 1, the CFR channel, to channel 2, the mutual aid channel, as Chief Parry had done. In his testimony, Mr Kruger discussed why he did not switch channels:

> Q. Did you have both channel 1 and channel 2 on your portable radio?
> A. Yes, I did.
> Q. Did you attempt to raise the Chief on channel 2?
> A. Not until some time later.
> Q. And why is it that you didn't think of switching to channel 2 when you didn't get a response on channel 1?
> A. I can't give you a definite answer on that. I think I was so caught up with the activity it – it did take some time. I had contacted my partner on the firefighting frequency. It never occurred to me, for any reason, that I should not be able to raise the Fire Chief on that channel.
>
> (Transcript, vol. 27, p. 63)

It would seem that the establishment of communications between Chief Parry and Mr Kruger would be a priority for both of them given their tasks as on-scene commander and fire-fighter. One radio call on the other channel by either Mr Kruger or Chief Parry would have accomplished this linkage.

Mr Kruger spent the duration of his time at the crash site attending to surviving passengers and directing arriving individuals to various duties. On his immediate arrival, Mr Kruger gave his fire-fighter's coat to flight attendant Sonia Hartwick who was carrying an infant child, thereby negating his effectiveness as a fire-fighter. Mr Kruger became involved in assisting and carrying stretcher patients as "there was no surplus of help, rescuers, at the time" (Transcript, vol. 26, p. 149). On the arrival of Mr Rivard, Mr Kruger instructed him to grab the power saw out of Red 1 and brush out a trail to allow the stretchers to be carried out to Middle Marker Road. Mr Kruger then became involved in a ground search team that checked the flight path for passengers who may have been thrown from the aircraft.

Although all his actions were commendable, Mr Kruger became so involved in assisting the injured passengers that he forgot that, as the first professional fire-fighter at the scene, he should have focused his attention on fighting the aircraft fire, on the possibility of assisting trapped passengers, and on the preservation of evidence.

Fire-fighter Rivard

Mr Gary Rivard, on his arrival in Red 2 at the intersection of McArthur and Middle Marker roads at 12:43 p.m., was signalled by Chief Parry to drive down Middle Marker Road. On driving towards the site, Mr Rivard realized that an ambulance, which had been allowed access down Middle Marker Road by the OPP and was parked behind Red 1, would be blocked by Red 2. Mr Rivard parked behind the ambulance and assisted Mr Harold Rabb, a Dryden ambulance driver, in getting two surviving passengers into Red 2. Mr Rivard then backed Red 2 out of the intersection to allow the ambulance to exit. As he was crossing McArthur Road at the intersection, there was a loss of air pressure from the air system of Red 2 that caused its brakes to apply automatically and the engine throttle to fail to idle power. The loss of air had been a recurring problem on Red 2. Mr Rivard, leaving the vehicle's engine running, assisted the survivors who were riding in Red 2 into other vehicles located on McArthur Road. Then, with the aid of a Dryden airport maintenance worker, Mr Christopher Pike, he overrode the failed engine throttle and locked brakes and moved Red 2 out of the way of the intersection. He parked Red 2 on the side of McArthur Road where it remained for the balance of the afternoon. Mr Rivard then made his way through the bush to the aircraft crash site.

While Mr Rivard admitted during testimony that he could, with the assistance of Mr Pike, have moved Red 2 back down Middle Marker Road close to the crash site, and, thereafter, with the assistance of civilian rescuers, run a handline into the wreckage, he had no explanation why he did not do so. Nor did he check with Chief Parry to see whether he had heard the urgent requests for handlines made by Mr Kruger on channel 1. It strikes me that a properly trained fire-fighter, hearing no response to such important calls to the fire chief, would have done no less.

On his way in to the crash site, Mr Rivard came across rescuers struggling with passengers on stretchers. He assisted them and became involved with others in carrying three individuals on stretchers to Middle Marker Road. After helping with three stretchers, he spent a further half hour with a fellow fire-fighter from the town of Dryden, Mr Craig Bulloch, using a chain saw from Red 1 to clear a trail through the wooded area from the aircraft crash site to Middle Marker Road. Thereafter, Mr Rivard, Mr Kruger, UT of O and the Town of Dryden fire-fighters and others assisted survivors of the crash in making their way to Middle Marker Road and transporting injured passengers in stretchers to ambulances. Shortly after 1:30 p.m., when the UT of O fire-fighting vehicles drove down Middle Marker Road, Mr Rivard assisted other UT of O fire-fighters in extending a handline from the UT of O pumper truck to the aircraft crash site. Water and foam were first applied to the burning aircraft at approximately 2:00 p.m.

Use of Fire-fighting Equipment Available at the Crash

Airport CFR fire-fighting equipment that arrived at the scene of the crash were:

- Red 1, a rapid intervention vehicle carrying 300 gallons of premixed water and foam, 300 pounds of dry chemical, and equipped with a dual-agent handline 150 feet long on either side of the truck (the lines could not be joined together);
- Red 2, a crash response tanker vehicle holding 1000 gallons of water and separate foam tank and equipped with connectible 2½-inch 50-foot and 100-foot handlines with a total length of 600 feet (a 100-foot section of 2½-inch hose with connections weighs 11 kilograms); and
- Red 3, a four-wheel drive suburban van equipped with three communications radios and carrying two 30-pound fire extinguishers. Its radios are a 10-frequency VHF scanner that receives only, a two-channel FM two-way radio used for communicating between airport vehicles and offices and the Town of Dryden Fire Department, and a single frequency VHF radio for communicating between airport vehicles and the Kenora Flight Service Station.

Red 3 and Red 1 arrived at the scene of the crash at 12:18 p.m., less than 10 minutes after the crash, and Red 2 arrived at 12:43 p.m., approximately 33 minutes after the crash.

The UT of O fire-fighting vehicles that arrived in response to the crash were a self-contained rapid attack vehicle carrying water, unmixed foam concentrate, and about 1000 to 1200 feet of fire hose, and a tanker truck carrying about 1000 gallons of water, unmixed foam concentrate, and a port-a-pond water tank. The two UT of O fire-fighting vehicles arrived at 12:34 p.m. and 12:40 p.m. respectively, less than 30 minutes after C-FONF crashed. Three fire-fighters arrived with the UT of O fire vehicles, with additional fire-fighters arriving continually in their private vehicles. UT of O Fire Chief Roger Nordlund arrived at the crash site at 12:45 p.m.

The Town of Dryden Fire Department dispatched two vehicles to the crash site after a request was made by Chief Parry at 12:26 p.m. for a pumper truck. The Town of Dryden pumper truck, a suburban van, 10 fire-fighters, and two fire captains arrived at the intersection at 12:44 p.m., 34 minutes after the crash. (Mr Louis Maltais, the fire chief for the Town of Dryden, testified that, because all the fire-fighting equipment from the airport had been committed to the crash site, he sent the town's pumper truck to the airport fire hall at approximately 2:30 p.m. to provide CFR coverage for any incoming aircraft.)

By 12:45 p.m., approximately 35 minutes after the crash, there were seven fire-fighting vehicles near the scene of the crash from three fire-fighting units. Three of the vehicles, the CFR truck Red 2, the UT of O pumper truck with portable tank, and the Town of Dryden pumper truck were capable, with the use of their extended fire hoses, of delivering water and/or water and foam to the burning aircraft. However, no attempt was made to use any of the fire-fighting equipment on the peripheral fires and burning aircraft until after 1:30 p.m., when the UT of O tanker truck was driven down Middle Marker Road to a point within 150 yards of the crash site. Extinguishing and controlling the fire was not commenced until approximately 2:00 p.m., one hour and 50 minutes after the crash, when the first water and foam mixture was applied by UT of O fire-fighters.

There were two 30-pound, cartridge-activated fire extinguishers on Chief Parry's suburban vehicle, Red 3. One was a standard multi-purpose, dry chemical extinguisher, and the other was specifically for metal fires such as wheel brake fires. Neither extinguisher was used on the aircraft fire. Chief Parry gave the following reasons for not using these extinguishers:

> A. ... I knew that it was an F-28 that had gone down in heavy bush. I had seen smoke from a distance and both arriving and the

> magnitude of that disaster was not going to be affected in any significant manner by a 30-pound extinguisher.
>
> (Transcript, vol. 6, p. 251)

When questioned further, however, Chief Parry agreed that these fire extinguishers could have been used to contain spot fires and flare-ups described by rescuers who arrived early at the crash site.

In discussing the use of rapid intervention vehicle, Red 1, for fire-fighting, Chief Parry stated that Red 1 does not have handlines suitable for use away from the immediate vicinity of the truck. He stated in testimony that "it has a fixed dual agent handline which is extremely heavy and short. It is intended for immediate mop-up use in the close proximity" (Transcript, vol. 7, pp. 10–11). The suburban vehicle, Red 3, parked at the intersection all afternoon, was used as a command post by Chief Parry.

During testimony, Chief Parry explained why he did not instruct Mr Rivard in Red 2 to proceed back down Middle Marker Road and position the vehicle close to the crash site:

> A. We already had a pumper truck in that area. A pumper truck can be supplied with water. It has drafting capability. It also carries a great deal of hose. It was sent in there initially.
>
> (Transcript, vol. 6, pp. 253–54)

Chief Parry was referring to the UT of O pumper truck that arrived at the intersection at 12:40 p.m. and parked on McArthur Road three minutes prior to the arrival of Red 2. While Chief Parry admits that he made an error in signalling Red 2 to go down Middle Marker Road when it first arrived, he stated that his action was a "natural instinct" and he waved Red 2 in, not realizing that there was an ambulance already down Middle Marker Road.

In Chief Parry's view, Red 2's fire-fighting capability would have been less effective than the UT of O pumper truck and, in his words, it would have been "perhaps disastrous" for the CFR fire-fighters to "try and set that up and get those handlines in" from Red 2 (Transcript, vol. 6, p. 255). Chief Parry felt that it would have taken the efforts of Mr Kruger, Mr Rivard, and himself just to string the 500 feet of fire hose into the crash site, and "that it probably would have taken us a long time, just three of us mainly, trying to get that hose in there" (Transcript, vol. 6, p. 255). Chief Parry was also of the view that he would have lost the coordination aspect of "getting all those other resources there. In my opinion, that would have been disastrous" (p. 256). Chief Parry stated in testimony that, even if it was physically possible for the three CFR personnel to hook up the links of hose and string the line from Red 2, it would have been a 20- to 30-minute operation. Based on his experience from previous exercises, Chief Parry elected to man his command post and he stayed there, in his words, "[a]s much as I possibly could" (p. 257).

Chief Parry explained that he did not instruct Red 2 to proceed back down Middle Marker Road because Red 2 would have been less effective than the UT of O pumper truck. While he explained why the UT of O pumper truck would be more effective, Chief Parry had no explanation of why the UT of O pumper truck was not directed down Middle Marker Road to a position near the crash site as soon as possible after its arrival. Chief Parry stated in testimony that:

> A. ... what really happened ... the UT of O pumper truck showed up around about the same time as the Red 2 and I instructed them to go in and see if they could get a handline in ... when the UT of O pumper truck showed up, it was the first thing I said to them. See if you can get a handline in there.
>
> (Transcript, vol. 8, p. 15)

The UT of O fire-fighter who drove fire truck number 2, the tanker truck, was Mr Gerald McCrae. He testified that when he arrived at the intersection, he was instructed by an OPP officer standing next to a police cruiser to park the truck off to the right out of the road. Someone then told Mr McCrae that "we need back boards" (Transcript, vol. 8, p. 242). Mr McCrae found two mini-stretchers in the back of Chief Parry's van and ran down Middle Marker Road. Mr McCrae stated that there were all kinds of survivors walking out as he was running down Middle Marker Road. He followed a path into the crash site and came upon survivor Mrs Nancy Ayer, 40 feet from the aircraft, and immediately assisted her. Mr McCrae, with the help of Dryden airport employee Allan Haw, Terraquest pilot Craig Brown, and surviving passenger Alfred Bertram, carried Mrs Ayer to Middle Marker Road, transported her to the intersection, and placed her in an ambulance. Mr McCrae stated that no one in the UT of O made an effort to take either the pumper truck or the tanker truck down Middle Marker Road. As he explained, "[w]e more or less did what we were directed to do when we arrived on the scene" (Transcript, vol. 8, pp. 269–70). He does not recall who gave him the instructions to take stretchers and back boards to the site, but he perceived his role at the time to be one of rescue of survivors as opposed to fire suppression.

Whether Chief Parry made a request to "see if they can get a handline in there" will not be definitely known. The request either was not made, was not heard, was not remembered, or was ignored by the UT of O fire-fighters. Nor did the UT of O fire-fighters take the initiative to take a handline into the crash site. The UT of O pumper truck was not driven down Middle Marker Road until sometime after 1:30 p.m. A briefing took place between Chief Parry and UT of O Fire Chief Nordlund, when the latter arrived at 12:45 p.m., only minutes after the arrival of the UT of O tanker truck. Chief Nordlund was advised by Chief Parry of the steps he had taken in alerting various parties, but there was no discussion as to what each was going to do, and no discussion regarding the use of handlines. Chief Nordlund thereafter proceeded, as did many of his fire-fighters, immediately towards the crash site. In making his way into the site, Chief Nordlund assisted carrying stretchers part way out to Middle Marker Road. He stated that he "eventually got in to the fire scene and took a minute or two just to assess what was going on" (Transcript, vol. 8, p. 109).

Mr Rivard agreed that Red 2 could have been moved back down Middle Marker Road, close to the crash site. He also agreed that he could have rounded up several rescuers and run the handline from Red 2 to the crash site. It was Mr Kruger's evidence that coupling two sections of hose together would take only a matter of seconds. In reconstructing the time that it might have taken a fire-fighter, with the assistance of civilian rescuers, to extend the 500 feet of hose from Red 2, Mr Kruger estimated that it would be 15 or 20 minutes. He also stated that a handline would have assisted in the rescue effort of the last two passengers removed from the aircraft, Mr Uwe Teubert and Mr Michael Kliewer. In testimony, Chief Nordlund stated that it would take one fire-fighter and two to three volunteers less than five minutes to extend 500 feet of hose, in four 100-foot sections and two 50-foot sections, to the crash site.

During testimony, although Chief Parry agreed that providing a fire-free escape route for the passengers and crew of a burning aircraft was his primary responsibility, he stated that, in this case, "that was not possible" (Transcript, vol. 7, p. 48). Because he thought that the aircraft had crashed some distance into the bush, because the smoke and perhaps the fire had died down, and because it was his own belief that the chances for survival of anyone in the crash were slim, Chief Parry did not even consider running a fire hose through the bush into the crash site from Red 2. It was Chief Parry's view that his first priority was getting in a great deal of help, and that neither he nor his crew chief and his fire-fighter were going to make any significant difference by themselves.

When asked if it was his obligation to make efforts to contain the fire at the crash site, Chief Parry stated, "No, it was not. By that time, I had injured people under my care" (Transcript, vol. 7, p. 42). Chief Parry's view of his obligations at the crash site illustrates the depth of his misunderstanding of his responsibility as the CFR chief.

In discussing the use of the CFR tanker truck Red 2, Chief Parry indicated in testimony that the election not to use Red 2 and its fire hoses immediately to extinguish the fire at the crash site was "fortuitous" (p. 68). One could infer from this evidence that Chief Parry considered it more important to conserve the fire truck water supply than to use it to suppress the fire. In explaining this apparently incongruous position, he stated as follows:

> A. Once it was set up, if it had been set up and in use, it has a limited water supply and has no drafting capability, so once the truck is empty, it will just sit there and be an obstruction for the remainder of the duration, whereas a pumper truck, which was the unit that was on site, carries more hose, has much more versatility, has unlimited water supply in that it can draft and can be supplied by tankers.
>
> (Transcript, vol. 8, p. 64)

Fire-fighter Rivard, during testimony, had a different view. In proper circumstances, handlines from both tanker truck Red 2 and the UT of O tanker truck could have been used at the crash site.

Chief Parry agreed during testimony that although a continuous stream of foam mixture from the fire hose lasts approximately eight to nine minutes, he also admitted that it would last considerably longer if the operator of the hose used short bursts rather than a continuous stream. Chief Parry agreed that the foam was available immediately from fire truck Red 2. The UT of O pumper truck carries and is equipped to use the same A Triple F foam as described below.

Mr Thomas Harris was a passenger on flight 1363 and the only one who escaped out the left emergency exit, receiving severe burns to his hands in the process. At that time, he was the senior technical assistant at Abitibi Price in Thunder Bay, and he is a chemical engineer. In testimony he stated that he had seen intense fire and training films of aircraft fires and fire-fighting, and that he had seen how easily these fires can be extinguished with proper fire-fighting equipment and foam.

Mr Harris stated that, when he escaped from the wreckage, the flames were two to five feet high. About 10 minutes after the crash, he saw two rescuers arrive, one a fire-fighter (later identified as Mr Kruger) and the other a non–fire-fighter. At this time, the flames were 5 to 10 feet high on the left side of the aircraft, and Mr Harris was of the opinion that had the rescuers had a fire hose they could have extinguished the fire at that point in time. This may be true, but, as explained in chapter 8, Dryden Area Response, the earliest that a handline could have reached the aircraft was approximately 12:50 p.m., some 25 minutes later.

Experts' Views of CFR Activities March 10, 1989

Mr Brian Boucher

Mr Brian Boucher, an Air Canada pilot and trained specialist in aircraft fires, testified that the foam supplied by Transport Canada for use in Red 2 is probably the best foam on the market and is recommended for use at all airports. He stated that Red 2 was carrying aqueous film-forming foam, commonly referred to as A Triple F. Mr Boucher described the fire knock-down characteristics of that foam as superb. Having listened to Mr Kruger's testimony as to the state of the fire on his arrival at the crash site and having spoken to him personally, Mr Boucher thought that a fire-fighter with a handline using the foam from Red 2 could probably have knocked down the major part of the fire in 10 minutes, and it could have taken 20 to 30 minutes to extinguish the fire completely. In Mr Boucher's opinion, the fuselage would have been saved from complete destruction by the fire and the flight data recorder would have been saved had a handline been brought in immediately. Mr Boucher stated:

> A. ... The fire hadn't penetrated past the floor. The fire was burning in the ceiling. The fire burned downwards. It didn't start impinging on the flight data recorders until later on in the fire. So if that fire would have been knocked down within ... 15 minutes, 20 minutes, the way the flight data recorders are designed to sustain a certain amount of heat, as you have already heard testimony from, it's most likely, most probable that those flight data recorders would have been saved.
>
> (Transcript, vol. 68, pp. 113–14)

It should be noted that the Dryden airport CFR unit supplies the UT of O Fire Department with A Triple F foaming agent for use on aircraft fires, and that that foam was used by the UT of O on March 10, 1989.

Mr Jeffrey Hamilton

Mr Jeffrey Hamilton, the Transport Canada emergency services officer who provided expert evidence on a number of matters, was specifically asked to assess the Dryden CFR unit's response to the crash. As well, he was asked to give his opinion on the procedures used during the hot refuelling and on the fact that the CFR did not keep the access roads clear of snow.

It was Mr Hamilton's opinion that a properly trained CFR fire-fighter would not have lost control of his vehicle turning off the runway and should have proceeded with a little more caution. He was of the view that the maintenance road from the fire hall to the runway should have been kept sanded. Mr Hamilton testified that Mr Rivard should not have stopped to top up Red 2 with water. The loss of brakes on Red 2, due to a known and repairable defect in the braking system of the vehicle was unacceptable. While Mr Hamilton agreed with Chief Parry's action in manning a communication post at the intersection of McArthur Road and Middle Marker Road, he stated that Chief Parry should have ordered the lines from the UT of O pumper truck to be taken in to suppress the aircraft fire. In Mr Hamilton's view, that order should have been given immediately. In addition, Mr Hamilton testified that crew chief Kruger should not have given up his fire-fighter's coat, a piece of protective apparel, to one of the survivors.

Mr Hamilton concluded that the response by the Dryden CFR personnel to the crash of C-FONF was unacceptable, and he agreed that lack of training was the cause of some of the errors made by the fire-fighters. Mr Hamilton stated that this lack of training and knowledge should improve in the future, not only at the Dryden airport but at all Transport Canada–owned, operated, and subsidized airports, through the introduction of Transport Canada's Firefighter Certification Program. This program, in the words of Mr Hamilton, "will bring every firefighter in the region, or the country for that matter, to the same level of training, both practical and theoretical in every aspect of their job" (Transcript, vol. 34, p. 14).

Mr Larry O'Bray

At the time of the crash, Mr Larry O'Bray was superintendent of CFR services, Transport Canada, Central Region, and, as such, was responsible for implementing and overall coordination of Transport Canada's CFR programs within Central Region. This included assisting and advising airport managers in the running of their CFR programs, conducting training programs, and evaluating CFR units within Central Region. Both emergency services officers, Mr Jack Nicholson and Mr Jeffrey Hamilton, reported to Mr O'Bray.

In mid-January 1990 Mr O'Bray and Mr Nicholson visited the Dryden airport and reviewed with the CFR personnel their response to the Air Ontario crash. The purpose of their visit was to discuss the implementation of Transport Canada's new Firefighter Certification Program with Airport Manager Louttit and Fire Chief Parry and to review the events of March 10, 1989, including the errors made and procedures that should have been followed by the CFR unit.

During testimony, Mr O'Bray summarized his review of the initial response of the CFR unit and the UT of O Fire Department. He approved of Mr Kruger's going to the crash site to assess the fire; however, he was critical of Chief Parry's lack of communication with the UT of O fire chief upon the latter's arrival. As an expert CFR fire-fighter, Mr O'Bray was of the view that many of the fire-fighters became distracted when they arrived at the crash site. He stated that their distraction was, to some extent, due to lack of training and repetitive drills and lack of knowledge.

Mr O'Bray pointed out that there was ample evidence over the years from the training reports provided by Chief Parry and Mr Louttit, the airport manager, to Transport Canada and from the evaluations conducted by Transport Canada to show that the Dryden CFR unit was not properly trained to Transport Canada's "full standard" (Transcript, vol. 36, p. 14).

I share Mr O'Bray's view that such crash-site distraction could occur to any inadequately trained fire-fighter, and that there should be a training program within Transport Canada aimed at preparing CFR crews for the realities of a catastrophic aircraft crash such as occurred at Dryden. I am satisfied from the evidence that the underlying cause of the distraction of the CFR fire-fighters was, in large part, the result of inadequate fire-fighter training and lack of repetitive drills by the CFR unit.

Aircraft Crash Charts

Transport Canada's airport emergency services fire-fighter training standards document AK-12-06-002 requires fire-fighters to have a thorough knowledge of items that are critical to an aircraft accident or incident response. Paragraph 3.03 states as follows:

> 3.03 Aircraft
>
> AES personnel shall possess a comprehensive knowledge of all aircraft in continuing and regular use at their respective airports. This knowledge shall be acquired through training and independent study. The required knowledge will include configurations, construction, passenger capacity, fuel capacity, and location of exits. An associated requirement is a detailed knowledge of the hazards associated with aircraft, i.e., aviation fuels, jet engines, propellers, wheel fires, explosives, helicopter rotors, etc. The Fire Chief shall, through regular testing, ensure that each person is current and adequate in his/her knowledge. Firefighters shall have a detailed knowledge of the various types of aircraft incidents, their peculiarities, and generally accepted practices in approaching each. Based on the required knowledge of aircraft, airports, and accepted basic tactics, appropriate tactics shall be developed by the Fire Chief.
>
> (Exhibit 244)

Mr Jack Nicholson, the Transport Canada Central Region emergency services officer responsible for evaluating the Dryden CFR unit at the time of the crash, testified that an important element of the knowledge required by fire-fighters is provided by aircraft crash charts. Witnesses who gave evidence on this subject agreed that aircraft crash charts are essential for the identification of the critical areas that fire-fighters must be aware of in their response to potential or actual aircraft accidents or incidents. Accordingly, it is important for airport CFR units to obtain crash charts for each aircraft that uses their airports on a regular basis.

The crash chart of a Fokker F-28 Mk3000 and 4000[3] (see figure 9-2) provides critical information for fire-fighters and rescuers regarding the location and operation of doors and emergency exits, passenger seating arrangements and escape routes, and location of hazardous items such as aviation fuel, batteries, high pressure lines and reservoirs, and onboard fire extinguishers. The crash chart also shows the location of the aircraft flight recorders.

At the time of the crash of C-FONF on March 10, 1989, the scheduled passenger-carrying aircraft using the Dryden Municipal Airport most frequently were the Fokker F-28 jet aircraft operated by Air Ontario and the British Aerospace Jetstream 31 turboprop aircraft operated by Canadian Partner. Air Ontario also operated the de Havilland Dash-8, the Convair 580, and the HS-748 turboprop aircraft into the Dryden Airport from time to time. Chief Parry testified that, of the five aircraft listed, the Dryden CFR unit had in its possession a crash chart for only the HS-748 aircraft. The fact that there was no F-28 crash chart available to the CFR may have been of significance in the case of the Dryden crash.

There was no doubt in the minds of both Chief Parry and Crew Chief Kruger that crash charts are valuable and necessary tools to inform fire-fighters of the critical areas of an aircraft that will be of concern in any emergency. The evidence shows that obtaining crash charts, at least at the Dryden Municipal Airport, was left up to the fire chief, with no assistance or direction from Transport Canada as to how they were to be obtained. Chief Parry testified that he received a Fokker F-28 Mk3000/4000 crash chart, depicted above, only days before he appeared before this Commission of Inquiry as a witness, more than three months after the F-28 crash. He also testified that when he contacted Boeing-de Havilland Aircraft for a Dash-8 chart, he was advised that they did not have a crash chart for the Dash-8. As a case in point, I was surprised to hear during the course of Transport Canada witness testimony that crash charts for the Boeing 747-400 series aircraft, one of Boeing's newest aircraft, were not at that time available at airports such as Lester B. Pearson International Airport, Toronto. This Boeing 747-400 aircraft differs from other Boeing 747 aircraft in that there is a fuel tank in its

[3] The crash chart for the Fokker F-28 Mk1000 aircraft shows that the layout and configuration of a Mk1000 are similar to that of a Mk3000 aircraft.

vertical stabilizer. I have no doubt that there is information on other differences in this aircraft that could also be used by CFR units.

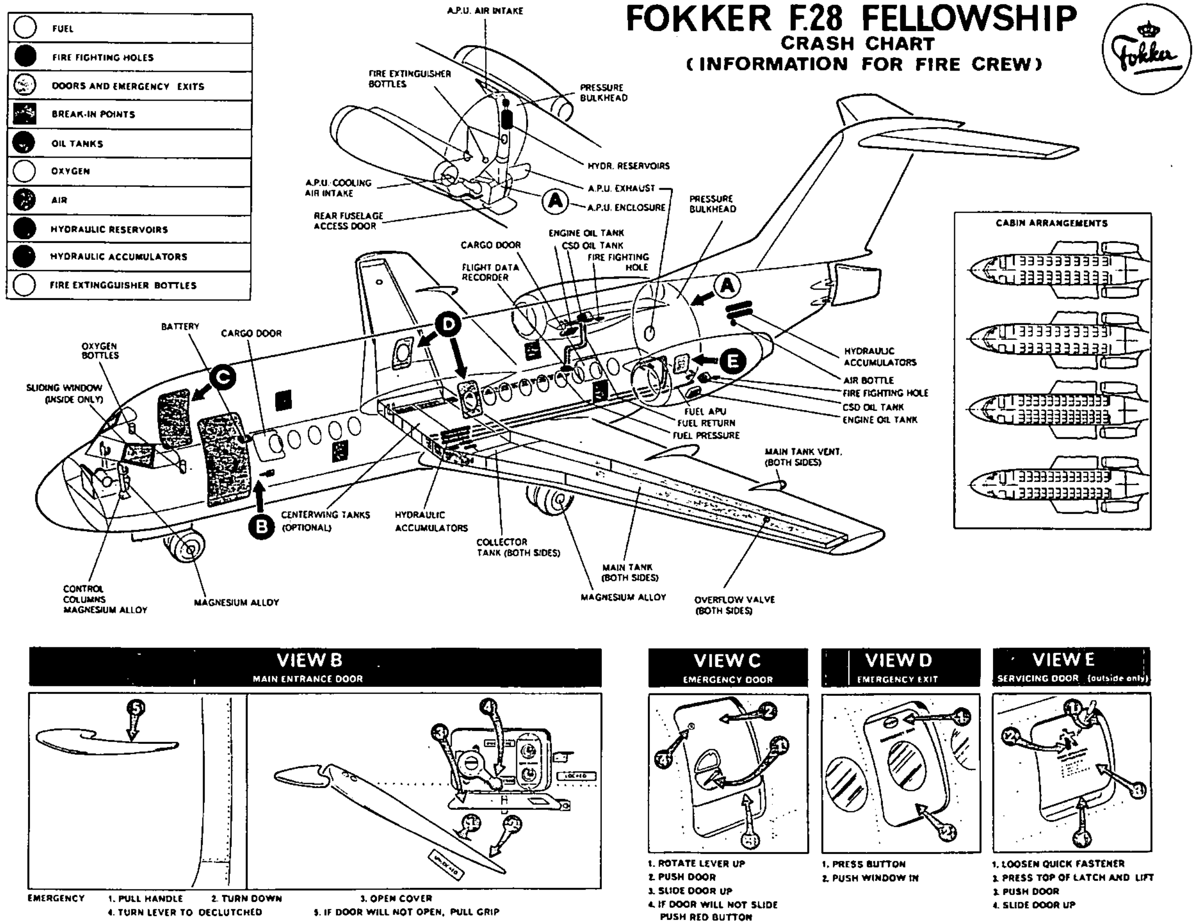
The problem of lack of aircraft crash charts is not isolated to the Dryden Municipal Airport. During testimony, Mr Nicholson stated that there was no Transport Canada policy that he was aware of requiring crash charts to be made available at any airport. However, it was the responsibility of the fire chief to ensure that the CFR fire-fighting crews possessed information of the type contained in crash charts. Testimony of other Transport Canada witnesses revealed that Transport Canada left it to individual fire chiefs at airports operated by Transport Canada to ensure that crash charts of aircraft that used the airport on a regular basis were available to the CFR unit.

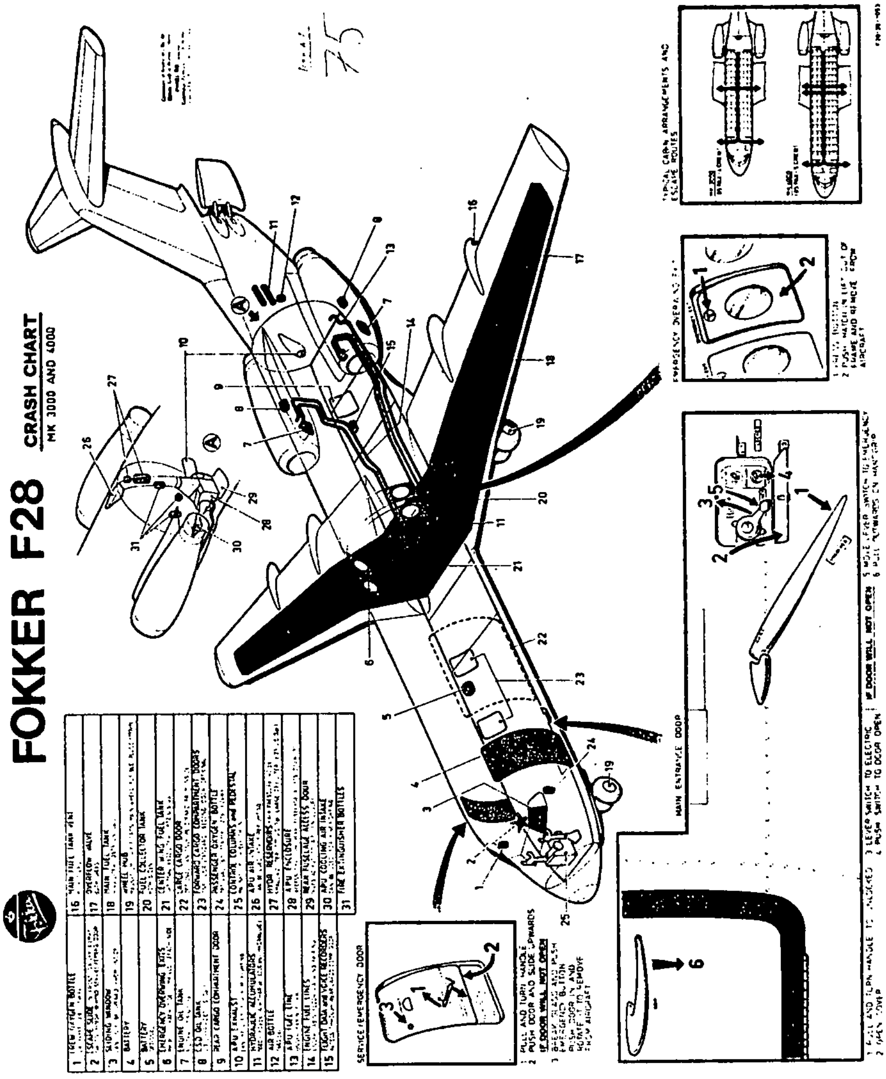
The fact is that fire chiefs may not be in the best position to obtain or demand aircraft crash charts from either the manufacturer or from an aircraft operator. I am of the view, having heard the evidence, that the onus should be placed on the carrier to provide the CFR unit at any airport used by the carrier with a crash chart for every aircraft it operates into that airport.

I will not review in detail all the testimony dealing with the necessity for crash charts to be available to CFR fire-fighters. Suffice it to say that crash charts are an important tool which, together with actual visual inspection of an aircraft, enable fire-fighters to familiarize themselves with components of the aircraft that may be critical in any aircraft crash, fire, or rescue scenario. Crew chief Kruger in testimony confirmed that, after saving lives, his secondary mandate is the preservation of evidence and the protection of the accident site. He stated that preservation of evidence "is a very fundamental and important one" (Transcript, vol. 26, p. 143).

It is reasonable to assume that if the Dryden CFR unit had been more familiar with F-28 aircraft through study of its crash chart and a thorough familiarization of the critical aspects of the aircraft, including the aircraft flight recorders, all of the crew, including the fire chief, may have been more alert to the need to attempt to control the aircraft fire and preserve the aircraft structure. Testimony revealed that the CFR fire-fighters did not know where the F-28 aircraft flight recorders were located. Clearly the chances that the recorders might have been saved from destruction, and the information therein used in analysing the cause of this crash, would have been increased had the Dryden CFR unit had crash charts. It was estimated that the recorders were exposed to an average temperature of 850°C for two hours, which destroyed the tapes. Reducing the time that the recorders were exposed to high temperatures would have increased the likelihood that the information stored in them would have been recovered.

Figure 9-2 Fokker F-28 Crash Charts





Fokker F-28 Mk1000
Source: Fokker Aircraft

As a result of this crash and the testimony heard before this Inquiry regarding the unavailability of crash charts, Mr Henry Moore, director, Airport Safety Services, Transport Canada, testified that in August 1989 his staff conducted a survey to determine the availability of crash charts on a national basis. Based on that survey, Mr Moore stated that Transport Canada was not "as well prepared" as it should be regarding crash charts. As a result of this survey, Transport Canada issued a policy directive instructing all Transport Canada Regions as follows:

> **CRASH FIRE RESCUE – AIRCRAFT CRASH CHARTS**
>
> Headquarters, AKOB, have recently completed a survey on the availability of aircraft crash charts at all airports.
>
> While it appears that, for the most part, charts are available, it is evident that not all aircraft are covered, and not all charts are up to date. It is therefore suggested that Regional CFR staff provide guidance and assistance to airports within their area of responsibility to ensure the following:
>
> - Up-to-date crash charts for all regularly scheduled, charter and/or cargo aircraft are obtained.
> - Copies of charts are carried on each CFR vehicle, in the fire hall for training purposes and in the ECC.
> - CFR personnel conduct familiarization exercises on all aircraft, using their airport as part of their regular training program.
> - Crash charts on all other aircraft using the airport are also recommended.
>
> Once you are satisfied that this very important requirement has been met, it would be appreciated if this Headquarters (AKOB) is advised.
> (Exhibit 272)

I am advised that Transport Canada's instructions to the regions regarding provision of crash charts to all CFR units apply to CFR units at subsidized airports as well as to Transport Canada–owned and operated airports. Mr Moore also testified that Transport Canada will in the future require manufacturers and operators of new aircraft to provide to Transport Canada, as a requirement of the aircraft type approval, a crash chart of the aircraft for distribution by Transport Canada to all airports. Transport Canada issued a policy letter, dated February 6, 1991, stating in part:

> <u>POLICY STATEMENT</u>
>
> All Canadian air carriers introducing new aircraft types or aircraft that have not been operated in Canada will be required to provide

> aircraft crash charts. This information will be required 25 working days before the aircraft may be used in a commercial air service.
>
> PURPOSE
>
> To ensure service that Emergency Response Service (ERS) formerly Crash, Fire, and Rescue (CFR) units, at airports, have up-to-date crash charts before an aircraft goes into service.

This policy letter will be incorporated into the next amendment of Transport Canada Air Carrier Certification Manual.

I agree with the action taken by Transport Canada in both ensuring that requisite crash charts of aircraft using airports on a continuing and regular basis be made available to all CFR units and in requiring all Canadian air carriers introducing new aircraft types or aircraft that have not been previously operated in Canada to provide crash charts to Transport Canada.

I wish to emphasize that these crash charts should be made available to all airports, whether they are Transport Canada–owned and operated or subsidized and community airports. If passenger-carrying scheduled carriers use an airport on a regular and continuing basis, these charts should be at that airport.

Training and Proficiency of Dryden CFR Unit Personnel

Transport Canada Training Policy

The Transport Canada Firefighting and Rescue Services training standards manual, which was in effect at the time of the crash, states that it is Transport Canada's policy that:

> Crash Firefighting Rescue Services will be provided at all airports operated by Transport Canada that are used by commercial air carriers on a regularly-established basis.

It is further stated that:

> Crash Firefighting Rescue Services, whose duties consist of the provision of aircraft crash fire protection services, are infrequently called upon to face a serious situation involving a major aircraft accident. It follows that only by means of a most carefully planned and executed program of training, can there be any assurance that both men and equipment will be ready to cope with a major aircraft

> fire should the need arise. Training requirements fall into two broad categories: initial training and ongoing training.
>
> (Exhibit 243)

This Transport Canada manual further states that the objective is "to provide highly trained AES (Airport Emergency Services) personnel capable of carrying out prevention, control and suppression." The document contemplates that training programs shall elevate AES personnel to and maintain them at a high level of knowledge and skills relevant to fire prevention, control, and suppression. Airport fire-fighters are required to possess a comprehensive knowledge of and be highly skilled in the operation of all AES vehicles at their respective airports. The manual states that fire-fighters should possess a comprehensive knowledge of all aircraft in continuing and regular use at their respective airports. They should also possess detailed knowledge of their airports and those areas immediately surrounding the airport, be aware of all natural and man-made hazards in their area of operations, and acquire, through training and study, a knowledge of the most direct and secondary routes to all points within their area of operations. The manual contemplates that, in all cases, the fire chief should ensure by training, regular examination, and testing, that each fire-fighter is current, has adequate detailed knowledge of, and demonstrates competency in all aspects of his or her duties and responsibilities.

The Transport Canada Safety Services Branch in Central Region, within which the Dryden area is located, consisted, at the time of the crash, of three experienced CFR fire-fighters (a superintendent, Larry O'Bray, and two emergency services officers, Jack Nicholson and Jeffrey Hamilton).

The branch is responsible for either evaluating or training CFR units at 23 airports, some of which are owned and operated by Transport Canada, owned and subsidized by Transport Canada, or owned by Transport Canada and contracted out for operation (see figure 9-3). According to Mr O'Bray, half the airports subsidized by Transport Canada are located in Central Region.

The branch reports and provides advice on Central Region CFR matters to superiors in Central Region and in Ottawa. It also provides training, evaluation, advice, and guidance regarding CFR, crash protection, and fire prevention programs to airport managers and fire chiefs in the region. By necessity, Mr O'Bray's organization relies almost exclusively on the airport managers and the fire chiefs to maintain the proper level of knowledge, training, and proficiency of CFR fire-fighters and to ensure that all airport equipment and facilities are in proper operating condition. In the normal course, Transport Canada expects that a fire chief at a Transport Canada–operated airport has a number of years' experience in crash, fire, rescue, and in general fire-fighting. Some of that experience should be in a supervisory capacity. Transport Canada attempts to obtain by competition the best qualified people within its organization to take the position of fire chief. Accordingly, Transport Canada has some control over who is placed in the position of fire chief at a Transport Canada–owned and operated airport.

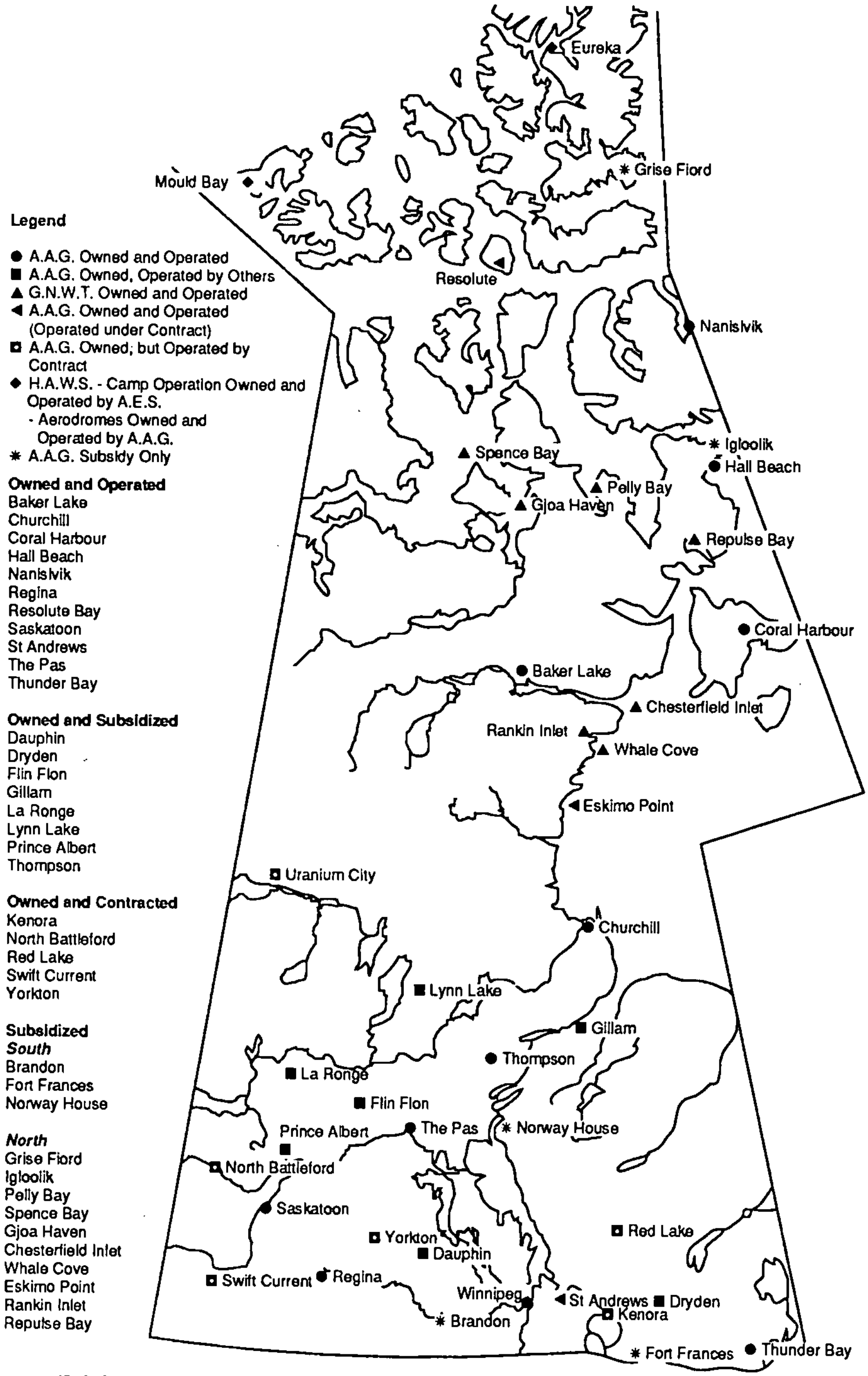
Mr O'Bray stated that a supportive and cooperative airport manager is essential to maintaining a good CFR program. In a line organization, such as Transport Canada, the airport manager is ultimately responsible for ensuring that a proper CFR program is maintained at the airport. If that airport manager does not ensure that a proper CFR program has been implemented and maintained, then Mr O'Bray's branch may provide advice to the regional director general or the director of operations within Central Region Airports Authority Group, who will then ensure that a specific airport manager comply with Transport Canada policy documents. Airport managers of international airports, such as the Winnipeg International Airport, located in Central Region, however, report directly to the director-general, Airports Operations Directorate, Transport Canada Headquarters, Ottawa. In summary, airports owned and operated by Transport Canada must comply with the CFR standards and requirements as set forth in the various Transport Canada policy AK documents.

Mr O'Bray explained that he conducts two initial training courses in Central Region each year for CFR personnel, a two-week course designed for professional fire-fighters and a one-week course designed to train auxiliary fire-fighters. Professional fire-fighters from non-Transport Canada–owned and operated airports are invited to attend the professional course.

In addition, Mr O'Bray's Safety Services Branch evaluates each of the professional CFR units within Central Region once each year. This evaluation consists of attendance at the airport, briefings with the airport manager and the fire chief, and evaluation of the fire-fighting unit's capability through various drills and exercises. The CFR chief and airport manager are debriefed after the evaluation, and a written report is provided to the airport manager. The Safety Services Branch expects training to be carried out by the fire chiefs on a regular basis and provides annual training courses to auxiliary CFR units to enhance their own training programs.

During testimony, Mr Hamilton defined a "professional" fire-fighter as one who is a paid, full-time, dedicated CFR unit member responsible for fighting fires and carrying out the airport CFR program, which includes airport fire prevention. Mr Hamilton cited the Brandon Airport as one that has a mixed fire-fighting staff, the fire chief being a full-time, salaried, dedicated fire chief and the remaining fire-fighters being auxiliary staff from the airport.

Figure 9-3 Airports and Aerodromes in Central Region



Source: Exhibit 245

Mr Hamilton, during his evidence, described the duties and responsibilities of fire-fighters, fire officers, and the fire chief in day-to-day operations. He gave evidence that, in addition to conducting normal duties during a shift, each fire-fighter must complete two hours of training each day averaged over a period of one month. Fire officers, in addition to being responsible for their own fire-fighter duties and training, are tasked with supervising their shift of fire-fighters and are responsible for ensuring that the duties of the shift are carried out. A fire officer also must ensure that the training program laid out by the fire chief is properly conducted. The fire chief, who is responsible for ensuring that he himself is properly trained as a fire-fighter, is responsible for designing the training program for CFR fire-fighters and ensuring that it is carried out. While he may delegate the responsibilities for training to others, as the administrator of the fire hall, the chief has the ultimate responsibility for its operation, including the posting of each month's schedule of training. All training, programs, and duties are to be conducted in accordance with Transport Canada AK policy documents.

All Central Region fire-fighters write Central Region examinations semi-annually, and they write a headquarters' examination annually. Fire officers are responsible for testing and examining fire-fighters on a regular basis. In addition to their own testing, fire officers are evaluated yearly by the fire chief. The fire chief is responsible to the airport manager for ensuring that all CFR examinations and tests are conducted in accordance with Transport Canada AK policy guidelines. There is no provision in Transport Canada that requires a fire chief to take the examinations that are required of fire-fighters and fire officers. It is expected by Transport Canada that fire chiefs will ensure that each of the CFR fire halls has a library of required Transport Canada AK documents, manuals, and appropriate National Fire Protection Association (NFPA) manuals, and it is mandatory that the fire-fighters conduct a self-study program of all these manuals and documents. It is the responsibility of the fire chief to produce the training schedule, and it is the responsibility of the fire officers and individual fire-fighters to ensure that the study and training are completed.

In addition to the yearly evaluation conducted by the Safety Services Branch on each CFR unit within Central Region, the Safety Services Branch relies on CFR training reports prepared by the fire chief and reviewed and forwarded by the airport manager to Central Region, Safety Services. These reports are made on a detailed form with provisions for the fire chief to list the training conducted during any six-month period in the following areas:

- training fires
- training materials
- vehicle driver training
- aircraft familiarization
- regional conducted training
- other aircraft practical training
- structure practical training
- theory training
- films shown
- Emergency Services (CFR) Chief remarks
- Airport Manager remarks
- Region remarks
- HQ remarks.

The annual evaluations provide Transport Canada with an opportunity to review an airport's facilities, inspect vehicles and equipment, and evaluate the ability of the CFR fire-fighters to respond to an emergency. On most airports there is located away from runways and buildings a specially constructed fuel burn area where CFR personnel can conduct live fire exercises. This allows the use of vehicles and handlines in extinguishing fuel-fed fires similar to those expected on a crashed aircraft.

A major part of CFR training is directed to the fire-fighters' ability to respond to a burning aircraft. Live-fire ("hot-drill") training exercises are conducted during annual courses run by Safety Services Branch. Regular hot-drill exercises are also conducted by a CFR unit as part of its training program. The ability of a CFR fire-fighter to respond to live-fire situations is to be evaluated by Transport Canada Emergency Services officers on an annual basis.

Dryden Airport Management Training Policy

The Dryden airport CFR unit personnel received a two-week initial fire-fighting training course at Winnipeg in the fall of 1982, shortly after Chief Parry was hired as fire chief and the unit was staffed by full-time professional fire-fighters. Although Chief Parry had experience with a mining company as a captain on a mine fire brigade and had trained as an underground mine rescue member, he had no previous active fire-fighting experience. Unlike Transport Canada fire chiefs, who must have a previous CFR fire-fighting background and compete for the position, Dryden Airport Commission hired all their fire-fighters, including their fire chiefs, from outside Transport Canada ranks. Chief Parry did not have the fire-fighting experience Transport Canada looked for; however, it was the view of Mr O'Bray that Transport Canada could train him as a fire chief if he was "receptive." Mr O'Bray stated during testimony that it was difficult to hire fire chiefs for subsidized airports. Although Transport Canada canvassed Transport Canada CFR fire halls in an attempt to hire a fire chief, in Mr O'Bray's words "no one would make the jump" (Transcript, vol. 35, p. 39).

By the end of the second week of the initial training course, Mr O'Bray was satisfied that the Dryden CFR fire-fighters were sufficiently trained to get involved in their own on-site training and quickly become a good crash fire rescue team. Chief Parry and the airport manager provided training reports to Transport Canada initially on a quarterly basis, and, commencing in 1987, on a biannual basis indicating materials used, training conducted, and studies completed during that period. Chief Parry and Mr Louttit used the form to address any concerns or make any remarks to Transport Canada. The Central Region Safety Services Branch began conducting annual evaluations of the Dryden airport CFR unit early in 1984. Copies of many training reports and of evaluations were reviewed.

I do not propose to review, in detail, the Dryden airport training reports or all of the evaluation reports prepared by emergency services officers; however, two matters arise from the reports and evaluations that are of concern to me. The first is the lack of training that was conducted by the Dryden airport CFR unit over the years and the continuing refusal by the airport manager and fire chief to conduct the required training, in the face of repeated recommendations by Transport Canada Central Region officials that they do so. The second matter is the inadequate manner in which Transport Canada tried to ensure that required training was being performed by the Dryden CFR unit.

It is clear from the testimony and from the documentation presented before me that, from the time the professional CFR unit was established at Dryden, Chief Parry did not have a carefully planned and executed program of training, as contemplated by Transport Canada policy documents. In addition, the evidence clearly indicates that Chief Parry was not conducting, and indeed was refusing to conduct, hot-drill training. He also was not requiring his crew chiefs to conduct sufficient hot-drill training to ensure that his fire-fighters and equipment would be ready to cope with a major aircraft fire. Airport manager Louttit supported and condoned Chief Parry's actions of reduced training as his comments on the training reports show.

While Chief Parry and Mr Louttit took the position that training was being reduced as a result of budgetary restraints, Mr O'Bray maintained that funds were always allocated and available to the Dryden airport for CFR training. Mr O'Bray testified that, while the Safety Services Branch was advising Dryden airport that funding was available and telling them to get on with training, the Dryden airport manager and fire chief simply ignored its requests to increase the level of training and often refused to follow Transport Canada's advice and direction, each time suggesting that the cause was due to funding restrictions.

When reviewing the October 1 to December 31, 1986, training report which showed "there were no hot drills conducted at all," Mr O'Bray stated that calls were made to the airport fire chief and the airport manager suggesting to them that funding restrictions should not have been a problem because funds had been allocated (Transcript, vol. 35, p. 69). When asked what their response was, Mr O'Bray stated in testimony that:

> A. Mr Parry's response specifically was that they were operating on a global budget and that the funds could be allocated to other airport operations.
> Q. And I take it you disagreed with them?
> A. Yes, sir, I did.
>
> (Transcript, vol. 35, p. 69)

Because Mr O'Bray was concerned about the position taken in the training reports regarding funding restrictions, he made inquiries with Central Region's community airports officers and was advised that, as far as they were aware, the funds were available and that the Dryden airport had the funds to conduct CFR training.

The position taken by Chief Parry was not an isolated occurrence. On October 10, 1989, seven months after the crash of C-FONF, Central Region emergency services officers Jack Nicholson and Jeffrey Hamilton conducted a site evaluation of the Dryden CFR unit. In addition, Mr Hamilton testified that they also wanted to know why the CFR training program was not being carried out. Upon their arrival at the Dryden airport, the emergency services officers met with Chief Parry, the acting airport manager at the time. During the meeting, Chief Parry was asked why he was not spending the allocated training funds to purchase fuel for fire-fighting training, and Mr Hamilton testified as follows:

> A. ... Mr Parry told Mr Nicholson that there wasn't any money spent on fuel or the money that was allocated was not spent on fuel and that he was not intending to spend it that he didn't have to spend it, on training fuel.
>
> (Transcript, vol. 33, p. 202)

Mr Hamilton stated during testimony that he was left with two clear impressions: Chief Parry did not want to conduct the training and Chief Parry was quite confident that he could take money allocated for CFR training and spend it on other airport operations. The October 1989 site visit was Mr Hamilton's first to the Dryden airport CFR unit, and he disagreed with the position taken by Chief Parry.

The testimony indicates that, as early as 1986, Mr Louttit and Chief Parry were either not spending funds allocated for CFR fire training or were using the funds for other airport expenses. This situation continued after the crash of C-FONF and the commencement of the work of this Commission of Inquiry, as is evident from the October 1989 evaluation.

Ms Paulette Theberge, Transport Canada Central Region's financial officer responsible for dealing with the Dryden Municipal Airport and the Dryden Airport Commission, gave evidence that funds for fuel and extinguishing agent for training are specifically allocated in the annual budgets. For example, in 1988, Dryden submitted a $30,000 budget request for fuel for fire drills and for extinguishing agent. After negotiations with Transport Canada, the authorized allocation was $17,500; however, the actual amount spent was $5088. She had no information on how the remaining money was spent. Ms Theberge agreed that it would appear that over $12,000, allocated for CFR training fuel and extinguishing agent, was spent on other needs at the airport. Ms Theberge also agreed that there was no justifiable reason for the fire chief and the airport manager to use training funds to accommodate shortfalls in the overall budget (Transcript, vol. 36, p. 203).

Superintendent O'Bray testified that he spoke to the financial assistance officers and community airports officers within Transport Canada and was advised that funds were available for training. However, he did not specifically request that these officers require Mr Louttit and Chief Parry to use the allocated funds for training. When asked why he did not request that these Transport Canada officers enforce proper use of the allocated funds, Mr O'Bray replied as follows:

> A. Perhaps – it was always our philosophy to go to the ... what we perceived at that time to be the line managers of those airports. But as we were finding out throughout that period ... they did not have line authority over these airport[s] either.
>
> Q. So the Community Airports people who were basically in the same region did not have line authority over the community airports – or subsidized airports?
>
> A. That was my understanding, yes.
>
> (Transcript, vol. 35, p. 70)

Mr O'Bray also agreed in testimony that he was "getting messages" from senior managers in Airports Authority Group, Ottawa, regarding the lack of enforceability of AK standards on subsidized airports.

Transport Canada–Subsidized Airport Policy

Testimony at the Commission hearings demonstrated that Transport

Canada personnel were unable to persuade or to force the Dryden airport management to train their CFR unit fire-fighters to a level of proficiency they believed satisfactory. The evidence is equally clear that Dryden airport management, and in particular Chief Parry, did not ensure that the Dryden airport CFR unit fire-fighters received sufficient training to enable them to carry out their duties and responsibilities as CFR fire-fighters adequately.

During the summer and fall of 1986, the Program Control Board (PCB) of Transport Canada advised the then executive director, Airports Group, Mr David McAree, that no additional funds would be forthcoming for subsidized airports. Accordingly, Mr McAree, the senior Transport Canada officer responsible for the operation of Canadian airports, by memorandum dated October 3, 1986, entitled Grants and Contributions to Subsidized Airports, passed that information to the regions and instructed them to deal with subsidized airports as follows:

> Therefore, it is imperative that negotiations be hard and tough to control costs; that standards are to be re-examined and local airports allowed more flexibility and freedom to manage. In addition, revenue-generating opportunities should be emphasized.
>
> To this end, it is recognized that subsidy airports may find it necessary to deviate from standards in effect at departmentally-operated airports. However, in no case can safety and security standards be allowed to be compromised.
>
> (Exhibit 279)

At the same time, the Airports Group was advising subsidized airports that, because of budget restraints, Transport Canada would allow standards to be relaxed, since subsidized airports would not be receiving all the funds they might need to maintain their airports at those standards; however, safety and security standards could not be compromised.

Various regions began asking Airports Group headquarters for clarification regarding the standards that subsidized airports were required to meet. The original request for clarification came from Pacific Region. Mr McAree responded to all regions, in a memorandum of October 20, 1986:

> Due to present and future funding limitations and legal opinions rendered, it has been decided that we should not concern ourselves with the day-to-day operations at subsidy airports per se, except as affected by:
>
> a) Safety and security
> b) Airside – regulations
> c) Groundside – value for money

> AK documents are considered to be Transport Canada policy-related documents, and as such, cannot legally be imposed on subsidy airports except in those cases where the AK documents are given effect or incorporated in relevant regulations, or have been specified within the lease/agreement document prior to signature by both parties.
>
> Although it is desirable that the subsidy airports meet Transport Canada standards, it is recognized that they may find it necessary to deviate from AK standards applicable at Transport Canada operated airports. However, in no case can safety and security standards be allowed to be compromised.
>
> PCB has directed that standards are to be re-examined and local airports allowed more freedom to manage; that we encourage local flexibility in such matters as non-safety standards and landing and terminal fees. Please also refer to my 3 October 1986 memorandum providing your 1987/88 Preliminary Reference Level.
>
> AK documents can continue to be provided to subsidy airports as information and guidance tools.
>
> (Exhibit 280)

These two memoranda provided instructions that looser control was to be exercised over subsidized airports and that managers of those airports were not bound by the standards specified in Transport Canada AK policy documents, with the exception of safety and security, aviation regulation, and value for money. At least in Central Region, emergency services officers questioned whether subsidized airports could deviate from the requirements of AK documents regarding CFR standards and training.

It was the view of emergency services officers Nicholson and O'Bray that, if funds were allocated for CFR training, they must be spent on CFR training. In the words of Mr O'Bray, "there was a lot of confusion in almost everyone's mind of whether, with respect to the documents that were coming down talking about safety and security, of whether CFR was a safety issue or a level of service" (Transcript, vol. 35, p. 79). Mr O'Bray stated that, within his branch, Mr Nicholson considered that CFR was a safety issue and that Transport Canada should be firm and require training levels to be maintained at subsidized airports at a level satisfactory to Transport Canada. Mr O'Bray testified that he was of the same view. However, direction received from senior management levels in Transport Canada headquarters and the position taken by the Transport Canada Community Airports Branch indicated that CFR was not a safety issue but a level of service. Mr O'Bray's impression was that both Transport Canada headquarters and Community Airports Branch agreed that, because CFR was not a safety issue, subsidized airports could deviate from CFR training requirements.

It is apparent that, as part of the effort by Transport Canada to reduce the cost of subsidizing airport operations, Airports Group lumped AK CFR standards with other airport AK standards. This created a situation where subsidized airports could deviate from required CFR training standards.

On behalf of his superior, H.J. Bell, Mr O'Bray prepared a memorandum to the executive director, Mr McAree, requesting clarification of the situation regarding CFR standards. The message, designated GRDG 3 145 and dated November 7, 1986, is as follows:

> RE: EDA MEMO A5172-1 OF OCTOBER 20, 1986
> SUBJECT: APPLICABILITY OF AK'S TO SUBSIDIZED AIRPORTS.
> PLEASE CONFIRM THAT CFR IS A LEVEL OF SERVICE ISSUE AND IS NOT CONSIDERED A SAFETY ISSUE IN TERMS OF COMPROMISATION OF AK'S. YOUR CONFIRMATION WILL ASSIST US TO DEVELOP A CONSISTENT LEVEL OF SERVICE AT SUBSIDIZED AI[R]PORTS EQUIVALENT TO I.C.A.O. STANDARDS.
> H. J. BELL
> CRDG
>
> (Exhibit 281)

Mr McAree responded on December 1, 1986, sending copies to all regions. His response was as follows:

> REFERENCE IS MADE TO CRDG MESSAGE NO. 145 DATED 7 NOVEMBER RE. APPLICABILITY OF AKS TO SUBSIDIZED AIRPORTS. LEASE OF AIRPORT TO MUNICIPALITIES ENTITLED LESSEE TO QUIET ENJOYMENT WITH COMMITMENT TO MAINTAIN AIRPORT AS PUBLIC AIRPORT TO LICENSABLE STANDARDS AND TO CHARGE FEES NOT LESS THAN THOSE CONTAINED IN AIR SERVICES FEES REGULATIONS. THEREFORE CFR SERVICES ARE NOT MANDATORY AND SHOULD BE DETAILED IN APPROPRIATE AERONAUTICAL PUBLICATIONS. AKS ARE AVAILABLE TO MUNICIPAL SUBSIDIZED AIRPORTS FOR GUIDANCE PURPOSES ONLY.
>
> (Exhibit 282)

Since both Mr O'Bray and Mr Nicholson were of the view that CFR was a safety issue, the memorandum signed by Mr Bell did not truly reflect their views. It appears that Mr Bell only wanted confirmation from Mr McAree that CFR was a level of service without a safety component and, therefore, AK standards need not be followed at subsidized airports. The first message did not ask the right question and the second message avoided any reference to the level of service–safety issue raised by Mr Bell, and declared that CFR services are not mandatory at subsidized airports.

Mr McAree's December 1, 1986, response is similarly ambiguous. As Mr McAree did not appear before this Commission, I will not speculate as to his intentions in providing such a message. Mr O'Bray stated during testimony that it was obvious to him that the question that had been asked was not specifically answered.

Even though Mr O'Bray's concern had not been addressed by Mr McAree, Mr O'Bray testified that he was not about to ask for further clarification "given the fact that it was not customary to ask Mr McAree the same question twice" (Transcript, vol. 35, p. 86).

What is clear, however, is that no further effort was made by Central Region to clarify the meaning of the message contained in the statement, "CFR services are not mandatory and should be detailed in appropriate aeronautical publications." Clearly clarification of this instruction should have been sought from headquarters by Central Region if they were not satisfied that the instructions were unequivocal. In view of Central Region's knowledge of lack of training by the Dryden CFR unit and the impression being conveyed by Transport Canada headquarters that CFR units at subsidized airports did not have to train to Transport Canada standards, Central Region should have instructed the Dryden Municipal Airport Commission to publish, in the *Canada Flight Supplement*, a notification that Transport Canada CFR training standards were not being met at the Dryden airport. I find that Transport Canada should have but did not take action either to enforce training standards or to have airport users notified that training standards were not being met.

The evidence is clear that Transport Canada, faced with budget restraints, instructed regions to negotiate "hard and tough" regarding budget requests made by subsidized airports. Transport Canada headquarters also gave instructions to regions to allow managers of subsidized airports to deviate from Transport Canada AK document standards when it came to maintaining and operating their airports.

On December 22, 1986, Mr H.J. Bell sent a letter to Mr W.F. Beatty, the chairman of the Dryden Municipal Airport Commission, providing Transport Canada's view on deviation from standards. Part of the letter reads as follows:

> Relative to our discussions regarding airport standards, you are advised that although desirable, Transport Canada standards cannot legally be imposed upon leased airports, excepting for those matters affecting safety, security and certification requirements. Our AK documents may however continue to serve as information and guidance tools. Further, our Program Control Board directs that Transport Canada encourage more flexibility and freedom to manage among local (leased) airport administrations.
>
> With specific reference to the provision of crash, fire, rescue services (CFR); again this service is not mandatory at leased airports.

> Your administration is free therefore to maintain that service to a level commensurate with funding levels available, in consideration of overall airport functions. As an example, it may be appropriate, given an adjustment of your hours of operation, etc., to staff a CFR nucleus of a Fire Chief plus one Firefighter, around which auxiliary support may be established, thus providing a capability comparable with that provided at The Pas, and proposed at Churchill Airport.
> (Exhibit 91)

Internal Transport Canada directives and correspondence to the Dryden Municipal Airport Commission clearly indicated, to both the Transport Canada regional employees and the Dryden airport managers, that subsidized airports could deviate from AK standards, which included standards dealing with CFR, and that funds allocated for CFR purposes could be applied to other airport expenses. Although Mr O'Bray may have disagreed with the position taken by Mr McAree, he accepted Mr McAree's directive and, accordingly, he should have acted on its instructions. As the Community Airports Branch also received similar instructions, Mr O'Bray would receive no assistance from them.

From the evidence, it was obvious that Mr Louttit and Chief Parry believed they did not have to comply with AK CFR standards, and they considered that funds designated for CFR training could be used elsewhere to cushion the effects of the decreasing airport subsidy.

Enforceability of Agreements

I will now turn to Mr McAree's memorandum of October 20, 1986, wherein he states, in part, the following:

> ... AK documents cannot legally be imposed on subsidy airports except in those cases where the AK documents are given effect or incorporated in relevant regulations, or have been specified within the lease/agreement document prior to signature by both parties.
> (Exhibit 280)

Ms Theberge testified that, in her opinion, the Dryden Municipal Airport had to provide airport services, including CFR services, to the satisfaction of the minister. It was also her opinion that CFR, as an airport service, falls under the terms and conditions of the financial assistance agreement between Transport Canada and the Town of Dryden. Clauses 7 and 12 of the agreement state as follows:

> 7. *Ministerial Approval*
> The Corporation shall not, without the consent in writing of the Minister, being first had and obtained, assume any obligations

> or make any expenditures under the provisions of this Agreement which is not in accordance with annual operating budgets approved by the Minister.
>
> 12. *Corporation Provision of Facilities*
> ... the Corporation shall be responsible for the operation, management and maintenance of the Airport, and all related facilities which, without limiting or restricting the generality of the foregoing, shall include airport services, runways, fences, hangars, shops, terminal and other buildings, airport lighting equipment, and like services, and the Airport shall be maintained in a serviceable condition, all to the satisfaction of the Minister.
>
> (Exhibit 288)

Ms Theberge also referred to the airport lease agreement which, in her view, also obligated the Town of Dryden as a lessee to maintain CFR services to the satisfaction of Transport Canada.

Clause 8 of the lease agreement states as follows:

> That the Lessee shall at all times during the currency of this Lease, operate, manage and maintain the said airport, and all related facilities which, without restricting the generality of the foregoing, shall include airport services, runways and taxiways, fences, buildings, airport lighting facilities, airport maintenance, equipment and like services, all herein referred to as "the said facilities," all as designated by and to the satisfaction of the Administrator and at the expense of the Lessee.
>
> (Exhibit 27)

It was Ms Theberge's opinion that if the CFR services provided at the Dryden airport did not satisfy Transport Canada, then the Town of Dryden would be in violation of both the subsidy agreement and the lease agreement.

While not specific in referring to CFR services in clauses 12 and 8 of the respective agreements, both the airport subsidy agreement and the lease agreement in effect on March 10, 1989, required the Town of Dryden to operate and maintain the airport and all related facilities, including airport services, to the satisfaction of the minister of transport. I agree with Ms Theberge. I interpret the agreements, and specifically the following wording within the agreements, "without limiting or restricting the generality of the foregoing," "all related facilities," and "airport services," to be broad enough to include CFR services.

The airport subsidy agreement and the lease agreement are general in nature. However, without specific direction to a subsidized airport to the contrary, I interpret the intent of the statements "to the satisfaction of the Minister" and "to the satisfaction of the administrator" to mean that Transport Canada intended to impose upon subsidy airports, to their fullest extent and in the same manner as it does upon Transport Canada – operated airports, AK document standards, including CFR training requirements.

In summary, I disagree with Mr McAree's view that AK documents cannot legally be imposed upon subsidy airports. The intent of both clause 12 in the airport subsidy agreement and clause 8 in the lease agreement is that they contemplate standards satisfactory to the minister. As the standards of Transport Canada are the internal Transport Canada AK policy documents, these same standards are those to which subsidized airports must adhere unless otherwise advised.

In addition, clause 7 of the subsidy agreement provides that the Town of Dryden cannot, without the consent of Transport Canada, make any expenditures under the subsidy agreement that are not in accordance with annual operating budgets approved by Transport Canada. It follows that, if the airport manager wanted to use funds allocated for CFR training for other airport expenses, he could only do so with the express consent of Transport Canada. No such approval was given.

It is clear, however, from the memoranda and messages signed by Mr McAree and from Mr Bell's letter to the Dryden Municipal Airport Commission, that Transport Canada was prepared to allow subsidized airports to deviate from Transport Canada AK standards with certain exceptions. This was in keeping with the government's policy of fiscal restraint and specific instructions by the Program Control Board (PCB) to various senior managers. Mr McAree's instructions to negotiate "hard and tough to control costs" and to re-examine standards to allow local airports "more flexibility and freedom to manage" were designed to relieve the pressure upon Airports Group to provide additional funds to subsidized airports under their grants and contributions program. However, Mr McAree also advised the regions that in no case can safety and security standards be allowed to be compromised.

CFR Services: The Issue of Safety

Two issues must be considered: did Transport Canada intend to allow subsidized airports to deviate from Transport Canada's required CFR training standards; and, do CFR units provide a level of safety at airports? During the hearings, in attempting to determine why Dryden airport managers refused to train their fire-fighters to the same standards as at Transport Canada–owned and operated airports, considerable testimony dealt with the safety component of CFR services. It was the testimony of Mr Nicholson that, when he confronted Chief Parry for not using funds as allocated for fire-fighter live-fire (hot-drill) training, Chief Parry referred to Mr Bell's correspondence to the Dryden airport commission as his authority for not being obligated to train his men to Transport Canada AK standards. This discussion took place between Chief Parry and Mr Nicholson in October 1989 at a time when Chief Parry was not only the chief of CFR services but also the acting airport manager.

It was the view of Mr Nicholson that the training of CFR fire-fighters is a safety-related operation and that Chief Parry was obligated to comply with Transport Canada standards in terms of maintaining a fire-fighter's level of knowledge and proficiency in carrying out his duties.

Mr McAree in his message of December 1, 1986, stated that CFR services are not mandatory and that AKs are available to municipal subsidized airports for guidance purposes only. Mr Bell, in his letter to the Dryden Municipal Airport Commission, advised that the airport commission was free to maintain the CFR service to a level commensurate with funding levels available, in consideration of overall airport functions, and suggested ways this might be done. He suggested that it might be appropriate to adjust the hours of CFR operation, and/or to decrease the professional fire-fighting staff to a nucleus of a fire chief plus one fire-fighter and establishing an auxiliary fire-fighting team.

While Mr McAree's message is ambiguous, I do not find the position of Mr Bell in conflict with the view of Mr Nicholson that training standards of fire-fighters must be maintained to Transport Canada AK standards. While Mr Bell suggested decreasing the number of professional fire-fighters and augmenting them with auxiliaries, he did not recommend that they need not train to AK standards. Specific funds for the purchase of training materials for CFR fire-fighters were allocated in the Dryden airport budget. Training was always contemplated and, therefore, funds for training were always allocated in the budgets no matter what funding level was available. While Mr McAree's instructions were unclear, I cannot believe and do not find that it was the intention of Transport Canada to allow subsidized airports to deviate from Transport Canada's CFR training standards.

Whether CFR is a level of service or a level of safety is an important issue. It is readily apparent to me that a CFR unit is established at an airport for one reason, to provide a level of safety with regard to aircraft crashes and aircraft fires. Therefore, once the CFR unit is established, the fire-fighters of that unit must know exactly what is expected of them and be capable of effectively and efficiently operating their fire-fighting equipment. It makes no sense that expensive and sophisticated fire-fighting equipment sat on the sidelines on March 10, 1989, because the CFR fire-fighters, for lack of adequate training, did not use their equipment in carrying out the primary and secondary objectives of CFR, that is, saving lives by providing a fire-free escape route and preserving the property involved by containing or extinguishing the fire. Two of the three professional CFR fire-fighters, as well as the volunteer fire-fighters of the UT of O, carried out some of the tasks that could have been handled by untrained rescuers, such as the assistance rendered to surviving passengers after they had arrived at a safe distance from the fire.

The fact that the CFR fire-fighters at the Dryden airport were not properly trained is the fault of the entire system. The Dryden airport managers avoided the training requirements. Transport Canada headquarters personnel were too far removed from the problem to appreciate fully the difficulties resulting from the lack of clear direction with regard to CFR training. Although Transport Canada regional personnel attempted to persuade Dryden airport staff to conduct the required training, and although the CFR crew chiefs may have espoused that they wanted training, no one made a concerted effort to see that meaningful training was accomplished. In sum, it is my opinion that no one was sufficiently serious about CFR.

In his Report of the Commission of Inquiry on Aviation Safety of 1982, Mr Justice Charles L. Dubin discussed airport emergency services (AES). In this report, the Public Service Alliance of Canada is quoted as stating the following: "Firefighting is a profession – not something to be carried out in a haphazard manner by untrained personnel."[4] I totally agree with this statement.

In delineating the responsibilities of AES (CFR) personnel, Mr Justice Dubin stated that "it is not the AES responsibility to care for the injured after they have arrived at a safe distance from the accident site" (vol. 3, p. 973). I also agree with this view. Once aircraft occupants are removed to a safe distance from the accident site, fire-fighters should be left to their role of fighting the fire, preserving the wreckage, and securing the area from any further danger. Finally, in his comments regarding the role of AES (CFR) services, Mr Justice Dubin stated: "The emergency services personnel are an integral part of the overall safety system" (p. 975). I cannot state the role of CFR services more clearly.

The above comments and observations made in Mr Justice Dubin's report clearly echo my own views, and those of the experts who appeared before me, on the duties, responsibilities, roles, and training of CFR services personnel. Had the fact that CFR services are an integral part of the overall safety system been recognized by Transport Canada and had the message been clearly conveyed to the Dryden Municipal Airport that fire-fighting training must be conducted properly, I might not have needed to review in such detail the actions of and response by the Dryden Municipal Airport CFR services unit to the crash of C-FONF.

---

[4] *Report of the Commission of Inquiry on Aviation Safety*, 3 vols. (Ottawa, 1981–82), vol. 3, p. 972

CFR Assessment by Transport Canada and Dryden Authorities

On the day of the crash, Mr Desmond Risto of Transport Canada, Airports Authority Group, Central Region, went to Dryden to provide assistance and encouragement where he could to the Dryden airport staff, and the airport commission was so advised. An emergency services officer, Mr Jack Nicholson, was also dispatched by Central Region two days later to determine what the Dryden airport CFR unit had done in response to the crash. Both Mr Risto and Mr Nicholson prepared reports that were sent to Mr George Knox, the acting regional director-general, Airports Authority Group, Winnipeg.

During their visits, Mr Risto and Mr Nicholson were briefed by CFR Chief Ernest Parry and by crew chief Stanley Kruger regarding the response of the CFR unit to the crash. In their reports, Mr Risto and Mr Nicholson summarized the circumstances leading up to the crash and discussed the subsequent activities of personnel of the CFR unit, the UT of O fire unit, and the OPP.

On page 5 of his report, Mr Risto praised Chief Parry for his actions as follows:

> Within a space of seconds, AFC [airport fire chief] decided to take on the responsibilities of On-Scene Co-Ordinator (O.S.C.), rather than abandon his vehicle and respond to the crash scene for fire suppression. Had this correct decision not been made, immediate multiple communications, direction and requests would have been lost, and complete chaos would have ensued pending the arrival of support agencies and equipment.
>
> Because of the correct position taken by the AFC, and direction applied, there is no question that a systematic and organized rescue operation was conducted as response personnel were given positive and immediate instructions, with main arteries being kept open until the arrival of the O.P.P. Again, because of the correct action being taken, there is no doubt in the minds of the airport staff that more casualties/passengers were saved.
>
> (Exhibit 237)

In reporting on the CFR unit response generally, Mr Risto stated that because of the snow depth and heavily treed area between the access road and the crash site, it was impossible for one to three men to pull a handline to the crash site. However, it would not have been necessary to pull a handline to the crash site because lengths of hose could have been connected in sequence. In addressing the mechanical breakdown of the CFR unit vehicle Red 2, Mr Risto considered that use of the CFR unit fire trucks was "irrelevant" because of the conditions.

Mr Risto stated in his report that the response of the UT of O Fire Department was exceptional, and he remarked on the speed at which the UT of O Fire Department arrived on the scene and set up the water tank and foam equipment. Again, Mr Risto commented that it was impossible to drag 400 feet of hose through the terrain until a trail was cut to the crash site.

On March 16, 1989, the Town of Dryden and Transport Canada held a debriefing session in Dryden to discuss any major problems and concerns that arose out of the implementation of the Town of Dryden's Peacetime Emergency Plan. Mr Risto's report on the debriefing is short and touches briefly only on the need for a better communications network and the need to upgrade existing resources and inventory.

Based upon his experience as Central Region coordinator for emergency and disaster planning, Mr Risto could see nothing "flagrant or critical done out of context with established procedures and *common sense.*"

Mr Nicholson in his report of March 22, 1989, summarized the activities of the Dryden Airport CFR services unit in responding to the crash. Mr Nicholson reviewed its actions, summarized the circumstances of Red 2 having to fill up with water, Mr Rivard losing control of the vehicle, and the loss of the air brake system in the vehicle. After describing the actions of the CFR fire-fighters, Mr Nicholson concluded in his report that in his judgement the CFR crash vehicles could never have "dozed" their way to the crash site. He also stated that Red 2 carried only 300 feet of 1½ inch hose line and Red 1 had 100 feet of unusable handline. The information that Mr Nicholson obtained from Chief Parry regarding Red 2 was incorrect. Red 2 actually carried 500 feet of handline. Mr Nicholson concluded that the CFR fire chief and crew could be commended for "the conscientiousness and professionalism shown during the events leading up to and attending the crash incident."

The Dryden CFR crew chiefs, Stanley Kruger and Bernard Richter, provided observations and suggestions to their fire chief and to the airport manager regarding the CFR response to the crash. These observations and suggestions in my view were well conceived and, accordingly, I quote their entire submission to their superiors:

<u>Observations and Suggestions of Dryden CFR Crew</u>

March 13, 1989

Better call in system, steps should be taken to ensure all CFR personal is called in for any and all significant emergency response.

Paging system could be activated to help with the problem of contacting personal.

Better maintain access roads to runway, road from firehall to the runway should be kept sanded on a priority basis in winter months. Access roads at the end of the runway at each end should be kept open in winter months.

Trucks should be maintained to peak conditions regardless of cost, or replaced.

Transport Canada should be made aware or the need to reevaluate policy of only one man per truck, especially at northern airports. Due to the depth of snow and rugged terrain experienced in the north it does not seem reasonable to expect one fireman one truck to do a proper job of rescue, firefighting, and/or saving possible evidence under these conditions. Even two men in one truck and one in the second would be a major improvement.

We should align ourselves more closely with Transport Canada so we can receive similar benefits re information and training.

Should try and make sure there is a town pumper to provide fire protection if airport operations continue during an emergency.

CFR personal directly involved in a disaster should continue to be involved as much as possible in the days following the incident if they wish so they do not feel they had to leave the job unfinished. There should also be an optional debriefing if possible within twenty-four hours.

The above are observations resulting from discussion among CFR crews following the crash of Air Ontario's F28 March 10, 1989 in Dryden. These are made in hopes of benefiting future operations of CFR, and is in no way, nor is it meant to be, a criticism of any person, department or organization.

(Exhibit 186)

On April 12, 1989, the Dryden airport manager, Mr Peter Louttit, forwarded a report of the F-28 accident to Transport Canada. The report was submitted as an Emergency Exercise Report, presumably fulfilling an exercise requirement. The report dealt with the response by the airport and its CFR unit to the crash. There were five specific deficiencies identified regarding the response by the CFR unit as follows:

1. There was no formal alarm given. CFR were made aware by witnesses waving and yelling.
2. Town dispatcher and others did not recognize the magnitude of the situation from only being given the aircraft model i.e. "F-28 crash." Need to be more specific for non-aviation personnel.
3. CFR vehicles could not reach site due to snow depth and dense bush. Firefighting was done with handline from a fire pumper truck.
4. The CFR call-in system for calling in off-duty personnel didn't work. Needs to be replaced with a better system.

5. Supply of blankets in CFR firehall could not be located by non-CFR persons sent for them. (Boxes have since been marked)

(Exhibit 240)

The report, after identifying problems encountered during the crash, suggests solutions. One of the solutions was to add a pumper truck to the CFR fleet. The report lists other salient points learned from the emergency as follows:

1. CFR tactics, equipment, and manning standards need to be re-examined for sites such as Dryden that are surrounded by heavy bush, rough and/or swampy terrain, and heavy snow falls in the winter.
2. The On Site Coordinator is too busy with the logistics and priorities of the emergency to keep written records of events in chronological order. Some means of tape recording his activities and the time intervals is required.

(Exhibit 240)

Mr Louttit's report of April 12, 1989, did not include all the observations and suggestions of the Dryden CFR crew chiefs. In particular, he did not comment on deficiencies they observed, such as maintenance of access roads to the runway, maintenance of the fire vehicles, re-evaluation of Transport Canada policy regarding personnel and vehicles, and alignment of Dryden airport policies closer to those of Transport Canada so that the Dryden CFR fire-fighters could receive better information and training. In my view, Mr Louttit's report should have included all these observations.

Although both Mr Risto and Mr Nicholson were quick to praise the response of the CFR fire-fighters, neither of their reports analysed deficiencies in the CFR response so that the Dryden Municipal Airport and Transport Canada could correct the deficiencies. It was not until both Mr Risto and Mr Hamilton testified before me that they confirmed that the CFR unit had made a number of errors in its response to the crash.

While it was the intention of Transport Canada to provide assistance and encouragement to the Dryden airport staff, it is my view that they should have investigated the response of the CFR unit more thoroughly to determine if there were inadequacies in the response. Because Transport Canada did not analyse the response rigorously and because the airport manager and the fire chief did not provide to Transport Canada their own thorough critique, a true picture of the CFR response was not available to the Dryden Airport Commission or to Transport Canada.

Mr Henry Moore was, at material times, the director, Airports Safety Services, Airports Authority Group, Transport Canada headquarters, and, as such, was responsible for standards and training for CFR services. During his testimony before this Commission, he was asked if there was any existing mechanism whereby Transport Canada CFR experts participated with Transportation Safety Board of Canada (TSB) investigators to assess the response of a CFR unit to a crash. Mr Moore stated that Transport Canada does not have a formal procedure either internally or with the TSB to review the response of a CFR unit to a crash. Although Transport Canada emergency services personnel are normally asked to visit an accident site immediately to assess CFR actions, no procedure exists to evaluate a CFR unit's response to a crash.

Mr Moore testified that his branch carefully followed this Commission's hearings to determine what lessons could be learned with regard to CFR and what information could assist his headquarters branch. I deal with Mr Moore's response to the hearings under the section in this chapter titled Observations. However, I deem it important to quote part of Mr Moore's testimony as an example of how Transport Canada has responded to deficiencies revealed during these hearings. When asked what lessons Transport Canada had learned and what sort of information had been obtained, Mr Moore stated as follows:

> A. I decided to become quite involved in [the] ... hearings of the Commission because we don't very often have – thank God ... crashes or serious accidents in aviation, and, just for the very purposes that you outlined, I wanted to follow it as very closely as an individual.
>
> And I have attended most of the hearings, the majority of the hearings, I believe, and it has certainly raised the degree of urgency, if I can use that type of terminology, both for myself and for my staff.
>
> Without prejudice and without making any assumptions in terms of the status, whether or not CFR services were being provided well at other airports, I sort of took the approach, if that sort of thing could happen at Dryden, there's a possibility it could happen somewhere else and how should we prepare to deal with that type of an incident should it occur.
>
> A couple of things became apparent to me early in the exercise. One was the need ... to ensure that we had adequate crash charts available. In August of last year, I had my staff conduct a survey to determine the adequacy and the availability of crash charts on a national basis.
>
> Based on that survey, we decided that we weren't as well prepared there as we felt we should be ... back in November, then, we went out again with a stronger memo saying that you – essentially, get those crash charts and have them available.

Then it was sometime after that the question was raised here at the hearings, and, since that time, we've decided to take a very strong position in this case here, and our approach is going to be to ensure that, when new aircraft ... receive type approval for operations in Canada, part of that package is going to be to provide us with crash charts, and we're going to distribute them from our headquarters. And my people evaluate the availability when they visit airports, so I don't want any more problems with crash charts.

Q. So that's a positive step in the right direction, obviously?

A. Yes.

...

A. A second thing, very early in the exercise, my assessment of what happened, based on the testimony at the scene and in consultation with members of my staff, we felt that we were going to have to do something to emphasize further the need for a strong, well-trained and knowledgeable on-scene commander.

And I have given instructions to my people to proceed with developing such a training course, and we should have that in the new year.

A number of other programs, without any specific written direction from me, but just the general sense of urgency, that we had better get on with some of these things, to the best of our ability, I feel that ... as an example, the FR Certification Program was accelerated.

I made the decision to distribute all of the documentation for this training program probably in the July – August time frame, in that area, with advice to the people affected that the specific instructions as to how the documentation was to be used would be forthcoming.

In other words, we had all the documentation, but the specific administration of the program hadn't been finalized. But we said, here is the documentation, you fellows start taking a look at it, you start using it, start becoming familiar with it, critique it, come back to us, specific instructions will be forthcoming. And they were in fact forthcoming, and the program had an official start date of November 1.

Q. And so you have accelerated the program by, what, two or three or four months?

A. Probably a couple of months, right.

(Transcript, vol. 38, pp. 26–29)

Mr Moore, in the above-quoted testimony, cited a few examples of where Transport Canada has responded positively to the evidence on CFR that unfolded during the Inquiry hearings. These and other responses are listed in the Observations section below. I commend the positive effort taken by Transport Canada regarding actions which I agree are appropriate in dealing with obvious deficiencies in the aircraft crash response system. However, in order to assist both the responding unit, other CFR units, and Transport Canada in improving CFR capabilities, I recommend that, whenever a CFR unit responds to an aircraft crash, Transport Canada, as part of its post-crash response, immediately analyse the actions of the CFR unit. It is important that all the CFR actions be reported on so innovative ideas can be discussed, deficiencies in the response can be corrected, and useful information, both positive and negative, can be passed to other CFR units.

Observations

I have paid particular attention to the matter of crash, fire-fighting, and rescue services not only because of the involvement of and response by the Dryden CFR unit but also because of the need to recognize its importance as part of the overall safety net at airports where air carriers operate on a frequent and regular basis. As a result of the testimony that was heard before this Commission, Transport Canada has responded to deficiencies exposed in a positive manner prior to the issuance of this my Final Report.

While I have deemed it necessary to identify the errors that were made by the Dryden CFR unit, I also wish to recognize those actions taken by Transport Canada to correct the CFR shortcomings uncovered during this Inquiry. I deem it appropriate to list in its entirety a letter from Mr Moore, dated March 13, 1991, addressed to Senior General Counsel, Department of Justice, Canada. A copy of this letter was provided to me for my review and consideration. Action taken by Transport Canada as outlined by Mr Moore is as follows:

> **Item 1 – Aircraft Crash Charts**
>
> Every effort has been made during the past year to ensure that airports have the requisite crash charts. We are confident that the availability of crash charts at Transport Canada owned and operated airports has never been better. As a separate thrust, we concluded a letter of agreement with the ADM – Aviation Group that led to Policy Letter No. 49. This policy provides for a means of ensuring the provision of pertinent crash charts concurrent with the introduction of new aircraft types into regular service. My staff are also engaged in the final production of a crash chart manual, which will include over 260 different types of commercial aircraft. This document will be distributed in sufficient quantities so as to provide for one manual to be placed in each crash truck in the system. In addition, a second manual in larger-size format will be provided to each fire hall and Emergency Co-ordination Centre for quick

reference and training purposes. This latter project has been extremely demanding because of the need to rework numerous charts to provide for standardized drawings. The results have been well worthwhile, and the first printing should be distributed during the next two or three months.

Attachments:
Appendix A – Letter of Agreement, dated June 1990
Appendix B – Policy Letter #49

Item 2 – On-Scene Controller Training

Our approach to developing the documentation for this training course was predicated on the need to act quickly. Briefly, the first training course was presented to key personnel at the Transport Canada Training Institute (TCTI) during November of 1990. The course participants then returned to their respective Airports or Regional Headquarters to present the training to employees within their areas of responsibility. In addition, the On-Scene Controllers Course will be incorporated into our on-going Disaster/Emergency Planning and Airport Duty Managers' courses. You will note that we have also chosen a new title "Controller" to better reflect the importance placed on this activity. Our program is on-schedule, and the results to date have been most gratifying.

Attachment:
Appendix C – AK Directive 1990-A0-20
On-Scene Controllers' Course
December 10, 1990

Item 3 – Safety Officer Certification Training

The development and presentation of this training is right on schedule. The first regular two-week certification course was presented at the Transport Canada Training Institute in March of 1990. Additional courses took place during September 1990 and February 1991. This is now an on-going program.

Item 4 – Critical Incident Stress Debriefing (CISD) –

This refers to my undertaking to address the matter of post-accident counselling for non-government firefighters at subsidized airports. This was discussed with the responsible Transport Canada officials on a number of occasions; however, a final determination has not been made in respect to this item.

Item 5 – Airport Fuelling Procedures

An AK Directive, dated March 22, 1990, was dispatched for the purpose of ensuring that the procedures established in TP 2231 (fuelling manual) were followed, and that the importance of this activity was clearly understood by managers on a national basis. TP 2231 was reviewed and revised in consultation with the Air Transport Association of Canada, and the new version was published in April of 1990.

Attachment:
Appendix D – AK Directive – Airport Fuelling Procedures, March 22, 1991

Item 6 – Tracking of Firefighter Certification Program Training Progress

A computer program has been set up, and progress reports are being entered on a site-by-site basis to enable program implementation to be tracked by the Headquarters training officer.

Item 7 – All-Weather Training and Training on Difficult Terrain

A training committee review of this training indicated that the individual skills required of firefighters were already covered in the Firefighter Certification Training Program; however, it was also agreed that increased emphasis was in order. Additional Certification Program lesson plans were developed by specialists in this area and distributed to airports for review and comment. Final revised lesson plans are now ready for printing.

Item 8 – Snow-Clearing Access Roads/Crash Gates

A directive was forwarded to all affected Managers effectively instructing them to ensure that roads and gates are maintained clear of snow.

Attachment:
Appendix E – Snow Removal – Emergency Access Roads and Gates, March 23, 1990, File 5160-12-23 (AKOBC)

Item 9 – Emergency Response Services (formerly CFR) Evaluation Procedures

Revised evaluation checklists were developed for distribution to Airports for review, comments and guidance. Revised procedures were also developed to guide Headquarters staff during evaluations at Major Federal Airports.

Item 10 – Deletion of Water for Fuel Spills, etc.

Revised Certification Program lesson plans state that water must no longer be used to wash down a spill that is not contaminating a critical area.

Item 11 – Fire Officer Certification Program

This program is currently being developed. To date, working groups consisting of experienced Fire Chiefs and Fire Officers have completed the formulation of specific training objectives. The identification of requisite Fire Officer knowledge and skills has also been completed. We will now proceed with the preparation of detailed lesson plans. A parallel thrust is the development of a strategy for the delivery of the program. Consideration includes a number of centralized training courses complemented by on-site training. Formal training should get under way during 1991.

Item 12 – Primary Role of a Firefighter in Event of a Crash

The primary role of a firefighter is clearly identified in the Firefighter Certification Program; however, added emphasis has been place on this area at the Level I phase of the training program.

A number of other activities have also been under way, which can only serve to improve the response to any future incident that may occur at a Transport Canada Airport. Widespread circulation of selected Commission transcripts has taken place throughout the organization. A number of video tape recordings of key witnesses have also been distributed.

The details of the Dryden accident, as presented by Commission witnesses, have been discussed at many National and Regional conferences, meetings, seminars and safety-related training courses during the past year. We have no difficulty in suggesting that it would be almost impossible for any Airports Group employee, associated with safety and/or emergency planning, to be untouched by the events of March 10, 1989.

Henry L. Moore
Director
Airport Safety Services

Attachments

The actions taken by Transport Canada listed above are all appropriate in dealing with the obvious deficiencies revealed as a result of this Inquiry. This positive effort by Transport Canada regarding aircraft crash responses should not end with the above actions but must be a dynamic process that continues beyond the term of this Commission of Inquiry.

Findings

- There is no legislation in the *Aeronautics Act*, Air Regulations, Air Navigation Orders, or any other Canadian legislation governing the requirements for CFR services at Canadian airports. Nor does legislation exist in Canada to compel a certificate holder of an airport not owned or operated by Transport Canada to comply with Transport Canada policy standards and guidelines regarding CFR services.

- The Dryden CFR unit personnel were not sufficiently trained to meet Transport Canada standards as set out in its AK policy documents.

- The Dryden airport manager, the CFR fire chief, the CFR crew chiefs, and the CFR fire-fighters did not ensure that all CFR personnel were trained in all aspects of crash, fire-fighting, and rescue as required by Transport Canada AK policy documents and as requested by Transport Canada emergency services officers on a continuing and regular basis.

- Budgeted funds from Transport Canada were allocated and available for the required training of the Dryden airport CFR personnel.

- The Dryden airport manager did not ensure that budgeted training funds were made available to the Dryden CFR unit. The budgeted training funds were diverted for use on other airport projects.

- Both the Dryden airport manager and the CFR fire chief incorrectly stated in training reports to Transport Canada that the reason hot-drill fire training was not completed was because of the lack of funds, economic restraints, and funding cuts.

- Transport Canada personnel were unsuccessful in their attempts to persuade Dryden CFR personnel, directly and through the airport manager, to train properly.

- Both the lease agreement and the subsidy agreement between the Dryden Airport Commission and Transport Canada required that CFR services be maintained to the satisfaction of Transport Canada. The subsidy agreement required that variances in the expenditure of approved budget funds not be made without the expressed consent of Transport Canada.

- Transport Canada did not advise or warn the Dryden Airport Commission of the fact that proper CFR training at the Dryden airport was not being conducted. The lack of advice or warning was due in part to ambiguous direction given by Transport Canada Airports Group, Ottawa, to Transport Canada, Central Region, regarding the treatment of CFR units at subsidized airports.

- Communication between Transport Canada, Central Region's Safety and Services Branch, responsible for CFR services within that region, and the Community Airports Branch, responsible for the allocation of funds and the determination of budgets for subsidized airports, including the Dryden Municipal Airport, was deficient.

- Transport Canada, Central Region, Community Airports Branch, did not adequately monitor the spending of CFR training funds allocated to the Dryden Municipal Airport.

- Transport Canada, Central Region, Safety Services Branch, lacked vigilance and initiative in pursuing the fact that the fire chief and the airport manager did not ensure that adequate and proper CFR fire-fighting training was being carried out.

- The workload and responsibility placed upon one supervisor and two emergency services officers in Transport Canada, Central Region, was overwhelming in that they had the responsibility to train, evaluate, and supervise CFR units and to provide guidance and assistance to the airport managers and fire chiefs in Central Region, as well as assisting Transport Canada, Headquarters Emergency Services Division, in developing policy.

- The support provided by Transport Canada Airports Authority Group to the emergency services organization in Central Region was wholly inadequate.

- The Dryden CFR personnel were not familiar with the term CRFAA or its implications. This lack of familiarity with the CRFAA did not affect their response to the crash.

- AK-12-03-011, Transport Canada Crash Firefighting and Rescue Services Standards, is ambiguous when referring to "the CRFAA and the airport boundary," or "the CRFAA or the airport boundary," in that it is not clear whether these phrases are meant to include the entire CRFAA if its boundaries extend beyond the airport boundaries.

- The Dryden CFR personnel were not trained properly to deal with an aircraft accident on terrain inaccessible to fire-fighting vehicles.

- Transport Canada did not emphasize the use of extended handlines as part of the CFR training and evaluation programs.

- Transport Canada CFR policy documents are generally of a high standard.

- There was ample information in numerous documents available to CFR personnel and aircraft refuellers regarding precautions to be observed when hot refuelling.

- There was no information in manuals or documents normally available and used by Air Ontario F-28 pilots regarding hot refuelling.

- Aircraft refuellers at the Dryden airport did not follow correct hot-refuelling procedures.

- CFR personnel at the Dryden airport did not ensure that refuellers followed correct hot-refuelling procedures.

- Fire-fighting vehicles expended fire-fighting resources to clean up a small fuel spill when alternative means existed.

- Mr Vaughan Cochrane, contrary to ESSO instructions and Transport Canada documents, normally defeated the dead-man switch while refuelling aircraft and did so during the refuelling of C-FONF on March 10, 1989.

- Dryden airport management personnel did not ensure that the crash gate access roads at the airport were kept open and usable during the winter.

- Dryden CFR personnel reacted properly in hurrying to the crash area, setting up a command post, and assessing the crash.

- The Dryden airport manager did not cause to be issued, in a timely manner, a notice to airmen (NOTAM) regarding the lack of CFR services at the Dryden airport following the crash of C-FONF.

- Except for the initial radio contact between them, immediately after crew chief Kruger's arival at the crash site, Mr Kruger and Fire Chief Parry did not establish vital radio communications between the crash site and the command post, although they had radios capable of providing such communications.

- There was overlapping jurisdiction among the responding agencies, being the UT of O Fire Department, the Dryden CFR unit, and the OPP. This overlapping jurisdiction caused confusion and uncertainty as to the respective roles of those agencies involved.

- It cannot be shown that any activities by any person or organization in response to the crash altered, or could have altered, the fate of any of the persons who died as a result of the crash.

- By 12:45 p.m. there were several fire-fighters and at least three fire-fighting vehicles at the crash site capable of being used effectively to fight the aircraft fire, but there was no attempt to do so until after 1:30 p.m., when a UT of O pumper truck was driven to a position opposite the crash site.

- Handlines could have been in use at the aircraft fire by approximately 12:50 p.m. at the earliest. They could have been used to assist rescue personnel, preserve more of the evidence, and protect the flight recorders from the fire and heat.

- As the result of inadequate training, the CFR fire-fighters, including the CFR fire chief, did not carry out their duties and responsibilities at the crash site as professional fire-fighters but instead spent their time performing duties that others could have performed. This is not to suggest that the duties they did perform were not important; they became distracted by their concern for the survivors.

- The UT of O fire-fighters likewise did not initially perform duties as trained fire-fighters but became, as did the CFR personnel, distracted by the survivors.

- The CFR fire chief did not properly direct the fire-fighters on their arrival at the crash area.

- Although Transport Canada headquarters officials stated that there could be no compromise in safety standards caused by spending reductions, the fact that they did not specify whether CFR was a safety issue created problems for Transport Canada regional officers and for airport management.

- The recently instituted Transport Canada fire-fighter certification program provides a comprehensive means to ensure compliance with fire-fighter standards on a national basis in Canada.

RECOMMENDATIONS

It is recommended:

MCR 23 That Transport Canada ensure that airport authorities at all Canadian airports, in conjunction with crash, fire-fighting, and rescue (CFR) unit personnel, determine the best and most practical ways to deal with emergencies within each airport boundary and critical rescue and fire-fighting access area (CRFAA), having regard to available CFR personnel and equipment and to the surrounding terrain.

MCR 24 That Transport Canada ensure that all documents which describe or refer to the critical rescue and fire-fighting access area (CRFAA), be they Transport Canada documents or local airport authority documents, are informative, consistent, and unambiguous with regard to the CRFAA, and that such documents specifically define the responsibilities of a crash, fire-fighting, and rescue unit within the CRFAA both within the airport boundaries and/or beyond.

MCR 25 That Transport Canada ensure, through the fire-fighter certification program, and other programs and agreements as necessary, that all crash, fire-fighting, and rescue fire-fighters, including the fire chiefs, are adequately trained.

MCR 26 That Transport Canada proffer for enactment legislation that empowers Transport Canada to ensure that all crash, fire-fighting, and rescue (CFR) personnel, including those at non-Transport Canada–owned and non-Transport Canada–operated airports, meet Transport Canada CFR training and operating standards.

MCR 27 That Transport Canada encourage all communities where there is an airport with fire-fighting services to include in their mutual aid/emergency response plans specific instructions regarding the duties, responsibilities, and area of authority of each organization that is expected to respond to an aircraft emergency on and/or off airport property.

MCR 28 That Transport Canada ensure that refuellers at Transport Canada–subsidized or operated airports are fully knowledgeable in and follow safe refuelling practices.

MCR 29 That Transport Canada implement a policy of having airport crash, fire-fighting, and rescue units, after appropriate training, responsible for monitoring aircraft fuelling procedures and ensuring compliance with fuelling standards and procedures.

MCR 30 That Transport Canada ensure that training programs for airport crash, fire-fighting, and rescue units include preparing fire-fighters for the realities of an air crash, so that they are not distracted from their primary responsibilities at a crash site.

MCR 31 That whenever a crash, fire-fighting, and rescue (CFR) unit responds to an aircraft crash, Transport Canada, as part of its post-crash response, objectively review and analyse the actions of the CFR unit forthwith, in order that deficiencies in the CFR response can be corrected and useful information, on both the positive and negative aspects of the response, may be passed on to other CFR units.

MCR 32 That Transport Canada ensure that local arrangements be made between airport managers and air carriers that will result in crash, fire-fighting, and rescue personnel being informed of the number of persons on board, fuel on board, and any hazardous cargo on board an aircraft in the shortest possible time following an incident or accident. These procedures should accommodate the possibility that the aircraft flight crew will not be able to provide this information.

PART FOUR

AIRCRAFT INVESTIGATION PROCESS AND ANALYSIS

10 TECHNICAL INVESTIGATION

The Aircraft and Its Systems

Conduct of the Investigation

This chapter is based on reports prepared for the Commission by Canadian Aviation Safety Board (CASB) investigators, by interested-party participants, and, where indicated, by other investigators working independently. It also draws on the evidence given at the Commission hearings.

Upon receipt of notification of the Air Ontario F-28 crash at Dryden, the director of investigations of CASB, following the normal procedures for major aircraft accidents, mobilized the pre-designated investigation response team (Go-Team). The Go-Team comprised the following: the investigator in charge, a head office coordinator, a deputy investigator in charge, an administration officer, a regional coordinator, and 12 group chairpersons. The groups were: aircraft powerplants; aircraft structures; aircraft systems; flight data recorder and cockpit voice recorder; human factors and survivability; operations; photo and video; public affairs; records and documents; site security and survey; weather/air traffic control and airports; and witnesses. A special performance subgroup, formed shortly after the accident, worked with the operations group. Ten additional CASB investigators worked within the group system.

Arrangements for accommodation, expenses, and travel were completed by CASB administration staff while the investigators carried out preparatory duties for their areas of responsibility. A briefing held in the late afternoon and evening of March 10, 1989, brought everyone up to date on the known facts surrounding the accident and ensured that the investigators were prepared. Most of the team members departed Ottawa airport early the next morning on a de Havilland Dash-8 operated by Transport Canada, arriving at Dryden at approximately 11 a.m. local time. The balance of the team travelled in a Beech King Air, also operated by Transport Canada, and on commercial airlines. All investigators were in Dryden by the evening of March 11, 1989. The investigation headquarters were set up in a Ministry of Natural Resources building on Dryden Municipal Airport property.

The investigation was conducted in accordance with established procedures, applicable legislation, and regulations in effect at the time:

- *The Canadian Aviation Safety Board Act* and Regulations, R.S.C. 1985, c-12
- CASB's Manual of Investigation Operations
- The International Civil Aviation Organization (ICAO) Manual of Aircraft Accident Investigation
- Annex 13 to the Convention on International Civil Aviation (*International Standards and Recommended Practices, Air Accident Investigation*)

Observers representing parties with direct interest in the accident assisted the CASB investigators in appropriate areas of investigation and made their own observations in all phases of the field investigation. There were observers from Air Ontario, Transport Canada, the Canadian Air Line Pilots Association (CALPA), the Canadian Union of Public Employees (CUPE, representing flight attendants), Fokker Aircraft, Rolls-Royce (manufacturer of the aircraft's engines), and insurance companies. An aircraft-accident investigator from the Department of National Defence assisted in the investigation as part of his own training.

Pursuant to Order in Council P.C. 1989-532, passed on March 29, 1989, a public inquiry was ordered, and the investigation of this accident was turned over to this Commission of Inquiry. The responsibility of CASB in this investigation was terminated. At my request, the CASB team of investigators already involved in the investigation of the accident, including the investigator in charge, Mr Joseph Jackson, and three aviation technical experts, Messrs David Rohrer, David Adams, and Reginald Lanthier, were seconded to my Commission and thereafter reported directly to me. Representatives from interested parties having expertise in areas of interest to the CASB investigation team were assigned to work as full participants with particular CASB groups. As an example, CALPA provided the operations group with representatives offering expertise as pilots and performance engineers, and Air Ontario provided the aircraft structures group with those knowledgeable about the F-28 aircraft. In some instances, these individuals had initially served as observers on the CASB investigation teams. These participants were given access to all investigation information gathered prior to their having joined the investigation and had more investigative responsibility than that enjoyed by the observers. The participants were of great value to the investigation and were able to offer information of a highly specific nature in relation to their organizations.

At the end of the active investigation phase, the participants helped prepare their group's factual report. Each participant either signed his or her group's report as an indication of agreement with its contents or provided a written explanation of why he or she could not agree. The few differences of view that arose were resolved before the final investigative group reports were submitted to this Commission. Various group chairpersons thereafter appeared on the witness stand at the Commission hearings and were questioned on the contents of their reports.

Initial Investigative Activity and Observations

Members of the CASB investigation team arrived at the accident site at approximately noon on March 11, 1989. At that time, members of the Ontario Provincial Police (OPP) were controlling access to the site, and fire-fighters had extinguished the fire. In order to ensure that evidence was not lost, none of the bodies and no part of the wreckage, other than as necessary during the rescue and fire-fighting operations, had been moved. CASB photographers photographed and videotaped the entire accident scene, and other CASB investigators made a cursory inspection of the area. Over the next days the OPP removed bodies and belongings.

An OPP district search and rescue team, together with CASB personnel, searched the area from the end of runway 29 to the crash site out to 100 m on either side of the wreckage trail. The locations of all the debris from the aircraft were subsequently plotted on a diagram, with information obtained from surveying results, ground plots, and photographs taken from the air. The accuracy of the survey is estimated to be within 10 cm in horizontal and vertical positioning with reference to the elevation of the Dryden airport. Before being removed, each piece of wreckage was photographed with a 35 mm camera.

The site security and survey group determined that the aircraft first contacted a single tree 127 m off the end of runway 29, 3° to the left of the runway centre line. The treetop was broken off at an elevation of 413.1 m above sea level (asl); the west end of the runway is 413 m asl. The aircraft struck 18 more trees in the next 600 m, all at an elevation of 413 m asl, plus or minus 1.5 m. The aircraft then contacted a more heavily wooded area at the top of a knoll and started to descend. It struck the ground and slid about 80 m before coming to rest. The knoll elevation was 404 m asl and sloped downwards to 390 m asl, where the aircraft came to rest.

Vertical colour and infrared photography and subsequent evaluation using photogrammetric techniques established the exact position and height of the cut-off trees. It is estimated that this technique registered the tree heights within a standard deviation of 10 cm.

The first piece of wreckage located on the wreckage trail was the broken red lens cap from the rotating beacon on the lower fuselage of the aircraft. Lens pieces were found in the vicinity of the first tree strike. The left wing tip, the main landing-gear doors, and pieces of the radome were found in the heavily wooded area on the knoll where the aircraft started to break up from striking the trees. As the aircraft entered the heavily wooded area, the wings were relatively level; however, as it travelled through the trees, it rolled some 10 to 20° to the left. Most of the left wing broke away in pieces before the fuselage struck the ground. The wreckage along the trail consisted primarily of parts of the left wing, the main landing-gear doors, and the underside of the fuselage.

The main wreckage came to rest upright and consisted of three relatively intact major pieces, joined on the left side and in the form of a U, with the tail and nose sections pointing backwards, towards the airport. There were two large breaks in the fuselage, one just aft of the main passenger door and one through the fuselage at approximately seat row 12. The centre fuselage section came to rest approximately perpendicular to the flight path, the tail section was oriented about 50° off the centre line of the fuselage, and the cockpit was about 90° to the fuselage.

Fire broke out coincident with the rupturing of the left-wing fuel tank, approximately 50 m beyond where the aircraft entered the heavily wooded area. The fire along the wreckage trail superficially burned the trees but was not sustained after the sprayed fuel had burned. After the aircraft came to rest, the fire continued to burn until it was extinguished by fire-fighters, about two hours after the crash. The cockpit and fuselage aft to the rear pressure bulkhead were almost totally destroyed by fire. The empennage (tail section) and engines were lightly sooted and relatively unburned. There was no evidence that the aircraft was on fire prior to the main tree strikes.

Following documentation of the wreckage *in situ* and subsequent on-scene examination, all wreckage that could be found was either locked in trunks/crates or guarded by security personnel, before being moved by air, truck, and rail to the CASB engineering laboratory in Ottawa. Detailed examination of all pieces of the wreckage was then carried out by CASB investigators as well as by others under their supervision. After the snow had melted at the accident site, another search was conducted. Further pieces of wreckage were found; these too were documented, sent to the laboratory in Ottawa, and examined.

Reconstruction and examination of the wreckage and of the breakup patterns showed that all aircraft damage was consistent with collision with trees or the ground.

The aircraft flight path and wreckage location were pictorially reconstructed, and the results are reproduced in the report of the aircraft structures and the site security and survey groups. (This detailed report, which graphically describes the actual flight path and resulting crash, is included in its entirety as technical appendix 1 to my Report.)

Engines

Aircraft C-FONF was equipped with two Rolls-Royce Spey RB 183-2 Mk555-15 jet engines, one attached to each side of the rear fuselage. When viewed from the rear, the engine on the left side is designated number 1 and that on the right side is designated number 2. The engines provide thrust; power to drive accessories connected to the engines; and hot air from the engine compressor for, among other things, air-conditioning, pressurization, and airframe anti-icing.

On-site examination of the wreckage revealed that the engines were still securely mounted to the aircraft and had suffered minimal damage. The left engine was damaged as follows: the engine was still cowled, but the bottom of the cowling was impact damaged; the hinged portion of the cowling was severely damaged; the gearbox was fractured; the engine nose cowl and tailpipe were dented upwards and the cowl was forced against the compressor; and all components from the left engine appeared to be contained within the engine cowlings. The right engine was found completely cowled and had been subjected to only minor impact damage. The low pressure (LP) compressor was free to rotate and was still coupled to the LP turbine, and the LP compressor blades showed damage from foreign objects.

To detach the engines from the aircraft, the engine pylons (stubwings) were cut from the aircraft structure with the engines still attached. The units were then shipped in a sealed trailer to the engineering laboratory of the Canadian Aviation Safety Board in Ottawa. The engines were subsequently shipped to the Rolls-Royce (Canada) facility in Montreal for disassembly and examination under the supervision of CASB investigator William Taylor. Following the examinations at the Rolls-Royce (Canada) facility, all components from the stubwings and engines were shipped back to the CASB engineering laboratory for further study and analysis both by CASB investigators and by an independent engine-management consultant retained by this Commission, Mr Peter Clay.

Number 1 (Left) Engine

The number 1 (left) engine (serial number 9130) was generally intact, although the lower and aft cowling panels were torn and partially burned. The lower portion of the compressor's intermediate case was split adjacent to the rear flange, and the gearbox case was broken. The accessory units were externally damaged, with most of them separated at their mounting flanges. The engine power controls were broken and twisted. The emergency fuel shutoff mechanism had been shifted to the off position by the breakup, and the low-pressure shaft failure system had not been actuated. This was demonstrated by an intact shear pin in the cable quadrant on the side of the engine. If the low-pressure shaft disconnects from the turbine while the engine is running, the failure system causes a cable to actuate the emergency fuel shutoff, thus shutting down the engine to prevent further damage.

The engine anti-ice valves were found in the closed position. When selected ON (open), and there is both electrical power and air pressure available, these valves open – and they are held open – by the electrical power and the air pressure. With failure of either electrical power or air pressure, the valves move to the closed position. The internal area of the engine anti-ice ducting was examined for ingested vegetation. Small amounts of vegetation were found, but it could not be established if the vegetation entered via the engine compressor, which would indicate that the anti-ice was on, through breaks in the structure, or through normal air exit points. An examination and a basic electrical test of the anti-ice shutoff valves showed that the valves were serviceable. Equipment for a full functional check was not readily available; however, there was no reason to suspect that the valves would not operate as required. The anti-ice gauge-pressure transmitter was serviceable.

The fuel spray nozzles were heavily sooted but were not damaged. Testing of the nozzles showed some streakiness during low-pressure flow, but, except for a marginally low flow rate on several nozzles, the nozzle set was serviceable under combined flow conditions, as is the case at high engine-power settings. There was much discussion about the serviceability of the fuel nozzles because the Rolls-Royce test data showed that most or all of the nozzles tested out of limits. In the opinion of the powerplants group's chairman, Mr Joseph Bajada, there was nothing in the reports regarding the nozzles or other fuel control components to alarm him or indicate any inability of the fuel delivery systems.

In an attempt to establish the relative position of the torque shaft of the compressor bleed valve at the time vegetation and other foreign material was passing through the engine, investigators examined the debris pattern on the torque shaft. No identifiable pattern was found. The position of the torque shaft would indicate the position of the bleed valve, which in turn would give an indication of engine power. The valve is closed when the engine operates at high power.

The LP compressor was damaged by debris: five first-stage blades (one near the root) and one second-stage blade were broken. Other blades in the compressor were gouged and bent. All the breaks were the result of overload at impact. Some blades in the high pressure (HP) compressor showed minor damage in the form of nicks, rubs, and minor bends. The turbine sections were in generally good condition, but there were extensive metal deposits throughout the entire HP and LP turbines and, especially, on the HP nozzle guide vanes.

All bearings were in good condition, with no evidence of a distress or other lubrication problem. The oil tank was ruptured; no oil sample was available, but the filters appeared clean on visual inspection. The magnetic plugs were clean.

Number 2 (Right) Engine

There was little external damage to the number 2 right engine (serial number 9187). There was some post-crash fire damage to the pylon, but the engine was not affected.

The fuel HP shutoff valve arm was at mid-travel, and the LP shaft failure system had not been actuated. The power lever linkage to the fuel regulator unit was found at the MAX position. Normally, this would indicate that the engine had been selected to full power; however, the linkage could have been moved to MAX as a result of the breaking up of the linkage during the crash.

The observation and conclusions about the engine anti-ice valves for the left engine apply to the right-engine valves, except that the gauge-pressure transmitter, although functioning acceptably, leaked a small amount.

Functional tests of all fuel system components were performed, with the results much the same as for the left engine. A fuel sample was obtained from the engine fuel lines. The fuel sample was straw coloured and contained no visible free water or suspended matter. The sample did contain traces of fine black particles and several other small pieces of particulate matter; National Research Council Canada (NRC) concluded that the amount was not excessive. The simulated distillation characteristics of the sample indicated a mixture of fuel types.

Examination of the bleed-valve torque shaft for fan duct debris showed that, when ingested vegetation collected on the shaft, the valve was in the bleed-valve–closed position. The bleed valve is closed when the engine is operating at high power.

The T6 thermocouples, which measure turbine gas temperature, were checked for continuity. One was internally shorted, but it was not determined whether the short was in the controlling or the indicating section; either system will continue to function acceptably with one probe unserviceable.

The adjustment of the rod that actuates the switch to control the selection of seventh- or twelfth-stage air was found to be incorrect, with the clearance being less than specified. The function of this switch is to match bleed-air output to the airframe pneumatic system requirements. Incorrect adjustment would have had no effect on engine operation.

The interior of the right engine showed a greater accumulation of tree debris, in finely chopped form, than was found in the left engine. In the fan duct there was vegetation packed in the exhaust collector's support struts and at flanges, and there was a collection of charred vegetation around the inlet areas of the burner cans.

The LP compressor had one broken blade, broken in overload, with others moderately gouged and bent. The overall condition was good relative to the amount of debris ingested. The HP compressor suffered light damage. A heavy coating of soot appeared throughout much of the engine, especially in the HP compressor area. A sample of the soot was analysed by NRC's chemistry division, and the soot was found to be organic material related to tree fragments and other objects ingested during the crash. The turbines were also sooted, and there was metal spatter throughout the engine to the number 2 LP turbine. The metal deposits were not as heavy as in the left engine.

The oil tank had ruptured, and only a small oil sample was recovered for analysis. From visual inspection, all bearings and filters were in good condition and there was no indication of a lubrication problem. The magnetic plugs were clean.

Engine Accessories

The engine accessories from both engines, including the constant speed drives, were delivered to the appropriate manufacturer's facilities and were functionally tested under the supervision of CASB investigators. Accessories that were damaged and could not be tested were disassembled and examined. No discrepancies that could adversely affect engine operation were found in the components tested and examined.

The airflow control unit and the fuel flow regulator of the right engine were bench tested and found to be slightly out of specified limits on some points. The airflow control unit controls the position of the compressor inlet guide vanes, and at takeoff power the guide vanes are in the full open position. Both the engine and the aircraft manufacturers commented that the out-of-limits condition existed at a point where the inlet guide vanes would already be fully open and, therefore, would have no effect on engine power at takeoff. At takeoff power, the fuel flow regulator condition would result in a slight thrust increase above normal.

Oil Analysis

The oil sample recovered from the oil filter housing of the right engine was analysed by National Research Council Canada (NRC). The analysis showed the oil to be typical of synthetic ester-type aviation turbine oil. Approximately 75 mg of particulate material was filtered from the 75 mL sample. The material was identified as mostly silicious matter plus a few fibres and bits of vegetation. The sample did not include any other type of contamination, and there was no indication that the oil had been subjected to undue oxidation.

Fuel Analysis
Fuel samples were collected from the fuel delivery vehicles in Dryden (Jet B) and Thunder Bay (Jet A), and a small sample was recovered from a fuel line on the right engine. The samples were analysed at the NRC.

The Jet B and Jet A samples were clear, water white, and contained no visible free water, suspended matter, or sediment. The Jet B sample contained 0.13 and the Jet A sample 0.31 mg/L of particulate matter; the maximum allowable particulate matter at time of delivery to an aircraft is 0.44 mg/L. Both samples met all the specification requirements for which they were analysed, including the distillation characteristics.

Metal Spatter Analysis and Engine Power
Samples of the metal spatter deposited on the turbine blades of each engine were collected. Dr Kenneth Pickwick, CASB's chief of physical analysis, examined the samples at the CASB laboratory in Ottawa, using a scanning electron microscope and subjecting the samples to energy-dispersive X-ray analysis. Dr Pickwick has a doctorate in metallurgy from the University of Manchester. He served two years as a postdoctoral fellow in the NRC's applied chemistry division before joining CASB.

CASB's physical analysis section is charged with two general areas of concern: fractographic analysis, the examination of fracture surfaces with a view to determining modes of failure and causes of failure, for which electron optic machines are used; and the determination of the chemical compositions of materials, for which a full range of X-ray spectrometric equipment is used. The spatter material from the blades was found to be the same aluminum alloy used in the LP compressor blades.

It has been the experience of the manufacturer, Rolls-Royce, that extensive diffusion within the limited time available during engine failure from ground contact can occur only if the turbine's operating temperatures are sufficient to sustain the aluminum-based component of the spatter in the molten state. The blade material has solidus and liquidus temperatures of 549 and 638°C, respectively. Thus, over an operating range of 550 to 640°C, some proportion of liquid aluminum would be present in the spattered deposits.

During the developmental stage of this engine type, the manufacturer conducted thermal-indicator paint studies of the temperature distribution in various locations of the turbine assembly of the engine. The paint used is colour sensitive to temperature and duration at temperature. These studies indicated that the temperature of the LP2 turbine, especially on the midspan range of the turbine blades, approached and exceeded the range of 550 to 640°C for all engine operating levels above cruise power. The temperatures existing in the LP turbine areas of both engines during the failure sequence were sufficient to allow aluminum diffusion into the blade surfaces (that is, they were in the 550–640°C range). Accordingly, it can be concluded that both engines were operating at or above the cruise power range at the time of failure of the LP compressor blades.

During Dr Pickwick's testimony it was pointed out that there were some variables which the investigators did not take into account in their temperature and power determinations:

1 All 20 burners on these engines were out of specification.
2 The combined flow rates from 16 of the 20 engine fuel nozzles were out of specification.
3 Two of the engine burners were leaking at 1500 pounds per square inch (psi).
4 Some of the fuel nozzles exhibited very streaky spray patterns.
5 The fuel nozzles from the burners were very heavily sooted.
6 Jet B fuel may burn at a different temperature from Jet A fuel. (The fuel in C-FONF was a mixture of Jet A and Jet B, and the manufacturer used Jet A during the temperature tests.)
7 The fuel/air mixture of the engines is affected by the sooted fuel nozzles.
8 An engine malfunction such as a compressor stall may have affected engine power.

Dr Pickwick agreed in testimony that, in determining the power level of the engines, he had assumed the engines were functioning properly just prior to the time that the metal diffusion occurred. His conclusions were based on the premise that none of the variables mentioned above would affect the evaluation of the engines. At the end of his testimony, Dr Pickwick agreed that, to the best of his knowledge, the temperatures were consistent with cruise power or better at the time of the incident.

Mr Clay commented in his testimony on the variables mentioned above. He was contracted by the Commission to participate in this investigation as an independent engine analyst who would provide another opinion about the engines of C-FONF. He is a fellow of the Institution of Mechanical Engineers, a fellow of the Institution of Production Engineers, and a member of the Royal Aeronautical Society; while he resided in Quebec, he was a member of the Corporation of Professional Engineers of that province. Mr Clay started working at Rolls-Royce, United Kingdom, in 1943, at the same time studying at the College of Technology in Darby. Graduating in 1949, he continued his postgraduate studies for about another 10 years while working with Rolls-Royce, where he trained in all aspects of engine repair and overhaul. Throughout his career with Rolls-Royce, Mr Clay specialized in engine design, development, manufacturing, and product support. At the time of his retirement from Rolls-Royce in 1982, Mr Clay was working in Montreal as the director of product support responsible for Rolls-Royce products in service in Canada, the United States, Central America, and Venezuela. He has been involved as an investigator in other aircraft accidents where Rolls-Royce engines powered the aircraft and where engine teardowns were required.

Mr Clay provided insight into the variables mentioned above. Variables 1, 2, 5, and 7 pertain to the nozzles. Mr Clay's evidence was that the noted variations in the nozzles would have no effect on engine operation. The fuel control system is flow sensitive, and the fuel flow regulator ensures that the proper flow is achieved for a set (requested) engine condition by varying the fuel pressure to the nozzles. Mr Clay also stated that he "wouldn't expect, on flows and angles, any burners [nozzles] taken from service to differ to these" (Transcript, vol. 62, p. 15). In response to a question regarding the nozzles, Mr Clay stated:

> A. ...The condition of these fuel nozzles was such that it would not have had any effect on combustion. The fact that they are outside the new or fully overhauled limits, those limits are established to ensure that, with the normal deterioration and sooting which occurs throughout the life of the engine, they will still be serviceable, not new, but they will still be serviceable at the end of that life.
>
> (Transcript, vol. 62, p. 63)

Regarding variable 3, the normal combined flow-nozzle operating pressure is 500 psi. Mr Clay placed no significance on the fact that two of the nozzles leaked slightly, at 1500 psi.

Variable 4 pertains to the nozzles and the primary fuel flow. The primary flow is active alone (that is, not in conjunction with secondary flow) only during engine startup to approximately 20 per cent N_2. Above 20 per cent N_2, there is both primary and secondary fuel flow. In Mr Clay's view, there was no significance in the fact that the flow was streaky.

Regarding variable 6, Mr Clay could not even conceive that the type of fuel being burned in the engine would make any difference, even going outside the range of normal fuels. There is virtually no difference in calorific value among fuels variously called Jet A, Jet B, JP1, JP4, Avtur, or Avtag.

In a letter dated December 1989, the powerplants chairman, Mr Bajada, requested information from Rolls-Royce regarding compressor stalls. Among several questions, he asked whether, during compressor stall or air disruption as may have been encountered while the aircraft was going through the trees, the LP2 blade temperature rises. Rolls-Royce replied:

> During compressor stall or air disruption a rise in turbine gas temperature can occur. The effect of this on the L.P.2 turbine blades, however, is not immediate and depends on the duration of the temperature increase. Small increases in gas temperature over a few seconds do not necessarily result in an increase in L.P.2 blade temperature. If the increase in gas temperature is maintained, this will, of course, produce an increase in the temperature of the L.P.2 blades.
>
> (Exhibit 452, appendix Q)

Mr Bajada also asked Rolls-Royce whether, in the event of compressor stall or air disruption, the airflow within the engine is sufficient to carry the aluminum material to diffusion on the LP2 blades. Rolls-Royce responded:

> During a compressor stall condition air continues to flow through the engine and would therefore be capable of carrying pieces of aluminium debris to the L.P.2 blades.
>
> A compressor stall we define as an unstable airflow in some of the stages.
>
> (Ibid.)

Engine Assessment by Rolls-Royce

The engines were disassembled and examined, under the control of CASB, at the Rolls-Royce (Canada) facility during the period April 24–28, 1989. Rolls-Royce engine experts personally provided technical assistance as required. A report was compiled by Rolls-Royce to record the condition of both engines at disassembly. The conclusions drawn in the report are as follows:

> 2.0 CONCLUSIONS
>
> 2.1 Examination of Spey Mark 555-15 Engine Numbers 9130 and 9187 at Rolls-Royce (Canada) Ltd, revealed no evidence of a pre-impact mechanical failure or malfunction.
>
> 2.2 Examination and testing of accessory units from both engines revealed no evidence of any malfunction or mechanical failure which could have affected engine operation.
>
> (Exhibit 504, p. 2)

Engine Assessment by Mr Peter Clay

Mr Peter Clay, the independent engine consultant, visited the CASB engineering laboratory, where he viewed the disassembled engines and related data and talked to CASB staff. Drawing on his observations and knowledge, he came to the following conclusions, which are taken from both his testimony and his report for the Commission (Exhibit 466).

1 There was no evidence of any failure or unserviceability being present prior to initial ingestion/impact.
2 All damage observed was consequent upon foreign-object ingestion and tree and ground impact.
3 The low-pressure compressor damage resulted from ingestion and impact of and with trees, aircraft material, and the ground.
4 There was no evidence to suggest any impediment to achievement of the full power range of the engines. In fact, the evidence supports the fact that the engines were at high power beyond the points of debris ingestion and through to major external impact.
5 The anti-icing systems on both engines were operating beyond the point of initial foliage ingestion. Since the valving was fully operational on post-accident bench test, it is correct to conclude the system was operating throughout.
6 The material temperatures in the later stages of the high-pressure compressor of the right engine were of the order of 400°C at the time of final impact and cessation of engine rotation. These HP compressor components would be in the 400°C temperature range with the engine at takeoff power at the ambients present at the time of the accident. This conclusion is evidenced by sooting, and by the form and texture of the sooting, found on these components.
7 All oil and fuel filters and oil scavenge strainers were clean. The magnetic plugs sampling the total oil system had the usual minor amounts of sludge around their periphery, with no trace of metal particles. All bearings, air and oil seals, and oil passages were in good condition.

Mr Clay in his report also commented on the diffusion of aluminum throughout the turbines of both engines, the position of the bleed valves, and the anti-ice selection. His conclusions are summarized below:

1 Examination of sections taken from the LP2 turbine blades from both engines reveals the initiation of grain-boundary penetration of molten aluminum into the Nimonic of the blade, in the active area with the aluminum coating. This evidence confirms that the aluminum remained molten and that the host blade remained at a suitable temperature to promote the conditions found. For the turbine to be at this temperature requires a high engine-power setting. It is clear from this evidence that both engines were operating at high power when material from the LP compressors was in the system (following the initial impact and ingestion, which caused the release of such material). Penetration and diffusion were more advanced on the right engine because, although the blade temperatures at onset were comparable, the operating time was less on the left engine.

2 Debris deposited on the bleed-valve quill shafts established that the bleed valves were closed, as they ought to be at the higher operating condition (high power).

3 The engine anti-icing system was free and clear and capable of operation, and the valves were operative on bench check. That the system was operating at the time of ingestion/impact is evidenced by the presence of pine needles and other foliage debris in the piping, in the nose fairing (the bullet), and in the nose cowl. The nose fairing on either engine had not been penetrated by external impact; therefore, since the nose-cowl flow is downstream of the fairing, the debris had to come through the system.

Engine Sounds at Takeoff from Dryden

Witness Description Witnesses who were in the aircraft or on the ground described their recollections of the sounds of the engines during the takeoff roll at Dryden and while the aircraft was airborne.

Mr Norbert Altmann, a commercial pilot, was in the terminal building and saw the aircraft near the departure end of runway 29. He was walking through the terminal building and heard a "muffled roar" of the engines of the F-28 on the takeoff roll (Transcript, vol. 22, p. 189).

Mr David Berezuk, a Dash-8 captain with Air Ontario, was seated in 12A. He described the power application as "smooth," without any "unusual engine noises," as the aircraft accelerated down the runway (Transcript, vol. 14, pp. 82, 86).

Mr John Biro is a retired RCAF technician and was seated in 11E. He did not recall anything unusual about the sound of the engines at any time or any sense of power-on or power-off during rotation. He did remember "quite clearly that the right engine ... was just above and behind" where he was sitting, and "the sound from it didn't change at all" until the aircraft "started hitting the trees" (Transcript, vol. 21, p. 54).

Mr Craig Brown is a commercial pilot and was on the east side of the terminal ramp. To him, the engines "sounded normal. The engines powered up, and there was nothing that I noticed or took note of" (Transcript, vol. 5, p. 245).

Mr Ricardo Campbell was seated in 7D. He heard no change in engine noise, "just loud jets, full force of a jet, now loud and fast ... I heard it." He did not hear "anything unusual" about the engine sound coming out of Dryden (Transcript, vol. 17, pp. 52, 94).

Mr Vaughan Cochrane was the general manager of the Dryden Flight Centre and is a pilot. He was on the tarmac by the fuel cabinets. During the takeoff, he was looking directly at the aircraft. He did not hear "anything at all unusual about the engine noise" (Transcript, vol. 53, p. 237).

Mr Donald Crawshaw was seated in 13B. During the initial part of the takeoff roll there was nothing unusual that caught his attention. However, on rotation the aircraft "just seemed to lose a little bit of power – or a lot of power, actually, and it came back down, and power was again put to the engines, it went back up a little bit, then came back down again" (Transcript, vol. 17, p. 308). He noted that "where we were sitting was right by the left engine, and, on our – on the initial takeoff, it was whining pretty good like one of those engines do, and then there was nothing and the plane flattened out. And then there was a lot of power put back to it again" (ibid.). Mr Crawshaw equated the sound as the aircraft was rolling down the runway to that of "a DC-9" (Transcript, vol. 17, p. 319). The aircraft was in the air when the decrease and increase in sound occurred.

Mr James Esh worked for Dryden Air Services as a baggage handler and is also a private pilot. At the time of the accident he was near the fuel cabinets. He did not describe the engine sounds he may have heard as the aircraft was taking off, but he stated that, as the aircraft disappeared behind the trees, he heard the engines "still screaming away" with no unusual noises (Transcript, vol. 24, p. 204).

Mr Jerry Fillier worked for Dryden Flight Centre and was by the fuel cabinets. He observed the takeoff run but did not hear "any unusual sounds coming from the engines" (Transcript, vol. 25, p. 46).

Mr Michael Gatto was seated in 11A. To Mr Gatto, the engines sounded sluggish as the aircraft proceeded down the runway. They did not have that high-pitched sound. He recalled the high-pitched sound as the aircraft took off at Thunder Bay, but in Dryden that sound was not there. "It just didn't feel that they had full steam. It didn't feel like it was going to its full max" (Transcript, vol. 13, p. 128).

Mr Raymond Gibbs is a commercial pilot and was in the airport manager's office. He neither saw nor heard anything unusual as the aircraft took off. He heard the engine noise, and it "sounded like a typical jet engine" (Transcript, vol. 23, p. 39).

Mr Daniel Godin was seated in 9B. He heard nothing abnormal and remembered hearing "the engines seemingly at full power with no noises" that would have been alarming to him. He also "distinctly remember[ed]" the engines running while the aircraft was in the crash sequence (Transcript, vol. 17, pp. 189, 193).

Mr Murray Haines, a DC-9 captain with Air Canada, was seated in 13D, between the engines. To him, the engines were "running perfectly," and they "both made a lot of noise." Based on his experience flying jets, "those engines sounded good" (Transcript, vol. 19, p. 39).

Mr Thomas Harris was seated in 8A. To Mr Harris, everything appeared to be normal until about half to three-quarters of the way down the runway, when he heard what appeared to be "a momentary change in pitch of the engines," which he likened to "a throttle-off, throttle-on instantaneous type engine noise" (Transcript, vol. 12, p. 173).

Mrs Sonia Hartwick, a flight attendant on the flight, was seated in 8D. She heard "nothing" that she "noticed that was unusual" during the takeoff (Transcript, vol. 10, p. 238).

Mr Roscoe Hodgins is a commercial pilot who observed the F-28 take off while he was standing near the Ministry of Natural Resources building. He described the acceleration of the aircraft as slow, and

> A. ...as the engines spooled up and came up to full throttle, there wasn't a steady whine or crackling noise of a jet engine.
>
> Normally on jet engines, any that I have heard, have a steady whine or swish to them, a high-pitched, ear-piercing noise. This had an intermittent burping noise to it which was happening maybe every three to four seconds.
>
> (Transcript, vol. 22, p. 144)

According to Mr Hodgins, the intermittent burping noise came at regular intervals and continued throughout the takeoff sequence. At rotation, the engine noise seemed to die off, which Mr Hodgins attributed to the fact that the jet blast was pointed down at the runway; however, as the aircraft started to fly, he could again hear the intermittent burping noise. Mr Hodgins had observed the F-28 take off from Dryden approximately 12 to 15 times in the two-and-one-half weeks prior to the crash. At those times he heard only "the normal high-pitch scream of a jet engine" (Transcript, vol. 22, p. 146).

Mr Gary Jackson was seated in 13A. He recalled the engines being powered up, and they sounded normal. He stated that there was "a slight wavering to the pitch, but that's all" (Transcript, vol. 16, p. 144). When the aircraft was at about 15 or 20 feet, he then heard what he thought was "extra power going to the engines. They increased in intensity, and we got a little bit more altitude" (Transcript, vol. 16, p. 132).

Mr Stanley Kruger, the crew chief of the Dryden crash fire rescue unit, was in a fire truck near the fire hall. He did not hear "anything unusual about the sounds of the engines" during the takeoff of the aircraft (Transcript, vol. 27, p. 67).

Mr Peter Louttit, the Dryden Municipal Airport manager, was in his office in the terminal; he is a former military pilot with about one thousand hours' experience flying the CF-100 jet aircraft. He saw the aircraft for a very short time during its takeoff, his impressions gained as it went by the intersection of taxiway Alpha and the runway. When he observed the aircraft, it was at a point on the runway where, in Mr Louttit's opinion, the aircraft would normally already have been airborne. The aircraft was in a rotated attitude, with the main wheels still on the runway. When Mr Louttit saw the aircraft, its sound caught his attention. He described the sound as

> A. ... an intake noise. It was not the exhaust noise. The jet engine has an intake noise when it is approaching. It has an exhaust noise when it is going away. And it was an intake noise that I heard and it was a descending noise.
> ... It was quite – quite a sharp noise, explosive I guess would be a good word for the description of it.
> (Transcript, vol. 5, p. 23)

To Mr Louttit, the noise meant a malfunction in the engine, probably a flame-out, which is an engine failure. (He has experienced a flame-out while flying the CF-100 aircraft.) Mr Louttit stated that the noise was "very quick. It came, it went to high pitch, and was gone" (Transcript, vol. 5, p. 44).

Mr Ronald Mandich, of Green Bay, Wisconsin, who holds a master's degree in mechanical engineering from the Massachusetts Institute of Technology, was seated in 8C. He has a work history with Hughes Aircraft, involving the management of flight test programs and vibration testing. He testified that he has done extensive work in vibration analysis and testing. His evidence was that the aircraft left the runway and came back down. When the wheels hit the runway he noticed that, assuming both engines were going the same speed initially, the sound of one of the engines "decreased in pitch ... about a half an octave ... about four, five, six times." Just before the aircraft left the runway the second time, he heard the pitch of both engines "increase somewhere between 3 to 5 per cent, as if someone in the cockpit had advanced the thrust levers" (Transcript, vol. 17, p. 358). The engine noise that he heard was definitely not a "synchronization" noise; it was a "step function ... not a beat frequency phenomenon" (Transcript, vol. 17, pp. 375–76).

Mr Richard Waller was seated in 3D. Compared with the sound of the engines during takeoff from Thunder Bay, at Dryden the engines had a higher-pitched sound, "as if he had more throttle to the engines ... the engines were very, very loud, as if they were at full throttle" (Transcript, vol. 18, p. 149).

The following is a summary of the witness testimony regarding engine sounds. Of the 21 people who discussed engine sounds during testimony, 14 said that the engines sounded normal, were screaming away, were running perfectly, or that there was nothing unusual in the sound. The 7 other witnesses gave inconsistent testimony regarding the sounds of the engines. Two of these thought the engines were operating normally, and one described a musical step-function sound; these three witnesses then heard power being added as or after the aircraft became airborne. Another thought the engines sounded sluggish and did not have full power; another described the sound as if the throttles had been moved instantaneously off then on, three-quarters of the way down the runway; another thought the engines were not making the normal steady whine or crackling noise of a jet and made burping sounds from the start of the takeoff until becoming airborne; and another heard a sharp, explosive noise like the sound of an engine flame-out as the aircraft passed taxiway Alpha: the noise came, went to a high pitch, then was gone.

Analysis of Engine Sounds Investigators who had examined the engines after the crash testified with respect to the question of whether the engine sounds described by the witnesses indicated possible engine malfunctions, specifically, engine compressor stall or engine flame-out.

Mr Joseph Bajada, the CASB powerplants group chairman, stated that there was no evidence of damage in the high-pressure compressor that would indicate there had been a severe compressor stall. Such evidence would include, for example, bent compressor blades, and none were found. (Compressor stalls create back pressure in the compressor area, which causes the blades to bend.) As well, Mr Bajada found no evidence from his examination of the engines of a flame-out having occurred on the takeoff roll.

Mr Bajada agreed that there can be "less severe" compressor stalls that do not damage the engines, but said these will result in bangs, or "a series of bangs," as the compressor stall goes through the engine (Transcript, vol. 60, pp. 143, 144).

Mr Bajada stated that he had reviewed testimony of a few witnesses with regard to the abnormal engine sounds they heard and discussed with Rolls-Royce personnel these sounds and their possible origins. Neither Mr Bajada nor Rolls-Royce could come to any conclusions over the source or cause of the abnormal sounds.

Mr Clay, the independent engine consultant, discussed the evidence that would have indicated a compressor stall had occurred. He stated that if there had been a very severe compressor stall, then, as the offloading and onloading of the HP compressor blades occurred, there would likely have been a "woof" sound. A severe compressor stall would also result in physical evidence, namely contact between the rotating blades and the static blades, since the blades, during onloading and offloading pressures, moved forward and rearward as they rotated. During his examination of both engines, Mr Clay did not find any such physical evidence in the HP compressor section.

Mr Clay commented on the engine sounds described by Mr Mandich. Mr Clay's theory was that when the pilot tried to rotate the aircraft, he found he was unable to do so, and the "first normal self-preservation reaction was to firewall the engine or engines" (Transcript, vol. 62, p. 27). To Mr Clay, this meant pushing the throttles forward just as fast as the pilot possibly could.

During cross-examination, Mr Clay stated that it is possible to have a compressor stall occur without any evidence being left within the engine. He also stated that if the stall is so minor as to leave no physical evidence, it is doubtful there would be any loss of power.

When questioned about whether the ingestion of ice, slush, or water into an engine could possibly cause a compressor stall, Mr Clay replied: "In sufficient quantity." He further described "sufficient quantity" as an "alarming amount." He explained that Rolls-Royce does tests where fire hoses are directed full bore into intakes of engines, and "all kinds of things" are shovelled into the engines. He was quite proud to say that "Rolls-Royce probably has the best record on their engines of exceeding all regulations in that regard" (Transcript, vol. 62, p. 55). In summary, the engine experts could give no explanation for the engine sounds heard by the witnesses, except for the sound of an increase in power at or after liftoff. It would be a natural reaction for the pilots to advance the throttles to maximum when it became apparent the aircraft was not flying properly.

Apart from the abnormal sounds described by some witnesses, there is no evidence that the engines were not operating normally throughout the takeoff and flight. Indications that the engines were operating normally are as follows: the flight crew did not reject the takeoff, so it can be assumed that the engine indications as seen and heard in the cockpit were normal up to the time the aircraft reached V_1 (the takeoff-decision speed); as demonstrated in the performance analysis, both engines had to have been operating to achieve the flight profile flown; and the physical examination and tests conducted on the engines and accessories did not reveal any reason why the engines could not have produced full power up to the time they started ingesting tree material. Although some witnesses heard abnormal engine sounds, it is considered that the conditions which produced those sounds were transient and did not affect the performance of the engines.

Engine Smoke on Startup at Winnipeg

Description of Occurrence On March 8, 1989, an Air Canada ground handler, Mr William O'Connell, worked on the turnaround of an Air Ontario F-28 aircraft in Winnipeg and observed the startup of the engines when the aircraft was ready to depart. According to his testimony, the engines were started using the aircraft's auxiliary power unit. The number 2 (right) engine was started first, and it was a normal start. When the number 1 (left) engine was started, "excessive black smoke" came from the rear of that engine for a "good five minutes" before the engine stabilized (the smoke stopped) (Transcript, vol. 58, p. 55). The captain "opened the cockpit window and looked back at that number 1 engine at least three times" (ibid.). The wind was from the left, perpendicular to the aircraft fuselage. After the left engine stopped smoking, the aircraft taxied out for takeoff.

During the start, Mr O'Connell gave no signs to the crew to indicate that the engine was smoking; he was certain they were aware of the problem. Mr O'Connell described a "wet start" as a blast of flames out of the engine tailpipe that lasts only a few seconds, and he stated that what he saw was not a wet start. He described the smoke as being four or five times the normal volume one would get from an F-28 engine, and, although he had been working around jet aircraft for 21 years and had seen thousands of engine starts, he had never seen anything like this from a jet engine. Mr O'Connell did not know the registration of the aircraft, but it was later shown to have been C-FONF.

Analysis of the Engine Smoke The engine experts were asked to comment about why the engine smoked during startup.

Mr Bajada, the CASB powerplants group chairman, stated that, based on his experience with jet engines, he could not come to any conclusion as to why the smoke to which Mr O'Connell attested would have appeared. Mr Bajada talked to Rolls-Royce many times about the smoke, and the company could not provide an answer either. Mr Bajada did say that fuel pooling could cause "a little bit of black smoke on startup" (Transcript, vol. 60, p. 139), but he knew of no other reason for a jet to produce black smoke. Mr Clay, the independent engine consultant, stated:

> A. With no action in between and, as I say, 12 to probably, I don't know, 12 to 14 starts satisfactory subsequently, if indeed the black smoke occurred, then a possible explanation is that the start sequence, for whatever reason, either human or mechanically or any other reason was not followed; such that he would get an overage start which, traditionally, on all kinds of engines creates a black smoke or a very dark smoke with the potential for some yellow flame, which is incomplete combustion where you have more fuel or you either have more fuel or less air ... it is the only explanation that I can arrive at on this particular system.
>
> I am somewhat incredulous – in fact, not somewhat, I am totally incredulous, with due respect, to the five minutes. In some training that I do, I ask people to understand ten seconds

> and so frequently they think it is five minutes. It depends on the circumstances as to your understanding of time.
>
> But I am also encouraged in this interpretation by the fact that although ... I believe, the captain on that particular occasion in the left-hand seat was reputed to have looked out three times, which in and of itself is most unusual, has no recollection of this occurrence.
>
> (Transcript, vol. 62, pp. 29–30)

Mr O'Connell's description is the only known report of an engine of the F-28 emitting an unusual amount of smoke during startup. The incident was not reported by the pilot, who, when questioned on the matter by Commission investigators, did not recall it. Engine experts could give no explanation as to why a jet engine would smoke for five minutes during startup. At times, jet engines will smoke for a few seconds during startup because of fuel pooling or incorrect startup procedures. It is considered that this incident was, at best, an isolated case and had no bearing on the serviceability of the engines and, therefore, no bearing on the accident.

Evaluation of Engine Condition

There was no material evidence of any pre-impact malfunction or failure of either engine. The left engine sustained impact damage because it struck the ground; the right engine did not strike the ground and did not sustain impact damage. Both engines exhibited similar foreign-object damage related to ingestion of tree material, and both engines exhibited similar metal spatter on internal components in the air path. This evidence indicates that the engines were subjected to approximately the same conditions at approximately the same power level during the descent into the trees.

Engine Power It was concluded by the investigators and engine experts that the engines were capable of producing full power beyond the point at which they started ingesting tree material. Indicators used by the investigators to determine the amount of power being produced by the engines are as follows:

1 The crew did not reject the takeoff. This indicates that takeoff power had been achieved and was sustained until the aircraft reached at least V_1 speed.

2 When the engines were ingesting vegetation, the bleed valves in the engines were closed, as is the case when an engine is operating at high power.

3 The metal spatter indicated, if one assumes the engines were operating normally when the compressors started to break up, that the engines were operating at or above cruise power.
4 The material temperatures in the later stages of the right engine's HP compressor were, at the time of final impact, approximately 400°C, which is the temperature of the compressor with the engine at takeoff power.
5 Although some witnesses said the engines were screaming away, or were very, very loud, or were increased to full power, none of the witnesses suggested that the engines were operating in an abnormal manner after the aircraft was airborne.

It is concluded that the engines were operating at normal takeoff power until the aircraft became airborne. After the aircraft became airborne, it is probable that the power was increased to full power.

Engine Anti-Ice The engine anti-ice valves, found in the closed position, were not damaged, and limited tests showed no faults with the valves. These valves are held open by electric solenoids when the valves are selected OPEN and if there is air pressure on the valve. When either electric power or air pressure is not available, the valves close. During the crash, the valves would have gone to the closed position; therefore, the position of the valves in flight could not be determined from an examination of the valves. From examination of the mechanical components of the system, it could not be determined whether the system was on or off. However, the presence of minute particles of organic material in the anti-ice ducting of each engine suggests that the anti-ice valves were open and that the system, therefore, was selected ON. The engine anti-ice system should have been selected ON for takeoff in the weather and airport conditions that existed at the time of the takeoff.

Auxiliary Power Unit

The F-28 aircraft is equipped with a gas turbine engine that drives a generator and a hydraulic pump. The complete unit, called an auxiliary power unit (APU), enables some aircraft systems to operate independently of ground-power sources. It is installed in the fuselage behind the rear pressure bulkhead. On the ground, the APU can provide all electrical power to all of the aircraft electrical systems and can supply air for the air-conditioning system and for engine starting. In flight, the APU can be used as a stand-by power source in the event of failure of one or both of the main engine generators.

There is a fire-detection and protection system within the enclosure for the APU. The system is automatic in that if it detects an overheat condition, it will activate the warning system, shut down the APU, and discharge its fire extinguisher. The shutdown of the APU and the firing of the extinguisher can also be accomplished by operating a manual switch in the centre of the glareshield panel. The system can be checked by operating the TEST/RESET switch on the secondary instrument panel.

The APU on C-FONF was not used on the day of the accident because the APU fire-detection circuit did not test satisfactorily. The applicable journey log entry of March 9, 1989, was, "APU will not fire test – Deferred as per MEL 49.04 – Licence ACA 87101" (Exhibit 492, appendix 17). The APU was placarded as inoperative and a main engine had to be kept running while the aircraft was on the ground in Dryden. The cause of the unsatisfactory test had not been determined prior to the accident. After the accident, there was too much crash and fire damage to the aircraft to allow the cause to be determined. The only part of the fire-detection system that remained was the fire-detection loop, housed within the APU container. A continuity check of the sensing loop found it acceptable.

The APU was sent to the manufacturer, Garrett (auxiliary power division), in Phoenix, Arizona, to verify that the unit was in an operable condition and to confirm the reported low bleed pressure during main engine start. Entries had been made in the journey log on March 4, 1989 (air pressure only 14 psi), and on March 9, 1989 (three entries: APU air pressure low, engine starts becoming more and more difficult, APU load control valve u/s), indicating that the APU was not providing adequate air pressure during start.

The APU was visually examined under the supervision of a CASB investigator. There were no abnormalities noted, except that an O-ring on the starter mounting flange was damaged; it had been damaged during removal of the APU from the aircraft. The O-ring was replaced, and the APU was started. The APU accelerated normally to the "no load" operating speed; however, the oil pressure slowly decreased until it stabilized at 30 to 35 psi. The minimum operating pressure is 70 psi, but Garrett elected to continue operating the unit to obtain a performance calibration.

On initial testing, the APU speed dropped excessively when under load, the cause of which was determined to be a malfunctioning fuel control unit. The reported low bleed pressure from the APU was exacerbated by the excessive speed drop. The fuel control unit was replaced, and the APU performance was acceptable in all respects for a unit that was in operational use.

During testing, it was discovered that the APU exhaust overtemperature thermostat either was not functioning or was misadjusted on the unit as tested. Since the malfunctioning of the thermostat did not affect the output of the APU, no troubleshooting was conducted. The oil-pressure regulator was disassembled and inspected, and the setting of the low–oil-pressure switch was verified; the cause of the low oil pressure was not determined.

Systems

The post-crash fire destroyed major portions of the aircraft, including parts of many of the aircraft systems. In general, most of the mechanical items, such as control valves and actuators, survived with limited damage, but almost all the electrical systems and electronic controls located in the area commonly called the radio bay and in the cockpit were severely burned. Although crash and fire damage precluded determining the complete state of serviceability of the aircraft, it should be noted both that critical systems are designed to be fail safe in the event of failure and that there are redundant mechanical systems.

Hydraulic System

Hydraulic power comes from two separate systems, identified in the cockpit as Utility System 1 and Flight Control System 2. Each system is identical to the other in concept and performance; they differ only in capacity, subsystems supplied, and component location. Utility System 1 supplies power to the elevator, horizontal stabilizer, left aileron, rudder, flaps, lift-dumpers, speed brakes, landing gear, normal brakes, and nose-wheel steering. Flight Control System 2 supplies power to the elevator, horizontal stabilizer, right aileron, rudder, and alternate brakes. During flight, both systems operate at 3000 psi at varying flow rates, depending on the demand for services. Each system has two engine-driven pumps and one electrically driven pump (used for maintenance only). Cockpit controls and indicators are located on the secondary instrument panel.

Reservoirs for both systems are located in the rear fuselage section immediately behind the rear pressure bulkhead. The reservoirs were undamaged but were depleted of fluid because of the rupture of the hydraulic lines during the crash.

The connector caps on the hydraulic system ground-service panel were in place, and the fluid-quantity test switch was in the proper off position. Flight-deck indicators and controls were extensively damaged, and determinations of readings and selections could not be made.

The four engine-driven hydraulic pumps were recovered in good condition, were tested, and were found to be serviceable. The electric hydraulic pumps appeared to be in good condition but were not tested since they are not used in flight operations. The four hydraulic shutoff valves were found in the open position. These valves can be shut off from the cockpit to isolate parts of the hydraulic system in case of fire or malfunction.

The return-line filters were undamaged, and the bypass indicators were in the normal position. Under microscopic examination, an insignificant quantity of solid contaminant was observed on the filter surfaces. Hydraulic-fluid analysis revealed no fault with the fluid.

The redundancies in the hydraulic systems are such that multiple failures would have to occur to affect the operation of the aircraft systems significantly. Although major sections of the hydraulics were destroyed in the crash and fire, examination and testing of the available items provided a good indication that the total system was serviceable.

Landing-Gear System

The landing gear is a tricycle configuration, with the main gear retracting inward and the nose wheel retracting forward. There are two wheel assemblies on each landing-gear strut.

At the crash site, the left main gear was found in the down-and-locked position. The right main gear was partially retracted, and, when the fuselage was lifted during recovery, the right gear dropped to the down-and-locked position. The landing-gear doors were found at the start of the main wreckage trail. The leading edges of the main gear inboard doors showed signs of tree strikes, which indicates that the doors were open when the aircraft was contacting trees. These doors are closed when the landing gear is fully down or fully up, and the doors are open when the landing gear is in transit. The nose gear was found to be near the up position, but the uplock was not engaged.

The landing-gear–selector handle in the cockpit was found in the up position, but the position of its associated valve could not be determined.

The main landing-gear–selector valve, which is located in the hydraulic tunnel in the aircraft, was moderately fire damaged but generally intact. There is a slide within the valve that moves to either of its full travel positions, depending on whether an up or down landing-gear selection is made. The slide is held in the full travel position by the action of two spring-loaded balls. The position of the slide as found equates to an UP selection.

The forward actuator for the left main gear-door was broken away from the aircraft structure at the cylinder-end fitting. Internal examination showed marks on the cylinder wall caused by heavy side-loading of the piston while the actuator was in the fully extended position.

Examination and testing of the landing-gear system and components did not reveal any pre-impact faults.

The fact that the landing-gear–selector handle was found in the up position supports the conclusion that the gear was selected UP, and there is additional evidence for such a conclusion. As well, the lever could have been moved to the up position by the loads placed on the gear-selection linkage during the breakup of the aircraft. The most definitive evidence showing that the gear had been selected UP was the position of the slide in the main gear-selector valve. The design of the ball and detent system is such that the position of the slide should not be affected by crash forces. Accordingly, it is concluded that the gear was moving to the up position at the time of the accident.

Wheels and Wheel-Brake System

The tread on the four main tires was good, and there were no flat spots or evidence of hydroplaning. The wheels showed no signs of overheating, and the fusible plugs in the wheels were in place, with no signs of rupture. There was no evidence that any of the wheel bearings suffered rolling-element distress.

All four brake units remained intact. The right and left outboard brakes were within the in-service wear limits; however, the right and left inboard brakes were worn beyond the specified limit. The Fokker F-28 Engineer's Guide, under the heading "Wear Check for Mounted Brakes," shows a maximum dimension of 0.250 inch from the face of the outer spring-holder to the tip of the return pin, with brakes applied. Both left and right inboard brakes measured 0.290 inch but were assessed as still being operational. Although two sets of brakes were worn beyond specified limits, the CASB investigation team assessed the brakes, tires, and wheels as having been in a serviceable condition at the time of the crash.

Electrical System

The aircraft is equipped with AC- and DC-operated systems, with the electrical power, when required, supplied through electrical buses by a battery, two engine-driven AC generators, an APU-driven generator, and an AC ground-power unit (external power).

The AC bus arrangement is such that one particular bus is supplied by one electrical source at a time. In case the source becomes inoperative, the bus is automatically transferred to another source. The DC buses are supplied by transformer-rectifier units (TRUs), which in turn are supplied from the AC buses. When a TRU becomes inoperative, the DC bus can, in some cases, be transferred to another TRU. The battery is for starting the APU and, in case of an emergency, is the last source of electrical power.

The aircraft electrical system was extensively damaged by the crash and fire, and examination of the wiring and components was therefore limited. From what was found, the only evidence of malfunction in the electrical system was a fault in the left generator.

The main frame of the number 1 (left) generator was cracked, and full functional testing was not possible. Testing confirmed that the rotor windings were in good condition, although there was an open circuit in the rotating rotor assembly. Significantly, two wires from diodes to the main rotating field were broken. Fracture analysis showed that the first wire had been broken for some time; in this condition, the generator would continue to produce power but, short of providing its full-rated load, would break down. There is no indication that an abnormally high load was placed on either generator. Based on the capacity of the generator to continue to operate with one wire broken as long as there is no unusually high load placed on it, and on the fact that the analysis showed that the break was not new, it is probable that the wire was broken prior to the accident flight.

The fracture of the second wire would have resulted in output failure of the generator. The break in this wire showed evidence of arcing. Its fracture surface was not as contaminated as that of the break in the first wire, indicating a more recent failure. It is probable that this break was related to the impact forces which caused the external damage to the generator, but it cannot be stated conclusively that the wire was not broken prior to the crash.

In the event of a generator failure, the relevant GENERATOR INOPERATIVE light will illuminate, and automatic transfer of the load will take place. The operating procedures specify that should a generator fail at some point during the takeoff, no crew action is required prior to establishing a normal climb configuration. Because of redundancy in the electrical system, multiple faults are unlikely and individual faults would have no significant effect on the aircraft's operation. Therefore, it is concluded that electrical failure, even in the improbable event that it did occur, did not likely contribute to the crash.

Fuel System

The fuel system controls in the cockpit and the left-wing fuel system components were not recovered because of the fire and impact damage. The integral fuel tanks were ruptured in the crash, all of them subjected to some degree of fire damage.

The two booster pumps from the right fuel tank were recovered and tested; they operated satisfactorily. The canister shutoff valves and vent valves were open, and the tank internal plumbing in this area was in good condition. Debris found on the surface of the intake screens was typical of miscellaneous contaminants found in fuel tanks, and the quantity would not have significantly affected fuel entry to the pumps. The fuel system's left and right fire-shutoff valves were open, and both cross-feed valves were closed.

The open fire-shutoff valves and the closed cross-feed valves show that the fuel system was configured as would be a serviceable fuel system. Evidence of proper operation is reflected in the findings that both engines were running at the time of the crash and the cross-feed valves were closed.

Fire-Protection System

An independent fire-detection and protection system is installed in the aircraft for each of the left and right engines and for the APU. Each system consists of a detection system and an extinguishing system. The detection system consists of a sensing element loop in each engine nacelle and in the APU enclosure, and a warning system of lights and audible alarms in the cockpit. Three fire-extinguishing–agent containers installed in the tail section supply extinguishing agent to the two engines and the APU. There are three portable carbon dioxide fire extinguishers in the aircraft, one in the cockpit and two in the cabin, and there is one water/glycol fire extinguisher in the cabin.

The engine fire-protection–system controls in the cockpit were destroyed by the post-crash fire and were not recovered. The sensing element loops in the engine nacelles had been subjected to some impact damage but were generally in good condition, and no pre-crash faults were noted.

The three fire-extinguishing–agent containers were found intact. None of the cartridges from any container had been fired, and all of the outlet discs were intact. The left container safety disc in the thermal discharge fitting was ruptured, and the container was empty; there was evidence of exposure to the fire, but there was no significant damage to the container. The right container and the APU container were still charged with gauge readings of approximately 600 and 575 psi, respectively. It was concluded that the fire-extinguishing system had not been activated by the flight crew.

Impact and fire damage precluded testing of the fire-protection system to determine pre-crash integrity. There was no evidence of fire prior to impact.

Bleed-Air Supply System

Bleed air supplies the following systems: air-conditioning and pressurization, airfoil anti-icing, engine anti-icing, engine starting, and hydraulic reservoir pressure. The air can be supplied from the main engine compressors and, on the ground, by the APU or a pneumatic high-pressure ground-power unit.

The pneumatic system valves and ducting in the engine pylons and in the rear fuselage section were in good condition. The shutoff and pressure-regulating valves and the shutoff and pressure-modulating valves are electropneumatically operated and are spring-loaded to the closed position; all four of the valves were closed.

Ice- and Rain-Protection Systems

To prevent the buildup of ice in the main engine air intakes and on the leading edges of the wings and the horizontal and vertical stabilizers, hot compressed air from the bleed-air supply system can be directed to these areas by cockpit controls. The windshields, the sliding windows in the cockpit, the angle-of-attack vanes of the stall-protection system, the static ports, and the pitot tubes of the air data indicators are electrically heated to prevent ice accumulation. An ice-detect probe under the aircraft's nose section detects ice in flight. The aircraft is equipped with windshield wipers for operation in rain.

All the cockpit controls and indicators for these systems were destroyed in the fire. The ice-detect probe was found in relatively good condition, and both its detection and heating systems tested satisfactorily. The airspeed pitot head from the left side of the aircraft was impact damaged, but the heater circuit was still functional. The pitot head from the right side was not recovered. Both angle-of-attack sensors were recovered, but they were too severely damaged to permit an assessment of the condition of the heaters.

The wing anti-ice valve and the tail anti-ice valve were recovered in good condition. They are motorized butterfly valves, electrically operated, and both were found in the closed position. When tested, the valves operated satisfactorily; the wing valve moved from open to closed or closed to open in approximately 5 seconds, and the tail valve moved in approximately 5.7 seconds.

The finding of the wing and tail anti-ice valves closed is a good indication that the wing and tail anti-ice system was off at the time of the takeoff. As the aircraft takes off or lands, switches on the lower portion of each of the main landing-gear struts direct some aircraft systems, such as touchdown protection for the wheel brakes, landing gear anti-retraction solenoids, and the wing lift-dumpers, to operate in a specific manner. The switches are called "ground/flight switches" by Fokker Aircraft. When the aircraft is on the ground, the ground/flight switch prevents normal opening of the wing and tail anti-ice valves. Thus, if the wing and tail anti-ice system is selected ON while the aircraft is on the ground, the valves will remain closed until the aircraft becomes airborne and the switch indicates that the aircraft is in the air. The crew would then have had to assess the situation and select the system OFF. The valves would then have had to move to the closed position while there was still electrical power available. It is deemed unlikely that there would have been sufficient time for this sequence to have occurred. It is improbable as well that the valves went full closed as a result of intermittent electrical shorts during the aircraft breakup. During use, the wing and tail anti-ice system bleeds air from the engine compressors, a process that results in a significant engine performance penalty; therefore, the wing and tail anti-ice system is not used during takeoff. This penalty would be felt just as the aircraft becomes airborne. To open the wing and tail anti-ice valves while the aircraft is on the ground, a test switch located behind the co-pilot's seat must be positioned to ANTI. IC. L.G. OVERR. (anti-ice landing-gear override) and held there. When the switch is released, the valves are powered to the closed position.

Air-Conditioning System

The air-conditioning system control panel and the right-side refrigeration unit were destroyed in the post-crash fire. The left-side refrigeration unit, which supplies conditioned air to the cockpit, sustained some impact damage but was untouched by fire and remained relatively intact. Although the unit could not be tested, visual examination revealed it to be in relatively good condition.

Instrument Systems

The left-side (captain's) flight instruments were almost completely destroyed by fire. The engine instruments and the right-side (first officer's) instruments were relatively intact, but many of the instruments had returned to a zero reading with the loss of input signal. The impact damage had not been severe enough to freeze pointers in position, to capture any pointer imprints, or to damage any of the gear trains; thus, reliable indications of the instrument readings at impact could not be obtained from a study of the impact damage.

Examination of the instruments revealed the following:

1 The right-side airspeed indicator "bug" was set at 132 knots indicates the calculated V_1 speed.
2 The left- and right-engine thrust-meter index displays, which indicate the calculated power settings for setting takeoff power, were both set to a value of 166.
3 The left and right fuel-quantity indicators were reading 5400 and 6950 pounds, respectively. The difference may have been as the result of the loss of fuel from the left wing, which was breaking up during the crash; the gauge was reflecting the loss until electrical power was lost to the gauge.

4 The left and right fuel-consumed indicators were reading 2078 and 2091 pounds, respectively. It was reasoned that, for the numbers to make sense, the gauges had last been reset to zero at Thunder Bay.
5 The left and right fuel load–limit indicators, normally located in the refuelling access area on the underside of the right wing, were set to 7200 and 6800 pounds, respectively. These numbers would normally be the same. On the right instrument, the set knob was somewhat displaced from the needle, which could account for the difference in the settings.

The static ports from the right side of the fuselage were severely fire damaged, with the lines from the ports inboard of the connecting nuts burned away. All portions of the navigation system instrumentation were either consumed or too badly damaged by fire and impact to allow an assessment of serviceability.

Indicator Lights

A study of the annunciator and other indicator lights was conducted by Mr James Foot to determine if any of the lights was illuminated at impact, which in turn would give an indication of the status of the lights associated with that system. Mr Foot is an electrical/mechanical analyst employed by CASB and working at the CASB engineering laboratory in Ottawa. A certified electrician, he has a diploma in chemical technology and a bachelor's degree in mechanical engineering. Mr Foot prepared a report on his study of the lightbulbs and filaments, which was entered as Commission exhibit 441, and he gave testimony on this subject at the Commission hearings.

The examination entails a microscopic inspection of the bulb filaments for stretching, distortion, coloration, and types of failure. Normally, when shocked, an incandescent filament will exhibit deformation of the coils in the form of stretching or uncoiling, and the filament may or may not be fractured. A fractured filament without deformation is normally associated with a cold shock, since the tungsten fails in a brittle manner. Cooldown for a "hot" filament to a "cold" filament, which occurs with the loss of electrical power, takes place in less than 50 milliseconds for a typical lightbulb or lamp.

A total of 117 lamps were examined, 21 of which had fractured filaments. Nine of the lamps with fractured filaments were from the landing-gear–position indicator. Two of the lamps from that indicator – the service door light and the right main landing-gear red light – exhibited a small amount of localized stretching, although not enough to allow a conclusion that either or both lamps were on at impact. The observation that 21 filaments were considered to have fractured when cold indicates that localized g forces (impact forces) were significant. It was reasoned that had any lamp filament been incandescent (on) during the crash, the g forces were sufficient to have caused filament distortion, thus identifying those filaments that were incandescent. However, this theory assumes that electrical power was still available to the lamps when the impacts occurred.

It was concluded that one lamp from the number 1 constant speed drive (CSD) annunciator was illuminated when its envelope cracked, but it could not be determined whether the envelope was cracked during the accident or prior to it. All the other lamps exhibited signs of being off at impact, which is not to say that they all should have been off. Lamps could have shown signs of being off because the local impact forces were low or because of the loss of electrical power prior to impact.

The CSD on each engine connects the generator to the engine and drives the generator at a constant speed of 8000 rpm, irrespective of changes in engine operating speed and/or electrical load. The CSD warning light will illuminate if there is low oil pressure, if the oil overheats, or if there is a reduction in CSD speed. It is possible that the light illuminated during the crash when the engine speed became too low to operate the CSD at a constant speed.

Radio and Navigation Systems

There is no evidence that communication radios or navigation radios and systems were of significance in this accident. All the radios and other cockpit-located components were burned and could not be tested. The last radio transmission from the aircraft occurred just before the takeoff commenced, indicating that the communications radio was functioning. It is highly unlikely that the failure of any navigation equipment would have contributed to the crash.

Flight Controls

Many of the component parts of the flight control systems were recovered, and examination, testing, and assessment of these components did not indicate any pre-crash fault or unserviceability. All the fractures were identified as impact overload in nature, with no evidence of fatigue or other premature failures. The considerable crash and fire damage to the flight control systems, particularly from the cockpit to the centre wing area, precluded a complete analysis of the pre-crash serviceability of each system.

Primary Flight Controls

The primary flight controls consist of the ailerons located on the outboard trailing edge of each wing, the rudder hinged to the trailing edge of the vertical stabilizer, and the elevator located at the trailing edge of the horizontal stabilizer. The controls are hydraulic powered, and all have mechanical backup systems. There was nothing found during the investigation that indicated the primary flight controls were not fully serviceable.

Gust Locks Mechanical gust locks can be engaged on the ailerons, elevators, and rudder to prevent the wind from damaging these components when the aircraft is parked. All the locks are operated by a single control in the cockpit; to allow engagement, the ailerons and rudder must be centred and the elevator trailing edge must be full down. The elevator gust lock was not engaged when examined after the crash, and it operated freely. The mounting bracket for the rudder gust lock was broken as a result of overload transmitted through the gust-lock operating cable during breakup of the aircraft. There was no evidence to indicate that the rudder lock was engaged at the time of impact.

In addition to the physical evidence, there is other evidence that the gust locks were not engaged during the takeoff: the pilots in all likelihood performed a flight control check prior to takeoff, which could not be accomplished with the locks engaged; there is an interlock system that prevents forward throttle movement when the gust-lock control is in the engaged position; and the aircraft was rotated during takeoff (evidence that the elevator was free to travel).

Secondary Flight Controls

The secondary flight controls consist of the wing flaps, lift-dumpers, and speed brakes. The controls are hydraulic powered, and the flaps have an electrical backup; there is no backup system for the lift-dumpers or speedbrakes. There was nothing found during the investigation that indicated the secondary flight controls were not fully serviceable.

Wing Flaps The wing flaps are located at the trailing edge of each wing, between the ailerons and the fuselage. From examination and measurements of the flap actuators and from the position of the cam shaft, which operates the flap control switches, it was determined that the flaps on both sides of the aircraft were between 25° and 27° extended at the time of the crash. The cockpit controls were destroyed in the fire, and the selected flap position could not be determined. According to Captain Berezuk, who was seated in seat 12A, the flaps were set at 18° prior to commencement of the takeoff. This setting would be normal for the conditions of the takeoff. (The fact that the flaps were found positioned at 25° to 27° will be discussed in chapter 12 of this Report, Aircraft Performance and Flight Dynamics.)

Lift-dumpers The lift-dumpers are installed on the upper surface of each wing's inboard half, in front of the wing flaps, and are used to reduce the landing roll of the aircraft. The damage to the lift-dumper controls and the hydraulic manifold precluded any determination of the selected lift-dumper position. System analysis was limited to tests of hydraulic actuators (to establish serviceability) and to an examination of damage to the linkage and lift-dumper surfaces (to determine the actual position of the surfaces at the time of the aircraft's breakup). The damage patterns on the lift-dumpers and the surrounding fixed portions of the aircraft clearly show that the lift-dumpers were in the closed (retracted) position at the time of the crash, and there is no evidence that the lift-dumpers were deployed at any time during the takeoff. The cockpit lift-dumper controls were not recovered.

Speed Brakes The speed brakes are hinged on either side of the tail cone. The complete speed-brake assembly was torn from the aircraft during the crash. Examination and testing of the recovered components did not reveal any significant discrepancies, and there was no evidence to support a definitive finding as to speed-brake position during the flight or during the time of impact with the trees. The damage to the speed brakes shows they were in the closed position at the time of ground contact. The cockpit control was not recovered. When the throttles are advanced for takeoff, or to the detent, an electrical signal is given to the hydraulic actuator to close the speed brakes, and the control lever is moved by spring force to the in position.

Supplementary Flight Controls

The supplementary flight controls include trim controls for the aileron and rudder, the adjustable horizontal stabilizer, and the automatic pilot system. There was nothing found during the investigation that indicated the supplementary flight controls were not fully serviceable.

Trims Trimming of the ailerons and rudder is accomplished mechanically by rotating trim knobs on the pedestal to alter the neutral positions of springs within the control systems. Longitudinal trim is provided by adjusting the entire horizontal stabilizer. The horizontal stabilizer, which is hydraulic powered, is controlled by trim wheels in the cockpit connected with a cable system to the control unit's input mechanism. In case of hydraulic failure, stabilizer deflection can be accomplished with an electric motor controlled by a switch on the pedestal.

During the investigation, it was noted that the screwjack of the rudder trim system was slightly out of the neutral position in the direction of deflecting the rudder to the left. The position of the rudder trim setting as found is not a good indication of the setting prior to aircraft breakup.

When one control cable breaks, the other will usually pull and turn the drum to a new position before overloading fails the second cable. From the index mark painted on the vertical stabilizer, the horizontal stabilizer setting was at -1.5° after impact. It was determined from the Fokker F-28 Flight Handbook that, for takeoff, the horizontal stabilizer should be set at between +2° and -2°, depending on the centre of gravity of the aircraft; therefore, -1.5° would be a normal setting for the takeoff. The locking feature of the redundant electric drive system in the horizontal stabilizer actuator will retain the stabilizer surface in position when hydraulic pressure is lost, and there is reasonable confidence that -1.5° was the setting prior to impact. The position of the aileron trim could not be determined.

Autopilot The autopilot is an electromechanical system that provides flight stabilization and manoeuvre control in the three aircraft control axes, namely yaw, pitch, and roll. The autopilot can be coupled to the VHF navigation and flight systems.

Although it would not be expected to have the autopilot on during takeoff, the possibility of inadvertent engagement or seizure of the clutch mechanism in a critical component, such as the elevator or the stabilizer, was considered. Unfortunately, the autopilot computers were destroyed in the fire, leaving only the servo units available for examination. Examination and testing revealed no faults other than those that were crash related.

The stabilizer position after impact indicates the probability that no "runaway" of the trim or autopilot system occurred during the takeoff. Failure of the trim to move from the preset position, if such had occurred, should not have been a significant problem for the pilot. The possible result of a failure in the elevator autopilot control is less certain. However, since no fault was found in the autopilot servo clutch, the pilot would have had no problem overriding any spurious output to the elevator controls.

Flight Data Recorder/Cockpit Voice Recorder

The aircraft is equipped with a flight data recorder (FDR) and a cockpit voice recorder (CVR). In normal operation, the FDR in C-FONF would record 19 parameters, with indications of aircraft heading; speed; attitude; altitude; acceleration; engine thrust; positions of the control column, control wheel, and rudder pedal; pitch trim position; and whether the autopilot and pilot's radio key are on or off. The CVR records all conversation and noise within the cockpit and radio conversations with outside agencies.

Both the FDR and the CVR were located and recovered by a member of the investigation team approximately 24 hours after the crash. On March 11 CASB investigator David Adams located the recorders in the expected area – near the right rear cargo entry door in front of the rear pressure bulkhead, but buried in debris. The recorders were delivered by CASB investigators to the CASB engineering laboratory in Ottawa at 8 p.m., March 11, 1989. The FDR was determined to be a Sundstrand UFDR (universal flight data recorder), and the CVR was determined to be a Sundstrand Model V-557.

It is a matter of concern that the crash, fire-fighting, and rescue (CFR) unit at Dryden did not have a chart of the F-28 aircraft depicting the locations of important safety-related items. This type of chart, commonly referred to as an aircraft crash chart, is essential in assisting fire-fighters to locate items such as batteries and oxygen bottles, which pose a danger to themselves or others, or objects such as the recorders, which provide information vital to the safety of future travellers. It is absolutely essential that every airport CFR unit have a crash chart available for each type of aircraft that commonly frequents its airport, and that all unit personnel have a good understanding of the charts.

Data Recovery

The recorders on C-FONF suffered extensive fire damage but generally sustained little impact-related damage. The fire had destroyed the normal fasteners, and both recorders had to be cut open; a pneumatic cutoff wheel was used to minimize further damage to the storage medium. On disassembly, it was discovered that the recording medium (one-quarter-inch mylar tape) of both recorders had essentially been destroyed by severe heat damage. There was no practical way to recover the analog information from the CVR tape remnants. Attempts at partial recovery of the digital information on the FDR tape remnants, using optical and scanning electron microscopes, were not successful. No data were recovered from either recorder.

Because no data from the recorders were available to allow determination of the flight profile or to indicate the conversations that took place in the cockpit, it was necessary to conduct a highly detailed investigation into the events that took place during the final minutes of the flight. Unfortunately, because of the lack of information from the recorders, some details about the flight will never be known.

Fire Damage Analysis

Representatives from the manufacturer, Sundstrand Data Corporation, assisted in the investigation in an attempt to determine the temperatures endured by the crash-protected enclosure of the FDR. Sundstrand conducted a series of elevated temperature tests, for various durations, on a tape transport of identical construction to that recovered from C-FONF. It was determined from damage comparison that the FDR from C-FONF was subjected to a flame at an assumed temperature of 1100°C for 1.5 hours. Then, based on the review of the C-FONF FDR metallurgical information provided by CASB, the estimate was refined to exposure to an average temperature of 850°C for a period in excess of two hours.

Fire Survivability

Flight recorder regulations in place on March 10, 1989, are contained in the United States Federal Aviation Administration (FAA) Technical Service Order C51a (TSO-C51a), the standard for flight recorders, which has been adopted by Canadian authorities for Canadian-registered aircraft. The regulations require that flight-recording devices withstand a temperature of 1100°C for 30 minutes with 50 per cent of the recorder enclosed in flames. Discussions between CASB investigators and personnel from the FAA and Sundstrand, and a review of the documentation regarding the certification tests, confirmed that both recorders in C-FONF met the specifications contained in TSO-C51a.

An international working group, the European Organization for Civil Aviation Equipment (EUROCAE), is endeavouring to bring about changes to the regulations for flight recorders. The Transportation Safety Board of Canada (TSB) is a member of the organization. A more rigorous fire test for the next generation of flight recorders was developed at a EUROCAE meeting in May 1989. The proposed new specification is still based on 30 minutes at a temperature of 1100°C, but with 100 per cent of the recorder enclosed in flames rather than 50 per cent, and with a thermal flux (heat transfer) of 50,000 BTU per square foot per hour. The increase in the flame coverage and the addition of the thermal flux parameter ensure that the test represent a severe fire; the current test is non-uniform and interpretive. The general feeling in the recorder community is that the addition of the thermal flux requirement makes the test twice as severe. The specifications recommended by EUROCAE are contained in two documents: "ED55 – Minimum Operational Performance Specifications for Flight Data Recorder Systems"; and "ED56 – Minimum Operational Performance Specifications for Cockpit Voice Recorder Systems."

With current technology, an increase in the duration of the fire test in addition to the thermal flux requirements would require increased insulation and thus a larger box in which to house the recorder. Since it is undesirable to increase the size of the box, industry representatives at the May 1989 meeting were generally opposed to an increase in the test duration, although the accident investigation community, and Canada in particular, expressed a strong interest in both an increase in the test duration and the addition of the thermal flux parameter. In the interest of preserving this most valuable investigative tool, I recommend that the TSB continue to press for the adoption of more rigorous test requirements for data recorders.

Location of Recorders

The recorders in the F-28 aircraft are normally located just in front of the rear pressure bulkhead. This area of C-FONF, which was pressurized, suffered extensive fire damage in the crash, whereas the area behind the bulkhead, which was non-pressurized, was undamaged by fire. It was noted by the investigators that if the recorders had been located in this non-pressurized area, they likely would not have been fire damaged and therefore would have yielded useful information.

Recorders are certified to endure the temperature, humidity, and environmental conditions in non-pressurized areas of aircraft; however, locating recorders in these areas is generally viewed as undesirable because of increased maintenance concerns. Current recorders are essentially tape drives with many mechanical parts, prone to serviceability problems in hostile environments. Although locating recorders in non-pressurized areas may result in less chance of damage in a crash or fire, the recorder may not be serviceable when required because of its exposure to the elements. Further study of recorders and their locations, correlated to maintenance history, would be helpful for assessing the relative desirability of locating recorders in non-pressurized areas. Solid-state recorders may increase the commercial acceptability of locating recorders in non-pressurized areas.

Solid-State Recorders

Solid-state FDRs are now operating on some aircraft in North America, and solid-state CVRs are in the process of being certified; they will be operating on aircraft in late 1991. Data for both recorders are stored in computer chips; there are no moving parts. It is possible to record almost 300 parameters on present magnetic-tape FDRs. Existing solid-state FDRs have about the same capacity, although some solid-state FDRs with double that capacity are now being offered on the Airbus A320 and the new Boeing 777. Solid-state CVRs can record from 30 to 120 minutes by having memory modules added to them. In December 1990 the cost of 120 minutes of memory was predicted to be about U.S.$50,000.

Modern electronic aircraft have thousands of parameters on their electronic buses, and FDRs on these aircraft are able to save data of a quality and quantity that has not been previously available. Based on recent TSB experience working with the tape recorders from A320 aircraft involved in occurrences, the FDRs and CVRs contain enough information to provide detailed accounts of the occurrences. The use of solid-state recorders, with their ability to store greater amounts of more reliable data, will improve on the capability of data recorders and undoubtedly be of greater benefit to everyone who has a use for the data, particularly those involved in accident investigation.

The manufacturers of solid-state recorders are building recorders to meet the EUROCAE specifications as detailed in publications ED55 and ED56 with regard to fire and heat, water submersion, and impact and acceleration forces. At the time of publication of this Report, these specifications were not law in any country; however, it is anticipated that the specifications will be universally adopted. It is also believed that, because solid-state recorders have no moving parts, the recorders will be better able to withstand the environment in the non-pressurized areas of aircraft. The solid-state recorders are the same size as the most popular magnetic-tape recorders in service.

Flight Path Reconstruction

In support of the overall investigation, the CASB engineering laboratory constructed three-dimensional flight path models, using computer-generated imagery. Information for such modelling is normally obtained directly from flight data recorders. Since the recorders from this accident were destroyed by fire, the information had to come from other sources. These sources included eyewitnesses, wreckage distribution, photographic evidence, survey evidence, tree-strike evidence, a model of the F-28 aircraft, past flight recorder data from this very aircraft, and some assumptions based on an understanding of the way aircraft fly. It is important to note that the reconstruction depicts an approximation of the aircraft's flight path and behaviour; the results are qualitative and were not, and should not be, used for quantitative analysis. From an analysis of the reconstructed flight path, the aircraft did not exhibit any unusual yaw, pitch, or roll prior to impact. This finding agrees with the conclusions reached related to aircraft damage assessment and aircraft attitude.

Aircraft Weight

The maximum structural gross takeoff weight of the Fokker F-28 Mk1000 aircraft is 65,000 pounds. Before taking off from Dryden on the accident flight, the crew of C-FONF did not leave a completed weight-and-balance form with the company agent, as required. As part of the calculations used to estimate the weight and centre of gravity of the aircraft at takeoff, the investigation team's operations group reviewed passenger and baggage weights used by Air Ontario, Air Canada, and Canadian Airlines International Ltd (CAIL) as well as those included in the Transport Canada–issued A.I.P. Canada: Aeronautical Information Publication, TP 2300E.

In determining aircraft takeoff weight and centre of gravity, Air Ontario F-28 flight crews normally use a winter weight of 169 pounds per passenger and a baggage weight of 23.5 pounds per bag. Air Canada uses winter weights of 193 pounds for males and 146 pounds for females, arriving at an average winter weight of 178 pounds, and a per bag weight of 26 pounds. CAIL uses 28 pounds per bag. The A.I.P. dated October 20, 1988, contains weight calculation data extracted from an airline/Transport Canada survey, with winter weights of 188 pounds for males and 141 pounds for females and an average weight of 164.5 pounds. These passenger weights include exterior clothing and articles of carry-on baggage. Using the above passenger and baggage weights and other relevant information, the operations group calculated that C-FONF weighed between 62,600 and 64,800 pounds when it commenced its takeoff roll prior to the crash.

Airworthiness of C-FONF

As part of the investigation, the maintenance records of C-FONF were reviewed in detail to determine the manner in which Air Ontario was operating and maintaining the aircraft and to ascertain whether the aircraft was being operated and maintained in accordance with the *Aeronautics Act*, the Air Regulations, the Air Navigation Orders (ANOs), and Transport Canada policies.

Applicable Legislation and Regulations Effective March 10, 1989

Section 4 of the *Aeronautics Act*, as amended, makes the minister of transport, or such other minister as designated by the Governor in Council, responsible for the development and regulation of aeronautics within Canada and applies to all aircraft operations within Canada. Section 4 of the Act authorizes the Governor in Council at the request of the minister to make regulations and orders for such development and regulation of aeronautics. Subsection 4.9 is a broad section giving the Governor in Council general powers to make such regulations as necessary, including licensing of persons involved in aeronautics and the conditions under which aircraft may be utilized and operated within Canada.

Part II of the Air Regulations, Consolidated Regulations of Canada, deals with Canadian aircraft registration, airworthiness certification, and markings of aircraft. The documents that govern airworthiness certification and standards for aircraft and aeronautical products in Canada are the United States Federal Aviation Regulations, and the Canadian airworthiness manual and engineering and inspection manual. Sections 210 through 221 of the Air Regulations deal with aircraft certification and airworthiness and provide the minister with the powers to ensure that he or she is satisfied that an aircraft operating in Canada "conforms to the applicable standards of airworthiness or is of a design in respect of which a type approval has been issued" or a "certificate of airworthiness in respect of that aircraft" has been granted (s. 211(2)). The Air Regulations empower the minister to make such orders or directions in the form of Air Navigation Orders (ANOs) relating to, among other things, the aeronautical design, airworthiness, approval, and operation and use of aircraft and aeronautical products in Canada.

Certification

Certification Requirements

Before an aircraft can be operated commercially in Canada, the operator must meet certain conditions. With regard to certification, the operator first must apply for and be granted a certificate of airworthiness (C of A) and then must maintain the aircraft in accordance with applicable regulations.

From the Department of Transport Certificate of Airworthiness/Flight Permit Application Form 26-0024 1-77 Amended by AL 24 (not verbatim):

> The operator must submit to the Department of Transport an application for a certificate of airworthiness for an aircraft. The application clearly identifies the aircraft and contains the following affirmations: that the aircraft conforms with the Aircraft Type Approval or Type Certificate Number and is airworthy; that the aircraft has been inspected and on the date of inspection was serviceable; that the aircraft was flown and found to meet the standards; and, that all applicable DOT airworthiness/serviceability requirements have been complied with.

The following is from the Air Regulations:

> 211.(2)
> The Minister shall, on being satisfied that an aircraft conforms to the applicable standards of airworthiness or is of a design in respect of which a type approval has been issued and is still current, issue a certificate of airworthiness in respect of that aircraft.

The following is from ANO Series II, No. 4:

Conditions of Certificate of Airworthiness

3. Every certificate of airworthiness issued in respect of an aircraft is issued on condition that
   (a) the aircraft will be maintained is accordance with a maintenance program that meets the aircraft standards of airworthiness established by the Minister pursuant to section 211 of the *Air Regulations*, and
   (b) an entry will be made in the Aircraft Journey Log of the aircraft by an authorized person, certifying that the aircraft is
      (i) airworthy, or
      (ii) released to service,
      whichever is applicable, at the times and in accordance with the procedures set out therefor in the *Airworthiness Manual* or in the *Engineering and Inspection Manual.*
5. Notwithstanding anything in this Order [ANO Series II, No. 4], a certificate of airworthiness issued in respect of an aircraft is not in force at any time when either of the conditions set out in paragraph 3(a) or (b) fails to be satisfied in respect of that aircraft.

Transport Canada inspectors Randy Pitcher and Ole Nielsen both testified that the certificate of airworthiness of an aircraft is void (that is, invalid) if there is any essential aircraft equipment unserviceable and the defect has not been deferred with respect to the approved minimum equipment list (MEL) for the aircraft. This subject is dealt with in greater detail later in this chapter.

Canadian Certification History of C-FONF

On May 6, 1988, a "Certificat de Navigabilité pour Exportation" (certificate of airworthiness for exportation), number 14638, was issued for the aircraft by the minister of transport for the Republic of France. Typed on the certificate was, "The airplane identified by this Certificate has been examined and found to conform to Canadian Type Approval No. A-108." Aircraft type approval A-108 was issued by the Department of Transport on February 27, 1973, with respect to the Fokker F-28 Mk1000 (approved August 3, 1972) and Mk2000 (approved August 30, 1972) aircraft.

Transport Canada issued a provisional certificate of registration (C of R) and flight permit for C-FONF on May 11, 1988, which allowed Air Ontario to fly the aircraft from France to London, Ontario. On May 19, 1988, Transport Canada issued a C of R for the purpose of private operation, and on June 10, 1988, it issued a C of R for the purpose of commercial operation. A further C of R was issued June 13, 1988. (It appears a typographical error was made; the June 10 C of R stated F28 MK100, whereas the June 13 C of R stated F28 MK1000.)

A certificate of noise compliance for the aircraft was issued May 26, 1988.

The application for the issue of the Canadian C of A was made under company approval number ACA 57078 (May 18, 1988). A Canadian C of A in the "standard" category was issued May 30, 1988, by Transport Canada after an inspection of the aircraft in London, Ontario, by a Transport Canada inspector.

The Air Ontario Maintenance Control Manual was amended to include reference to the F-28 aircraft. The amendment (no. 3) was approved by Transport Canada on June 3, 1988.

Letter of Approval

A letter of approval, dated March 22, 1989, 12 days after the crash at Dryden, was sent by Transport Canada (Aviation Regulation), London, Ontario, to Air Ontario; on it the Fokker F-28 had been added to the list of aircraft that Air Ontario was authorized to maintain. In testimony, Ms Elaine Summers, CASB chairwoman of the investigation's records and documents group and formerly a Transport Canada airworthiness inspector, stated that a letter of approval would normally be issued at the time the company maintenance control manual amendment regarding a new aircraft is approved, in this case June 3, 1988. In testimony, Mr Nielsen stated that the operating certificate is not predicated on the issuance of a letter of approval. The letter of approval is without basis in legislation, and the authority for a company to maintain an aircraft type is in the approved maintenance control manual.

Airworthiness Staff Instruction, File No. ARD 5009-003-33, Air Carrier Approvals, Audits and Surveillance, was issued by the acting director, Airworthiness Branch, Transport Canada, on July 20, 1987. The purpose of the instruction was to establish the national standards for air carrier certification, audits, and inspections. The instruction contains some information regarding the letter of approval and a sample of the letter. Part II, paragraph 1.3.4, "Issue of Company Approval," states: "Upon being satisfied that the Air Carrier meets all of the Transport Canada requirements, the RMA [regional manager (airworthiness)] may issue a Letter of Approval" (Exhibit 494, p. 18). It is not stated in the instruction that issuance of the letter is a requirement for operation of the aircraft by the company. In order to obviate the ambiguity of the instructions regarding the requirement for a letter of approval, I urge that the issuance of the letter be made mandatory as an indication that Transport Canada is satisfied that the applying air carrier has met all Transport Canada requirements.

Minimum Equipment List

Most large aircraft are designed and certified with a significant amount of redundancy in their systems so that the minimum standards of airworthiness are satisfied by a substantial margin. A minimum equipment list (MEL) is an alleviating document that regulates the dispatch of an aircraft with inoperative essential aircraft equipment. Basically, compliance with an MEL allows an operator to defer repair or maintenance and fly an aircraft without all the essential equipment operative in order to complete a flight segment, or until repairs can be made. Compliance with an MEL is accomplished through one or more of the following means: adjusting the operating limitations to provide an equivalent level of safety; transferring functions or referencing other operating components; changing the operating procedures; or changing the maintenance procedures. A fundamental understanding is that the continued operation of an aircraft with inoperative essential equipment should be minimized. In Canada, MELs are prepared by the operator and approved by Transport Canada.

Essential aircraft equipment is defined in ANO, Series II, No. 20, section 2 ("Interpretation") as follows:

> "essential aircraft equipment" means an item, component or system installed in an aircraft, that
> (a) has a primary role of providing information or performing a function required by regulation or order; or
> (b) is directly related to the airworthiness of the aircraft;
>
> (Exhibit 311, p. 1)

It is a matter of concern that during the testimony of many witnesses, no one, including commercial pilots and Transport Canada employees, found the definition of "essential aircraft equipment" to be readily usable or useful to pilots and technicians during normal aircraft operations. I will discuss this lack of a useful definition of essential aircraft equipment in detail in chapter 16 of this Report, F-28 Program: APU, MEL, and Dilemma Facing the Crew.

Air Navigation Orders, Series II, No. 20, sections 4, 7, and 8, state as follows:

> 4. An air carrier may submit [to Transport Canada] for approval a minimum equipment list for each type of aircraft that he operates.
> 7. No air carrier shall operate an aircraft if any essential aircraft equipment is inoperative unless he does so in compliance with a minimum equipment list.

8. Notwithstanding section 7, no aircraft shall be operated where, in the opinion of the pilot-in-command, flight safety is or may be compromised.

(Exhibit 311, p. 2)

From June 1988 until December 1988, Air Ontario conducted F-28 operations without having an F-28 MEL approved by Transport Canada. Operation of an aircraft without an approved MEL is permitted; however, the Air Ontario F-28 aircraft could not have been legally operated between June and December 1988 with any essential aircraft equipment inoperative. Evidence before me revealed that Air Ontario operated the F-28 aircraft between June and December 1988 with essential aircraft equipment inoperative.

Maintenance History

Airframe

The aircraft C-FONF, serial number 11060, had a date of manufacture of November 3, 1972. The aircraft was initially sold to Turk Hava Yollari (THY) (Turkish Airlines, Istanbul) about January 1973. It was subsequently sold by THY to Transport Aérien Transrégional (TAT) (France) about January 1988, and then leased by TAT to Air Ontario for the period March 15, 1988, to March 14, 1989. The aircraft was accepted by Air Ontario about mid-March 1988. At that time, the aircraft had flown a total of 20,394:38 hours and 23,316 cycles. (A cycle is one takeoff and one landing.) At the time of the crash, the aircraft had flown 21,567:23 hours and 24,635 cycles.

The aircraft's maintenance trail, from the time the aircraft was prepared for delivery to Air Ontario to the time of the crash, was closely examined by Commission investigators and canvassed at length during the hearings of this Inquiry. Prior to delivery to Air Ontario, the aircraft was inspected and brought to normal TAT and Canadian standards. It became known during the testimony of Mr Teoman Ozdener, a former director of maintenance for Air Ontario and previously the engineer responsible for the F-28 at THY, that the aircraft had been parked and stored for about two years at THY, Istanbul, before it was purchased by TAT. Mr Ozdener holds a master of science degree in mechanical engineering from California State University and has been employed as a senior liaison engineer in structures and substructures for McDonnell Douglas. Mr Ozdener testified that during the type of storage to which C-FONF was subjected, parts of the aircraft, especially hydraulic seals, deteriorate and lead to breakdowns that in turn cause delays and flight cancellations.

The records for the maintenance performed since the aircraft entered Canada indicate that the aircraft was maintained in accordance with the

Transport Canada–approved maintenance system contained in the Air Ontario Maintenance Control Manual. The records also indicate that all requirements of the approved maintenance program were completed on time or within the approved tolerance (10 per cent of the time between inspections or other related activity, or 50 hours non-cumulative, whichever is less). As well, none of the components on the aircraft when it crashed was overdue for inspection, replacement, or overhaul on a time basis.

During the review of the maintenance records, it was discovered that the records contained numerous entry and mathematical errors. It was the opinion of Ms Summers that, at the time of the accident, the errors had not resulted in any components going beyond their operating limits or any inspections being missed. (It was discovered during the investigation of the wreckage that the left and right inboard wheel brakes were worn beyond specified limits, but errors in the records were not a factor here.)

The aircraft was last reweighed on May 16, 1988, at TAT, France, and had a basic empty weight of 36,501.89 pounds and a centre of gravity of 483.22 inches aft of the datum. The weight and balance were amended October 19, 1988, to 36,539.00 pounds and 483.06 inches, because of some minor additions, deletions, and substitutions (primarily the change to a different flight data recorder). Although an additional weight of approximately 136 pounds was added when new fire-blocking seat material was installed in December 1988, the weight and balance were not appropriately amended. The engineering and inspection manual referred to in the Air Regulations requires that the operator amend and submit revised weight and balance reports to Transport Canada. Although the total weight change may have been small, it still must be included in the weight and balance calculation. By failing to recalculate and revise the weight and balance on C-FONF and submit it to Transport Canada, Air Ontario failed to comply with the requirements of Transport Canada's engineering and inspection manual and was therefore in breach of the Air Regulations.

Engines

The history of the engines is outlined below:

	Left (No. 1)	**Right (No. 2)**
Make	Rolls-Royce	Rolls-Royce
Model	Spey RB 183-2 Mk555-15	Spey RB 183-2 Mk555-15
Specification	1037	1037
Serial number	9130	9187
Date of manufacture	December 1971	February 1973
Date installed C-FONF	April 28, 1988	May 4, 1988

At the time these engines were installed in C-FONF, this aircraft had a total time of 20,393:03 hours and 23,315 cycles. The engine times/cycles at the time of installation were as follows:

	Left (No. 1)	Right (No. 2)
Total hours since new	21,729:55	10,026
Hours since overhaul	8,380:10	4,037
Total cycles since new	20,938	6,641
Cycles since overhaul	9,055	2,357
Cycles since hot section inspection (HSI)	zero	zero

Prior to its first flight of March 10, 1989, C-FONF had a total time of 21,565.7 hours and a total of 24,632 cycles. According to the Air Ontario SOC log, the aircraft flew 1:41 hours and three cycles on March 10, 1989. The engine times/cycles at the time of the crash were calculated to be as follows:

	Left (No. 1)	Right (No. 2)
Total hours since new	21,901:57	10,198:02
Total cycles since new	21,258	6,961

As of March 10, 1989, all applicable engine airworthiness directives (ADs) had been complied with. Logbook entries verify that both engines were maintained in accordance with the approved maintenance program.

Deferred Unserviceabilities

An exhaustive review of the journey log for C-FONF, undertaken during the course of the hearings of this Inquiry, revealed that many aircraft unserviceabilities were carried forward or deferred by the Air Ontario maintenance department in the approximately six months that Air Ontario operated its F-28s without an approved MEL. The following is a list of such deferrals dating from June 9, 1988, when Air Ontario first began revenue operations with the aircraft, to December 19, 1988, when the F-28 MEL was approved by Transport Canada and officially put into use by Air Ontario. The evidence was that Transport Canada had given verbal approval to the proposed MEL, but there was disagreement over the actual date that verbal interim approval of the MEL by Transport Canada was received by Air Ontario. This subject is covered fully in chapter 16 of this Report, F-28 Program: APU, MEL, and Dilemma Facing the Crew.

[1] June 9, 1988 – Fuel reported venting from wing vents by YZ ATC [Toronto Air Traffic Control]. Rectification – deferred MX Control #0158 YAM 9-6-8.

[2] June 19, 1988 – #2 system auxiliary AC hydraulic pump intermittent. Rectification – carried fwd.

[3] June 22, 1988 – F/O clock u/s. Rectification – carried fwd.

[4] June 23, 1988 – left flight control light (hyd pump) illuminated constantly. Rectification – carried fwd.

[5] June 24, 1988 – Flight crew reported #1 hyd quantity system gauge u/s. Rectification – operate as per Flight Manual operating deficiencies list Vol 1. Deferred.

[6] June 28, 1988 – Anti-skid u/s. Left side does not test in flight. Rectification – carried forward. Operate as per Flight Manual.

[7] July 15, 1988 – Captain's clock u/s. Rectification – Swapped for F/O clock. F/O clock u/s and carried fwd.

[8] July 27, 1988 – Cockpit pack temperature control only in manual position. Rectification – carried forward.

[9] August 15, 1988 – Flt crew reports APU fire ext test to be intermittent. Rectification – carried forward. Operate as per Flight Manual CDL [Configuration Deviation List].

[10] August 31, 1988 – Yaw damper slightly unsteady. Rectification – C/F.

[11] September 1, 1988 – Aileron control pilot wheel slight left right motion in cruise; autopilot on causing yaw damper to move all the time. Rectification – previously carried forward ... Servicing tool on order.

[12] September 12, 1988 – Yaw damper is starting to slew tail around again resulting in aileron's moving with slight rocking motion. Rectification – carried forward. Operate as per F-28 Flight Handbook.

[13] September 22, 1988 – F/O's alt [altimeter] not lit. Rectification – C/F. Parts on order.

[14] September 22, 1988 – Capts panel does not have lit time piece. Rectification – C/F

[15] September 25, 1988 – Barber pole showing at least once during take-off and landing roll. Indications problem only, liftdumpers do not come out. Rectification – carried forward. Test equipment ordered.

[16] September 25, 1988 – #2 fuel flow meter is intermittent. Works about 75% of the time. Did same in #1 position yesterday. Rectification – carried forward. Parts ordered.

[17] October 9, 1988 – Please adjust F/O's rudder pedals for correct left right alignment. Rectification – carried fwd.

[18] October 14, 1988 – Cockpit a/c pack magnetic indicator shows "off line" most of the time. Temperature can only be controlled manually. Rectification – carried forward – continue operation in manual mode.

[19] October 19, 1988 – APU hangs up at 20% RPM, TGT then rises to red line (705°) without further increase in RPM. APU was turned off. Rectification – APU u/s – Deferred.

[20] October 29, 1988 – Wing and tail anti-ice panel goes dark (lights go out) when selected on, comes back on when selected off. Rectification – carried foward.

[21] November 15, 1988 – If cockpit air conditioning not selected cold after t/o the pack drives full hot producing a hot smell. Rectification – previously carried fwd.

[22] November 23, 1988 – Knob on L/H thrust index gauge slips. Rectification – C/F. Part on order.

[23] November 28, 1988 – Gen. #1 drive coupling disengaged. Rectification – C/F.

[24] November 30, 1988 – Cockpit pact temp control u/s in auto selection. Rectification – C/F.

[25] December 2, 1988 – Upper half of airfoil anti-ice panel is without lights (intermittent, when pressure is applied lights come on). Rectification – Deferred.

[26] December 2, 1988 – Automatic control for cockpit air cond pack is intermittent. Magnetic indicator is "off line" most of the time, occasionally it goes to "in line." Rectification – previously deferred.

[27] December 14, 1988 – Autopilot rolls wings inducing yaw in put above 15,000' and mach .60 same as page 18866 #1. Rectification – C/F.

[28] December 18, 1988 – #3 Alt under frequency when APU loaded up. Rectification – C/F as per ANO Series 2, #20. Alt not ESS [essential?] for flight.

As will be seen in chapter 16 of this Report, which deals in detail with the MEL, the definition of "essential equipment" in ANO Series VII, No. 2, is ambiguous. In the absence of a clear definition as to what constitutes essential equipment, it may be that some of the above-noted defects do not relate to essential aircraft equipment; it is, however, obvious that some of them do relate to it. Some of the more obvious defects related to essential equipment are those listed above as numbers 2, 4, 9, 15, 19, 23, and 25, but the list is not necessarily complete. *Any deferral of a defect related to a piece of essential equipment must be made with reference to an approved MEL.* This procedure must be carried out to ensure that the deferral is made with a full appreciation of the ramifications of the unserviceability on both operations and maintenance; it is also required by legislation. Based on the evidence before me, it is my opinion, and I conclude that, *any deferral of a defect related to an item of essential aircraft equipment, without reference to an approved MEL, effectively voids the certificate of airworthiness.* That being the case, it follows, and I find, that Air Ontario operated its F-28 aircraft, C-FONF, on a number of occasions without a valid certificate of airworthiness.

Reportable Incidents

The Canadian Aviation Safety Board Regulations, as part of the *CASB Act*, define, in section 2, what are "reportable incidents" and require, pursuant to section 5(1), that these incidents be reported to CASB. Contravention of the Act or the regulations is referred to in section 32 of the *CASB Act*, which states, "Every person who contravenes any provision of this Act or the regulations for which no other punishment is provided is guilty of an offence punishable on summary conviction."

One type of reportable incident is smoke occurring in an aircraft. The review of Air Ontario records revealed three apparently reportable incidents related to smoke in the cabin of C-FONF in flight. There is no indication that the incidents were reported to CASB. The three incidents were recorded in Air Ontario logbooks as follows:

> [1] January 21, 1989 – cockpit a/c pack causing smoke in cabin. Pack switched "off" for remainder of flight. Rectification – Carried fwd.
>
> [2] February 27, 1989 – On 1st & 2nd flight of day, cabin filled with oil smoke – very thick. Rectification – found cooling turbine drain releasing oil on duct. Drain repositioned.
>
> [3] March 6, 1989 – On first t.o. cabin became smoky. Pass. complained. Smoke detector went off. Cabin temp. on overhead showed 30°. Smoke went away after 5 – 10 mins. Rectification – oil found in APU outlet ducts, oil removed.

On March 8, 1989, aircraft C-FONF, piloted by Captain Robert Nyman, at the time an Air Ontario F-28 check pilot with no management duties, and First Officer Keith Mills took off from Winnipeg. Just after takeoff, the cabin once again filled with an oily haze, which, according to Captain Nyman, emanated from the APU. Captain Nyman stated in evidence that this occurrence was another instance of a recurring problem on the aircraft. It had not been logged in the aircraft journey logbook, but Captain Nyman agreed that it should have been entered. No record of deferral appears in the logbook, nor is there a description of rectification by maintenance. Neither this occurrence nor the three previously listed ones were reported to CASB, nor was the aircraft grounded until such time as the problem could be rectified.

The absence of any report to CASB with respect to the above occurrences indicates either a lack of awareness of the reporting requirements by those involved, who are presumed to know the law, or a reluctance to report the incidents owing to the possible consequences and the follow-up actions required. In the worst-case scenario, these incidents could have entailed the grounding of the aircraft until a thorough CASB investigation had been completed, which could have resulted in loss of the aircraft from revenue service for a considerable period. The temptation not to report to CASB was obviously there. In my view, it is unlikely that flight crew and maintenance personnel would be ignorant of the requirement to report cabin smoke to CASB. The evidence is overwhelming that Air Ontario management and many of the F-28 flight crews were bent on keeping the F-28s flying.

State of Serviceability of C-FONF on March 10, 1989

The following unserviceabilities were outstanding according to the C-FONF journey logbook on the morning of March 10, 1989, prior to departure from Winnipeg:

> [1] September 22, 1988 – Capt's panel does not have lit time piece. Deferred IAW ANO Series 2-20. Licence ACA 87077. (Note – This deferral had been carried for almost six months).
> [2] February 8, 1989 – Roll and yaw not working properly in autopilot. Licence ACA 87118. Deferred
> [3] February 8, 1989 – F/O windshield wiper creeps up in flight. Licence ACA 87118.
> [4] February 23, 1989 – Pilot reports LH fuel gauge still intermittent (reads full). Licence ACA 87015. Carried Forward – Deferred.
> [5] February 24, 1989 – Number 1 Constant Speed Drive warning light tests but won't come on after shut-down. Licence ACA 87042. Deferred MEL 02-24.
> [6] March 9, 1989 – APU will not fire test. Licence ACA 87101. Deferred MEL 49-04.

During her testimony before me, flight attendant Sonia Hartwick stated that there were other discrepancies brought to the attention of the flight crew, either by Mrs Hartwick herself or by flight attendant Katherine Say, prior to the first flight on March 10, 1989. As far as could be determined during the investigation, these discrepancies were not entered in the journey logbook or any other log. It is not known what determination the flight crew may have made about these reported discrepancies, but there was no evidence that the discrepancies were rectified at any time. They were as follows:

1 The exit light over the main entry door was not working.
2 The exit light over the cabin door, on the cabin side, was not working.
3 The cabin emergency floor lighting was dimmer than normal and had a bluish rather than a bright white colour.
4 There were three altitude-compensating oxygen masks missing from the back of the aircraft.

5 There had been some difficulty closing the main entry door in Winnipeg. A plastic surclip that normally held the door handle in the stowed position when the door was closed had broken, and the handle was being held in place by double-sided tape. The difficulty in closing the door could have been attributable to the fact that the door operating handle was being held in the stowed position by the tape while an attempt was made to close the door. Neither the tape itself nor the fact that the surclip was broken apparently posed any danger of the door opening inadvertently.

I have no reason to believe the flight crew was not made aware of the above discrepancies. Since the approved MEL did not provide alleviation for some of these deficiencies and since the crew took off without having these discrepancies rectified, the crew would have done so in violation of existing regulations regarding essential equipment unserviceabilities.

Validity of Certificate of Airworthiness of C-FONF while Operated by Air Ontario

Letter of Approval

My review of the evidence suggests that a letter of approval is an administrative tool, with no basis in law, used to assist the regulator in ensuring that operators have knowledge of their requirements with regard to the certificate of airworthiness and to assist the regulator in auditing and inspecting the company to which the letter applies. Upon reviewing the evidence regarding Air Ontario's letter of approval, it is my opinion that the absence of any reference to the F-28 aircraft in the letter did not affect the validity of C-FONF's certificate of airworthiness.

Maintenance Control Manual

Amendment number 3, which added the F-28 aircraft to the Air Ontario Maintenance Control Manual, was approved June 3, 1988. This amendment effectively gave Air Ontario the right to operate C-FONF as long as the carrier followed the maintenance practices described in the approved manual, other regulations not considered. Upon review of the evidence and information before me, it appears that Air Ontario deviated from its Maintenance Control Manual only with regard to the minimum equipment list (MEL), as described earlier.

Minimum Equipment List

In accordance with the applicable legislation, and according to the testimony of Transport Canada inspectors Randy Pitcher and Ole Nielsen, the certificate of airworthiness of an aircraft is invalid if the aircraft is operated with any essential equipment unserviceable and there is not an approved MEL pursuant to which the unserviceability can be deferred. The MEL for the F-28 aircraft operated by Air Ontario was not approved until December 19, 1988. Between the time C-FONF went into operation with Air Ontario in June 1988 and December 19, 1988, the aircraft was frequently dispatched and operated with essential aircraft equipment inoperative. Rectification of this inoperative equipment was deferred without reference to an approved MEL. Rectification was deferred with reference to the flight manual's operating deficiencies list, deferred with reference to the configuration deviation list, or deferred by stating "operate as per the F-28 flight handbook"; or the deficiency was simply carried forward. As well, there is ample testimony that notes describing unserviceabilities were written on pieces of paper and passed from pilot to pilot without the pilots entering the information in the journey logbook until the end of the flying day; effectively, this practice allowed the aircraft to be flown when unserviceable. None of these procedures is Transport Canada approved. Based on the evidence before me, and as previously stated, Air Ontario, prior to December 19, 1988, when the F-28 MEL was finally approved, operated C-FONF without a valid certificate of airworthiness each time it operated the aircraft with essential equipment inoperative.

Findings

Aircraft Wreckage Investigation

- There were no pre-crash faults found with the aircraft or engines that could have contributed to the accident.

- The engines were operating at takeoff power or greater during the takeoff.

- The engine anti-icing system was selected ON during the takeoff.

- All aircraft and engine damage was the consequence of impact with trees and the ground and the ingestion of foreign material.

- The fact that one of the engines reportedly smoked during a start at Winnipeg was not related to the accident.

- The auxiliary power unit (APU) was unserviceable because it would not fire test, and it was not used during the stop at Dryden.

- During post-crash testing of the APU, it was discovered that its fuel control unit was unserviceable.

- The landing gear was moving to the up position at the time of the crash.

- The wing flaps were positioned at 18° at takeoff but were found at 25° to 27° extended at the time of the crash.

- The wing and tail anti-icing system was off during the takeoff.

- There was no evidence of fire prior to the aircraft striking the trees.

- The flight recorders revealed no useful information because they were destroyed in the post-crash fire.

- The brakes of both inboard main wheels were worn beyond limits.

Airworthiness of C-FONF

- Both aircraft main engines were maintained in accordance with the approved maintenance program.

- Air Ontario personnel often deferred aircraft unserviceabilities in an unauthorized manner and then flew the aircraft without the unserviceability being rectified.

- Because of the unauthorized manner in which some aircraft unserviceabilities were deferred, Air Ontario on a number of occasions operated its F-28 aircraft, C-FONF, without a valid certificate of airworthiness.

- Air Ontario failed to report certain reportable aircraft incidents to CASB in accordance with requirements of the *CASB Act*, as evidenced by the fact that on at least four occasions there was smoke in the cabin of an Air Ontario F-28, yet CASB has no record of such reports to that effect.

RECOMMENDATIONS

Aircraft Crash Charts

Based on the evidence that there were no F-28 aircraft crash charts available at the crash, fire-fighting, and rescue (CFR) unit at Dryden on the day of the accident, and that the flight data and cockpit voice recorders were destroyed by fire, I had intended to make recommendations as to the availability of crash charts and their use in the training of CFR unit personnel. It appears, however, that, since the hearings of this Commission, Transport Canada has been instrumental in ensuring that all Transport Canada–owned and operated airports have aircraft crash charts readily available. These initiatives more than satisfy my concerns in relation to Transport Canada–owned and operated airports, and recommendations for such airports are, accordingly, not required. In relation to all airports in Canada that are not Transport Canada–owned or operated, I make the following recommendation:

MCR 33 That Transport Canada, in cooperation with airport operators, ensure that all Canadian airports not owned or operated by Transport Canada, which service a scheduled air carrier operation, have appropriate crash charts made available to the same degree and extent as at airports owned and operated by Transport Canada.

Survivability of Flight Data Recorders and Cockpit Voice Recorders in Aircraft Crashes

The recorders in C-FONF were destroyed by fire and were of no use to the investigators of this crash. Because recorders capture essential parameters of aircraft information and performance, and are normally the source of the best investigative information, it is vitally important that their crash survivability be enhanced. I therefore make the following recommendations:

MCR 34 That Transport Canada and the Transportation Safety Board of Canada, through national and international initiatives and committees, continue to press for the adoption of more rigorous survivability test requirements for aircraft flight data-recording systems.

MCR 35 That Transport Canada and the Transportation Safety Board of Canada undertake a research program leading to the development of the most suitable deployable or non-deployable aircraft flight data-recording systems that can reasonably be expected to survive any crash and yield usable data.

MCR 36 That Transport Canada and the Transportation Safety Board of Canada study, or cause to be studied, the location of aircraft flight data–recording systems in aircraft, with a view to assuring the survival of the recording systems in any crash.

Letter of Approval Requirement

It is not clear in the Transport Canada instructions whether the issuance of a letter approval is a requirement. In the approval process of the maintenance control manual or any amendment thereto, in my view, the letter serves a purpose, and thus I make the following recommendation:

MCR 37 That Transport Canada make mandatory the issuance of a letter of approval to an air carrier as an integral part of the approval process of the "maintenance control manual" or any amendment thereto.

Definition of "Essential Equipment"

Testimony given at this Commission's hearings revealed that there is not a definition of the term "essential equipment" that is readily usable or useful to pilots and technicians during normal aircraft operations. It is therefore recommended:

MCR 38 That Transport Canada redefine in Air Navigation Order Series II, No. 20, the term "essential equipment," in order that it be unambiguous and easily understood by pilots and technicians who have to use or refer to the term.

11 AIRCRAFT CRASH SURVIVABILITY

On March 10, 1989, Air Ontario flight 1363 carried 65 passengers and an aircraft crew of four when it crashed. Forty-four passengers and one crew member survived the crash of C-FONF.

The first section of this chapter briefly outlines the survivors' accounts of this crash and their escape from the aircraft wreckage. Most survivors were interviewed and were asked, for purposes of the investigation, to provide their recollections of the crash. Having heard the evidence of many of the survivors and rescuers, I was struck by the fact that so many passengers survived this severe crash and managed to escape from the aircraft wreckage and fire. Their stories are a lasting reminder of the effect that such a tragedy can produce.

Subsequent sections provide more clinical descriptions as to what happened to the aircraft as it crashed.

Passengers' Recollections

> The aircraft was hitting trees, hitting trees, and at that point the aircraft I guess was decelerating and we were inside the blender effect ... you take a blender, threw in some metal, some trees, people and turn it on.
>
> (Transcript, vol. 14, pp. 91–92)

These are the words used by Mr David Berezuk, a surviving passenger and an Air Ontario Dash-8 captain, to describe his memory of that short flight. They vividly depict the reality of the aircraft accident. I heard many other descriptions of the crash, and, for most of the surviving passengers, those few seconds of flight can be described as a slow motion replay in their minds. It seems that, as the realization grew that an accident was inevitable, events crystallized in the memory of each person.

Many of the passengers described how the aircraft taxied out and lined up for its takeoff roll. Many described two liftoffs during the takeoff roll, and some were very specific about the height and angle of the aircraft during each of those liftoffs. As the aircraft finally lifted off near the west end of the runway, many on board knew that something was wrong. Passenger Murray Haines, an Air Canada DC-9 captain, described the takeoff in the following words:

> As the aircraft got to speed, it rotated I would say at least 10 degrees, and it lifted a bit and then sat back down. And then more power was added, and it rotated further. And then the mushing I'm talking about ... it just maintained this attitude and was mushing through the air. It didn't drop a wing until we started hitting the trees.
>
> (Transcript, vol. 19, p. 45)

As the aircraft began hitting the trees, flight attendant Sonia Hartwick shouted to the passengers to brace themselves, telling them to grab their ankles and keep their heads down. In the rear of the aircraft cabin, Captain Berezuk shouted similar commands, as did Mr Clyde Ditmars at the front.

After the first tree strike, the aircraft levelled briefly and a few passengers thought the aircraft would fly away. Then the aircraft hit more trees, and the drumming noise on the bottom of the fuselage intensified. Special Constable Dennis Swift of the Royal Canadian Mounted Police recalled his feelings as the aircraft plunged into the trees:

> I was bent over and hanging on and it was – the trees kept coming and coming and coming. I could – was visually thinking of what was going on.
>
> As the aircraft was going through the trees, I could hear the trees grinding away or tearing away at the underside of the aircraft. It seemed to take forever. It was – it seemed to take an awfully long time.
>
> And I was just, I don't know, subconsciously thinking of how long it was going to be before the trees finally came through the floorboards of the aircraft and what would happen at that point.
>
> It just seemed to take a long time. The rumbling through the trees and the tearing away of metal.
>
> (Transcript, vol. 18, pp. 84–85)

One can imagine the horror experienced by the passengers as the aircraft tore through the trees. Bent in the brace position, some passengers saw a bright flash of light outside the left side of the aircraft, and others saw the light flash through the cabin. Originating from somewhere at the left rear of the aircraft, this flash, described by some as a fireball, shot from the rear to the front of the cabin. The flash was followed by a spray of jet fuel through the cabin that soaked the clothing of many passengers. Then the aircraft came to a sudden stop. Mr Brian Perozak related the abruptness to a previous experience:

> Yes, I remember impacting the trees and it felt like we were almost stopped, and then – and then the impact was worse, like, we stopped dead.
>
> ...
>
> I had an accident a few years ago in a vehicle hitting a tree and the truck stopped dead at 40 miles an hour and, like that, even harder, without moving.
>
> (Transcript, vol. 16, p. 241)

From the testimony, it was apparent that the abrupt stop rendered many surviving passengers momentarily stunned or unconscious. Those who remained conscious testified that, as the fuselage came to a stop, the overhead bins became dislodged, causing cabin baggage stored therein to move about and to fall on the passengers below. Snow, mud, and parts of trees had entered the cabin, covering some of the passengers. More fuel sprayed on the still seat-belted passengers through holes in the cabin. As they fumbled for their seat belts, they smelled smoke, saw fire, and searched in a darkened cabin for a way out.

The aircraft had broken into three parts and lay in the woods in the shape of a large U. The front portion of the aircraft, compressed to the left, formed one arm of the U; the main fuselage, the passenger cabin portion of the aircraft, formed the base; and the tail section lay parallel to the nose of the aircraft.

There were 13 rows of seats in the aircraft, each row with three seats to the left of the centre aisle and two to the right (figure 5-2 in chapter 5, Events and Circumstances Preceding Takeoff). When the tail section swung away from the fuselage, the last row of seats, row 13, remained with it. Captain Murray Haines and one of his daughters found themselves almost in the open on the right side of this section. Two RCMP special constables and a prisoner were more enclosed on the left. With the exception of Special Constable Dennis Swift, all these persons easily exited the aircraft. He suffered a severely fractured leg, and, after removing his seat belt, he fell into the gap between the fuselage and the tail section. He was then stepped on while he lay there, until fellow passengers Mr Alfred Bertram and Mr John Biro dragged him to a safer position.

Passengers from row 8 back to the rear of the aircraft found that escape out the front of the aircraft was blocked by what seemed to be an impenetrable wall of debris. The left wing of the aircraft had disintegrated during the aircraft's descent through the trees, and a curtain of fire blocked escape to the left. Mr Thomas Harris, seated beside the left-side emergency exit at row 8, was the only survivor to escape through that exit, suffering severe burns to his hands in doing so. Passengers seated in the rear of the cabin went through either the opening in the fuselage at the rear of the aircraft or through the right-hand window exit. This exit may have been partly blocked, either inside or outside the fuselage, and those who exited this way could not determine if their point of egress was in fact the emergency exit.

Seated at the rear of the aircraft were a number of families who were travelling on spring school-break vacations. The Godin family of four from Thunder Bay was seated in row 9. Mr Daniel Godin was travelling with his wife and two children. After assisting his wife and one child exit the burning wreckage (his other child followed another passenger out of the aircraft), he returned to the interior of the rear portion of the aircraft, where he helped two survivors extricate themselves from debris and moved them towards the opening in the rear of the fuselage. He left the wreckage only after assuring himself that there were no other passengers amid the debris in the tail section visible through the thick, black, acrid smoke. After ensuring the safety of his family outside the aircraft, Mr Godin proceeded to the burning front section of the aircraft, which he entered. He then assisted four injured survivors to a safe distance from the burning aircraft. Next he opened suitcases that had been strewn about and distributed clothing to some survivors as protection against the snow and the cold. Despite having been doused with fuel during the crash sequence, he returned to the aircraft and attempted to rescue two passengers from an intense fire in the left-hand portion of the interior aircraft, only to be forced back by the flames and heat. It has been estimated that, in addition to his family, Mr Godin assisted 12 passengers to escape the aircraft.

Captain Haines, having first taken one of his daughters away from the aircraft, returned to extricate his wife. His other daughter exited through what may have been the right emergency exit location.

At the front of the wrecked aircraft, surviving passengers faced even greater dangers. Here the fire moved the fastest, and here the cabin area was compressed by the crash forces. It was from row 7 forward, and principally on the left side of the aircraft, that the majority of the fatalities occurred.

Two friends, Mr Brian Adams and Mr Brian Perozak, on their way to a curling tournament, were seated in the two seats on the right side of the aircraft in row 4. After the crash, they found themselves buried under trees, snow, luggage, and part of the aircraft. They could feel other passengers exiting over the part of the aircraft wreckage that was covering them. After a few minutes of struggle to free himself from the debris, Mr Perozak was able to unlatch his seat belt. He then crawled through a small opening in the rubble and got clear of the aircraft. Turning around, he observed his friend Mr Adams, whose legs were trapped under the wreckage. Mr Perozak immediately began to remove debris from his friend's legs. During this time, others exiting the aircraft fell over both of them as they hurried to leave the aircraft wreckage. Mrs

Nancy Ayer, her body in flames, fell on the trapped Mr Adams; she was then assisted by Mr Godin to an area away from the burning aircraft. Despite having suffered what would prove to be fatal burns, she encouraged rescuers to look after others. Mrs Shelley Podiluk, holding her baby, exited the wreckage with the assistance of Mr Ricardo Campbell. During this time, the fire in the aircraft was quickly approaching Mr Perozak and the trapped Mr Adams. The fire was close enough for Mr Perozak to feel the synthetic fibres in his sports coat become tacky from the heat. Mr Adams, trapped and lying on his back, saw a nearby tree catch fire and realized that there was little time left to escape. He described the scene as follows:

> And the heat was – the heat was getting hot and Brian [Perozak] was saying the heat is getting unbearable, I can't stand the heat or something like that.
>
> ...
>
> And I can remember thinking that we have time to give it one more try to pull my leg free. If we can't, I have got to tell him to get out and I'm on my own.
>
> And Brian at this time wedged his hands so he was grabbing on my calf and I somehow got some leverage on my – with my right foot on something and we just tug and all of a sudden it just popped out for some reason.
>
> (Transcript, vol. 16, pp. 203–204)

Many of the passengers who exited the right side of the aircraft gathered in the woods; flight attendant Sonia Hartwick and others called for everyone to stay together away from the aircraft. On the left side of the aircraft, two passengers were later found pinned in the wreckage and were extricated by rescuers; Mr Michael Kliewer, suffering burns and massive trauma, lay pinned on top of Mr Uwe Teubert, his body sheltering Mr Teubert from the heat of the fire. Mr Teubert shouted for help, but, although some may have heard his calls, it appears that no one discerned where they were coming from. It was not until nearly an hour after the crash that these two men were freed from the burning wreckage. When Mr Kliewer was removed, Mr Teubert, badly injured, managed with assistance to extricate himself from the wreckage. Mr Kliewer died later in hospital.

Most of the survivors made their way out of the woods along the path made by the first rescuers on the scene. The first group of survivors reached Middle Marker Road less than 20 minutes after the crash. At 12:32 p.m., 21 minutes after the crash, Fire Chief Ernest Parry radioed that there were about 20 to 25 survivors walking to the corner of McArthur and Middle Marker roads. Many of these people, suffering from burns and other injuries, departed the crash site in their shirtsleeves and stocking feet. They were put into vehicles or sent to a nearby house to keep warm. All were subsequently transported to the Dryden hospital, by ambulance and in vehicles volunteered by local people who had come to help.

Another example of unselfish assistance provided to surviving passengers by a crash survivor is to be seen in the actions of Mr Alfred Bertram. A flight services specialist working at Rankin Inlet, Northwest Territories, Mr Bertram was wearing a green Transport Canada security pass. His pass was still clipped to his shirt when he helped carry the stretcher bearing Mrs Ayer from the crash site to McArthur Road. By the time he reached the road, he was wet from falling in the snow, and his hand was frozen in position on the stretcher. When the stretcher was finally placed in an ambulance, almost an hour after the crash, the ambulance attendant, seeing Mr Bertram's badge and assuming he was an airport official, told him to return to the crash site. Mr Bertram headed back down the road, stopped, and helped load equipment to be taken into the site. Then, as he walked towards the crash site, he met two more survivors who were being brought out and was asked by those assisting the survivors to find an ambulance. After doing so and helping at the corner for a few minutes more, he started back down the road again. This time he did not get as far. With "rubbery legs," he decided that he might be a hindrance if he went back to the crash site. One and a half hours after the crash, Mr Bertram was taken to a police car for a much-needed rest.

Dennis Swift, the RCMP special constable, after being assisted from the aircraft and having a crude splint placed on his broken leg by fellow passengers Bertram and Biro, sat in the snow and recorded in a notebook his observations regarding the crash. He and one other survivor, Mr Michael Ferguson, were finally taken out of the woods by stretcher more than one hour after the crash. They were the last survivors to leave the crash site. Their ambulance did not depart until after 1:45 p.m., approximately the same time as the ambulance carrying Mr Kliewer and Mr Teubert left. Mr Godin, who travelled to the hospital with Special Constable Swift and Mr Ferguson, helped administer oxygen during the trip and assisted them into the hospital on arrival. Mr Godin's day as a survivor/rescuer finally ended two hours after the crash, when, cold and exhausted, he was reunited with his family at the hospital.

A number of other passenger survivors performed acts of heroism on that day. The evidence of many of the surviving passengers forms part of the record of this Commission. That record, gathered on behalf of all the passengers on flight 1363, has been invaluable.

Survival Factors

The following section consists of observations regarding relevant aircraft passenger survival factors. It is based on the investigation conducted by the human factors investigators, as reported by them in writing and in testimony before this Inquiry.

Cabin Safety

Prior to the final takeoff of C-FONF on March 10, 1989, a pre-flight safety demonstration was conducted by the flight attendants. All passengers had access to emergency information cards for the F-28 aircraft, which were stowed in the seat pouches. The majority of the survivors report having paid some degree of attention to the flight attendants' pre-flight safety demonstration and/or having read the emergency card. Various survivors reported that the overhead luggage racks contained such carry-on items as passengers' overcoats and at least one garment bag, all seat backs were upright, the seat trays were stowed, and all passenger seat belts were properly fastened.

During the week of March 6–10, 1989, flight attendants Katherine Say and Sonia Hartwick detected a number of problems with the aircraft. Each of the problems was recorded in the aircraft journey log and compared against previous entries to determine if these faults had been previously entered and if they had been previously repaired. Sonia Hartwick indicated that Katherine Say had a list of problems which she intended to take up with the manager of in-flight services when the flight attendant returned to the London offices on March 13.

Specifically, smoke, the cause of which was never conclusively determined, had entered the cabin and flight deck on several occasions during that week; there were discrepancies in the number and types of emergency oxygen masks in the passenger cabin; there was some difficulty experienced in locking the main aircraft entry door, and it was necessary to tape the door-locking handle in place; the emergency floor track-lighting was dim and bluish; and the emergency exit lights over both the aircraft's main entry door and the passenger side of the cabin entry door were not working; and there was difficulty with the aircraft pressurization system. It was reported that each of the problems listed above was brought to the attention of the captain, logged in the journey logbook each time it was discovered, and reported to maintenance. However, during that week none of the problems was corrected.

On May 18, 1988, Transport Canada inspector J. Rutherford had conducted a passenger safety inspection of C-FONF. During this inspection, a number of minor safety deficiencies were observed, among them a lack of directional indicators on the floor proximity lighting. On

June 2, 1988, Transport Canada inspector J. Brederlow conducted another cabin safety inspection of C-FONF and commented on the lack of a restraining web for a rear coat closet and the lack of shoulder harnesses for the flight attendants' seats. In fact, there was no legal requirement that the aircraft have flight attendant seat shoulder harnesses installed.

Because the aircraft was so badly damaged by the impact and the post-crash fire, it was difficult to assess many cabin safety issues. For example, some passengers reported that the collapsed overhead luggage racks and ceiling panels restricted their egress from the aircraft. However, with the cabin being all but destroyed by fire, it was not possible to determine if the collapse was attributable to design, construction, or maintenance. Given the nature of the impact and the breakup of the fuselage, it would seem unreasonable to expect luggage racks and ceiling liners not to collapse. The speed with which the fire took hold of the cabin interior was also considered. There is a requirement that passenger seats be constructed with fire-blocking material, but rapid fire propagation continues to be a recognized problem with most aircraft. (The issue of cabin material is addressed further in a later section of this chapter.)

Another cabin safety issue involves the clothing worn by the flight attendants. Flight attendant Hartwick's outer clothing comprised slip-on shoes, a light dress, and a sleeveless vest. She lost one shoe in the aircraft and the other outside the aircraft, in the snow. She eventually borrowed a pair of shoes from a passenger, enabling her to better help the survivors. I see a need for there to be more attention paid to clothing all flight attendants in a manner that will allow them to better provide the leadership required of them in an emergency.

Passenger Behaviour and Evacuation

Shortly after the aircraft became airborne, many passengers and at least one flight attendant, Sonia Hartwick, realized that the aircraft was not flying properly. Even before the initial contact with the trees, a few passengers were assuming a brace position, and flight attendant Hartwick, seated in the midsection of the aircraft in seat 8D, commanded passengers to brace themselves. Twenty survivors reported heeding her instructions. Some survivors, particularly those seated beside family members, attempted to protect their seat mates by covering them with their arms or bodies. All survivors, including those who had not heard the flight attendants' commands, had assumed some semblance of the brace position prior to the aircraft striking the ground.

The survivors reported hearing the aircraft initially begin hitting the trees. As the aircraft descended lower into the trees, battering sounds were increasingly more severe and the aircraft was shuddering increasingly more violently. The sound of the aircraft striking trees and the sound of tearing metal, up to and including the final ground impact, was accompanied by passengers' screams and yells. A passenger seated in the midsection of the aircraft reported looking up prior to the aircraft striking the ground and observing passengers being rocked about, items falling from the overhead luggage racks, fuel entering the cabin area and dousing the passengers, and a flash of fire. After ground impact and prior to the aircraft shuddering to a complete stop, passengers, still with their heads down in the brace position, observed a large quantity of dirty wet snow entering the cabin. This snow was mixed with mud and sections of trees. A strong smell of fuel also accompanied the influx of this debris. Because of the confusion inside the cabin, these survivors were unable to determine from which direction this debris entered the cabin. In addition, four passengers reported seeing and hearing electrical sparks and seeing and feeling the heat from a flash fire.

The scene inside the three sections was reported by survivors as chaotic, owing in large measure to the deformation of the fuselage. A large number of seats had failed at their floor-attachment points. These seats, along with their occupants, were strewn about, adding to the confusion. The accumulation of bodies, seats, and debris was primarily concentrated in the left front side of the fuselage. Survivors seated in the centre section described an accumulation of debris varying in depth from two to three feet that, in some cases, totally covered and immobilized them. Portions of the overhead racks had also failed during the last stages of the impact sequence, spilling their contents onto passengers and into the aisle. These broken sections of overhead racks, some already in flames and dripping molten, burning plastic, fell on a number of survivors.

Once the aircraft came to rest, the interior of the cabin sections was dimly lit by overcast daylight entering through the windows and through the two large gashes in the aircraft's right side. The interior lighting system was off, and the aircraft's emergency strip lighting either malfunctioned or, because of the debris, was not visible. Passengers' evidence revealed that the only guidance for survivors to exit the aircraft was from the daylight entering the cabin through the windows and various openings.

At the time the aircraft came to a stop there were already a few spot fires in the interior and on the exterior of the cabin. These fires increased in intensity, and the most severe one, just forward of the left wing, propagated rapidly. The fires soon filled the cabin sections with extremely thick black acrid smoke, severely restricting visibility inside the broken cabin enclosure and rendering normal breathing extremely difficult.

Survivors reported being severely jostled during the crash, and all were stunned or in varying degrees of consciousness by the time the aircraft stopped. Evacuation efforts began within seconds and became progressively more frantic as the intensity of the flames and smoke increased and as more and more survivors regained control of their senses. A few survivors recalled hearing the flight attendant ordering passengers to evacuate.

Forty-seven passengers evacuated, or were evacuated from, the aircraft, of whom two later died in hospital. Although the passenger reaction during the evacuation could not be described as panic, the evacuation was certainly disorganized and chaotic. Many passengers reported seeing other survivors scrambling over them or having their seat backs pushed onto them by passengers during the frantic effort to escape. There were many reports that, despite the frantic situation, survivors were helping one another exit the aircraft, and there were no reports of any competitive behaviour. Because of the increasingly intense fire, the smoke, the spilled fuel, and numerous minor detonations, all passengers perceived an immediate threat to life.

As previously stated, the person occupying seat 8E, the seat immediately adjacent to the right emergency exit, stated that when the aircraft eventually came to rest and he was ready to exit, he egressed through this overwing emergency exit and was followed by the flight attendant, who was seated to his left, and then by a young passenger seated immediately behind him in seat 9E. The survivor from seat 8E believed the emergency exit door had already been opened; he is certain he did not open it. Apparently, these two passengers were the only ones to egress via the right-hand overwing emergency exit.

The passenger in seat 7D stated that while he was pinned in his seat, he reached behind to his right side and twisted and pulled a latch. He could not positively identify the latch, but he may in fact have pulled in the emergency exit door. During the investigation, a burned corner remnant of the emergency exit door was found inside the aircraft abeam the emergency exit. It could not be positively determined how the right emergency exit was opened.

The person occupying seat 8A egressed through the overwing emergency exit to his immediate left. He was certain the exit was opened or torn out during the crash. He suffered serious burns while exiting the aircraft and was later flown to Winnipeg. Immediately after his exit an intense fire developed in the vicinity of the left emergency exit, thereby eliminating its use by any other passengers.

All other survivors exited the aircraft through tears in the aircraft fuselage. Fourteen survivors, including a baby held in her mother's arms, evacuated through a gash in the fuselage just forward of the right wing. Twenty-six evacuated through the opening aft of the right wing;

and one severely injured survivor egressed through an opening forward of the left wing.

There were seven surviving children under age 16, all of whom required some assistance to egress. The assistance was provided either by their parents or by the passengers seated next to the children. None suffered serious physical injury. As noted, one child was a baby held in her mother's arms on board the aircraft.

The aircraft had crashed in a heavily treed area which was strewn with deadfall and underbrush. The wet, heavy snow that had been falling prior to takeoff persisted for some time after the crash, adding to the already hip-deep snow at the crash scene. The temperature was at the freezing point.

All the survivors were poorly dressed for exposure to these conditions. The majority had removed their winter coats and jackets on the aircraft in preparation for the flight to Winnipeg. Eleven of the 47 survivors, including the flight attendant, lost their footwear during the crash or while extricating themselves from the aircraft.

As the survivors, most of them injured and many of them suffering from shock, exited the aircraft, they gradually gathered into small groups among the trees some 200 feet from the burning aircraft. Three survivors were too seriously injured to move any more than approximately 75 feet from the aircraft. They were assisted and tended to by less seriously injured survivors.

Once away from the immediate threat posed by the fire, the survivors were more motivated to work collaboratively, and in many cases they performed selfless acts in attempts to reduce the suffering of those less fortunate than themselves. Some passengers removed their jackets to allow others with no shoes to stand on them, and others gave up their shirts or sweaters to those who were cold. Some passengers performed rudimentary first-aid treatment on the injured. Other passengers provided encouragement to those who were more emotionally upset, and still others provided physical assistance to those who had difficulty walking.

The surviving flight attendant, Sonia Hartwick, despite her emotional shock, provided some of the leadership required to keep the groups close together. Once out of the aircraft she commanded those survivors still exiting to continue moving well away from the fire; then, while waiting for evacuation from the site, she ensured that survivors, many of whom were suffering from shock, did not wander off into the woods. She provided encouragement to survivors as well as assisting with the care and comfort of a severely burned passenger.

Seat Belts

Survivor statements indicate that all seat belts held; however, several survivors stated that they had some difficulty releasing their seat belt buckles. It is probable that the agitated state of some of the survivors resulted in frantic and inept efforts at releasing their seat belts. Others had difficulty finding their seat belt buckles because, since their bodies had shifted in their seats during the crash, the buckles were not positioned where expected. Some survivors indicated that they had difficulty because their access to the seat belt buckles was restricted by debris.

One survivor who reported having difficulty with his seat belt was Mr Gary Jackson, a prisoner in handcuffs being escorted to a detention centre. Mr Jackson believed his difficulty was due to a combination of factors: he was somewhat in panic or shock, his hands were burned and very painful, and he had handcuffs on. He was unable to release his seat belt until one of the escorting special RCMP constables, Mr Donald Crawshaw, who had initially left Mr Jackson in his seat, returned to the wreckage to assist the prisoner in response to his calls for help.

The fabric portion of most of the seat belts was destroyed by fire. A full physical assessment of the effectiveness of the seat belts was therefore impossible. However, each passenger seat originally had two seat belt anchor points, two anchors, and two parts of a single buckle; thus, there were 130 seat belt anchor points, 130 seat belt anchors, and 65 buckles.

All 130 seat belt anchor points were in place, but only 121 of the seat belt anchors were in place and intact; two further seat belt anchors were recovered intact, but were not in place. Only five seat belt buckles were eventually recovered, four of them still operative. None of the seat belts for the flight attendants' seats or the cockpit seats was recovered.

Assuming all passenger seat belts in the aircraft were the same as those recovered, it can be said that they met Canadian regulatory specifications. Because none of the flight crew seat belt components was recovered, no statement of compliance or non-compliance with Canadian regulatory specifications can be made.

Seats

It was found that many of the passenger seats were detached from the floor and were bunched in the forward portion of the aircraft. Most of the passenger seat frames were damaged and distorted as the result of impact and deceleration forces. The seats in rows 6, 7, and 9 on the right side of the fuselage were still in place after the crash. The seats in rows 13 right and 8 left showed very little frame damage, but they were dislodged and the front attachment knobs were missing.

In general, the seats towards the front and the left side of the aircraft were more severely damaged than were the other seats. The strongest part of the seats is the twin tubular beam that forms the base for each individual row, and many of these beams were bowed from excessive force. The most severe seat beam deformation was observed in rows 1 to 3 on the right side and rows 1 to 7 on the left side. The majority of these seats were subjected to deceleration forces with significant components in the sideward and downward directions during the final phase of the crash (analysed in the Flight Dynamics study, technical appendix 4).

Because of the fire destruction, apart from the very base structure of the captain's seat, nothing remained of the flight attendants' seats or the cockpit seats.

The forward flight attendant's seat was a pedestal seat without armrests, side restraints, or a rigid back. The seat was forward facing, located in the galley area, to the right of the centre line of the aircraft, and had a lap belt but no shoulder harness. Its location was intended to allow the flight attendant immediate access to an exit and the aircraft's only exit chute. Directly in front of this position and facing the seat were the aircraft galley cupboards and equipment. The flight attendant's seat and seat belt met the specifications of Canadian air regulations. For a detailed account of the shoulder harness issue, see chapter 22 of this Report, F-28 Program: Flight Attendant Shoulder Harness.

All the passenger seats had been upholstered with fire-blocking neoprene foam material and complied with Transport Canada regulations in regard to fire.

In order to comply with United States FAR 25.813, the seats immediately in front of and next to the overwing exits are required to have seat backs that will not recline. This requirement is achieved by the removal of the cables operating the reclining mechanism. In the other Air Ontario F-28 aircraft (C-FONG), the cables had been removed and the subject seats would not recline; in the accident aircraft, however, the recline cables were still in place.

In all other respects, all seats on C-FONF met Canadian requirements.

Interior Lighting

There were 16 emergency lights and 16 evacuation lights installed throughout the passenger compartment of C-FONF. There were seven lights of each type in the ceiling, and others in strategic places in the cabin. In general, the emergency and evacuation lights were co-located. The emergency lights receive electrical power from normal aircraft power systems, and the evacuation lights receive power from seven self-contained power supply units located throughout the cabin and containing rechargeable batteries. There is a three-position emergency light switch on the overhead panel on the flight deck, labelled OFF, TEST, and ARM. Under normal flight conditions, this switch is in the ARM position. With this switch in the ARM position, the evacuation lights, being powered by the self-contained battery units, will illuminate in the event of a total electrical power loss to the aircraft electrical system. In addition, there were four exit-location signs in the cabin containing bulbs from both the emergency and the evacuation light systems.

This accident occurred in daylight, and, therefore, lack of light was itself not a problem during the evacuation phase. There was evidence, however, that dark smoke permeated the cabin shortly after the crash, causing difficulty with visibility for the passengers in the central and forward areas of the cabin. If the crash had occurred in darkness, the conditions in the wreckage would have been much more chaotic and may have resulted in a greater loss of life. Surviving passengers were questioned as to whether they saw lights in the aircraft during the time the aircraft was breaking up and when it came to rest. Most passengers did not notice whether lights were on or off. A few stated that they had seen lights of some kind but could not say whether they were aircraft lights; some thought the light may have been from the fire. Two passengers identified lights that they saw as interior cabin lights.

When one considers the bedlam in the aircraft and the smoke and debris in the cabin that would have obstructed the passengers' vision, it is not surprising that the evacuation lights, if they functioned at all after the crash, were not noted by many. With the fuselage breaking into three distinct pieces, the electrical wiring to the lights would surely have been severed in a number of places. It is probable that some individual evacuation lights flashed or came on when the aircraft's normal power supply systems were interrupted during the final phase of the crash. In conclusion, it could not be established with any degree of certainty whether the evacuation lights worked as designed.

Survivor Survey

The Dryden accident provided an opportunity, albeit a tragic one, to obtain valuable information on the emergency evacuation of a medium-size jet aircraft and on other survivability issues. A study of these subjects could lead to the discovery of safety deficiencies and recommendations for their rectification. With this objective in mind, the human factors and survivability group of the CASB accident investigation team formulated a list of specific questions that interviewers would pose to each survivor.

Interviews began March 11, 1989, the day after the accident. Forty-two survivors were interviewed, many of whom were questioned while in their hospital beds. They represented various ages, backgrounds, and degrees of flying experience, either as a passenger or a pilot.

The following is a synopsis of the questions posed to the survivors and the responses received.

1 *Prior to takeoff from Dryden, did you pay attention to the flight attendants' safety demonstration?*
Nine survivors (21 per cent) responded that they had not paid specific attention to the flight attendants' demonstration. Two of these nine were pilots, and another three of this group stated that they had paid attention to the demonstrations given prior to takeoff in Thunder Bay.
It is interesting to note that one of the passengers, a 12-year-old girl, indicated that she had neither paid attention to the demonstration nor read the aircraft's evacuation card because "[i]t's always the same stuff and I know it all anyway." This passenger had difficulty releasing her seat belt after the crash and required assistance from the passenger seated next to her. The seat belt release, according to the passenger who provided assistance, functioned normally.

2 *Prior to takeoff from Dryden, did you read the evacuation card?*
Eighteen survivors (43 per cent) replied that they had not read the evacuation card.
Seven survivors (17 per cent) had neither read this card nor paid attention to the flight attendant safety demonstration.

3 *Did you assume the brace position prior to impact?*
Five survivors (12 per cent) stated that they had not. On further questioning, however, it was determined that although these survivors had not assumed the textbook brace position, these passengers had all braced themselves in some fashion. It is particularly significant to learn that 20 (48 per cent) of the survivors replied that they had assumed their brace position as a result of the flight attendants' orders prior to impact.

4 *Did your seat collapse as a result of the accident?*
Thirty-two (76 per cent) replied that their seat did not collapse, and five (12 per cent) stated that their seat collapsed.

5 *Did you have a problem releasing your seat belt?*
Seven respondents (17 per cent) replied that they had difficulty releasing their seat belt. Among these passengers was the prisoner travelling with his wrists handcuffed in front of him. One respondent mentioned undoing his trouser belt instead, as a result of nervousness.
Two survivors (5 per cent) related difficulties as a result of the seat belt buckle, once fastened, being displaced to one side of the abdomen.

6 *Did you strike any object in the aircraft space around you or were you struck by any object?*
Nineteen survivors (45 per cent) indicated either having been struck by an object or hitting something during the crash sequence. Only two respondents positively stated that their head struck the seats in front of them. Seventeen (40 per cent) could not remember what they had hit or what had hit them. Of this group, most stated that their lack of recollection was due to having their head lowered in the brace position and/or having their eyes closed. Many mentioned that there was too much debris moving around the cabin in a blur to identify what was hit.
Nineteen passengers (45 per cent) recall having overhead racks falling on top of them.
7 *Did you have any problems exiting the aircraft?*
Eight respondents (19 per cent) mentioned having some difficulty exiting the aircraft.
Most of the problems resulted from debris in the aircraft. Three survivors (7 per cent) had difficulty because their feet became lodged under the seat in front of them during the crash sequence.
8 *Did you assist anyone to exit the aircraft?*
Fifteen survivors (35 per cent) reported having given some form of assistance to other passengers.
9 *Did you receive assistance to exit the aircraft?*
Eleven passengers (26 per cent) reported having received assistance.

Crash Survival and Impact Survival

"Crash survival" is related to the ability of the aircraft's occupants to survive the impact or impacts, to evacuate the aircraft before conditions become intolerable as a result of fire, submersion, and other hazards, and to survive post-crash conditions until rescued.

"Impact survival" is related to the aircraft's ability to protect the occupant during a crash, with the following criteria applied:

1 The occupants' immediate environment must remain relatively intact; that is, there should be no intrusion into the livable space.
2 The deceleration forces acting on the occupants should not exceed human tolerance.
3 The seat/restraint system should prevent injuries from a second collision.
4 The immediate environment should protect the restrained occupants against serious contact injuries.

This section of the Report deals with the ability of the aircraft and all its parts to protect the occupants from the effects of rapid deceleration and the breaking up of the aircraft and considers the security of the seats and seat belts. The crashworthiness analysis provides a general understanding of the average magnitude of the impact forces experienced during the crash. The susceptibility of the aircraft to fire and the effects of the fire on the occupants are discussed in the following section of this chapter.

Mr James Hutchinson, a mechanical engineer and chief of the Engineering Analysis Division of the Canadian Aviation Safety Board (CASB), who served as chairman of the investigation team's aircraft structures group, outlined in testimony the reason for conducting an investigation into the structural breakup of an aircraft in an accident. Basically, the structures investigation provides an overall assessment of the crash dynamics of the accident sequence to determine the nature of the breakup patterns. These patterns are then compared with what could be normally expected, based on historical data, for the type of crash being investigated. If a particular breakup pattern was not consistent with the assessment of the impact dynamics, then a detailed examination would be required. In this accident, the breakup patterns of the F-28 aircraft, C-FONF, were all consistent with the overall assessment of the impact dynamics, and the investigators did not observe any breakup pattern that, in an engineering-design sense, was considered to be of an unexpected nature or could not be explained to their satisfaction.

Using the topographic maps produced by the survey team, the structures group estimated the terrain angle in the crash area to form a downslope of approximately 4° in the upper section of the wreckage trail, varying to approximately 8° on the lower section. The crash calculations were divided into two parts: the first from the point where the aircraft started striking trees on the top of the knoll, approximately 726 m from the end of the runway until the aircraft struck the ground 144 m farther on; and the second from the point the aircraft struck the ground until it came to a stop. The aircraft slid about 80 m after striking the ground.

Calculations using an estimated aircraft speed of 205 to 220 feet per second (121 to 130 knots) and an estimated coefficient of friction for flight through the trees resulted in longitudinal deceleration levels of approximately 1.33 g for the first part of the crash sequence. The shallow angle of the aircraft path through the trees on a slightly negative slope had the effect of keeping the deceleration levels (g) relatively low. Deceleration levels for the second part were calculated using the impact velocity derived from the previous calculations. It was estimated that the longitudinal deceleration levels on the second part were 2.33 to 3.05 g. The higher levels were attributed to the significant increase in sliding resistance on the ground over the resistance when travelling through the trees. The estimated deceleration levels are average levels for the aircraft as a whole, based on the total distance travelled. In reality, there were local deceleration levels that varied significantly from the average. The peak vertical level in the forward left side of the cabin, where primary ground contact was made, was calculated to be in the order of 15 to 20 gs. These calculations were based on a structural analysis of the deformation of the seat beam structures of one of the rows of three seats located in the forward left cabin area.

It should be noted that these calculated vertical g forces present only one vector of the peak crash force resultant that governed the damage and injury mechanism during the principal impact. Since the peak horizontal deceleration during main impact is a function of peak vertical deceleration and sliding resistance, the peak horizontal deceleration can be approximated by estimating the coefficient of sliding friction. During his testimony, Mr Hutchinson used a value of 1.4 for this purpose. Applying that value to the calculated vertical gs, the peak horizontal gs at main impact would have been in the order of 21–28 gs.

These estimated peak crash forces affected the front and left side of the fuselage during principal ground impact. They exceeded the human tolerance to deceleration when restrained by a seat belt only, the existing occupant-protection criterion, and the standards for structural integrity of jet transports. The severity of the process explains why the persons closest to the point of impact of the aircraft were killed, disabled or trapped. The survival of a few individuals in this area can be attributed only to random and fortuitous circumstances. The peak horizontal and vertical vectors, which occurred simultaneously, can now be combined to arrive at a crash force resultant in the order of 26–34 gs.

All the seats from the aircraft were recovered. Those from the forward left side in rows 1 to 7 were the most severely deformed, and seats that appeared to be from the right side in rows 1 to 3 were also deformed. Except for seats from rows 6, 7, and 9 on the right side, all seats were detached from their floor anchors. The original positions of some of the seats were determined by matching fracture surfaces and according to relative seat position and damage assessment. All passenger seats, except those from the right side of rows 6, 7, 9, and 13, and all those from row 8, were found to have deformed partially or completely because of impact and deceleration forces.

The regulations adopted by Canada that specify the required strength of passenger and crew seats of transport category aircraft are found in United States Federal Aviation Regulations (FARs) 25.561 and 25.562. The present regulations were in effect as of March 10, 1989. However, FAR 25.561 was amended and FAR 25.562 was added since the F-28 aircraft received its Canadian type certification, and these changes to the regulations were not made retroactive. In summary, FAR 25.561, regarding inertia forces and applicable to the F-28 seats, required that the structure be designed to give each occupant every reasonable chance of escaping serious injury in a minor crash landing in which the g forces experienced by the occupant do not exceed: upward 2.0 g, forward 9.0 g, sideward 1.5 g, and downward 4.5 g. As well, seat deformation must not occur at or below the noted g loads. Present regulations, namely those covered by the amendment to FAR 25.561, increase the above g minima to upward 3.0 g, forward 9.0 g, sideward 3.0 g on the airframe and 4.0 g on the seats and their attachments, downward 6.0 g, and rearward 1.5 g. FAR 25.562 gives details regarding dynamic testing and inertia forces relating to aircraft seats and their attachments. One of the seat/aircraft design criteria is that the seats must remain attached at all points of attachment, although the structure may have yielded, at a peak floor deceleration of a minimum of 14 g.

As explained above, the forward and left side of the aircraft were subjected to peak crash forces in the order of 26–34 gs; therefore, it is not surprising that many seats were deformed and became detached and that the fuselage broke open in two places.

After the crash, only three seat belts were still anchored to their seats and one additional belt buckle was recovered; all four buckles were found to be functional. Most of the seat belt anchors were still attached to their seat frames. Nine anchors had separated, and only two of these were recovered. Because nearly all of the seat belts were destroyed during the post-crash fire, they could not be properly evaluated for effectiveness.

Upon review of the evidence regarding the structural investigation I can find no fault with or attach any adverse significance to the design and integrity of the F-28 aircraft or to current seat design criteria. It was indeed a stroke of luck for the surviving passengers that the aircraft was broken apart during the final stages of the crash sequence, thus creating an escape route from the wreckage and fire.

Aircraft Fire

Introduction

Most of the information in this section of the Report was gathered and analysed by Mr Brian Boucher, a pilot with Air Canada, a specialist in fire-fighting, and, at present, the director of training for the Niagara-on-the-Lake, Ontario, fire department. He has been an assistant to the Ontario Fire Marshall's Office since 1983 and is involved with the Lester B. Pearson Disaster Contingency Planning Committee. Among the organizations of which Mr Boucher has been an active member are the Canadian Air Line Pilots Association (CALPA), the International Federation of Air Line Pilots Association (IFALPA), and the International Civil Aviation Organization (ICAO). Among the various fire-related groups on which he has served are the Aircraft Rescue and Firefighting Committee for the National Fire Protection Association, IFALPA's Airport Ground Environment Committee, and ICAO's Aircraft Rescue and Firefighting Study Group. Although his credentials and experience in fighting structural fires are impressive, Mr Boucher noted in evidence that he has never had occasion to participate as a fire-fighter at a major aviation fire.

Mr Boucher is a graduate of the Ontario Fire Academy and, as of April 1990, was in the process of completing a bachelor of science degree from the University of Cincinnati, concentrating on fire and safety engineering. Because of his extensive training and experience, Mr Boucher was asked to participate in the investigation and analysis of the fire aspects of the crash of C-FONF. Since he was not involved in the early stages of the investigation, he gathered the information for his analysis from inspection of the recovered wreckage and from photographs, videotapes, interview transcripts, personal interviews, relevant documents, and evidence adduced at the Commission hearings. He prepared his Fire Analysis Report, which was entered as Exhibit 514 and which, together with his sworn evidence, provided most of the information for the following section.

Fire Propagation

Dynamic Phase

The dynamic phase of the fire represents the time when the aircraft was in motion and on fire. The evidence shows that when the aircraft began to strike the heavy timber, about 726 m from the end of the runway, the left fuel tank ruptured. Fuel from the tank began vaporizing and trailing behind the aircraft in the form of a mist. Mr Boucher was of the opinion that all the fuel from the left tank was released during the time the aircraft was airborne. It is possible the right wing also ruptured and was releasing fuel during the dynamic phase, but there is no confirming evidence. The fuel on the left side of the aircraft ignited, and there is evidence of fire along the aircraft's path through the trees from a point about 50 m after entering the trees to the final resting spot of the aircraft. Trees were scorched but did not continue to burn after the sprayed fuel was burned. There is no evidence that the right side of the aircraft was on fire during the dynamic phase.

The fuel vapour plume created during the dynamic phase of the fire, in its flammable range, was probably ignited from the heat of the left engine and/or the severed energized electrical components and wiring exposed during the breakup of the left wing. The fuel vapour plume and fire followed the aircraft to its resting position. A number of passengers reported seeing flashes of fire on the left side of the aircraft as it was travelling through the trees.

Investigators who walked the path of the aircraft through the trees reported a strong odour of jet fuel present throughout. The odour was from the raw fuel that was released and not burned and from carbon by-products produced by the fire.

Static Phase

The static phase represents the time commencing after the aircraft was fully stopped and on fire. As the aircraft came to a halt, a large section of the forward left side of the fuselage separated, exposing the passengers seated in this area. The fire plume caught up to the aircraft and became static, initially burning debris and fuel on the left forward side of the aircraft. The fire plume, according to some witnesses, reached as high as 30 feet.

Many passengers stated that there was a strong smell of fuel inside the cabin. The smell was either from the misting fuel that was following the aircraft or from the fuel and fuel vapour that came from the right fuel tank, which was ruptured but not burning at this time. There was evidence of fuel spillage into the cabin, some passengers reporting that they were soaked with fuel. Fuel from the right wing tank poured onto the ground through a blanket of snow. The snow effectively trapped the fuel vapours and prevented a fire from starting on the right side of the aircraft. The vapour plume from the left wing tank probably mixed with a cloud of snow generated during the final impact. Some of the fuel in the vapour plume entered the aircraft, but, because of the snow, it remained out of its flammable range, which was fortunate in that there was an initial fire-free path out the right side of the aircraft for the ambulatory passengers. It is evident that the fuel that splashed on the surviving passengers was not in its flammable range since these passengers did not catch on fire.

The fire plume entered the aircraft through the large opening in the left forward area of the fuselage and contacted the fuselage sideliners, the overhead bins, and the combustible carry-on articles (collectively, the "interior combustibles"). The evidence indicates that burning plastics and other burning articles began dropping almost immediately onto both survivors and non-survivors. Because of the probable heavy concentration of fuel vapour that entered the aircraft and saturated the interior combustibles, the rate of flame-spread was very fast. The left forward area, where the fire entered the aircraft, was where most of the deceased were found. From there the fire then spread forward into the cockpit and rearward along the cabin ceiling, igniting all interior combustibles. Toxic and flammable gases travelled through convection heating to the ceiling and out through openings in the fuselage. The fire burned from the top down, as evidenced by the fact that the top of the aircraft was burned away while the lower portions of the fuselage remained intact.

The fire was fuel regulated: because of the breaks in the aircraft, there was adequate oxygen to support combustion, and the fire would burn as long as there was material to burn or until the fire was extinguished. It is not likely that fuselage flashover occurred. (Flashover is the spontaneous combustion of heated gases.) In order for flashover to occur, the temperature of the gases in the confined area of a fuselage must exceed 550°C. Although the temperature in this case may have exceeded 550°, the large openings in the fuselage allowed the heated gases to escape, and, accordingly, the fire propagated normally. The vapours from the fuel in the right wing most likely ignited because of the radiant heat and flames from the aircraft cabin as the fire spread. The fire in the area of the right wing was not intense; most of the fuel seeped into the snow, which effectively trapped the fuel vapours. The fire was most intense in the forward left area of the fuselage, as evidenced by the complete destruction of this area; in contrast, a good portion of the right side of the fuselage was not burned to the same extent.

It is the evidence that two Dryden airport crash fire rescue (CFR) fire trucks arrived at the McArthur Road and Middle Marker Road location at approximately 12:18 (Red 3) and 12:19 p.m. (Red 1). The Unorganized Territories of Ontario (UT of O) rapid attack vehicle arrived at the scene at approximately 12:34 p.m., and the UT of O tanker truck arrived at approximately 12:40 p.m. Red 2 (CFR) arrived at approximately 12:43 p.m. At 12:44 p.m., two Town of Dryden fire trucks arrived. Captain Roger Nordlund, the UT of O fire chief, arrived at approximately 12:45 p.m.

It is quite disturbing that, despite the presence of sophisticated fire-fighting equipment and many fire-fighters, no attempt was made to extinguish the fire until approximately 2:00 p.m., one hour and 50 minutes after the crash. Some time after 1:30 p.m., the UT of O pumper truck was driven from the intersection of McArthur Road and the Middle Marker access road, where it had been parked since about 12:35 p.m., down the Middle Marker access road to a point opposite to and approximately 360 feet from the crash site. A handline from the truck was then dragged by eight to ten volunteers through the bush to the site, and fire retardant was applied to the fire at approximately 2:00 p.m. Fire-fighters continued to suppress small flare-ups for about another hour. At 6:00 p.m. the pumper truck and portable pond (port-a-pond) were moved closer to the crash site via a newly bulldozed road. Fire-fighters remained at the site until about 11:30 p.m., and UT of O fire-fighters returned to the site during the next two days to ensure that further fire did not break out. Crash fire rescue is the topic of chapter 9 of this Report, Dryden Municipal Airport Crash, Fire-fighting, and Rescue Services.

The Fokker F-28 Mk1000 aircraft was approved in the transport category by Transport Canada on August 3, 1972, and, accordingly, was issued Canadian Type Approval No. A-108. Among other standards, the following standards applied: CAR 4b, dated September 1962, amendments 4b-1 through 4b-16, inclusive; and FAR 25, amendments 25-1 through 25-12, inclusive, 25-14 through 25-22, inclusive, and 25-24.

Accordingly, cabin materials on the F-28 aircraft, including seats and interior panels, were required, by type approval, to comply with the flammability standards of FAR 25 amendments no. 25-15 and no. 25-17, which, respectively, introduced the vertical Bunsen burner test and clarified the application of the standard with respect to specific materials and components.

Since the F-28 is a large aircraft used in commercial service, ANO Series VII, No. 2, applied. It required, in accordance with the Flammability Requirements for Aeroplane Seat Cushion Order (ANO Series II, No. 28, promulgated on June 6, 1986), that seat cushions comply with the flammability requirements introduced in FAR 25 by amendment no. 25-59, issued on October 26, 1984.

On July 21, 1986, the FAA issued two regulatory amendments: amendment no. 25-61, establishing upgraded flammability standards, and amendment no. 121-189, regarding implementation of the new standards. Because of industry feedback regarding the repeatability of the tests and the compliance times, and after further research and testing, the FAA issued, on August 25, 1988, amendments no. 25-66 and no. 121-198. These amendments established refined test procedures and apparatus to improve test repeatability, added a smoke emission test requirement and criteria to minimize the possibility that emergency egress would be hampered by smoke obscuration, and incorporated provisions for additional compliance time for unique components for which timely compliance could not be achieved.

Transport Canada has attempted to adopt the new FAA standards for cabin interiors in the proposed Improved Flammability Standards for Compartment Interior Materials Order (ANO Series II, No. 32). As of October 1, 1991, ANO Series II, No. 32, had not been promulgated; therefore, it was not applicable to the F-28 aircraft C-FONF.

Combustibility of Materials

The seat materials in C-FONF met the specifications requirements set out in Air Navigation Order (ANO) Series II, No. 28, which require that the materials in aircraft such as the F-28 meet the fire-protection standards as indicated in Federal Aviation Regulation (FAR) 25.853(c). The material standards deal with such matters as ease of ignition, rate of flame-spread, ability to self-extinguish, flame drippings, and toxicity of fumes given off during burning. Transport Canada inspectors approved the aircraft's seats for compliance on December 30, 1988.

Because of the difficulty in tracing the history of C-FONF, the exact description of the interior furnishings of the aircraft could not be determined with certainty. During the time Air Ontario operated C-FONF, the aircraft was fitted with new seat material and new carpets. There is no evidence that the aircraft interior was ever refurbished with other new cabin materials, and it is assumed that, except for the seats and carpets, the materials in the aircraft at the time of the accident were as described by Fokker Aircraft B.V. as being in the aircraft at the time of initial delivery. As in most modern aircraft, the interior furnishings of C-FONF consisted primarily of plastic materials. The following is a description of the predominant materials found in the cabin at the time of the crash, and their use:

- acrylonitrile butadiene styrene (ABS): sidewall panel trim and the blinds and retainers
- polyvinylchloride (PVC): decorative sheet-covering of sidewall panels and partition walls
- nylon (polyamides): window supports
- acrylics (PMMA): outer and inner window panes
- glass fabric epoxy laminate and nomex: sidewall panels, partition walls, and cargo-hold liners
- chloroprene rubber: window seals
- tedlar-covered glass fabric epoxy sandwich, nomex core: ceiling panels and hat-rack liner
- polycarbonate: ceiling light covers
- modified polyphenylene oxide (PPO, called Noryl): passenger service unit panels, speaker panels, airduct panels, blind panels
- neoprene: seat cushions
- aluminum: hat-rack frames, floor panels.

Thermoplastics (ABS, PVC, PPO, PMMA, and polycarbonate) made up the major part of the interior furnishings. These plastics normally have higher ignition temperatures than wood products but can be easily ignited with a small flame and will burn vigorously. The rate of flame-spread of burning plastics is as high as two feet per second, about 10 times greater than the flame-spread for burning wood. The smoke generated by burning plastics is dense, black, and sooty. Chemicals added to plastics to inhibit flammability often result in more toxic contaminants in the smoke. By-products of burning plastics are often toxic chemicals such as carbon monoxide (CO), hydrogen cyanide (HCN), hydrogen chloride (HCl), phosgene (benzine, toluene, styrene), and acrolein. Plastics subjected to heat and flame will melt, flow, and drip, causing burns to people and starting secondary fires. During his testimony, Mr Ricardo Campbell, who was a passenger in seat 7D on the right side of the aircraft, stated that molten burning material from the overhead bins dripped on him and the baby Podiluk after the aircraft came to rest. The chloroprene rubber (window seals) and the neoprene material of the seat cushions have fire characteristics similar to natural rubber. Overall there was not much rubber in the window seals, and the seat cushions burned very slowly because of their fire-inhibiting qualities. The contribution of the rubber products, the epoxy, and the aluminum to the lethality of the fire and its by-products was considered minimal compared with the contribution of the plastics.

Having reviewed all the evidence concerning the crash survivability of this accident, I conclude that the high survival rate in this severe crash was due to unpredictable and uncontrollable factors such as:

- daylight conditions,
- the heavy snow cover on the downsloping terrain, and
- the breaking apart of the aircraft during the final crash sequences, thus allowing many occupants to escape the wreckage and the fire.

Combined with the investigation problems associated with the near-total destruction of the aircraft by impact and fire, these factors preclude me from making technically specific safety recommendations with regard to crash survivability.

Findings

- During the crash, g forces in the aircraft reached 15 to 20 g, with local forces reaching perhaps 34 g.

- The breakup patterns of the F-28 aircraft, C-FONF, were all consistent with the overall assessment of the impact dynamics, and there was no observed pattern that, in an engineering design sense, was considered to be of an unexpected nature or that could not be explained. Therefore, I find that there is no evidence of fault in the design and integrity of the F-28 aircraft.

- Aircraft interior furnishings burned and gave off heavy sooty smoke and toxic gases; and burning, molten–plastic-like material fell on passengers.

- The clothing and slip-on shoes worn by flight attendant Sonia Hartwick did not afford her adequate protection after the crash. The weather was cold, and Mrs Hartwick lost her shoes in the crash.

- Passenger seats were deformed and many were detached from the aircraft floor and bunched in the front of the cabin after the crash.

- Overhead racks fell on at least 19 passengers.

- Many survivors of the crash were hindered in their escape by debris in the aircraft; some of the debris was certainly carry-on baggage from the overhead racks and from under the aircraft seats. (The subject of carry-on baggage is dealt with in chapter 24 of this Report, Flight Safety.)

RECOMMENDATION

It is recommended:

MCR 39 That Transport Canada press for the adoption of standards for aircraft interiors that would prevent the rapid spread of fire and the emission of toxic fumes.

12 FOKKER F-28, Mk1000, AIRCRAFT PERFORMANCE AND FLIGHT DYNAMICS

Mr Ralph E. Brumby, principal engineer, aerodynamics, Douglas Aircraft Company, in an article written in 1979, discussed wing surface roughness and aircraft performance:

> Most flight crew members and investigators are aware of the highly adverse aerodynamic effects of large amounts of wing surface roughness, such as the irregular shapes that can form on the leading edge during an icing encounter. However, what is not so popularly known is that seemingly insignificant amounts of wing surface roughness can also degrade flight characteristics ... roughness caused by frost, snow or freezing fog adhering to the wing surface, large accumulations of insect debris, badly chipped paint, or a distribution of "burred" rivets over the wing surface.
>
> (Exhibit 532, tab 11, "Wing Surface Roughness, Its Causes and Effects," *DC Flight Approach* (January 1979), 32)

A number of witnesses on board C-FONF on its final flight provided testimony as to their observations of snow and ice on the aircraft wings prior to takeoff at Dryden. These witnesses, and others, described in general terms the aircraft flight performance on takeoff and its flight path. Their descriptions greatly assisted the investigators and this Commission in determining what might have caused the F-28 aircraft to perform the way it did and, more importantly, why it failed to perform in a normal manner during its takeoff roll and its brief flight.

The most important and useful sources of information available for the investigation of aircraft flight dynamics and performance are the aircraft flight data recorder (FDR) and cockpit voice recorder (CVR). Because the recorders in C-FONF did not survive the fire, it was necessary for this Commission of Inquiry to pursue other avenues to determine what caused the flight profile of C-FONF.

It was the expressed view of the surviving crew member; of numerous passengers on the ill-fated aircraft, among them two professional airline pilots; and of a large number of observers on the ground, many of them pilots, that snow and ice adhering to the upper wing surfaces of C-FONF was the physical cause of the crash. The evidence of these witnesses, coupled with a thorough investigation by CASB investigators seconded to my Commission, left virtually no doubt that there was substantial contamination adhering to the upper wing surfaces during takeoff. The aircraft accident investigative process required and the mandate of this Commission of Inquiry demanded that a detailed and thorough analysis be conducted to determine the degree to which surface contamination affected the flight dynamics of C-FONF and whether performance of the aircraft degraded to the point that the aircraft was unable to maintain flight.

I stated in Part 2 of my first *Interim Report*, in the section dealing with wing contamination, that:

> The adverse effects on aircraft performance and handling qualities caused by contamination of an aircraft's lifting surfaces, as described by the professional pilot witnesses in their evidence, whether due to snow, ice, frost, or other contamination, are well documented and universally known in the aviation community (p. 25).

In the following section, on safety awareness, I stated:

> It is a matter of particular concern that, despite the existence in many countries of applicable laws which prohibit takeoffs with contaminated aircraft-lifting surfaces, and despite the existence of similar prohibitions in the flight operations manuals of many Canadian aviation companies, icing-related accidents on takeoff continue to occur. A possible explanation is that air and ground crews are not sufficiently aware of the insidious hazards of ice, snow, and frost contamination to aircraft surfaces and the accompanying performance degradations (p. 28).

The fact that the experienced crew of C-FONF departed from the Dryden airport terminal and elected to take off in weather conditions that not only suggested but also should have red-flagged, even to a pilot far less experienced than Captain Morwood, the possibility of snow- and ice-contaminated wings, clearly indicated to me either an incomprehensible and deliberate disregard by the flight crew of these obviously dangerous conditions or, more probably, a failure to appreciate fully the adverse effects of the cold-soaking phenomenon and the problems of performance degradation caused on takeoff by contaminated lifting surfaces. These problems are discussed elsewhere in this chapter.

In order to investigate properly the flight dynamics of the Fokker F-28 Mk1000 aircraft and to determine how wing surface contamination affected its takeoff performance, a performance subgroup of the investigation team's operations group, consisting of experts in aerodynamics and aeronautical engineering, was formed. The subgroup was chaired by Mr Donald J. Langdon, a systems engineer with the Canadian

Aviation Safety Board (CASB), now the Transportation Safety Board of Canada (TSB), located at Uplands Airport, Ottawa, Ontario.

When the investigation of this aircraft accident, commenced by CASB, was assumed by this Commission of Inquiry, I sought and obtained the assistance of highly qualified experts not normally involved in aircraft accident investigation. Collaborating on investigating and researching the flight dynamics of the Fokker F-28 Mk1000, and in preparing a report on that subject, were Mr J. Murray Morgan, a physicist, an engineering test pilot of National Aeronautical Establishment (NAE) at National Research Council Canada (NRC), and an expert both in human performance in the cockpit and in computer-generated simulations; Mr Richard H. Wickens of NAE at NRC, an aerodynamicist specializing in low-speed aerodynamics; and Mr Gary A. Wagner, a pilot with Air Canada, a member of the Canadian Air Line Pilots Association (CALPA), an aeronautical engineer, and an adjunct assistant university professor lecturing in aerodynamics. I am indebted to these highly specialized individuals, recruited by Mr Langdon, for providing this Commission with a thorough and in-depth analysis of aircraft flight dynamics and performance issues.

Assisting in aircraft performance matters for my Commission were Mr David G. Rohrer, a CASB accident investigator seconded to my staff as a technical adviser, and Captain Allan Murray, a senior airline captain with Canadian Airlines International, who has extensive experience flying the F-28 Mk1000. Mr Rohrer was the chairman of the operations group; Captain Murray, a member of that group, participated on behalf of CALPA, which prepared an operations group working paper and thereafter the operations group's report.

Because witnesses had observed snow and ice on the wings of the aircraft and because of the concerns that my investigators had at an early stage of the investigation regarding ice contamination, Mr Langdon, again on behalf of my Commission of Inquiry, also requested the assistance of the low-temperature laboratory of NRC. Dr Myron M. Oleskiw, a research meteorologist with expertise and experience in studying ice accretion on air foils, fulfilled the request to determine the process of accumulation and adherence of precipitation on the aircraft surfaces.

I note that CASB sought on a number of occasions the assistance of both NRC and NAE and has cooperated on an informal basis with them on matters such as ultralight and amateur-built aircraft flight testing, helicopter crashes, FDR interpretation and transcription, development of computer software for the readout of FDR tapes, and fuel and lubricant analysis. I commend this type of cooperation, and I strongly urge and recommend that the TSB continue in the future to elicit and use the valuable expert resources of NRC and NAE.

Background

During the first week of May 1989, the members of the operations group travelled to Charlotte, North Carolina, and to Tampa, Florida, to visit Piedmont Aviation Inc. and USAir ground- and flight-training centres. Piedmont Aviation Inc. was purchased by USAir in early 1987, and over the next two years USAir and Piedmont Aviation Inc. merged their operations, completing the system merger by the summer of 1989. Unless specifically referring to USAir, I will refer to the collective operation of Piedmont Aviation Inc. and USAir as Piedmont Airlines or simply Piedmont.

The purpose of the group's visit was to review in detail the Fokker F-28 flight crew ground-training course given by Piedmont, under contract, to members of a number of Air Ontario Fokker F-28 flight crews, including Captain George Morwood and First Officer Keith Mills. Mr David Adams, this Commission's human factors expert, who worked with the operations group, was among those examining Piedmont's flight attendant crew training. While there, the operations group also reviewed Piedmont's progress and training records for Captain Morwood and First Officer Mills and met with the ground school instructor who had taught the two pilots.

In addition, some of the team members flew Piedmont's Fokker F-28 Mk1000/4000 aircraft flight simulator in Tampa to attempt to duplicate the performance and the flight profile of aircraft C-FONF as described by witnesses and estimated from initial accident investigation information.

Investigators' examination of the aircraft wreckage indicated that there were no mechanical malfunctions, nor was there evidence of engine power loss. Review and examination of the available weather data indicated that a low-level wind shear phenomenon was unlikely.[1] Witnesses did, however, describe both snow and ice on the wings. Witness statements and flight path reconstruction data indicated a flat flight profile before the aircraft crashed, and witnesses described how the aircraft lifted off, settled back on the runway, and lifted off again at or near the west end of the runway.

The flight investigation team consisted of Mr Rohrer; Mr Ronald Coleman, a CASB accident investigator; Captain Allan Murray; and Captain Robert Nyman, a senior F-28 qualified pilot with Air Ontario

[1] A wind shear is an atmospheric condition in which the wind velocity vector (the wind speed and direction) changes significantly with small changes in the horizontal or vertical position. On takeoff, a wind shear could result in a significant performance loss if the aircraft climbed into a rapidly decreasing head wind, a rapidly increasing tail wind, or a strong vertical down draft.

and a member of the operations group. Together with the assistance of Piedmont Airlines, the team programmed various performance parameters into Piedmont's Fokker F-28 flight simulator and flew 30 takeoff profiles to identify factors that may have caused the aircraft to perform in the manner observed by witnesses.

The simulator is capable of simulating flight with a fidelity that meets Canadian and United States regulatory standards. The team was specifically interested in the modes of flight necessary to duplicate such flight anomalies as power loss, slush on the runway, wind shear, and mechanical malfunctions. Runway contamination could be simulated, but wing contamination could not.

During the tests by the operations group, the simulator was flown by Captain Nyman of Air Ontario and Captain Allan Murray of Canadian Airlines International, both qualified F-28 pilots.

The investigation team performed all takeoff profiles from a standing start on the runway using rated power and a flap setting of 18°. Airport elevation, runway length, and ambient temperatures and pressures similar to those at Dryden at the time of the accident were programmed into the simulator. Aircraft performance was measured at varying runway-contaminant depths of up to one-half inch of slush.

In addition to conducting the takeoffs from a slush-covered runway, the team flew a number of takeoffs, each time adding or changing factors that would progressively decrease the performance capability of the aircraft. In separate flights, one engine was failed at critical engine failure speed (V_1), wind shear was created by simulating a 30-knot tail wind at V_1, the aircraft was rotated at excessive rates and over-rotated to greater pitch altitudes than recommended, and the simulator was programmed to prevent the aircraft from rotating further than 6° pitch angle.[2] In each case where one of the factors was simulated, there was no significant degradation in performance and the aircraft completed its takeoff without difficulty.

The operations group concluded that the aircraft type performed well and had more than adequate thrust to operate from a 6000-foot runway at the estimated gross weight of C-FONF, and at the temperatures,

---

2 V_1, the takeoff decision speed, is computed for each takeoff and is, in general terms, the speed below which the takeoff should be rejected should an engine failure occur and above which the takeoff should be continued. V_1 is computed so that should an engine failure occur at or before that speed on a limiting runway, there would be adequate runway to stop the aircraft. Furthermore, should the engine failure occur at or after V_1 and the pilot continue the takeoff, the aircraft would be safely flyable and have a performance level that would allow the aircraft to reach a height of at least 35 feet over the end of the runway. A number of other complex criteria are involved in the V_1 concept and certification rules, but the above provides the general concept and purpose behind the V_1 takeoff decision speed.

pressures, and wind conditions present at Dryden on March 10, 1989. However, the Piedmont flight simulator was not highly calibrated, and, after analysing the results of the flights, the operations group realized that more in-depth study was necessary.

In order to inquire further into the performance of the Fokker F-28 aircraft, members of the operations group travelled to the aircraft design and manufacturing facility of Fokker Aircraft B.V. at Schiphol Airport, Amsterdam, The Netherlands. There they met with a number of Fokker's technical authorities, including Mr Rinse Jellema, Mr Frans Hollestelle, and Mr Jack van Hengst.

Mr Jellema, an aeronautical engineer, is the manager of the fleet airworthiness department, which is responsible for Fokker's fleet airworthiness, quality assurance, and safety investigations. He represented Fokker Aircraft during the early stages of the investigative process and assisted CASB's Engineering Branch in its examination of the aircraft wreckage and in dealing with the crashworthiness aspects of the aircraft crash.

Mr Hollestelle, who is Fokker's operations engineer, flight crew training and operations support, reviewed with the operations group the F-28 performance data and the operational capabilities of the aircraft and assisted in determining the performance capability of the aircraft by using the information available to the flight crew of C-FONF at Dryden prior to its takeoff and crash.

Mr van Hengst is the chief aerodynamicist and the manager of the aerodynamics and aeroelasticity department of Fokker Aircraft. He worked on the design and the development of the original Fokker F-28 Mk1000 and subsequent series F-28 aircraft, worked on the development of the Fokker-100 aircraft, and has participated in several research projects conducted by Fokker Aircraft unrelated to the F-28 and the Fokker-100 aircraft programs. Mr van Hengst provided to members of the operations group and the performance subgroup historical data on the design and development of the F-28 Mk1000 aircraft, together with aerodynamics studies relating to airfoil surface roughness and wing contamination. Fokker Aircraft also shared with my Commission investigators its collective knowledge of contamination-related accidents experienced by the Fokker F-28 over the years.

Manufacturer's Performance Research and Testing

The Fokker F-28 Flight Handbook was prepared by Fokker Aircraft B.V. (Fokker Aircraft or Fokker) to provide flight crew members as well as operations staff with a manual containing all information regarding operations and performance. This handbook consists of three volumes. Volume 1 includes operating information; volume 2, certified performance information; and volume 3, additional performance information. The general performance information set out in the handbook is presented to comply with the appropriate performance criteria and certification requirements of United States Special Civil Air Regulation No. SR-442B.

The procedures, techniques, and other conditions detailed in these manuals were developed and recommended by Fokker Aircraft and approved by the Rijks Luchtvaart Dienst (RLD), the Dutch airworthiness regulatory authority, for use in the operation of F-28 aircraft. Fokker emphasizes that the procedures are only for guidance in identifying acceptable operating procedures; they are not considered mandatory so as to prohibit operators from developing their equivalent procedures.

Accordingly, manuals such as Piedmont Aviation Inc.'s F-28 Operations Manual, USAir's F-28 Operations Manual (also referred to as USAir's Fokker F-28 Pilot's Handbook), and the draft F-28 Operations Manual prepared by Air Ontario are examples of equivalent procedures developed by operators to fit their operations. In no event, however, may the F-28 operations manuals prepared and developed by operators be less restrictive than the procedures, techniques, and other conditions contained in Fokker's F-28 Flight Handbook.

In certifying the F-28, Fokker Aircraft elected to meet the requirements of the United States Civil Aviation Regulation 4(b) (CAR 4(b)), now called Federal Aviation Regulation 25 (FAR 25). The Dutch RLD adapted and conformed to the United States CAR 4(b) and FAR 25 as its certification requirements and standards. Fokker Aircraft also met the equivalent British Civil Aviation Regulations (BCARs) in its certification process.

An examination of the applicable legislation and a review of the evidence by this Commission confirmed that the aircraft met all the requirements of CAR 4(b) (and now FAR 25) and of the BCARs; accordingly, the aircraft met the applicable equivalent Canadian legislation for the purposes of operation in Canada. I am also satisfied that, since the aircraft met the requirements of Dutch CARs, United States CARs and FARs, and British CARs, Transport Canada was in a position to issue the appropriate certificate of registration and certificate of airworthiness for the Fokker F-28 Mk1000, Canadian registration C-FONF.

Water/Slush Ingestion by Engines on Takeoff

The flight crew of a NorOntair Twin Otter took off from the Dryden airport at approximately 12:50 p.m. on March 10, 1989, approximately 39 minutes after the crash of C-FONF. In testimony before this Commission, members of the crew described the amount and type of contamination at the terminal ramp and on the east half of runway 29 to be one-quarter to one-half inch of slush at that time. Two witnesses on the ground heard engine noises coming from C-FONF during its takeoff run that they variously described during testimony as "burping," "sharp," "explosive," and "quick" then "gone." In view of this evidence, it was deemed necessary to determine if the noises described by these two witnesses might have been caused by slush ingested into the engines during the aircraft's takeoff run.

In order to comply with the United States FAR 25.1091–type certification requirements, Fokker Aircraft was required to design and locate the engine air inlet ducts on the F-28 aircraft in such manner as to minimize the ingestion of foreign matter during takeoff, landing, and taxiing, and it had to demonstrate that the design of the aircraft precludes a hazardous quantity of water and/or slush on the runway from being directed into the engine inlets. The evidence shows that flight and ground-run tests were conducted in natural slush conditions at Schiphol Airport in Amsterdam on February 5, 1968, with Dutch RLD observers present.

Fokker, in its certification report no. V-28-7, dated March 11, 1968, and entitled "Investigation on F-28 Slush Ingestion Characteristics," described the tests, the test results, and the conclusions. The tests consisted of one takeoff with 25° of flap selected and two ground-run accelerate-stops with, respectively, 42° and 25° of flap. During the tests, the spray patterns were observed from inside the aircraft and observed and photographed from two observation posts alongside the runway. There were large variations in the density and depth of the slush layer. The first part of the runway, where the aircraft was accelerating, was covered with patches up to two inches thick of relatively dry snow and low-density slush. On the portion of the runway where the aircraft passed at high speed or was stopping, the predominant condition was high-density slush, one-quarter to one-half inch thick. The temperature was slightly above zero. There were water deflectors on the nose tires.

Spray from the nose wheels emerged in the shape of a flat, narrow disc and passed beneath the wing and the fuselage between the main undercarriage struts. A small amount of slush deposit was found on the nose-gear doors and the underside of the fuselage aft of the nose-wheel well. This secondary spray from the nose tires was effectively blocked from the engine intakes by the fuselage. No spray from the nose tires was seen to pass over the wing or into the intakes. The spray from the main wheels had a similar shape and, apart from a small jet of slush emerging at a steeper angle from between the two wheels of each main undercarriage strut, passed well below the plane through the underside of the aft fuselage. The jet of slush was effectively prevented from entering the intakes by the inboard sections of wing and flap.

It was concluded that, under conditions representative of slush conditions that can be expected in airline service, the design of the aircraft precludes a hazardous quantity of water and/or slush from being directed into the engine intakes. Since there was no observed ingestion, Fokker concluded that the tests also showed that the location of the engines is also favourable in minimizing the ingestion of other forms of runway contamination.

Fokker provided to this Commission certification report no. V-28-7, together with photographs taken by Fokker, which describes and demonstrates the testing and conclusions. Shown below as figure 12-1 is one of the photographs provided by Fokker Aircraft showing the F-28 during slush tests moving at high speed in slush. Mr van Hengst, who was present during the tests, described in detail during his evidence before the Commission the findings of Fokker Aircraft. He also advised that he is not aware of any operators who have reported contamination entering the engines on slush-covered runways.

Mr van Hengst testified that, at a flap setting of 25°, slush lodged between the flap and the flap vane, a condition Fokker considered might cause damage on flap closure. Accordingly, Fokker, to avoid damage to the flap vane system due to the slush compaction between the flap and vane, recommended that takeoffs in slush be conducted at an 18° flap setting. Fokker in evidence showed that flaps set at 18° provide a shielding effect similar to a 25° setting but without exposing the flap and vane to slush compression damage.

There is some possibility that snow, slush, or ice that left the wing upper surface during the takeoff run was ingested into the engines. The Piedmont operations manual, in the section on adverse weather, contains information regarding ice that may form on the upper surface of the wings while the aircraft is on the ground. The ice forms either because of warm fuel, which can cause snow to melt, with the water subsequently refreezing; or because of extremely cold fuel, as may be the case after long flights at very low ambient temperatures, which causes water condensation or rain to freeze. It is stated in the manual that "[d]uring take-off this ice may break away and at the moment of rotation enter the engine causing compressor stall and/or engine damage" (p. 3A-24-1). During testimony, however, no one described seeing anything that could be taken to be unusually large amounts of ice or snow separating from the wing of C-FONF during the takeoff roll. Moreover, there was no damage found during examination of the engines that showed they had ingested slush or ice. (For details, see the section on engine investigation in chapter 10 of this Report, Technical Investigation.) During manufacturer's certification tests of the F-28 Rolls-

Figure 12-1 F-28 during Slush Test, February 5, 1968

Source: Fokker Aircraft B.V.

Royce engines, as described in chapter 10, it was demonstrated that the engines were able to ingest great quantities of water with no apparent difficulty. Bearing this point in mind along with the fact that most witnesses testified that the engines were operating normally throughout the takeoff run, it is probable that if the engines ingested snow, slush, or ice from the wings during takeoff, the ingestion could have caused only a fleeting abnormality and perhaps an uncommon noise.

From the evidence that I have heard and the documents reviewed, I am satisfied that, during the takeoff run of C-FONF from the Dryden airport on March 10, 1989, slush from the runway was not ingested into the aircraft's engines. If contamination from the aircraft wings had been ingested, it would not have caused a reduction in thrust or a failure of the engine such as to affect tangibly the takeoff performance of the aircraft.

Wing Leading-Edge Damage

Denting

Commission investigators were advised that the wing leading edges of one or both of Air Ontario's F-28 aircraft may have been dented. Since a smooth leading-edge surface is critical to the production of lift, my investigators felt it was important to make inquiries to determine if there was denting on the wing leading edges of C-FONF. They also approached Fokker Aircraft to determine the effects that denting on the wing's leading edge has on aircraft performance. Information on this subject was also solicited during the appearance of Air Ontario pilots on the witness stand. Some of the pilots recalled having some knowledge of denting on the wings of the F-28 aircraft, but only one stated that there were dents on aircraft C-FONF. Captain Monty Allan, a first officer on the F-28 at the time of the accident, stated that he was aware of dents on the wings, particularly of a fist-sized dent on the leading edge of C-FONF. Since the dents were written up in appropriate logbooks and apparently were not repaired, he believed the dents were within allowable limits. None of the other pilots was sure of the size or position of the dents. Ms Elaine Summers, the chairwoman of the investigation team's records group, stated in testimony that, while examining aircraft C-FONG after March 10, 1989, in relation to another incident, she noted some dents on the leading edge of the left wing.

Fokker Aircraft advised that on August 15, 1971, an F-28 aircraft operated by Martin's Air Charter encountered hail in flight at 230 knots at an altitude of 10,000 feet. The leading edges of the wings, the empennage (tail section), and the engine inlets were dented, and the fuselage nose was worn. The maximum depth of the dents was about 4 mm, and there were about 25 dents per m span of the wing. The structural integrity of the leading edges was not impaired, and continued flying was permitted by the Dutch RLD, provided Fokker could show that the aerodynamic capabilities were not downgraded. (The wing was required still to be able to generate the maximum lift coefficient (C_{LMAX}) as certified for the aircraft.)

On August 16, 1971, a test flight was flown on the aircraft, during which flight stall tests were performed to assess the maximum lift coefficient and the stalling characteristics. The flight was flown by a Fokker test pilot, and an F-28 captain with Martin's Air Charter acted as co-pilot. Observers on board included individuals from the Dutch RLD and Fokker's aerodynamics department. The testing revealed no measurable effect on the maximum lift coefficient and the stalling characteristics due to the dents in the leading edges of the wings.

In the report of the testing, Fokker described the hail encountered and the test results. The aircraft's stalling characteristics were found very satisfactory and not impaired whatsoever by dents in the leading edges of the wings. Fokker concluded in the report that, based on the indicated angle of attack during the tests, the g-break lift coefficients in the aircraft were at least equal to the g-break lift coefficients when the aircraft was certified and, most likely, were better.[3]

It is the evidence of Mr van Hengst that this report, generated as a result of the test flights, was used by Fokker Aircraft as a basis for the configuration deviation list (CDL) for the F-28, which specifies the amount of denting allowed on the leading edge of the wing. To summarize Mr van Hengst's evidence, basically the CDL stated that the amount of allowable denting on the leading edge of an aircraft wing can be no more than an amount equal to 25 per cent of the dents found on the test aircraft and that the maximum depth of any one dent was 4 mm. In determining the CDL requirements, structural integrity of the wing as well as aircraft performance was taken into consideration.

Mr van Hengst in his evidence discussed other types of denting on leading edges. He concluded that sharp dents in the leading edge of the wing would have the greatest effect on lift, with smooth dents on the trailing edge having no effect. Apart from those tests described in the aerodynamics report provided to this Commission, Fokker conducted no other tests relating to the effects of dents on aircraft wings. Since Mr van Hengst's views on the effects of denting on the leading edge are important, I include the following quotation:

[3] In ground terms, g-break is the point where an aircraft can no longer maintain one-g level flight. That condition is used during certification test flight to define the aircraft stall speed and corresponding maximum lift coefficient (C_{LMAX}).

A. ... When we did this flight test with the dents, deep in my heart, I thought it had an effect. And I learned a lot of it. I learned that maybe it has something to do with the sharpness and the steepness of the disturbance, and looking in all the data and wind tunnel testing done in the early days, that convinced me that that is a rule.

As long as the edge of the disturbance is not sharp but smooth, then the effect on the aerodynamics is mild. I won't say there is no effect. It depends on the place where it is. If it is on the leading edge, there will be effect. If it is on the trailing edge, there will be no effect.

Q. And if they are sharp, if the dents are sharper?

A. If it is sharpened, it's worse. That's the worst thing ... you can have.

(Transcript, vol. 71, p. 147)

Mr van Hengst also responded to a question about the effect of the dents on adhesion of contamination to the leading edge of a wing:

A. I – well, I'm not a [physicist], but if you look at the mechanism, if the precipitation is simply rain, it doesn't matter whether the surface is smooth, say a metal surface. As long as the temperature of the surface is cold, it will adhere. It will stick to the surface. And no matter whether it is [a] little bit roughened, it simply sticks.

(Transcript, vol. 71, p. 148)

Condition of the Paint

In order to complete the picture regarding the condition of the leading edges of the wings on the F-28 aircraft flown by Air Ontario, the Air Ontario pilots were questioned about the condition of the paint on the leading edges. During testimony, Captain Robert Perkins stated that he learned on the F-28 course that the F-28 aircraft was susceptible to leading-edge damage. He had noted some chipped paint on, he believes, C-FONF, and he stated that the paint on C-FONF was older than that on C-FONG. Captain Allan stated that the paint on C-FONF was peeling and flaking, and on C-FONG it was bubbling and blistering; the bubbles were "tiny, tiny, very small" (Transcript, vol. 91, p. 68), about the size of the tip of a pen. Captain Allan was never genuinely concerned about the leading-edge paint on the F-28 aircraft.

Mr van Hengst did not provide a detailed opinion on the aerodynamic effects of chipped paint on the wing leading edges. He stated that the wings should be kept as smooth as possible to minimize skin friction during flight. He also stated that the roughness on the wing from paint chipping and peeling is not especially significant and does not significantly affect lift characteristics.

While there may have been some denting and degradation of the paint on Air Ontario's two F-28 aircraft, I have no evidence before me to indicate that the condition of the wings' leading edges could have contributed appreciably to the degradation of the takeoff performance of C-FONF. I make this finding based on the fact that there was never any reported takeoff or performance degradation of either of Air Ontario's two F-28 aircraft during their operational lives. Accordingly, I do not believe that denting or chipped paint on the leading edges of the wings of C-FONF contributed to the performance degradation during its ill-fated takeoff run from Dryden on March 10, 1989.

Unexpected Stalling Due to Wing Anti-Ice Air Leakage

The matter of unplanned aircraft stalling while on approach for landing was brought to the attention of my investigators by members of the International Federation of Air Line Pilots Associations (IFALPA), who had observed unplanned stalling caused by leakage of hot anti-icing bleed air through joints in the wing's leading edge. The leaks cause the airflow characteristics to be modified. The partial flow separation that then occurs over the parts of the wings where the leaks appear adversely affects the aircraft stall characteristics. Accordingly, the matter was reviewed to determine whether this phenomenon may have occurred during the takeoff of C-FONF.

Both the Fokker F-28 Flight Handbook and the Piedmont and USAir operations manuals stress that wing anti-ice should not be put on during any phase of the takeoff or while the aircraft is airborne below 1500 feet above ground level. Wing anti-ice requires engine bleed air and results in a loss of some engine thrust. To ensure maximum available engine thrust during takeoff, pilots are advised not to use wing anti-ice during takeoff. Although the observations made by the IFALPA members related to flight at low speeds during the approach and landing with wing anti-ice on, my investigators took steps to determine if the wing anti-ice system was off during the takeoff at Dryden. This exercise was carried out to confirm that C-FONF had maximum thrust available during takeoff and also to eliminate any concern about possible wing stall due to wing anti-ice bleed-air leakage. The investigation confirmed that the wing anti-ice valves were in the off position after the crash and, owing to the absence of debris in the air passages of the anti-ice system, were in the off position during the time the aircraft was travelling through the trees.

It is unlikely that, owing to performance penalties which would have been suffered, the pilots would have used wing anti-ice in any event: C-FONF was being operated from a 6000-foot runway and the aircraft weight at takeoff was close to maximum structural takeoff weight. Although there was observed wing drop shortly after takeoff, the aircraft was also observed to have regained a wing-level attitude.

There is persuasive evidence that the anti-ice system was off during the takeoff of C-FONF, and there is no evidence of previous wing anti-ice air leakage problems on either of Air Ontario's F-28 aircraft. The fact that the anti-ice valves were closed would eliminate any concern that air leakage had affected the flight characteristics of the aircraft. I am therefore satisfied that wing anti-ice air leakage was not a factor during the takeoff from Dryden.

Relevant F-28 Wing Surface Contamination Occurrences

To determine whether the F-28 aircraft had a history of contamination-related accidents, my investigators reviewed the aircraft type's accident history. The F-28 accident and incident record, as revealed in International Civil Aviation Organization (ICAO) and CASB occurrence data bases, is not unusual in any sense. The records do not indicate any particular trend, nor is there evidence of the aircraft having abnormal flight characteristics. On the contrary, the Fokker F-28 Mk1000 appears to have relatively good performance and is reportedly easy to fly.

Two occurrences involving wing contamination and the Fokker F-28 are significant to this investigation and warrant a detailed description of the circumstances and the findings. The first occurred in Germany, at the Hanover airport, on February 25, 1969, and the second occurred in Turkey, at the Cumaovasi airport in Izmir, on January 26, 1974.

Hanover, Germany, February 25, 1969

The crew of an F-28 aircraft attempted to take off from runway 09 left on a demonstration flight from the Hanover airport at about 1626 GMT (1726 local), February 25, 1969. Runway 09 left is 2387 m (7832 feet) long and 45 m (150 feet) wide, and it has no slope. The elevation of the airport is 170 feet above mean sea level (asl).

At rotation speed, the captain rotated the aircraft to about 12°, and the aircraft lifted off. It immediately rolled to the right to an angle of bank of about 25°, which could not be corrected by aileron control. The aircraft did not accelerate and descended until the right wing tip struck the runway. The aircraft rolled to the left and then to the right, and the captain rejected the takeoff. The aircraft came to rest approximately 50 m (164 feet) to the right of the runway and 1975 m (6480 feet) from where the takeoff roll commenced. The stick-shaker had activated three times while the aircraft was airborne. The only damage to the aircraft was to the right wing, the flap, and the aileron. None of the two crew or nine passengers was injured.

Given the conditions at the time of takeoff, the aircraft should have reached rotation speed of 103 knots after a ground roll of 475 m (1558 feet) and become airborne at 113 knots. The Fokker F-28 Flight Handbook recommends that the aircraft be rotated to 5 to 10° on takeoff. From the flight data recorder it was determined that the aircraft was rotated at 105 knots after a ground roll of 535 m (1755 feet) and became airborne at 110 knots. The aircraft reached a maximum height of 50 to 60 feet and a maximum speed of 127 knots. The first stall developed three to five seconds after liftoff.

The captain held a valid airline transport pilot licence (ATPL) and had a total of 11,500 flying hours with recent flying experience on the Caravelle, the Hansa Jet, and the Nord 262 aircraft. He had a type rating on the F-28 with 12 to 14 hours on the aircraft. The co-pilot held a valid ATPL and had a total of 8000 flying hours. He had 10 to 15 hours on the F-28.

The aircraft was serial number 11004, registered as PH-ZAA, and was the fourth prototype and the first commercially operated aircraft of the F-28 series. It was owned by a German charter company (LTU). The aircraft was modified up to the latest standards of the production series and met Netherlands (RLD) requirements for airworthiness. There was no evidence that there had been any defects or malfunctions that had a bearing on the incident. The aircraft's weight and balance were within limits. The stabilizer setting for the flight had been set to 1° ANU (aircraft nose up); in the flight manual the recommended setting is 1° AND (aircraft nose down). The incorrect stabilizer setting would reduce the amount of control column force required to effect aircraft rotation.

The aircraft had been parked for about five hours preceding the attempted flight. During this time, the temperature was between -1 and -2°C, the relative humidity was near 100 per cent, there was overcast cloud based at 700 to 900 feet, and there was precipitation in the form of light snow and undercooled drizzle. At takeoff time, the temperature was -2°C and the visibility was 3 km in snow. The wind was 060° at 7 knots. The runway was covered with rime or ice but had been chemically de-iced and sanded during the day; the measured braking action was medium to good. The preceding takeoff had been made by a Viscount aircraft 15 minutes before the incident. On the basis of the weather, the investigators concluded that no wind shear, either in force or direction, existed, and that any turbulence from departing aircraft had dissipated.

During the pre-flight inspection, the captain and a factory mechanic noted that the precipitation had formed a thin layer of ice patches on the wing. The captain judged this accretion not significant enough to have it removed. It was later established that the ice was mostly at the nose of the wing, back to approximately 30 per cent of the chord and extending over the full span of the wing. The accretion was described by the captain and mechanic as a thin, irregular layer of ice patches, the ice crystals being of a granular form. A passenger, while leaving the aircraft via an emergency exit over the right wing, had trouble keeping his balance because of ice on the wing.

Fokker Aircraft, which participated in the investigation, was able to assess the degree and amount of contamination on the wing. In terms of area covered by the contamination, Mr van Hengst stated in testimony as follows:

> A. It was distributed over the whole wing, and what also happened is that it stands there, and in the memory of one of the witnesses, at that early day in the morning, there was also between all this freezing drizzling the sun coming up. It was in the morning.
>
> And one of the parts of the wing was in fact already melting, and the other not. Because the aircraft was standing like this and the sun is coming like this so this part was starting to melt and the other one not.
>
> So ... what then happened is they took off and in fact, one of the wings was clean due to the sun and the other not, and that is the reason why it rolls off.
>
> (Transcript, vol. 70, p. 78)

During the takeoff, the aircraft was over-rotated. It was found that the stabilizer was incorrectly set, resulting in lower control forces at rotation. However, the maximum rotation angle that was reached, about 12°, would not have caused an F-28 with a clean wing to stall.

It was therefore concluded that the contamination on the wing, in the form of a thin, irregular sheet of granular ice crystals, must have been the factor that caused the wing to stall.

Fokker Aircraft determined that the roughness on the nose and upper surface of the wing was equivalent to ice particles of 1 or 2 mm in diameter, distributed approximately one particle for each square cm of wing surface.

Izmir, Turkey, January 26, 1974

The crew of a Turkish Airlines F-28 aircraft, serial number 11057 and registration TC-JAO, attempted to take off from Cumaovasi airport, Izmir, Turkey, at about 0710 local time, January 26, 1974. The aircraft became airborne after a ground roll of approximately 975 m (3200 feet); however, when it was 8 to 10 m (26 to 33 feet) above the ground, it yawed to the left and pitched nose down. The aircraft contacted the ground in a near-level attitude, first by the outboard fairing doors of the left flap, then by the left side of the fuselage belly. The aircraft disintegrated and caught fire within 100 m (328 feet) of travel. Four crew members and 62 passengers died as a result of the accident; one crew member and 6 passengers survived.

With the conditions at the time of takeoff, the aircraft should have reached rotation speed after a ground roll of 850 m (2800 feet). From the flight data recorder it was determined that the aircraft became airborne at 124 knots after a 975 m (3200-foot) roll. The speed increased to 133 knots and then dropped to 124 knots, and the aircraft veered left.

The captain was an ex-airforce jet fighter pilot, held a valid airline transport pilot licence, had 577 hours in F-28 aircraft, and had 2600 hours' total flying time. He had been an F-28 captain since 1972 and an F-28 check pilot since 1973. The co-pilot was also ex-airforce, and his experience was in transport-type aircraft and helicopters. He had 395 hours in the F-28, had 2794 hours' total flying time, and held a valid airline transport pilot licence.

The aircraft broke into three main sections: the tail section, the fuselage, and the cockpit. The fuselage came to rest upside down. There was no evidence of any aircraft failure or malfunction prior to the accident.

The aircraft had been parked overnight in an open area of the airport. On the morning of January 26, the temperature was 0°C and the relative humidity 95 per cent. At the time of takeoff, the temperature was 3°C and the relative humidity 97 per cent. Frost formation was not noticed during the aircraft walkaround prior to the takeoff. The next day, however, with meteorological conditions almost the same, frost accumulation was seen on the wings of another F-28 parked outside overnight. There was more frost on the left than on the right wing, which was towards the buildings.

It was concluded that the cause, or probable cause, of the accident was that the aircraft stalled because of over-rotation and frost accretion on the wings.

Wing Contamination – Research

Following the February 25, 1969, F-28 takeoff occurrence at Hanover, Fokker reviewed early research on the subject of surface roughness on airfoils and conducted a series of wind tunnel and simulator tests. Fokker wished to confirm the findings of existing literature and determine the effects of apparently unobtrusive amounts of contamination on the ability of the F-28 wing to produce lift.

Literature published in the 1930s on the effects of protuberances and surface roughness on the characteristics of airfoils concluded that protuberances on the upper surface of an airfoil, so small they would ordinarily be considered surface roughness, have a significant detrimental effect on the maximum-lift and drag characteristics. As the portion of such roughness approaches the leading edge along the upper surface, the effect becomes particularly critical.

Mr Richard Wickens, an expert in low-speed aerodynamics and one of the members of the performance subgroup, stated during his testimony that the data in the reports and memoranda of the 1930s indicate that, on smooth airfoils, smaller grain roughness has a greater detrimental effect on the lift than does larger grain. When asked if the literature is saying that more smoothly finished airfoils are more susceptible to lift reduction when subjected to some sort of roughness, Mr Wickens stated:

> A. That's what it appears to be saying. The ... more smoothly finished airfoil is capable of achieving higher maximum lift coefficients, and this curve is still going up. So that when you roughen them, you have a greater relative loss.
>
> (Transcript, vol. 69, p. 88)

Mr Wickens further stated that although there is not a great deal of lift capability lost when the rear portion is roughened, there is still some loss, although nothing like that seen when the complete airfoil, including the nose, is roughened. Mr Wickens stated as follows:

> A. There was one other point, and that is there are data points which indicated only the rear half of the airfoil in this case was roughened, and according to this, that appears to restore the performance back to its original clean state, with this exception.
>
> Q. So when only the rear half of the airfoil was roughened, the lifting capability was almost the same as it was with a totally clean surface?
>
> A. There was a slight loss, but it was nowhere near as much as with the complete airfoil roughened, including the nose.
>
> Q. So can I assume from this that the roughness on the front portion of the wing is more critical than the roughness on the back portion of the wing?
>
> A. Yes.
>
> (Transcript, vol. 69, pp. 89–90)

Mr van Hengst aptly summarized the conclusion of the early research reports as follows:

> A. Well, the basic conclusion which you can draw from this report is that contamination on a wing will give rise to loss in lift, and especially loss in maximum lift.
>
> (Transcript, vol. 70, p. 82)

Based upon this early research literature and the description by the flight crew and by the engineer who inspected the F-28 prior to its takeoff at Hanover, Fokker conducted wind tunnel tests using a scaled 20-to-1 F-28 model aircraft with both wings roughened and contaminated evenly on a scale of one 1 mm diameter particle for each square cm of wing surface.

Following the wind tunnel tests and studies conducted by Fokker Aircraft, the company produced a report, entitled "Note on the Aircraft Characteristics as Affected by Frost, Ice or Freezing Rain Deposits on Wings, December 16, 1969." Referred to as the "Wind Tunnel" report (no. L-28-222), it was forwarded at that time to all F-28 operators. The report deals with the effects of sandpaper roughness on the wings of both jet and propeller aircraft and specifically describes the degradation in takeoff lift and the acceleration characteristics of the F-28 caused by roughness on the wings. It is included in its entirety as technical appendix 5 to this my Final Report. An illustration of the F-28 model in a wind tunnel is reproduced as figure 12-2.

The tests revealed that there was a 25 per cent loss of maximum lift coefficient and that the maximum angle of attack was reduced by approximately 5°. Early experiments at cleaning contamination from the forward 50 per cent of the airfoil chord restored most of the lift characteristics. In an effort to determine more closely where the F-28 wing was most sensitive to surface roughness, Fokker removed roughness from the forward 15 per cent of the wing chord, starting at the leading-edge nose. Fokker found that the lifting capability of the wing was almost completely restored.

The wind tunnel tests also demonstrated that, with severe roughness, the wing can be stalled before it reaches the angle of attack that would normally activate the aircraft's stall-warning system.[4]

The horizontal stabilizer on the F-28 during normal operations, including takeoff, is designed not to exceed an angle of attack of approximately 7°. Fokker designed the horizontal stabilizer to guarantee continued controllability even when the wing is stalled.

Similar wind tunnel tests showed that contamination roughness on the horizontal stabilizer had little or no effect on its performance, even when the wing is stalled as a result of contamination. The tests confirmed that

---

[4] A stall-warning system (SWS) is a system designed to alert a pilot to an impending aircraft stall. It consists of an angle of attack sensor(s), an aircraft configuration input data system, and a mechanical alerting mechanism, commonly a stick-shaker. The SWS is set to activate at a predetermined angle of attack a few degrees below the wing's normal stalling angle of attack. When activated, the stick-shaker vibrates the pilot's control column. Under normal conditions, activation is generally used to indicate the prudent limit of usable lift.

Figure 12-2 Wind Tunnel Model Used in the Design of the F-28 Mk1000 Aircraft

Source: Fokker Aircraft B.V.

contamination on the horizontal stabilizer would not have a significant effect on controllability and would not affect the total lift generated by the lifting surfaces. Generally, the horizontal stabilizer provides negative lift (the lower, uncontaminated surface is the critical surface), and the angle of attack of the stabilizer is well below its stalling angle of attack.

According to Mr van Hengst, the stall-warning device on the F-28 is activated at 11° wing angle of attack. Complete airflow separation where the aircraft loses aileron control occurs on a clean wing at a point between a 19° and 20° angle of attack. On a contaminated wing, however, complete airflow separation occurs with loss of aileron control at a 9° to 10° angle of attack. In other words, with roughnesses of 1 to 2 mm on every square cm of the entire wing, the aircraft will stall prior to the stall-warning device activating; in some cases, complete loss of aileron control could happen prior to such warning.

The results of the wind tunnel tests were fed into Fokker's engineering flight simulator to determine how the aircraft would behave with various degrees of roughness on the wings. The results were interpreted in various ways, but in every case the indication was a loss in the wing's ability to produce lift when contaminated. The two graphs that Fokker prepared from its engineering flight simulator data are included to demonstrate the loss of lift caused by varying degrees of wing contamination.

Up to a point, as figure 12-3 indicates, the more the wings were contaminated the greater the loss of lift. For example, during takeoff at a weight of 60,000 pounds, with 18° of flap and with a clean wing, the stalling speed of the aircraft was about 104 knots. With the wing lightly frosted, the stalling speed was about 117 knots, and with the wing heavily frosted, about 128 knots. The V_R speed (takeoff rotation speed)[5] for the aircraft was 121 knots and the V_2 (takeoff safety speed)[6] was 127 knots. With a clean wing, the speed margin at rotation speed before stall was approximately 17 knots. With a lightly frosted wing, the margin was 5 knots. With a heavily frosted wing, the wing was in a stalled condition as it was rotated.

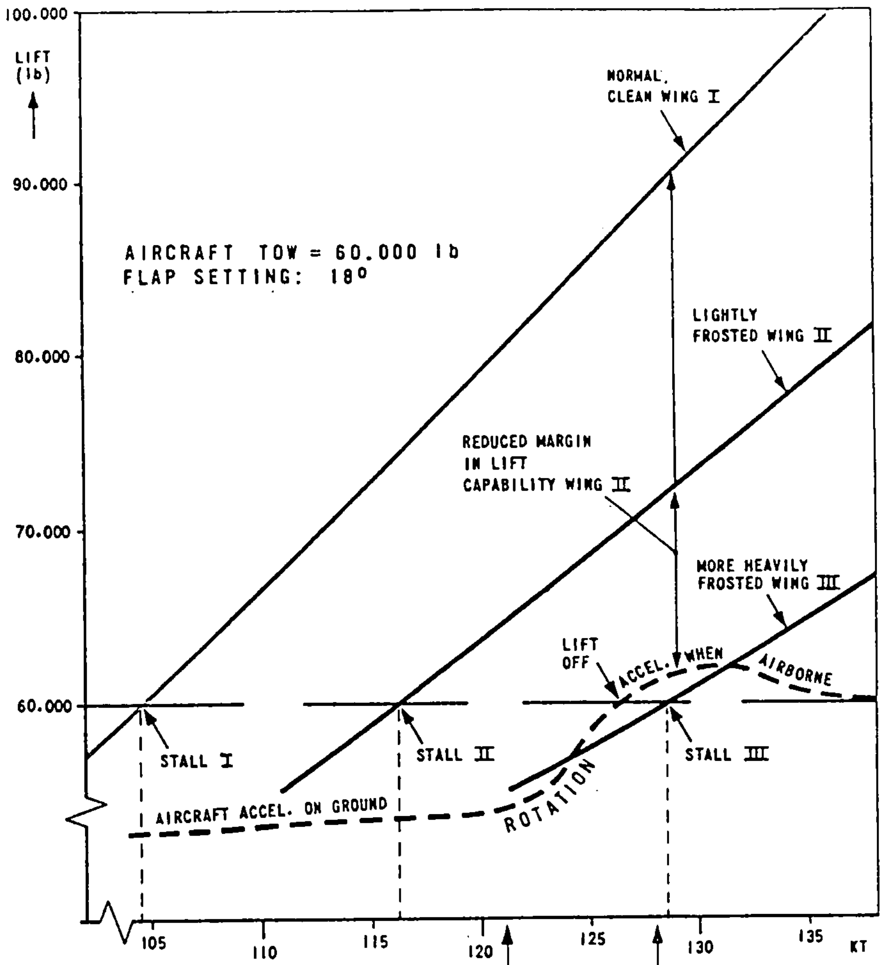
Figure 12-4 describes the decrease in stall margin between a normally clean wing and a lightly frosted wing and demonstrates that an aircraft

---

5 V_R, the takeoff rotation speed, in general terms is defined as the speed at which rotation is initiated during the takeoff to attain V_2 climb speed at the 35-foot screen height. V_R must not be less than 1.05 times the minimum control speed in the air (V_{MCA}) or less than V_1.

6 V_2, the takeoff safety speed, in general terms is equal to the actual speed at the 35-foot screen height as demonstrated in flight and must be equal to or greater than both 1.20 times the stall speed in the takeoff configuration and 1.10 times the minimum control speed in the air (V_{MCA}).

Figure 12-3 Comparative Margins for Two Arbitrarily Chosen Frost-Contaminated Wings and the Normal Clean Wing

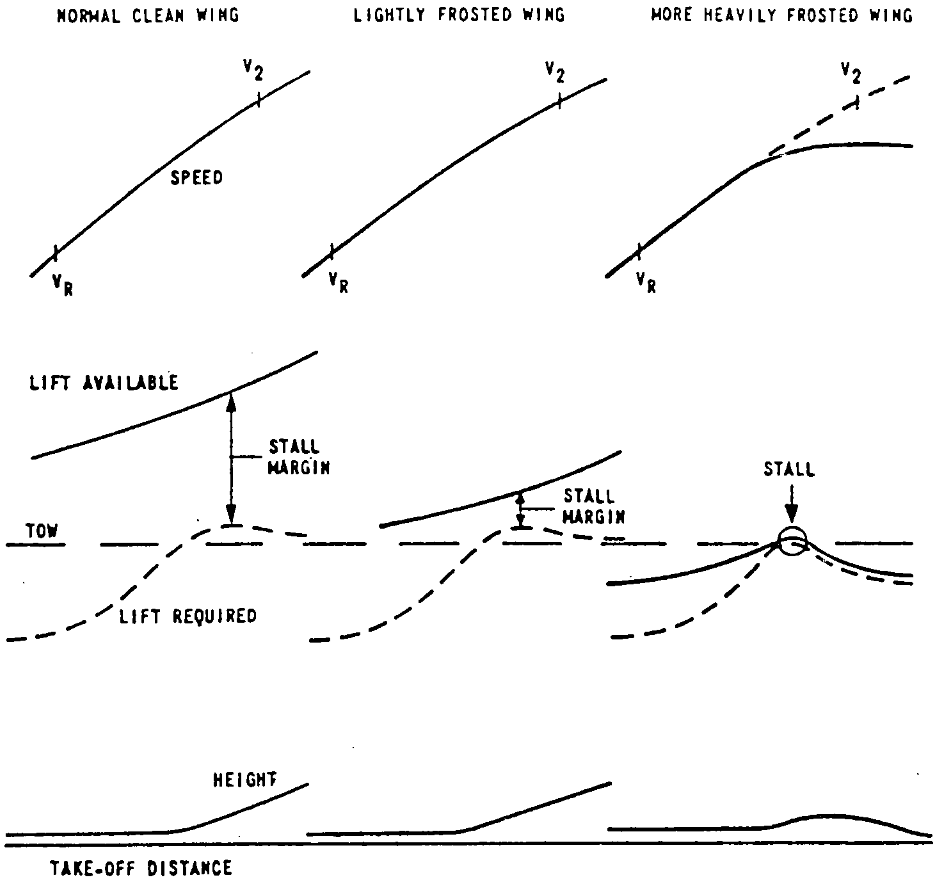


SPEED MARGIN TO STALL AT	V_R	V_2
WING I	16.5 KT	24 KT
WING II	5 KT	12 KT
WING III	–	–

Figure 1

Source: Shipwise (Fokker Aircraft), February 15, 1974

Figure 12-4 Comparative Stall Margins[1]



[1] Illustrates differently the comparative stall margins for the same (figure 12-3) two arbitrarily chosen frost-contaminated wings and the normal clean wing.

Source: Shipwise (Fokker Aircraft), February 15, 1974 with more heavily frosted wings is unable to sustain flight because the wing is in a stall condition at rotation.

As a result of the research and testing, Fokker Aircraft concluded with an ominous warning printed in large capitals on a separate page: *"Since there is no way of measuring the amount of frost contamination in relation to its effect on the wing lift capability, get the aircraft de-iced before departure"* (Exhibit 532, tab 4).

Flight Dynamics of the Fokker F-28 Mk1000

Following the initial test flights conducted by the operations group in Piedmont's F-28 flight simulator, the group confirmed that a more detailed examination of F-28 performance was necessary to identify factors that could produce a takeoff profile similar to the accident profile at Dryden. As noted, some members of the operations group travelled to Amsterdam to visit Fokker Aircraft to compare the manufacturer's contract flight crew training program with that of Piedmont. At the time, the performance subgroup also attended at the Fokker Aircraft facility in Amsterdam to commence its study of the F-28 aircraft flight profile. This section of my Report is based upon two reports prepared as a result of these investigations.

The first report, "Flight Simulator Investigation into the Take-off Performance Effects of Slush on the Runway and Ice on the Wings of a Fokker 100," was issued in August 1989 by Fokker Aircraft B.V. Referred to as the "Flight Simulation" report, it summarizes Fokker's data and findings on the takeoff performance of a Fokker 100 engineering flight simulator adjusted to approximate the flight characteristics of an F-28 Mk1000 aircraft. (The "Flight Simulation" report was entered as Exhibit 544 during the testimony of Mr Jack van Hengst.)

The second report, entitled "A Report on the Flight Dynamics of the Fokker F-28 Mk-1000 as They Pertain to the Accident at Dryden, Ontario, March, 1989" (the "Flight Dynamics" report), was researched and prepared by Mr Murray Morgan, Mr Gary Wagner, and Mr Richard Wickens.

Mr Morgan, manager of the in-flight simulator in the flight research laboratory of NAE at NRC in Ottawa, is a physics graduate and engineering test pilot with extensive experience in real-time software and mathematical techniques. Mr Wagner, an Air Canada pilot and a member of CALPA, as well is a qualified aeronautical engineer and an adjunct assistant university professor. Mr Wickens, a senior research officer in the low speed aerodynamics laboratory of NAE at NRC, is a qualified mechanical engineer with a specialty in low-speed aerodynamics.

The team's objective was to re-create the flight profile of C-FONF on takeoff at Dryden on March 10, 1989, and to determine the conditions that could have caused such a profile. Their report, entered as Exhibit 526, was addressed by each author during his testimony.

I believe that the data contained in the "Simulation" and the "Flight Dynamics" reports provide, in detail and with clarity, a thorough review of wing contamination and aircraft performance research and findings, and I have included both reports in the technical appendices to this my Final Report. (The Fokker "Flight Simulation" report appears as technical appendix 3 and the "Flight Dynamics" report as technical appendix 4.) It is my belief that the aviation community, and in particular flight crews, will find the background and detailed information, the test procedures, and the graphics contained in these two reports to be of value in appreciating more fully the insidious nature of wing contamination.

Because some of the data contained in these reports are complex in nature, I have provided the following summary and analysis to assist aviation safety organizations and other interested groups in disseminating information that has general application to all types of aircraft.

Fokker Flight Simulation Report

To assist my investigators, Fokker agreed to make available its Fokker 100 fixed-base engineering flight simulator to conduct flight tests on the F-28 Mk1000. The Fokker 100 aircraft is a new and larger derivative of the F-28 series aircraft, and, although somewhat similar in appearance to the F-28, it has appreciable aerodynamic differences. The Fokker 100 engineering flight simulator was capable of being adjusted to approximate the flight characteristics of the F-28 Mk1000 aircraft, and it was possible to simulate slush on the runway to provide rolling resistance contamination. The simulator was also capable of simulating performance degradation caused by wing leading-edge ice. Fokker, by calculation, was able to equate flight performance degradation from wing leading-edge ice with roughness caused by wing surface contamination. Aerodynamic testing demonstrated that 1 inch of leading-edge "horned" ice created approximately the same 30 per cent loss of lift as did the roughness of 1–2 mm diameter particles distributed one per square cm of wing surface.

To investigate the effect of runway slush and wing contamination, Fokker adjusted the Fokker 100 engineering simulator to enable it to perform as C-FONF should have performed during its takeoff at Dryden if the runway had been bare and dry and the aircraft wings clean. A 6000-foot airport runway was selected with an elevation of 1500 feet asl and 0° slope to approximate Dryden airport conditions. Takeoffs were conducted on a dry runway and on a runway covered with equivalent water depth (EWD) of up to 0.5 inches.[7] Most takeoffs were conducted with runway slush of 0.15 inches EWD to approximate the average EWD that was estimated, based on judgements, reports, and simulator studies, to have been on runway 29 at Dryden airport. Takeoffs were conducted with wing-ice equivalent on the wing from 0, representing a clean wing, to 1.00, representing contamination in an amount equal to one 1–2 mm diameter particles per square cm of the wing surface. A total of 30 takeoffs using 18° of flap were flown by the performance subgroup on June 7 and 8, 1989, and Fokker Aircraft flew a further 12 takeoffs on August 1, 1989, using 25° of flap. Normal takeoff profiles were varied by lifting the nose wheel out of the slush during the takeoff roll, rotating the aircraft more slowly at V_R, and failing the critical engine at V_1.

The details of the simulation testing, findings, and observations are summarized on pages 3 through 9 and in figures 35, 36, and 37 (reproduced below) of the "Flight Simulation" report. Fokker's observations were as follows:

1 The takeoff distance of an F-28 Mk1000 without runway slush or wing contamination was closely approximated by the F-100 simulator through weight and thrust selections.
2 The increase in takeoff distance of an F-28 Mk1000 with runway slush but without wing contamination was closely approximated by the F-100 simulator.
3 The effect of ice on the wing is considerable. Above a certain wing-contamination level, aircraft performance loss is so large that the aircraft cannot climb out of ground effect using normal handling techniques.
4 Engine failure at V_1 is catastrophic when combined with slush on the runway and some contamination on the aircraft wing.
5 There is greater sensitivity to wing contamination at higher altitudes owing to decreased aircraft performance.

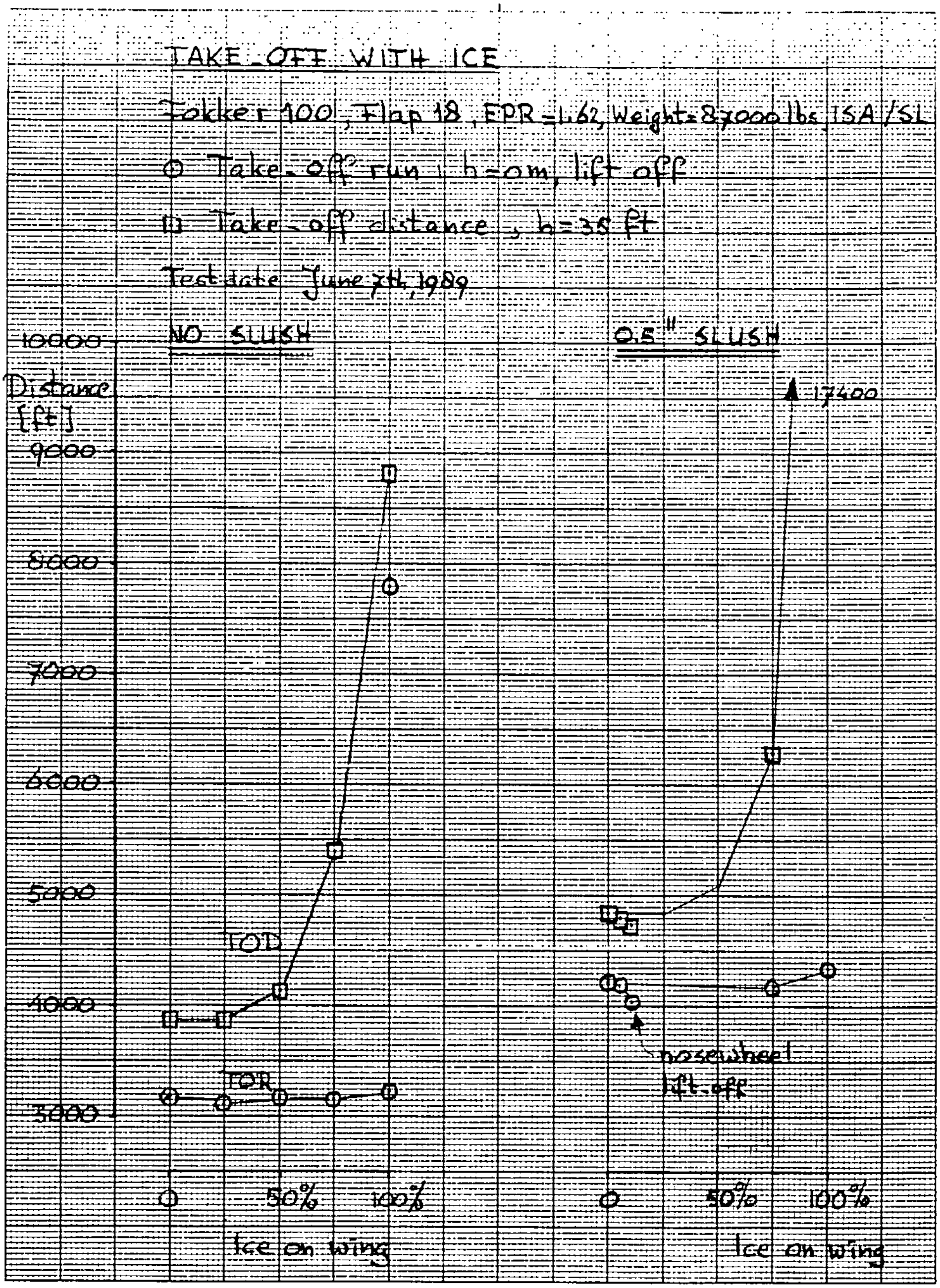
The above-noted figures of the "Flight Simulation" report graphically describe the increase in both takeoff distance (TOD) and takeoff run (TOR) required as a result of contamination on the wing and slush on the runway.[8] They are reproduced below as figures 12-5, 12-6, and 12-7.

---

[7] Equivalent water depth (EWD), in general terms, is the depth of free-standing water that is equivalent to the depth of given precipitation. (Precipitation covers the whole range of densities, from that of dry snow, to slush, to free-standing water.)

[8] Takeoff distance (TOD) is the horizontal distance from the start of the takeoff until the aircraft reaches a screen height of 35 feet. Takeoff run (TOR) is the horizontal distance from the start of the takeoff to the point at which the main landing gear of the aircraft lifts off the runway.

Figure 12-5 Fokker 100 Simulation of Takeoff with Ice, Flaps 18°



Source: Exhibit 544, figure 35

Figure 12-5 describes the Fokker 100 simulator with 18° of flap at sea level taking off with power and weight equal to full power on an F-28 at 63,500 pounds. By loading up the wing with contamination from 0, representing a clean wing, to 1.00, representing contamination in an amount equal to 1–2 mm diameter particles per square cm of wing surface, but with no runway slush, the takeoff run of the F-28 ranged between 3100 and 3250 feet. However, as contamination on the wing increased from 0.5 to 1.00, the takeoff distance increased from approximately 4150 to 8800 feet.

During takeoffs with 0.5 inches of runway slush, the takeoff run ranged between 4200 and 4350 feet, representing an increased takeoff run of approximately 1000 feet owing to slush. Raising the nose wheel out of the slush decreased the takeoff run marginally.

With 0.5 inches of runway slush and a wing-contamination range of 0.5 to 1.00, the takeoff distance increased dramatically. With 0.5 inches of runway slush and 0.5 wing contamination, the takeoff distance was 5100 feet. Fokker estimated that by increasing the wing-contamination level to 1.00, representing a wing completely contaminated with 1–2 mm particles on each square cm of the wing, the takeoff distance of the F-28 would be 17,400 feet. In other words, the aircraft was unable to climb out of ground effect.

Figure 12-6 provides information that reflects the runway slush condition assumed to exist at Dryden at the time C-FONF crashed. All takeoffs were conducted with runway slush of 0.15 inches equivalent water depth (EWD) and flaps set at 18°. Takeoff runs increased from 4400 to 6000 feet and takeoff distances increased from 5100 to 7900 feet as wing contamination increased from 0 to 0.8.

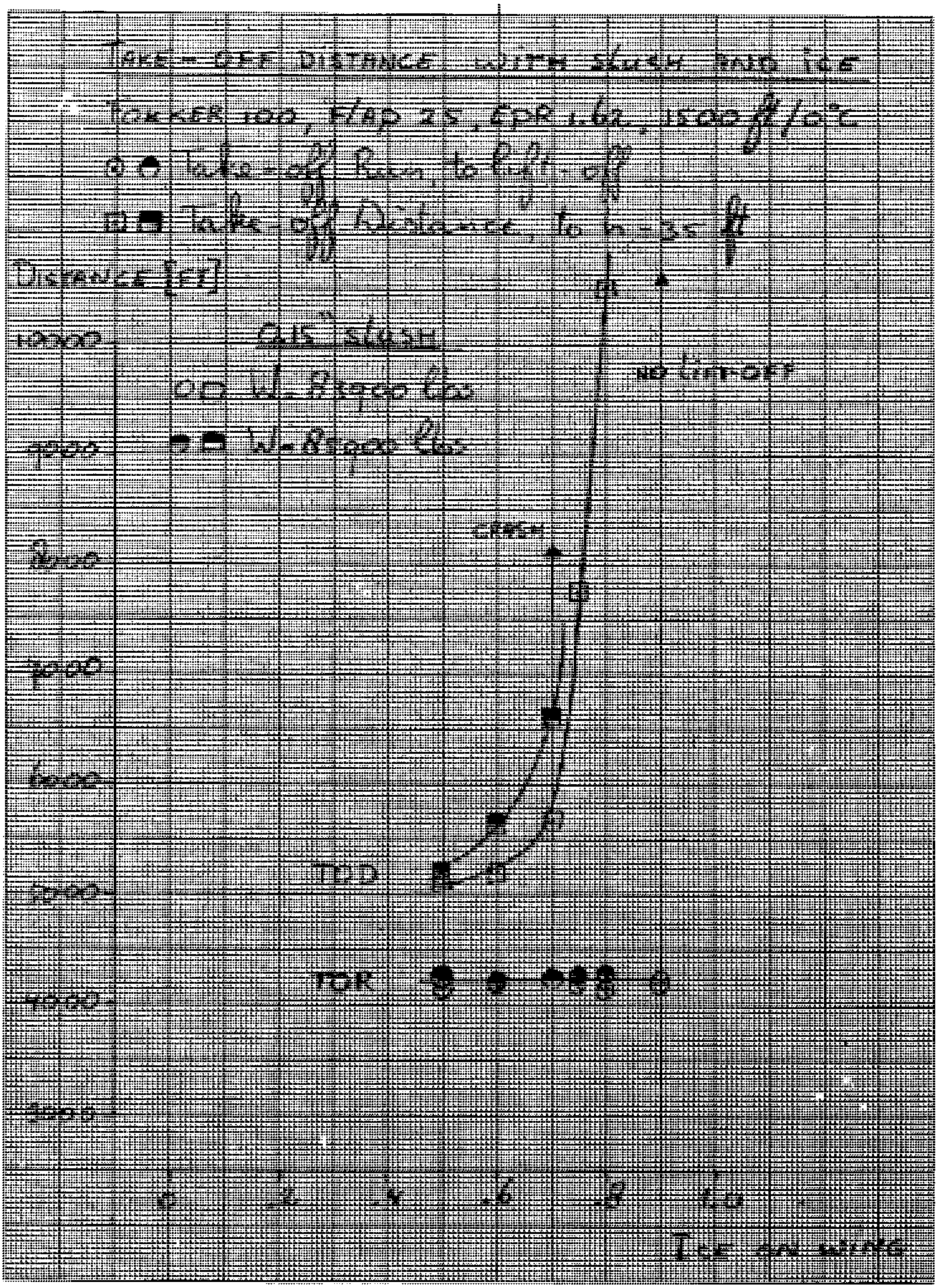
It is assumed that C-FONF had an equivalent wing-contamination level of at least 0.8 during its takeoff. With wing contamination in excess of 0.8, and slush depth of 0.15 inches EWD, both the takeoff run (TOR) and the takeoff distance (TOD) are greater than the runway length available at Dryden.

Figure 12-7 demonstrates the estimated takeoff performance of C-FONF utilizing 25° of flap in 0.15 inches of EWD of slush. Although the takeoff run performance is better at a 25° flap setting than it is at 18°, with higher amounts of wing contamination the takeoff distance required continues to be high or even increases, and at 0.8 wing-contamination level the aircraft failed to lift off.

In all cases where an engine failure occurred at V_1, with moderate wing contamination, the aircraft was unable to fly away, and in each instance it crashed.

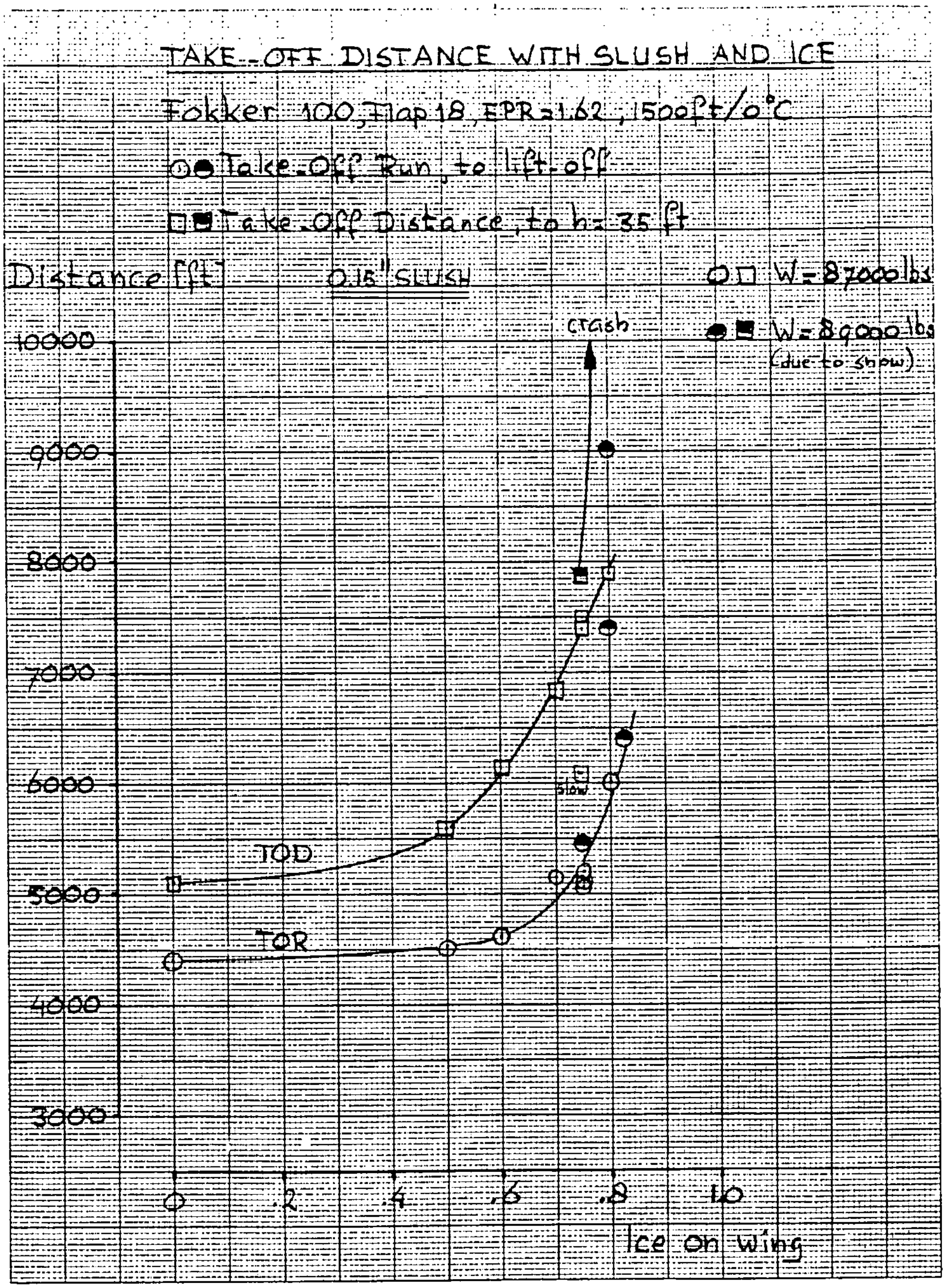
It was clearly revealed from the tests that by rotating the aircraft at a slower rate at V_R, the takeoff run increases slightly but the takeoff distance actually decreases. It was noted that, under similar conditions

Figure 12-6 Fokker 100 Simulation of Takeoff with Slush and Ice, Flaps 18°



Source: Exhibit 544, figure 36

Figure 12-7 Fokker 100 Simulation of Takeoff with Slush and Ice, Flaps 25°



Source: Exhibit 544, figure 37

of slush and wing contamination, with a slow rotation the takeoff run increased by 10 m (32.8 feet) from 1545 m (5070 feet) to 1555 m (5100 feet) while the takeoff distance actually decreased 435 m (1427 feet) from 2285 m (7495 feet) to 1850 m (6070 feet).

Mr van Hengst had the following to say regarding the use of a slow rotation technique when the aircraft wings are contaminated:

> Q. So if there is contamination and the pilot suspects contamination on the wing, there is a real advantage to him to rotate slower?
> A. Yeah. In fact, this is the same what is already said in our information we released to customers, and what is shown in the Boeing Airliner, what we just discussed yesterday.
> Q. So you have advised, in the flight manuals, and advised customers of that fact, that slower rotation may in fact save a situation that otherwise might result in a crash?
> A. Well, we advise that you increase your margin, but our advice is first to clean the wing.
>
> (Transcript, vol. 71, p. 35)

When asked what general conclusions were reached by Fokker Aircraft as a result of the simulator test flights, Mr van Hengst responded as follows:

> A. Well, that it was impossible to try to take off an aircraft with contamination on the wing. And you should always remember that this simulation test shows distributed contamination of 1 to 2 millimetre. That is the equivalent, so if the distributed roughness was worse than the picks, what you have seen on that grey plate, it should be worser and it can be worser. That's one.
>
> The second is for the engineering and technical pilots, it's very educative to do such studies. We did it with our test pilot in 1969, but you never must draw the conclusion that there is a chance to take off, because in actual practice, nature is never a thing what you can interpolate it linearly from zero to 100 per cent.
>
> (Transcript, vol. 71, pp. 36–37)

Flight Dynamics Report

The following pages provide a summary of the performance subgroup's "Flight Dynamics" report and of the evidence given before this Inquiry by the authors.

The function of the subgroup was to investigate both the takeoff performance of the F-28 and the effects of environmental conditions at the time of the accident on the aircraft's performance. The subgroup utilized F-28 performance data supplied by Fokker and developed computer programs to model mathematically the aerodynamic characteristics of the F-28 with and without contamination. Thereafter, the subgroup validated and correlated the results and offered conclusions as to the engineering reasons for the flight path observed at Dryden. The objective of the computer-simulation work was to develop a range of possible flight path scenarios similar to the one flown by C-FONF and then determine a range of conditions that could have caused C-FONF's flight path.

The purpose of the simulation and modelling was to determine, in the absence of recorder data, possible causes of the reported flight path of C-FONF. The modelling also allowed independent confirmation of the Fokker 100 engineering flight simulator study results, necessary because the study was carried out on a somewhat different aircraft. The modelling further allowed the exploration of other relevant areas such as engine-out performance and non-standard handling techniques. The aerodynamic analysis described in the "Flight Dynamics" report was carried out to support the simulation efforts and to provide enhanced background for this Commission's investigation.

The authors utilized available information with respect to C-FONF on March 10, 1989, including witness statements regarding aircraft performance as well as contamination on the aircraft wings and on the runway. The authors' analysis of available information suggested a sequence of events approximating the following, which was used by them for modelling purposes and was termed the "Dryden scenario":

> The aircraft, in an 18 degree flap configuration, commenced its take-off run from a normal position on the runway, achieved rotation speed somewhat further down than was normal and commenced a rotation. During the initial rotation the machine either became briefly airborne, or simply extended the oleos, and then settled back onto the runway, reducing its body angle somewhat. A second rotation very close to the end of the runway resulted in the aircraft becoming airborne but maintaining a very low altitude until striking the trees. Subsequent technical investigation has shown that at some time during the take-off attempt the wing flaps were extended from 18 to 25 degrees and that at the time of impact the undercarriage was in transit (neither fully down nor fully up).
>
> (Exhibit 526, p. 67)

The modelling task was simplified because, since the aircraft did not gain significant altitude, consideration of the vertical dimension could be eliminated. The subgroup accounted for the change in flap setting after the first rotation. The small change in overall drag coefficient resulting from the landing gear was not significant to the relevant portion of the takeoff performance.

Commission investigators were advised, and some Air Ontario pilots testified, that the paint on the leading edges and surfaces of the wings of one or both of Air Ontario's F-28s was cracked and deteriorated. The original paint on the leading edges and wings of an F-28 is 0.016 inches thick and consists of three or four layers. Although there was some evidence before me to indicate that the paint on the leading edges of the wings of C-FONF was in a deteriorated condition, the authors of the "Flight Dynamics" report and Fokker aerodynamicists, in particular Mr van Hengst, were of the view that the effect of the cracked paint on the maximum lift coefficient and stalling angle of attack is not significant. It was not determined to what degree, if any, cracked or deteriorated paint contributes to the adhesion of contamination to a wing.

In conducting their analysis, the authors of the "Flight Dynamics" report made the following assumptions:

1 The powerplants generated normal thrust throughout the takeoff attempt (although single powerplant failure was considered for completeness).
2 There were no structural failures prior to impact.
3 There was no failure of the brakes or tires such as to cause the ground roll to be extended.
4 There were no flight control system failures.
5 There was no interference in the flight control system from any source.
6 The flight crew handled the aircraft with normal handling techniques.
7 There were no system or instrument failures such that the flight crew was unable to fly the aircraft with the precision required for instrument flight.
8 There were no adverse wind conditions that would have affected the aircraft's performance.

All evidence before me, as detailed in this my Final Report, confirms either that the authors' assumptions were correct or indicates that there was no evidence found during the investigation or revealed in testimony to suggest that the assumptions were incorrect.

Witness evidence indicates that 18° of flap was selected on C-FONF before the takeoff run commenced. Investigation determined, however, that the flaps were positioned at approximately 25° when the aircraft crashed, suggesting that a selection from 18° to 25° was made by the flight crew some time after the takeoff roll commenced. It is probable that the selection of 25° of flap was made after the first liftoff, when it may have become apparent to the flight crew that a successful takeoff was in doubt. Performance analysis by Fokker and by the subgroup authors indicates that, with contamination on the wings, the use of 25°

of flap will not improve aircraft performance after liftoff. It is the view of both Mr Wagner and Mr van Hengst that extending the flaps beyond the position selected and used for the takeoff should not be considered in conditions of wing contamination; the greater flap angle would have a detrimental effect on the aircraft performance should the aircraft actually become airborne.

Aerodynamics

The aerodynamics section of the "Flight Dynamics" report, authored by Mr Richard Wickens, surveys the aerodynamics principles relevant to the Fokker F-28 during the ground-roll and initial climb phase. Mr Wickens also discusses the degree to which surface roughness, such as ice contamination, affects this low-speed portion of the aircraft's flight envelope. Fokker supplied aerodynamic data to the performance subgroup. Materials provided included the results of a wind tunnel test at the Nationaal Lucht-en Ruimtevaartlaboratorium (NLR), the Dutch national aerospace laboratory; a description of the aerodynamics of wing stall; flight test experience with the aircraft; airfoil pressure distribution at a variety of angles of attack; boundary layer data for an F-28 airfoil section; and Fokker's data base from which the F-28 simulator model was created.

The following is a summary of the findings and conclusions of Mr Wickens, as noted in the aerodynamics section of the "Flight Dynamics" report.

The F-28 wing section is designed for a cruise Mach number of 0.75 and a high maximum lift coefficient at low speeds. (Mach 1.0 is the speed of sound.) A generous wing nose radius minimizes the likelihood of separation under high lift conditions and promotes stall from the trailing edge. There is a stall fence on the forward midsection of the wing. Stalling of the basic smooth wing is from the trailing edge. The stall then spreads outwards from the leading-edge fence location in a fan-shaped manner towards the wing-tip and wing-root regions. These regions stall last, and, since the ailerons are near the wing tip, lateral control is possible after other sections of the wing are in a stalled condition. As well, because of the position of the fences, air flow into the engines remains smooth to high angles of attack. In ground effect, with the main wheels on the ground, stalling occurs at an angle of attack some 4° lower than flight in free air, but only the inner portion of the wing stalls. Maximum coefficient of lift (C_{LMAX}) is unchanged.

During wind tunnel tests conducted by Fokker Aircraft, artificial roughness on the upper surface of the wing of an F-28 aircraft model caused a premature stall during which time boundary layer separation could have occurred all along the leading edge. The roughness corresponded to an element size of about 1–2 mm on the full-scale F-28 wing, while the distribution corresponded to approximately one element per square cm on the same wing. With the flaps set to 30° on the model, the wing stalled at an angle of attack 7° lower than for the clean wing. Compared with the clean wing, the model showed 33 per cent loss of maximum lift coefficient.

Research on model wing sections at Reynolds Numbers[9] ranging from 100,000 to 10,000,000 showed that roughness not only increases drag below the stall but also increases the likelihood of a premature stall, particularly if the wing nose is roughened. Since the Reynolds Number increases towards the values experienced by the F-28 wing during takeoff (greater than 10,000,000), the loss of maximum lift can be as high as 50 per cent compared with a clean surface.

In some cases, the airfoil is sensitive to the size of the roughness elements, the loss of maximum lift being less for very small roughness heights. Most airfoil sections, however, respond to roughness of any scale by stalling prematurely and incurring the maximum loss of lift. Removal of roughness on the nose and over the first 15 per cent of the chord restores the airfoil to a surface close to its original "clean" characteristics.

Dynamic Simulations

The dynamic simulations section of the "Flight Dynamics" report, authored by Mr Gary Wagner, presents a description of and commentary on the results of the simulation flights carried out by the performance subgroup. Mr Wagner discusses the Fokker "Flight Simulation" report and provides background to it. He discusses the various modelling and flying techniques, both conventional and non-standard, utilized during the subgroup's sessions and summarizes the simulation experience. The following is a summary of the material dealing with the simulation sessions.

---

9 Reynolds Numbers, a measure of the scale effect, enable one to correct for the difference between doing a test under model conditions at small scale and extrapolate the data to full-scale values. It also determines when a laminar flow makes a transition to turbulent flow. Physically, it is the ratio of the inertia forces to the viscous forces in any flow. Inertia forces are the stream lines and flow outside the boundary layer. Viscous forces are the stream lines and flow inside the boundary layer. Reynolds Numbers are dimensionless. In the case of the F-28, and based on its wing mean aerodynamic chord, they range between approximately 15,000,000 at takeoff speed and 30,000,000 at cruising speed. Turbulence over a flat plate surface normally commences when Reynolds Numbers reach approximately 1,000,000. Reynolds Numbers are used in classical research of boundary layer and Reynolds Numbers behaviour on wings.

(Based on evidence of Mr Richard Wickens.
Transcript, vol. 69, pp. 66–68)

Dynamic simulations were those tests and experiments conducted in the Fokker 100 fixed-base engineering simulator. Three series of dynamic simulation sessions were flown using various wing- and runway-contaminant levels. Two series of simulations were flown on June 7 and June 8, 1989, by Mr Wagner and monitored by Mr Murray Morgan, and the third series was flown by Mr Jan Hofstra, a Fokker Aircraft test pilot, on August 1, 1989. The data from the simulations were plotted in the Fokker report to present pictorially and numerically the flight profiles and changes that would be experienced in aircraft performance.

Mr Wagner stated in his overview:

> A fundamental assumption made during the simulation exercise was that the pilots of the accident aircraft would have believed that their aircraft was flyable and would, therefore, have employed normal handling techniques. Therefore, for "Dryden" simulations no special procedures or techniques were allowed which would have provided a better flight profile due to the simulator pilots' a priori knowledge of the external conditions being applied. Ad hoc experiments with off nominal techniques left no doubt that handling technique greatly affects the resulting flight profile in the presence of contamination. This observation was later confirmed by the off-line numerical modelling.
>
> (Exhibit 526, p. 62)

Dynamic Simulations: Modelling and Flying Techniques

Runway Contamination The slush model depth was varied from 0 to 0.45 inches to determine the level of slush contaminant required to extend the takeoff run to the distance reported by the witnesses at Dryden (that is, approximately 500 feet in excess of the normal takeoff run). It was determined that a slush depth of 0.15 inches resulted in this increase. Mr Wagner noted that, because of reduction in the maximum coefficient in lift resulting from wing contamination, the aircraft must be rotated to a higher than normal pitch attitude in order to effect liftoff; this process takes additional time and results in a longer takeoff roll. The additional component was considered in the simulation.

For contaminated runway takeoffs, normal control wheel inputs were used in all but a few runs, where the nose was raised 2–3° at about 80 knots to get the nose wheel out of the slush (the specified procedure in the Fokker F-28 Flight Handbook). It was found that raising the nose wheel decreased the aircraft ground roll by approximately 100 feet.

Wing Contamination The wing contaminant was modelled by using the Fokker roughness simulation for the entire wing. The contaminant factor could be varied between 0 and 1.00. This factor is not equivalent to contaminant depth, although it is labelled as such on the plots provided in the Fokker report. Wing contaminants with different characteristics, even of identical depth, will result in very different performances. For example, a thin layer of a rough contaminant can result in a far greater performance loss than a thick layer of a smooth contaminant that follows the wing contour. In any consideration of wing performance, form and position of a wing contaminant are much more important factors than is thickness.

During the dynamic tests, it was determined by the authors that, at wing-contaminant levels greater than approximately 0.8, the aircraft would not fly off the runway at the aircraft speeds and conditions that generally matched those of C-FONF. Selection of contaminant levels ranging from 0.5 to 0.8 did, however, result in flight profiles that generally matched the profile of C-FONF. The runs that most closely matched the flight profile described by witnesses at Dryden were achieved with a slush depth of 0.15 inches and a wing-contaminant level of approximately 0.8.

For contaminated wing takeoffs, although normal control wheel rotation forces were used, the resultant rotation rate was slightly slower than with the clean wing model. The reason for the slower rotation rate was that the wing contamination had the effect of increasing the nose-down pitching moment of the wing; therefore, with normal forces being applied to the control wheel, the nose-up moment caused by the elevator had less rotational effect on the aircraft.

As the contaminant levels were increased, numerous takeoff runs were flown where the stick-shaker actuated immediately on or just after liftoff. This effect occurred because of the significantly greater angles of attack achieved in these cases. It was judged by the investigators that normal pilot technique would be to attempt to reduce the angle of attack to stop the stick-shaker. Nose-down control-wheel inputs were made accordingly, attempting to maintain an aircraft attitude right at the edge of stick-shaker activation. The reasoning here was that most pilots, in view of current training with respect to wind shear escape manoeuvres and ground school training, would expect to achieve close to maximum available lift at the point of stick-shaker activation.

In pointing out that the wing was stalling prior to stick-shaker activation, Mr Wagner in the "Flight Dynamics" report stated as follows:

> It should be noted that in cases of significant wing contamination, the wing can be well beyond the stalling angle of attack by the time the stick shaker activates. In essence, the stick shaker is responding to the normally expected maximum angle of attack of the clean wing. The stall warning system is not actually measuring stall and flow separation from the wing. Rather, it infers the onset of stall from the

known performance of the wing and is programmed to activate at a fixed geometric angle of attack based on that knowledge.
(Exhibit 526, p. 64)

Of significance is the fact that, with any amount of wing contamination, the aircraft wing may stall before the angle of attack required to activate the stick-shaker is reached.

Engine Failure on Takeoff A few takeoffs were attempted by Mr Wagner during which an engine was failed at V_R. All engine failures were complete (that is, no attempt was made to fly the simulator with partial engine failure). Regardless of the contaminant level on the aircraft, directional control was not a problem after the engine failed. Normal and appropriate control inputs were used to attempt to maintain proper speeds and direction. The climb-out characteristics of the aircraft were conventional with the engine failure, except that only a limited wing-contaminant load could be carried.

The wing-contaminant level at which the aircraft was able to lift off and climb was significantly reduced. Successful takeoffs were accomplished with wing contamination of less than 0.5, although that level provided minimal performance. Because the relationship between wing-contaminant levels and contaminant thickness is highly non-linear, the authors in this section of the "Flight Dynamics" report caution that the result cannot be interpreted to mean an aircraft is able to carry half the contaminant load with an engine failure. The report states that "it was clear that the reduced thrust at rotation severely reduced the available performance margin and thus limited the aircraft's capability to carry any contaminant through a successful takeoff" (Exhibit 526, p. 61).

Summary of Simulation Experience The following is a summary of the authors' observations and findings as a result of their flight-simulation experience and analysis:

- The effect of increasing the slush depth was limited, in general terms, to increasing the takeoff run. Additional effects became evident regarding the ability of the aircraft to accelerate after rotation with the wing significantly contaminated.
- The effect of wing contamination was to degrade the performance of the wing, the degree of degradation being a non-linear function of the contaminant level. As the wing-contaminant level increased from 0, the aircraft's climb performance was immediately reduced.
- At moderate levels of wing contaminant, the stick-shaker actuated shortly after liftoff, and the flight profile after that point reflected the pilot's attempt to keep the aircraft at the edge of the stick-shaker, being 13° angle of attack for the simulator. For

a contaminated wing, that angle of attack was already post-stall in most cases. Climbing out of ground effect became impossible in many instances.

- At critical levels of wing contaminant, between 0.75 and 0.825, the aircraft was able to lift off and sometimes fly. However, as the aircraft climbed out of ground effect, the performance loss resulted in the aircraft descending and touching down or crashing off the end of the runway.
- As the contaminant level increased, the liftoff pitch attitude and airspeed had to be increased to provide adequate lift to lift off. Since increasing levels of wing contaminant decreased the stalling angle of attack, liftoff occurred closer to and then beyond the true stalling angle of attack. Eventually, either liftoff occurred post-stall or the aircraft stalled shortly after liftoff as it climbed out of ground effect. Successful flight with the wing contaminated at levels between 0.7 and 0.825 was effectively impossible using normal techniques. The profiles resulting from flight at these wing-contaminant levels were, in general terms, representative of the flight profile of C-FONF resulting in the Dryden accident.
- In cases where an engine was failed, the aircraft was not flyable with even moderate levels of wing contaminant. The high angles of attack required to generate adequate lift with the contaminated wing produced drag levels so great that the thrust of one powerplant was inadequate to allow the aircraft to accelerate. Post-stall drag was also extremely high. The only way to get the aircraft to fly with the wing contaminant is to have sufficient thrust to accelerate to a sufficiently high airspeed. Thrust with one engine operating is inadequate to provide that acceleration.

(Based on Exhibit 526, pp. 64–65)

Non–Standard Handling Techniques Non–standard handling techniques were explored by the authors in an effort to determine whether the aircraft could overcome performance degradation resulting from contaminated wings. Successful flight was achieved in certain cases that might otherwise have resulted in either no takeoff or takeoff and a subsequent crash. The authors could not, however, predict precisely when these flights would succeed; when non–standard procedures were used, successful takeoffs with wing contaminant at levels between 0.7 and 0.825 were irregular and not guaranteed. Nevertheless, it was determined that the following non–standard handling techniques did allow for more successful takeoffs:

- Selection of rotation speed. A pilot who applied a speed increment above V_1 prior to rotation would have a higher probability of a successful takeoff. The converse is also true.

- Use of a lower rotation rate. A pilot who used a slower rotation rate would have a higher probability of a successful takeoff.
- Use of a partial rotation (as opposed to continued rotation until liftoff). A pilot who rotated the aircraft to usual liftoff attitude and held it there rather than rotating further would have a higher probability of a successful takeoff.

The above recommended techniques are also contained in the Fokker F-28 Flight Handbook. Fokker recommends these techniques where it is not completely certain that the wings and tail are clear of ice or snow.

The authors emphasize in their report that use of non–standard handling techniques is not intended to assist or condone operation of aircraft carrying wing contaminant. There are many other tradeoff factors that are balanced out in any takeoff. The authors state that the foregoing non–standard handling techniques may degrade such tradeoffs.

These non–standard handling techniques may, however, assist a flight crew finding themselves, for some reason, in a takeoff situation where there is no possibility for a safe rejected takeoff and the aircraft is not performing as expected. This situation could be the result of a number of factors, such as wing contamination, aircraft overloading, incorrect flap selection, or incorrect speed selection. The situation could also occur on a rejected landing and go-around if, on approach, the aircraft is contaminated with ice.

Once an aircraft has reached rotation speed (V_R) there is normally little or no opportunity to reject the takeoff. When asked whether a crew experiencing the effects of contamination at rotation or immediately after liftoff should continue or reject the takeoff, Mr Wagner stated the following:

> A. I would say that my best judgement would be that, once you've rotated and barely got a little bit airborne, it would be highly unlikely for a man to put his efforts into aborting the takeoff rather than putting his efforts into finding a way to try and make that takeoff successful. That would be my best judgement, sir.
>
> (Transcript, vol. 73, pp. 146–47)

On the basis of the evidence I have heard, I am firmly convinced that pilots should be made more aware of the inherent dangers of wing contamination. It is vitally important for a pilot to understand how wing contamination changes the aerodynamic characteristics of an aircraft, and to understand how the application of certain techniques, as described above by Mr Wagner, may allow a pilot to deal with an abnormal takeoff situation. It is incumbent on all pilots and on their respective organizations to ensure that this training is accomplished. Without prescribing how the necessary training be accomplished, I would state that it is possible flight simulators may be useful in this endeavour. It must be stressed, in the strongest terms possible, that neither the performance subgroup nor this Commission advocates the use of non–standard handling techniques to operate aircraft in adverse weather conditions as an alternative to the proper preparation of the aircraft for flight.

Mathematical Modelling and Modelling Validation

Mr Murray Morgan is the author of the mathematical modelling and modelling validation sections of the "Flight Dynamics" report. The following is a summary of the methods used for and the results of the mathematical analysis and validation of the flight dynamics of the attempted takeoff of C-FONF.

A computer model was developed to allow investigation of the effects of aircraft and runway contaminants on the takeoff performance of the aircraft. There is no "man in the loop" (pilot) in a computer model, thus removing one of the variables from the equations. The model was therefore able to reflect more accurately the effects of aircraft and runway contamination. Initially, two independent off-line computer models of the F-28 were developed simultaneously by Mr Morgan and Mr Wagner. The outputs from each model were periodically compared, and, where differences were found, the source was isolated and corrected. Once the programs were both operating and producing comparable results, the more powerful computer used by Mr Morgan at NAE was employed for most of the investigation and production of results.

There was no attempt made to model contamination of the horizontal stabilizer. The reasoning was twofold: first, as there was sufficient power (lift) on the tail to rotate the aircraft during the takeoff, the contamination on the horizontal stabilizer was not a factor during rotation; secondly, the angle of attack of the tail reduces as the aircraft accelerates after becoming airborne, thereby further decreasing the effect of any contamination.

The aerodynamic and performance models were based on two sources of data: the F-28 simulation data base provided by Fokker; and the Fokker wind tunnel study of the contamination model of the F-28 lift and drag characteristics when the flying surfaces were contaminated with artificial roughness. To develop a functioning simulation that included "man in the loop" control of the aircraft, the engineering and pilot judgement of Mr Morgan and Mr Wagner also played an important role. With the performance and contamination model of Fokker and control response algorithms developed by the authors, a functioning off-line simulation for the F-28 was developed. To verify the accuracy of the computer simulation, use was made of flight data recorder (FDR) data from 21 previous takeoffs by C-FONF. A month prior to the Dryden accident, C-FONF was involved in a minor accident, when a wheel failed on a landing. Investigation of this event necessitated FDR tape removal; hence, data from this tape were available to the authors.

Model-Run Matrix Once the modelling had been completed and validated, a matrix of cases was empirically determined and run. For all cases, the baseline configuration was an aircraft weight of 63,500 pounds, full-rated thrust, 18° of flap, and a V_R of 122.5 knots. The nominal rotation was an initial pitch rate of 3° per second towards a target attitude of 10° followed by a further rotation at 1° per second to 13° of pitch attitude after liftoff. This is the procedure preferred by Fokker Aircraft. Thereafter, three parameters of prime interest were varied: the depth of slush, the proportion of wing contamination, and the selection of V_R. These runs were completed using the nominal rotation technique, described above, together with the profile referred to above as the "Dryden scenario." Nominal (3° per second) and reduced (2° per second) rotation rates were used for the initial rotation. The sets of conditions tested were:

a. Slush Depth. 0, 0.1, 0.2, 0.3, and 0.4 inches.
b. Contaminant Ratio. 0 and .50 to 1.00 in steps of 0.01. (Zero to 1.00 represents 0 per cent to 100 per cent contaminant. When this resolution produced ambiguous results, boundaries were defined by making special runs at finer resolution.)
c. Rotate Speeds. 117.5 knots, 122.5 knots (nominal), and 127.5 knots.
d. Rotation Rates. 3° and 2° per second.

(Based on Exhibit 526, p. 73)

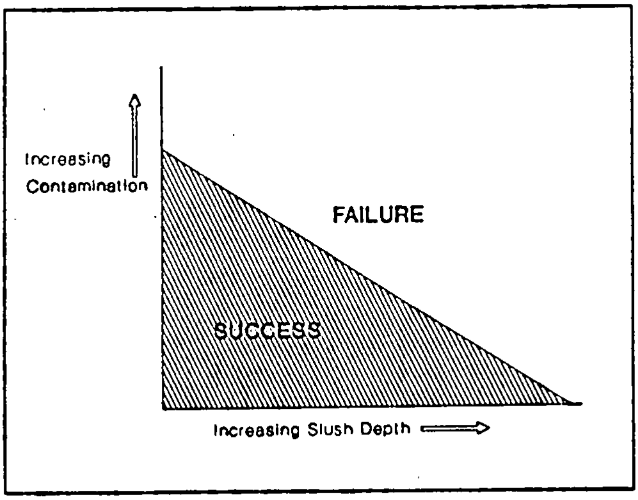
Presentation of Results Plots of the test runs are included in the "Flight Dynamics" report of (technical appendix 4, pages 76–85). These plots show that the presence of slush on the runway significantly increased the distance required to reach V_R, while wing contamination had little effect on this distance. However, as the level of wing contamination increased, the distance to liftoff increased quite rapidly, owing to the marked increase in drag produced by the contaminated wing at high angles of attack following rotation. This characteristic represents a situation in which the full extent of performance loss may not be apparent to the flight crew until the aircraft is rotated. Prior to this point, the reduction in acceleration is little more than what could be attributed to a slush layer. Figure 5 on page 76 of the "Flight Dynamics" report shows the reasons for this effect. As the level of wing contamination increased, even in the absence of slush, the distance between V_R and the liftoff point increased only slowly, until a dramatic "knee" was reached numerically at just over 0.6 contamination ratio. This is coincident with the aircraft being at or beyond the coefficient of maximum lift (C_{LMAX}) for the contaminated wing at its rotation angle of 10° and having to generate the necessary lift by increasing speed rather than increasing the coefficient of lift (C_L).

The drag rise, caused by the contamination once the aircraft was rotated, resulted in low acceleration rates. This in turn meant that excessive distance had to be used by the aircraft to attain enough speed to generate sufficient lift. Another effect was the increase in Theta required at liftoff as the level of contaminant increased. (Theta, or body angle, is the angle between the aircraft and the horizontal.) Moderate increases in Theta compensated for the reduction in the coefficient of lift due to the contaminant up to a contamination ratio of approximately 0.58. At that point the rate of increase in Theta, with respect to the level of contaminant, steepened markedly because of the reduced lifting capability of the wing.

The two "various boundary" plots in the "Flight Dynamics" report (p. 77) represent the crux of the performance investigation. They show that it is possible to define two boundary conditions, in terms of combinations of slush depth and wing-contamination factor, that can lead to catastrophic results during attempted takeoffs. A boundary condition here means "a continuous relationship between level of contamination and runway slush depth which represents the dividing line" between a successful or unsuccessful takeoff (pp. 73–74). This boundary relationship, which is illustrated in the "Flight Dynamics" report, is reproduced below as figure 12-8. The "various boundary" plots (figures 6 and 7 in the "Flight Dynamics" report) can be interpreted according to figure 12-8, below.

Figures 8a–10b of the "Flight Dynamics" report illustrate in detail the various test runs. A review of the figures reveals that there are well-defined boundaries of slush depth and contamination level that either allow or prevent the aircraft from flying successfully. For example, with a rotation speed (V_R) of 122.5 knots, a slush depth of 0.25 inches, and a wing-contamination level of 0.65, the aircraft flies away. At 0.68 wing contamination, the aircraft gets airborne, but, 500 feet beyond the end of the runway, it is only at 10 feet. At 0.69 contamination, the aircraft returns to the runway and runs off the end. In another example, with a rotation speed of 127.5 knots, a slush depth of 0.10 inches, and a wing-contamination level of 0.823, the aircraft flies away despite two bursts of stick-shaker. At 0.824 wing contamination, the aircraft height never exceeds 5 feet, and it eventually returns to the surface 1100 feet beyond

Figure 12-8 A Boundary Condition Plot for Successful Takeoff



Source: Exhibit 526, figure 3

the end of the runway. The figures also demonstrate that pilot technique can have a marked effect on the success or failure of a takeoff.

The implication of the results presented in this section of the "Flight Dynamics" report, especially the two sets of boundary conditions, is that there "exists a combination of values of slush depth and wing contamination which can cause aircraft trajectories of the type described by witnesses to the Dryden accident" (Exhibit 526, p. 75).

Validation Mr Morgan performed a thorough validation process to ensure that the computer model would fairly and accurately represent the basic behaviour of the F-28 aircraft, and the information and plots in the "Flight Dynamics" report indicated that very close agreement between the recorded performance of C-FONF and the mathematical model had been achieved. Accordingly, the authors of the report were confident that the information and results produced by the computer model were accurate.

Discussions and Conclusions

The authors of the "Flight Dynamics" report state that dynamic simulation demonstrated that the increased takeoff roll and short airborne segment could have been the result of the conditions of runway slush and wing contamination tested in the simulations. The numerical simulations strongly support the observations made in the Fokker 100 engineering simulator. A general observation made by the authors of this report is that the higher the rotation speed and the slower the rotation rate, the greater the probability that the takeoff will be successful. This observation conforms to the advice given in the Fokker Aircraft F-28 Flight Handbook. The "Flight Dynamics" report in its conclusions emphasizes, however, that the performance subgroup treated only the aerodynamic and aircraft-handling aspects of the accident and assumed there were no other factors that could have been related to the accident. The authors emphasize that major failures of aircraft systems or other factors not mentioned in their report and not considered in the simulation could also have resulted in the accident flight profile, alone or in conjunction with the known wing contaminant.

With the above caveats in mind, the authors of the "Flight Dynamics" report concluded as follows:

> 1. The witness reported flight paths and "Dryden scenario" which was based on [the witness reports are] physically possible from an engineering viewpoint.
> 2. The aerodynamic performance of the F28 ... was definitely degraded by the wing contamination ... the contaminants on the wings degraded the lifting capability and increased the drag on the accident aircraft.
> 3. The increased ground distance to the reported liftoff point could have been due to the following factors, individually or in combination:
>   a) Small slush accumulations on the runway
>   b) Selection of higher than normal rotation speed.
> 4. An additional contributing factor to the increased ground distance to liftoff was the higher speed and/or pitch attitude required for liftoff as a result of wing contaminant ... This was due to the additional time required to reach the required speed [for liftoff] and/or to rotate the aircraft to the higher liftoff attitude. At the liftoff speed for the F28 in the Dryden case on the order of 130 knots, each additional second during rotation increased the ground run by approximately 200 feet.
> 5. The deteriorated condition of the paint on the wing leading edge probably did not affect the aerodynamic characteristics of the aircraft directly. However, the effect of the deteriorated paint on the adherence characteristics of contaminants at the leading edge is unknown, but could potentially have been a minor factor in the amount of contaminant that remained on the wing.
> 6. Simulation and analytical work by [the authors of the "Flight Dynamics" report] has defined a range of conditions in terms of wing and runway contaminant levels which, alone, <u>could</u> have resulted in the accident profile.

7. Without [cockpit voice and flight recorder] data, the pilots themselves, and a mathematical description of the wing and runway contaminant levels, it can **NOT** be conclusively stated that wing or runway contamination **alone** caused the aircraft to crash.

(Exhibit 526, pp. 109–10)

Mr Morgan during testimony explained each of the above conclusions. When asked his opinion as to the cause of the accident, assuming there were no major failures of the aircraft systems and no degradation of engine performance, he stated:

A. If there really are absolutely no other factors, my opinion would be that ... the accident was a result of the contamination beyond reasonable doubt.

(Transcript, vol. 72, p. 155)

In summing up his conclusions during testimony, Mr Wagner stated:

A. ... assuming everything else worked the way it's supposed to work and there were no failures of any sort, as we described, I would say that there is a high probability that the engineering cause of the flight profile was the contamination on the airplane.

(Transcript, vol. 73, p. 78)

During his testimony, Mr van Hengst, chief aerodynamics analyst at Fokker Aircraft, was given information provided by another witness, a meteorologist. The information was that there was a minimum of 1.4 mm of rough precipitation along the wings of the F-28 in Dryden. When it was suggested by counsel: "So the conclusion, then, is that, in Dryden, with 1.4 millimetres, there is no takeoff possible" (Transcript, vol. 71, p. 124), Mr van Hengst agreed.

Particular Effects of Aircraft Contamination

Propeller-Driven Aircraft

Although the Final Report of this Commission of Inquiry primarily addresses the performance of the F-28 aircraft, information was gathered during the Inquiry regarding the performance of propeller-driven aircraft and the effect on them of wing contamination.

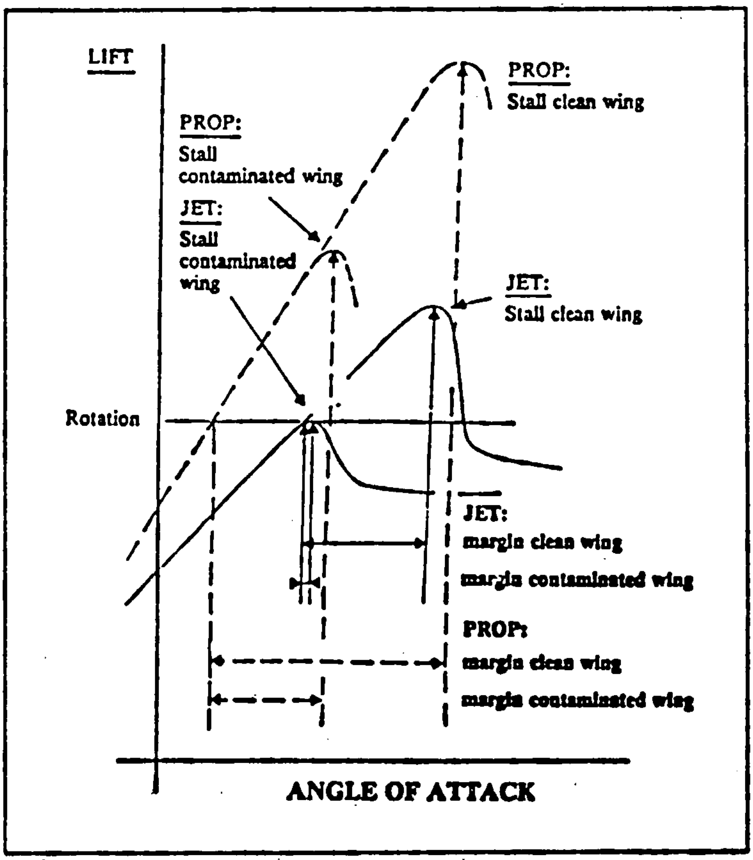
Although the performance study was specifically conducted for the F-28 aircraft, the results obtained are applicable to any other aircraft in this class, that is, to any jet-propelled, swept-wing aircraft. There is, however, a more severe performance penalty paid for contamination of a jet-propelled aircraft than for contamination of a propeller-driven aircraft. The shallower lift curve slope and the reduced maximum coefficient of lift of the swept wing make its performance more readily degradable. As well, the jet aircraft does not have the advantage of a relatively large area of its wing being immersed in high-velocity air from the propeller slipstream. The jet aircraft's only lift-producing capability is the result of the aircraft motion relative to the air. Diagrams in Fokker's Report no. L-28-222 (technical appendix 2 to the Final Report) and the "Flight Dynamics" report (technical appendix 4) show performance comparisons between jet- and propeller-driven aircraft when their wings are contaminated. Figure 12-9, from the "Flight Dynamics" report, depicts the comparison.

Mr van Hengst, Fokker's chief aerodynamics analyst, was questioned about the effects of contamination on a propeller-driven aircraft as compared with a jet-driven aircraft. He concluded that it was dangerous to fly with contamination on either type and explained the peculiar danger regarding contamination on a propeller-driven aircraft. He explained that if an engine fails and the wings are contaminated, then, in effect, one wing loses the benefit of the high-energy slipstream, which results in a rolling moment in the aircraft.

Mr Richard Wickens, in researching and writing the aerodynamics portion of the "Flight Dynamics" report, also reviewed the 1930s literature on the effects of surface roughness on airfoils, the material reviewed by Fokker Aircraft during its wing-contamination studies subsequent to the F-28 crash at Hanover, Germany. Mr Wickens and NRC wanted to obtain their own data as well as more recent information to confirm both the earlier literature and the Fokker Aircraft studies conducted in 1969 on the F-28 Mk1000 aircraft. Mr Wickens also wished to determine if there were any differences among various airfoils. Since he could not simulate high Reynolds Numbers in NRC's wind tunnel to determine differences among the wing sections of various jet airfoils, he utilized a ½ model NACA 4415 airfoil with an engine nacelle and a powered propeller. The airfoil had an aspect ratio of slightly over 6. The wing had a general shape corresponding to that of a de Havilland Twin Otter and a 15 per cent thickness, somewhat similar to that of both the Twin Otter and the F-28. The wing was tested in both a clean and a roughened condition and was tested both powered and unpowered.

It was determined that a clean wing with the benefit of high-energy propeller-driven airflow would achieve about 25 per cent additional maximum coefficient of lift (C_{LMAX}) at takeoff speeds compared with the same wing without the benefit of propeller airflow. For a contaminated wing with propeller airflow, the C_{LMAX} would be similar to that of the

Figure 12-9 Jet- and Propeller-Driven Aircraft Comparison



Source: Exhibit 526, figure 1

same clean wing without propeller airflow. For a contaminated wing of a propeller-driven aircraft where the propeller airflow is lost (engine stoppage), the C_{LMAX} would be approximately the same as that of a contaminated wing of an aircraft that does not have the benefit of propeller airflow (jet aircraft).

As can be seen, if one engine of a propeller-driven twin-engine aircraft fails, the wing that loses the propeller airflow loses the increased C_{LMAX} created by the airflow. Where there are clean wings and the aircraft is flying at high airspeeds, there should be little difficulty controlling the aircraft. However, if the wings are contaminated and the aircraft is at low speed with the engines producing high power, the reduction in the C_{LMAX} caused by the engine stoppage could cause the wing that loses the propeller airflow to stall. The aircraft would then experience a rolling moment towards the failed engine. This scenario would be particularly dangerous when the aircraft is at low altitude during takeoff; there would not be enough altitude in which to recover the aircraft.

Mr Wickens and Mr V.D. Nguyen, in a report based in part on research conducted for this Commission of Inquiry, summarized the effects of performance degradation on propeller-driven aircraft due to wing contamination:

> A wind tunnel investigation has assessed the effects of distributed upper surface roughness, and leading edge ice formation on a powered wing propeller model.
>
> In the unpowered state, it was found that roughness reduces the lift slope, and maximum lift by 30 to 50 percent, depending upon particle size and Reynolds number. The leading edge region is especially sensitive to these disturbances, however removal of the roughness over a small portion of the nose restored the wing to close to its original performance.
>
> The application of power to the wing, with an increase of slipstream dynamic pressure increases the lift slope and maximum lift; however this benefit is lost if the wing is roughened. Subtraction of the propeller reactions indicated that the slipstream interaction accounted for half the lift increase, and also resulted in reduced drag for the clean surface. This drag reduction was removed when the wing was roughened, indicating that the degradation of wing performance due to roughening is relatively greater when a slipstream is present, compared to the unpowered wing.
>
> Leading edge ice accretion causes similar large losses in lift and increases of form drag although a comparison of the two types of contamination showed that leading edge ice produces a smaller reduction of lift slope prior to flow separation. In both types of contamination, Reynolds number is important, and emphasizes the necessity of testing under near full-scale conditions.
>
> ("Wind Tunnel Investigation of a Wing-Propeller Model Performance Degradation Due to Distributed Upper-Surface Roughness and Leading Edge Shape Modification," p. 1)

The authors reach seven conclusions, of which numbers (1), (5), and (6) are particularly significant:

> 1) The main effect of distributed upper surface roughness on an unpowered wing is to reduce lift slope and maximum lift by as much as 30 to 50 per cent, depending upon roughness size, Reynolds number, and to a lesser extent, coverage.
> 2) The magnitude of the loss of maximum lift increases with roughness size, and also with Reynolds number and testing of roughened wings should be done at as high a Reynolds number as possible.

3) Roughness increases the parasite drag at zero lift and also results in a premature stall with resulting large increases of form drag.
4) The leading edge region is especially sensitive to distributed roughness regardless of particle size; there is a significant increase in drag and corresponding decrease of leading edge suction at angles of attack below stall. Conversely, removal of the roughness over a small portion of the nose restores the wing to almost clean performance.
5) If the wing is powered and clean, the slipstream interaction increases lift slope and maximum lift by 25 per cent, for thrust coefficients appropriate to the takeoff condition. If roughness is applied, maximum lift decreases by more than 25%, thus producing a lifting performance somewhat below the unpowered wing in the clean state. This may have significance in the event of an engine failure; the contaminated wing will suffer a further loss in maximum lift in the unpowered state.
6) An attempt was made to isolate the slipstream interaction on the wing by subtracting estimated propeller forces. When comparing the performance of the powered and unpowered wings, it was noted that roughness produced slightly higher losses on the wing immersed in the slipstream.
7) Loss of lift due to an accretion of rime or glaze ice on the leading edge of the wing may reach as high as 50 percent even when the wing is powered, and is sensitive to Reynolds number. Loss of maximum lift is greater for heavy rime ice than for heavy distributed roughness.

(Ibid., pp. 11, 12)

Because many air carriers operate propeller-driven aircraft, I believe that flight crews flying, and other operations personnel involved in operating, these aircraft types should have the benefit of all the information contained in this report by Mr Wickens and Mr Nguyen. I have therefore included as technical appendix 5 the entire report on propeller performance degradation, which was presented by Mr Wickens at an Advisory Group for Aerospace Research and Development (AGARD) conference on "The Effects of Adverse Weather on Aerodynamics" at Toulouse, France, on April 30, 1991.

Wing with Leading-Edge Devices versus Hard Wing

There is, in the aviation industry, some controversy over whether the effects of wing contamination during takeoff are less on aircraft that have wing leading-edge devices (e.g., leading-edge slats or leading-edge flaps) than on those that do not. A wing without leading-edge devices is often referred to as a "hard wing."

Literature suggests that deflection of trailing-edge flaps tends to increase the adverse effects of surface roughness on the maximum coefficient of lift (C_{LMAX}). Leading-edge devices tend to suppress the adverse effects of small amounts of surface roughness; however, it is acknowledged that leading-edge devices do not suppress the adverse effects of larger levels of roughness. Aircraft such as the Boeing 737, equipped with leading-edge slats and flaps, have been reported to experience pitchup and rolloff immediately after takeoff in weather conditions that were conducive to the formation of ice and snow on the wing leading edges. In most cases, the flight crew were able to recover by using extreme control-column movements and maximum power. In the case of the Air Florida, Inc., Boeing 737 crash at Washington, DC, on January 13, 1982, where no recovery was achieved, it was found, inter alia, by the United States National Transportation Safety Board that snow and/or ice contamination on the wing leading edges produced a nose-up pitching moment as the aircraft was rotated for liftoff.

Two expert witnesses, Mr Jack van Hengst and Mr Gary Wagner, suggest that the effect of wing contamination is equally dangerous on a wing with leading-edge devices and a hard wing.

Mr Wagner, in his article "Takeoff & Landing in Icing Conditions, Aerodynamic & Performance Issues" (CALPA's *Pilot*, December 1989), states as follows:

> There has been a focus on icing accidents in Canada in recent years, especially those involving aircraft with so-called hard wings (i.e. no leading edge devices). However, analysis of the performance of aircraft with wings with leading-edge devices shows, in general terms, the same kinds of performance problems when these aircraft are operated with contamination present. Since any benefit from the leading edge devices in these conditions is small, it is suggested that pilots of aircraft so equipped take no comfort from the fact that the aircraft are slatted/slotted, etc. and that any airfoil contamination be dealt with in the appropriate way. Should the contaminant not be removed, the same magnitude of performance decrement should be expected whether the wings have leading edge devices or not.
>
> (Exhibit 550, p. 12)

In addressing his article and providing his views on the relative performance of hard wings compared with wings with leading-edge devices, Mr Wagner stated in testimony as follows:

> A. I would think the fact remains, if the airplane's not going to fly, most likely, it's not going to fly, and if you get to the point where you've got so much contaminant on and you rotate the airplane and become slightly airborne, the point I'm trying to make in the article – and I thought my words were strong enough, sir – was that, if that airplane's contaminated, you should have it cleaned and take no comfort from having a

> leading edge slat.
>
> I don't think to suggest one is better or worse than the other is appropriate, because, sir, there are so many different designs of leading edge slats, leading edge flaps, it may depend on the trailing edge flap setting – it's a very complex problem.
>
> But the simple fact is, whether the airplane is slatted, slotted, flapped or whatever, if it's contaminated, you're going to have on the order of magnitude similar performance effects of contaminant.
>
> (Transcript, vol. 73, p. 144)

Mr van Hengst explained that, in aerodynamic terms, pilot recognition of a performance problem occurs at a different time during the takeoff, depending on the type of aircraft. If the wing is contaminated, then, for a pilot of a hard-wing aircraft or an aircraft with the wing leading-edge devices retracted, the problem is evident when the aircraft is rotated for takeoff and before it leaves the runway. The aircraft may eventually get airborne but cannot fly out of ground effect. On aircraft with leading-edge devices extended, the problem may become evident to the pilot only after the aircraft becomes airborne. Thus, for aircraft types such as the Boeing 737, flight crews have described pitchup or rolloff as occurring immediately after takeoff. The results can be the same for either phenomenon: the aircraft may not be able to accelerate to a high enough airspeed to fly out of ground effect.

Whether the pilot encounters performance problems such as stall, which might be caused by contamination, at rotation of the aircraft, or whether the problem, identified by a pitchup or rolloff, is evident once the aircraft is airborne, the important issue is immediate rectification of this dangerous situation. And although the two types of wings, when contaminated, may exhibit different takeoff flight characteristics, from the evidence of the expert witnesses it is clear that the effect of the contamination on either type of wing is equally dangerous.

To highlight much of the evidence that was before me, I include the following statement made at a September 1988 de-icing conference in Denver, Colorado, by Mr Ralph E. Brumby of the Douglas Aircraft Company:

> [S]imply a listing of some icing-related accidents ... while it is by no means inclusive ... does illustrate that ice contamination is quite democratic. Straight wing propeller aircraft like the Nord 262, small turbojet aircraft with conventional airfoils like the Learjet, and larger aircraft with conventional airfoils such as the F-28, DC-9, and DC-8 as well as aircraft with leading edge high lift devices, such as the 737, are all adversely affected.
>
> (Exhibit 532, tab 10, p. 7)

Freezing Precipitation on Aircraft Surfaces

Witness Descriptions of Wing Contamination

There was much eyewitness testimony that snow accumulated on the aircraft wings during the station stop in Dryden. Various descriptions were provided as to how the appearance and amount of the snow on the wings changed during the takeoff roll and rotation.

Mr Brian Perozak, who was seated in row 4 near the front of the aircraft, and Air Ontario Captain David Berezuk, who was seated in row 12, next to the left wing, respectively described the snow on the wings as "fluffy snow" and "wet snow accumulation" in the approximate amount of one-half inch prior to the takeoff roll (Transcript, vol. 16, p. 229; vol. 14, p. 79).

Mrs Sonia Hartwick, the surviving flight attendant, who was seated in row 8, stated: "It crystallized and turned to ice" (Transcript, vol. 10, p. 239). In a tape-recorded telephone conversation with Air Ontario executives approximately one hour after the crash, Mrs Hartwick stated: "the wings were icing up ... before take off there was quite a bit of wet snow on them, as we were taking off it was freezing" (Exhibit 126, p. 2).

Mr Murray Haines, an Air Canada captain who was seated in row 13, stated: "About a third of the way down the runway, when – as the speed got up, the snow crystallized into the ice, and it wasn't moving off the wings" (Transcript, vol. 19, p. 37).

Captain Berezuk stated: "I saw it [snow] dissipate ... it was a sculptured carpet texture, the parts that were white in colour got more of a greyish opaque colour and the parts that were greyish got more grey in intensity" (Transcript, vol. 14, p. 84).

Mr Perozak, who had a clear view of the front portion of the right wing, observed at the time of initial liftoff a "donut glaze" of ice over the leading edge of the wing (Transcript, vol. 16, p. 234). The glaze was not there at the start of the takeoff. He stated: "It looked like the snow had become ice" (p. 236).

Mr John Biro, a retired Canadian airforce warrant officer who was seated in row 11 next to the right wing, testified as follows:

> A. We started to roll down the runway and at this stage I was looking at the wing rather closely, hoping that as we gained speed this wet snow would slide off.
>
> We reached flying speed at seemingly about the same time as previously. And as the nose of the aircraft lifted, the snow on the back part of the wing, about halfway up across the wing, came off with a buff, almost an explosive-type buff.

> And the snow on the forward part of the wing seemed to freeze to an opaque, dull opaque ice, almost a flash freezing type thing. And it had a rough surface, not – not coarsely rough but definitely a rough surface.
>
> (Transcript, vol. 21, p. 12)

Mr Biro also stated that right after liftoff, the painted portion of the wing became visible as the snow blew off and the forward portion of the wing became ice. The ice had a rough surface such as the surface of a "knitted coverlet on the bed ... almost a waffled surface" (p. 32), and Mr Biro agreed that there was "a noticeable difference in colour between the front and the rear of the wing" (p. 37).

Because of concerns at an early stage of the investigation regarding wing contamination, it was decided to investigate phenomena that might explain the passengers' observations and why the precipitation adhered to the wings. The assistance of the National Research Council was obtained in this regard.

National Research Council Report: "Freezing Precipitation on Lifting Surfaces"

This section of the chapter is based upon a report prepared in support of the investigation and entitled "Freezing Precipitation on Lifting Surfaces." Researched and submitted by Myron M. Oleskiw, PhD, the "Precipitation" report was entered as Exhibit 521 during his testimony. Dr Oleskiw is an associate research officer at the low temperature laboratory, Division of Mechanical Engineering, NRC. As a research meteorologist he has expertise in computer simulations relating to rime ice formation on airfoils. For brevity and simplification, much of the background information and many of the test procedures, charts, and calculations from the report are not included in this section. However, so that the technical data and the results of Dr Oleskiw's research will be available to the reader, the study appears in its entirety as technical appendix 6 to this my Final Report.

The low temperature laboratory was requested to perform the following analyses, given the known meteorological conditions at Dryden, Ontario, on March 10, 1989:

- an estimation of the weight of snow per unit area that could have collected on the aircraft prior to takeoff;
- a determination of whether wet snow crystals could have stuck to the leading-edge of the wing during takeoff; and,
- a determination of whether snow on the surface of the wing could have turned to ice (as reported by witnesses) through the mechanisms of adiabatic and evaporative cooling of the airflow over the wing.

Dr Oleskiw was also requested to research the possibility of wing surface cooling being caused after landing by cold fuel in the wing tanks, the fuel having been cooled during flight, and to determine the effect the cooling might have had on precipitation falling on the wings while the aircraft was on the ground. The phenomenon of both the aircraft skin and the fuel cooling while the aircraft is flying in very cold temperatures at higher altitudes, resulting in the aircraft skin, on landing, being colder than the outside temperature, was referred to in much of the testimony at this Commission as "cold soaking." I will deal with the phenomenon of cold soaking further in a later section of this chapter.

The following provides a summary of the "Precipitation" report.

Quantity of Precipitation Accumulated

The thickness of wet snow that would have accumulated on the wings of C-FONF during its station stop at Dryden was estimated to be 1.38 mm. This value was determined from analyses of the visibility data as recorded by an Atmospheric Environment Service observer at the Dryden terminal as well as by a transmissometer located near the threshold of runway 11. The relationship used to estimate precipitation rate from visibility is an empirical one, and the data from which the estimate was derived show considerable scatter. The main uncertainty in the relationship is due to the variation in terminal velocity of the snowflakes because of the variations in their size and wetness and, thus, density. It is expected that, despite the efforts to calibrate the visibility-to-precipitation–rate relationship, unusually wet snowflakes may have contributed to a depth of precipitation greater than 1.38 mm.

During his testimony, Dr Oleskiw stated that he did not include in his calculations any information gathered from witnesses. Being aware of witness testimony that revealed the snow had been falling in a fashion not in agreement with the "hard" meteorological data, Dr Oleskiw estimated that the depth of snow could have been up to three times his estimate of 1.38 mm. According to witness testimony, the snow was heavy and the flakes were very large. Also, the visibilities used in Dr Oleskiw's calculations were from the centre and the west end of the airport. When during his testimony it was suggested that there could have been a "curtain" of snow between the terminal and the east end of the runway, with the transmissometer isolated at the west end of the runway, Dr Oleskiw stated: "a comparatively heavy and unrecorded amount of snowfall could have been occurring at the east end of the runway" (Transcript, vol. 68, p. 281). He considered it probable that, had this information been used in snow depth calculations, the estimated snow depth would have been greater.

Dr Oleskiw estimated the accumulated water-equivalent snowfall during the time the aircraft was on the ground to be 0.50 mm. This accumulation is equivalent to 0.5 kg per square m. Because of the shape and slope of the aircraft surfaces and the consistency and wetness of the snow, it is difficult to estimate the weight of snow and slush that stayed on the aircraft.

Freezing of Accumulated Precipitation

Adiabatic and Evaporative Cooling Some of the passengers on board C-FONF saw snow blow off the wings and observed slush on the wings turn to ice during the takeoff roll, especially at or near the point of aircraft rotation. Extensive calculations were made with regard to the effects of adiabatic and evaporative cooling during the takeoff run to determine if these processes could have generated enough heat loss to account for the fact that the slush froze.

The adiabatic cooling of the air just outside the boundary layer plus the evaporative cooling caused by less than saturated air passing over the wing produced a heat loss. The heat loss was, however, more or less offset by the heat gain caused by frictional heating of the boundary layer in combination with the heat release required to freeze the partially melted snowflakes impacting on the wing. With such a small net heat flux, and given the very short time that it would have been acted upon during the takeoff roll, it would have been impossible for essentially any change to occur in the precipitation layer. Any snowflakes impinging on the wing during the takeoff roll would thus have likely met a partially wetted precipitation layer surface.

Dr Oleskiw estimated that between 25 and 32 per cent of the snowflakes that are in the path of the wing during the takeoff roll would stick to the leading edge in the area extending from 3 per cent to about 19 per cent of the wing chord. Further back on the wing the snowflakes would graze the surface and would not stick to it. The fact that the snow on the wing was partially wet, in combination with the likelihood that the impinging snowflakes would have been somewhat wet, leads to the conclusion that many of these snowflakes would have stuck to the forward portions of the precipitation layer during the takeoff roll.

Dr Oleskiw concluded that there was an insufficient amount of adiabatic and evaporative cooling during the takeoff roll to account for the freezing of the precipitation layer on the wing.

Conduction of Heat into the Fuel Tanks The wing of the F-28 contains integral fuel tanks that, when full, wet the wing skin for most of the length of the wing between two wing spars located at about 12 per cent and 56 per cent of the wing chord. For the purpose of calculating heat transfer, it was first necessary to determine the temperature of the fuel in the aircraft before and after the aircraft was refuelled at Dryden. Calculations regarding fuel temperatures were made from the time the aircraft left Winnipeg to the time refuelling was completed at Dryden. Data considered were the initial temperature and weight of the fuel in the aircraft, the temperatures and weights of delivered and offloaded fuel, the outside air temperature both on the ground and at flight altitudes (the cold temperatures at altitude causing the fuel to cool), and the flight leg duration. During a flight of the sister Air Ontario F-28 aircraft, C-FONG, wing surface temperatures and fuel temperatures were measured to establish norms. The flight leg durations were similar to those flown by C-FONF on March 10, 1989, and the outside temperatures were approximately the same. These norms were used by Dr Oleskiw in his calculations. The temperature of the fuel in C-FONF at Dryden just prior to the accident flight was calculated at -6.4°C before fuelling and at -4.7°C after fuelling. The ambient air temperature at the Dryden airport at the time was between +0.4°C and +1.0°C.

Under certain circumstances and in combination with the other heat flux terms, the contribution of the conductive heat flux from the precipitation layer on the wing to the fuel tanks might have resulted in a complete freezing of the water fraction of the precipitation layer during the 10-minute interval of the heavier snowfall rate while the aircraft was on the ground. The assumed value of the water fraction of the falling snowflakes has been shown to alter significantly the time required to freeze the precipitation layer. The thickness of the precipitation layer also exhibited a strong influence on the freezing time.

Given that the depth of the wet snow on the wings was likely greater than the best estimate of 1.38 mm calculated from the available data, it seems probable that the heat conduction into the fuel tanks would have permitted a lower portion of the water in the wet-snow layer to have frozen, while leaving some upper portion in a partially liquid state. Because the density of the wet snow was between that of dry snow and ice, this layer was composed of a lattice of deformed and coagulated ice crystals interspersed with air pockets and water. As the water froze in the lower portion of this layer, it would likely have left a very rough interface between the lower and upper portions of the precipitation layer.

As the aircraft rolled down the runway, pressure variations outside the boundary layer and aerodynamic forces of air flowing over the wing at speeds, in places, of greater than 300 knots might have forced the remaining water in the upper portion of the precipitation layer to drain away, possibly carrying with it some of the slush, wet snow, and ice from that portion. The resulting very rough ice surface on the wings would have had a significant impact on the aerodynamic performance of the aircraft.

It should be noted that the thermal conductivity of the aluminum skin of the aircraft is in the order of 100 times greater than that of wet snow, air, or the fuel in the tanks. As a result, the aluminum skin might have conducted heat away from the precipitation layer even further forward on the wing than the location of the wing spar forming the forward wall of the fuel tanks. Thus, the rough precipitation layer surface may have extended forward to the leading edge, the more aerodynamically critical portion of the wing.

Discussion and Summary

The description given by Dr Oleskiw during his testimony provides a clear explanation of the phenomenon viewed by the passengers:

> A. ... there are pressure variations as a result of the lift that is being produced on the wing, that these pressure variations and this force of the air going over the wing could have been sufficient to suck or push the remaining water out of the upper portion of the wing – out of the precipitation layer, rather.
>
> It also could have allowed the force of the air to have taken away some portion of this wet snow on the upper portion of the precipitation, leaving behind the frozen precipitation which was entirely frozen.
>
> Now, since the crystal structure and such of this precipitation layer was very coarse, it appears to me that this motion of the air during the takeoff roll could have suddenly exposed a very rough layer, much rougher than was there prior to the takeoff roll, and that as a result, the witnesses on the aircraft that seemed to indicate that they had noticed a sudden change during the takeoff roll might have actually been seeing this sort of a phenomenon occurring.
>
> And that if that indeed did occur, it seems to me, and some of your aerodynamics experts can comment further on that perhaps, that this very rough surface would have been suddenly presented to the outer surface of the wing of the aircraft to the air flow and that that perhaps could have had a very adverse effect on the aerodynamics of the aircraft.
>
> (Transcript, vol. 68, pp. 219–20)

Findings

Dr Oleskiw's findings, with which I agree and which I adopt, are summarized as follows:

- The weight of snow and slush accumulation on the aircraft could not be determined, mainly because of the difficulty in calculating the amount of snow and slush that would stick to the sloping surfaces of the aircraft.

- The phenomenon of the slush turning to ice during rotation and liftoff could not be adequately explained by the processes of adiabatic and evaporative cooling.
- The heat transfer from the slush to the cold fuel probably caused at least the lower levels of slush on the wing to freeze. As the water drained away from the wing surfaces during the takeoff roll, leaving mainly rough ice on the wings, the change in appearance of the slush and ice layer may have left the impression on the witnesses that the slush had turned to ice.
- The aerodynamically critical portion of the wings, the forward 15 per cent of the chord, was most likely contaminated with rough snow and ice. First, because of the conductivity of the aluminum wing skin, the cooling effect of the tank fuel would extend beyond the limits of the fuel tanks towards the leading edges, causing ice to form on the leading edges; the forward portion of fuel tank limit itself being within the first 12 per cent of the wing chord. Second, it was concluded that the wet falling snow would stick to the leading edge of the wing during the takeoff roll.

Takeoff from Wet or Contaminated Runways

A runway, whether or not in an isolated area, is considered to be contaminated when more than 25 per cent of its surface, within the required length and width being used, is covered by surface water greater than 3 mm (0.125 inch) deep, or by slush or loose snow equivalent to more than 3 mm of water. The analysis of all the information regarding the runway condition at Dryden at the time of the takeoff of C-FONF on its accident flight indicates that one-quarter to one-half inch of slush covered the runway from its east end to, at least, the intersection of taxiway Alpha, a distance of approximately 3500 feet. It is therefore concluded that the runway was, at that time, contaminated.

All the published Fokker F-28 Mk1000 takeoff information contained in the Fokker F-28 Flight Handbook is based on acceleration and stopping taking place on hard, dry, and smooth runway surfaces and all means of braking being serviceable. The effects of variable factors such as temperature, moisture, density altitude, and wind on aircraft performance are also taken into account.

The takeoff performance criteria, applicable to commercial jet aircraft, including the Fokker F-28 Mk1000, are normally described as accelerate-stop and accelerate-go criteria.

In general terms, for the purpose of aircraft certification, accelerate-stop distance is defined as the distance required for an aircraft to accelerate to decision speed V_1 with all engines operating normally at takeoff thrust; to experience a power failure of the critical engine[10] at V_1; to allow an appropriate time delay for the pilots to recognize the failure and, upon recognition, allow an appropriate time to retard all engine throttles or thrust-levers to idle; to apply maximum wheel-braking and deploy speed brakes; and to continue with maximum braking until the aircraft comes to a full stop. Although reverse-thrust is not taken into account in the accelerate-stop calculation, pilots, to assist in stopping the aircraft, would also deploy and use thrust-reversers, if available, on the operating engine(s). (The F-28 does not have thrust-reversers.) The accelerate-stop distance is dependent upon such variables as wind, ambient temperature, aerodrome elevation, runway slope, aircraft weight, and aircraft configuration.

The takeoff path distance, often referred to as the accelerate-go distance, is in general terms the distance required for an aircraft to accelerate to decision speed V_1 with all engines operating normally at takeoff thrust; to experience a power failure of the critical engine at V_1; to allow an appropriate time delay for the pilots to recognize the failure and, upon recognition, elect to proceed with the takeoff and rotate the aircraft at a speed of not less than V_R to the target pitch attitude; and to achieve V_2 prior to or at a height of 35 feet above the end of the runway (often referred to as the screen height).

A runway length that allows for either accelerate-stop or accelerate-go once an aircraft experiences an engine failure at V_1 is called balanced field length or a balanced field.

Taking off from a contamination-covered runway will adversely affect the takeoff performance of an aircraft in different ways, depending on the type and the amount of precipitation on the runway. Slippery runways with little contaminant depth will adversely affect an aircraft's accelerate-stop performance but will not appreciably affect its accelerate-go performance. Although a slippery runway will reduce an aircraft's wheel-braking performance, it creates no significant drag to reduce the acceleration of the aircraft.

Accelerate-stop and accelerate-go performance are both adversely affected in conditions where the runway is contaminated with standing water, slush, or snow. Acceleration is adversely affected by wheel drag in the contamination and by the effects of spray thrown upwards against

[10] Critical engine is the engine whose failure causes the most adverse effect on the aircraft characteristics relative to the case under consideration. For the purpose of discussion of F-28 performance, neither engine, if it failed, would have had a more adverse effect than the other on aircraft performance.

the aircraft underbody by the aircraft wheels. This drag results in an increase in the distance that an aircraft requires to accelerate to V_1, to V_R, and, finally, to V_{LOF} (the liftoff speed).[11] Where an engine failure occurs at V_1 and the decision is made to go, the drag caused by the contaminant may decrease acceleration to the extent that it would be impossible to accelerate to liftoff speed after the engine failure. Where the decision is made to reject the takeoff and bring the aircraft to a stop, the reduction in the runway coefficient of friction caused by the contaminant will result in an increased stopping distance.

Because of the difficulty in predicting accurately the effect of runway contamination on acceleration and braking performance, aircraft flight manuals generally recommend that takeoffs from runways covered with standing water, slush, or snow be avoided where possible. In spite of general improvements in techniques at clearing contaminants from runways, Fokker recognized that operators might find it necessary to take off from contaminated runways. The Fokker F-28 Flight Handbook contains information to allow calculation of aircraft takeoff performance when operating from hard-surface runways contaminated with standing water, with slush, or with loose, uncompacted snow.

The Piedmont and the USAir F-28 operations manuals, which were the manuals used by Air Ontario in its F-28 operation, also contain information regarding contaminated runways, along with a caution regarding performance degradation. The following passage appears in both manuals:

> Apart from the substantial increase in stopping distance when takeoff is rejected on a contaminated runway, the degradation in acceleration caused by snow, slush or standing water can under adverse conditions result in the aircraft needing up to twice the normal takeoff distance.
>
> (Exhibit 307, p. 3A-24-4; Exhibit 329, p. 3-125-7)

Recognizing the negative effects that standing water, slush, or snow have on takeoff performance, both Piedmont and USAir provided identical correction charts recommending maximum allowable takeoff weights for various runway lengths. Inasmuch as Air Ontario pilots used the Piedmont and USAir F-28 operations manuals as guides in their day-to-day operation of the F-28, and because witness evidence indicates that there was one-quarter to one-half inch of slush on at least the east half of runway 29 at the time C-FONF commenced its final takeoff roll at

---

[11] V_{LOF}, the liftoff speed, is, in terms of calibrated airspeed, the speed at which the aircraft first becomes airborne. The aircraft is deemed to be airborne when the aircraft wheels are no longer in contact with the runway.

Dryden on March 10, 1989, I think it important to include, as figure 12-10, the Piedmont and USAir takeoff limitation and correction chart.

The normal operations sections of the Piedmont and the USAir F-28 operations manuals set out identical correction charts. The above-noted excerpt from the two manuals was included by Air Ontario in the first draft of its F-28 operations manual but was removed from the draft of the manual submitted to Transport Canada for approval. The chart was removed after discussion with the drafters, Captain Robert Perkins and Captain Steven Burton; the project manager of the F-28 program, Captain Joseph Deluce; and the director of flight standards for Air Ontario, Captain Larry Raymond. The discussions centred on the fact that the Piedmont charts were much more restrictive than the Fokker F-28 charts.

The contaminated runway performance charts produced for the F-28 aircraft by Piedmont, USAir, and Fokker were all based on the assumption of both engines operating normally throughout the takeoff flight path.

Using Fokker charts and the takeoff distance available of 6200 feet on runway 29 at Dryden, with a temperature of +1°C, a barometric pressure of 1020 millibars, and a tail-wind component of 1 knot (the conditions that existed at Dryden on March 10, 1989), with one-half inch of slush (EWD 0.425 inches), the operations group calculated that the maximum allowable takeoff weight of an F-28 would be 64,400 pounds. Under the same conditions, the Piedmont and USAir charts provided that the maximum allowable takeoff weight of an F-28 would be somewhere between 53,000 and 54,300 pounds.

Two matters that arise from the performance information available to Air Ontario F-28 pilots relating to operation from contaminated runways are of concern to me. My first concern is over the large difference between the correction factors provided by Fokker Aircraft and those supplied in the Piedmont and USAir operations manuals used by Air Ontario. My second concern is that the contamination-correction charts do not consider engine failure during takeoff; the charts are based on both engines operating throughout the takeoff flight path. Although information is provided to pilots for the determination of allowable aircraft weight and balanced field lengths when operating from a dry runway, no equivalent information is provided for takeoffs from a contaminated runway.

The chart provided in the Piedmont and USAir operations manuals imposes severe weight penalties for takeoff on slush-covered runways. If we assume the takeoff portion of the runway at Dryden was covered with one-half inch of slush, then, had the crew of C-FONF, prior to takeoff, referred to and complied with the information set out in the Piedmont and USAir manuals, they would not have been able to take off

Figure 12-10 Piedmont/USAir Takeoff Weight Correction Chart for a Contaminated Runway

5. Takeoff in Standing Water, Slush or Snow

Operation on precipitation covered runways is acceptable, however an assessment for the deteriorating effect on takeoff performance must be made. The following information is presented for guidance and has not been FAA approved.

This part contains information and recommendations to enable an assessment to be made at which the airplane should be able to take off from a snow, slush or water-covered runway. The precipitation is assumed to be of uniform depth over the complete length of the runway.

Takeoff in standing water depths greater than 0.25 inch, slush depths greater than 0.50 inch or dry snow greater than 2.0 inches is not recommended. The maximum takeoff weight shown in the following table is based on both engines operating throughout the takeoff flight path. The weights shown are always lower than dry runway take-off allowable weights. Therefore, no comparison is required. These are the maximum allowable takeoff weights on contaminated runways.

F28 MK 1000 CONTAMINATED RUNWAY
MAXIMUM ALLOWABLE TAKEOFF WEIGHT
FLAPS 18°

RUNWAY LENGTH - FT	STANDING WATER 0.25 INCHES	SNOW = 1.0 INCHES SLUSH = 0.25 INCHES	SNOW = 2.0 INCHES SLUSH = 0.50 INCHES
5000	48800 lbs	52700 lbs	49500 lbs
5500	49800 lbs	54000 lbs	51500 lbs
6000	50800 lbs	55400 lbs	53000 lbs
6500	51900 lbs	56800 lbs	54300 lbs
7000	52900 lbs	58000 lbs	55600 lbs
7500	53800 lbs	59100 lbs	56600 lbs
8000	54700 lbs	60100 lbs	57500 lbs
8500	55600 lbs	61000 lbs	58200 lbs
9000	56300 lbs	61700 lbs	58900 lbs
9500	56900 lbs	62200 lbs	59500 lbs
10000	57300 lbs	62600 lbs	60100 lbs

Note: This information is good for all temperatures and for airport elevations up to and including 3,000 feet.

Source: Exhibit 307

unless the runway had first been cleared of slush or the aircraft weight had been no greater than 54,300 pounds. Calculations using the Fokker charts for the same conditions at Dryden indicate that there was sufficient runway for an F-28 to take off at a weight of 64,400 pounds, even though there was one-half inch of slush on the runway. The large variation in permissible takeoff weights between Fokker Aircraft and Piedmont/USAir clearly indicates a difference between the manufacturer's certification requirements and the operational philosophy of Piedmont and USAir. A carrier that is conservative in its view of the requirements concerning contaminated runways might impose severe restrictions, as was the case with both Piedmont and USAir. The draft of the Air Ontario F-28 operations manual that was sent to Transport Canada did not contain a slush-correction chart. A less conservative carrier could simply adopt the less restrictive chart provided by Fokker Aircraft. Even so, approval of all the slush-correction charts mentioned is not required by Canadian, Dutch, or United States regulatory authorities.

Captain Robert Perkins, an Air Ontario F-28 check pilot, stated in his testimony that, because the Piedmont and USAir F-28 slush-correction charts were "fairly restrictive" (Transcript, vol. 43, p. 31), he felt he could use the Fokker F-28 Flight Handbook chart, which was less restrictive. However, while under close questioning during his testimony, he agreed with the subsequent evidence of Transport Canada and Air Ontario pilot witnesses that, to determine takeoff parameters, a pilot in the cockpit would find it difficult and time-consuming to use the detailed charts in the Fokker handbook. Captain Robert Nyman, the director of flight operations for Air Ontario, considered that the tables in the Piedmont and USAir F-28 operations manuals applied because these were the manuals used by Air Ontario F-28 pilots. With respect to Fokker's charts, Captain Nyman stated: "I tried post-accident to go through those charts. I have been trained in performance and use of charts. I found them very difficult to use, and, as has been pointed out by other people, you don't come up with consistent answers. I find them difficult to use" (Transcript, vol. 109, p. 210). During this Commission's hearings, testimony revealed that, within the pilot group of Air Ontario, there was no consensus on whether to use Fokker's or Piedmont's information with respect to operations from slush-covered runways. Clearly this lack of consensus constituted an alarming state of affairs within Air Ontario.

In light of testimony about the nature of the charts contained in the Fokker F-28 Flight Handbook, it is not only probable but virtually certain that the crew of C-FONF had insufficient time to use them to determine slush corrections. Moreover, the fact that C-FONF, at an estimated weight of 63,500 pounds, took off at Dryden from a slush-covered runway strongly suggests that the crew either did not consider or considered and elected not to apply the slush-correction information contained in both the Piedmont and USAir F-28 operations manuals. The uncertainty regarding which manual to use in calculating slush correction at Dryden would have posed a serious dilemma for the pilots of Air Ontario flight 1363. That dilemma should have been solved by Air Ontario long before March 10, 1989.

The final takeoff of C-FONF was from a runway contaminated with slush on at least the first half of its length and wet on the remainder. The slush was described by a number of witnesses, none of whom had actually measured its depth, as being up to one-half inch deep. The performance subgroup determined through precise analytical and engineering studies that, for the aircraft to reach its rotation point as described by many witnesses, the slush must have been in the order of 0.15 inches EWD. Although an engine failure did not occur, there was potential for the necessity to react to an engine failure during the takeoff and either continue the takeoff or stop on the runway. Calculations show that, according to aircraft weight and existing ambient conditions, the Dryden runway was close to balanced length for dry runway operations. Had an engine failure occurred at or near V_1 during the takeoff, it is probable that, because the last half of the runway was at least wet and thus slippery, the aircraft could not have been stopped on the runway. However, had there in fact been no slush on the last half of the runway, the aircraft, under normal circumstances, should have been able to complete the takeoff had an engine failed at V_1. Simulator tests conducted by the performance subgroup and Fokker Aircraft at Fokker's facility in Amsterdam indicated that, with one-half inch of slush on the entire runway length and with the aircraft wing clean, the aircraft would reach V_1 in about 3100 feet with a takeoff run of approximately 4250 feet. Engine-failure tests were not conducted under these conditions. If, however, an engine had failed at V_1, it is possible that, because of the slush, the aircraft would not have been able to get airborne in 6000 feet, the length of the runway at Dryden.

Neither United States Federal Aviation Regulations, which are the benchmark regulations for certification requirements for most transport aircraft, nor Canadian Air Regulations and Air Navigation Orders address the issue of engine failure during takeoff on a wet or contaminated runway; indeed, there are no standards available to enable manufacturers or operators to determine what weight corrections to apply. It is therefore not difficult to conclude, as in fact I do, that passengers and aircraft crew members are exposed to different degrees of risk on takeoff, depending on whether the takeoff is made on a contaminated or wet runway or it is made from the same dry runway.

Clearly this is an aviation safety issue that has existed for some time and must be addressed. As shown in a subsequent chapter of this Report, available information indicates that regulators are finally taking steps to address the problem.

The fact that Transport Canada and CASB have been aware of the problem for a considerable time is illustrated by the following abbreviated versions of two occurrence reports prepared by CASB, by the recommendations contained in those reports, and by Transport Canada's reaction to the recommendations.

The following information is from CASB report no. 86-A60024. On July 20, 1986, a Boeing 737 was taking off from Wabush, Newfoundland, when, as the aircraft speed approached V_1, a bird was ingested by the left engine and the engine lost power. The crew rejected the takeoff, and the aircraft came to a stop in a bog 200 feet beyond the end of the runway. No one was injured in the occurrence. CASB determined that, because the runway was wet, the distance required to stop the aircraft exceeded that which was available. Pre-flight performance calculations did not take into account the effects of the wet runway. Such calculations were not and are not required by regulations. CASB also found that existing aircraft flight manuals do not provide data that take into account the effects of wet runways on accelerate-stop distances.

The "safety action" portion of the CASB-produced report of this occurrence states the following:

> In view of the absence of certificated performance data and the apparent lack of knowledge on the part of flight crews regarding wet runway takeoff performance, the CASB recommends that:
>
> > The Department of Transport revise air carrier procedures involving wet runway take-off operations, in order to provide a margin of safety comparable to that for dry runway operations.
> > CASB 87-45
> >
> > The Department of Transport require air carriers to improve flight crew knowledge of the effects of wet runways on take-off performance and the means available to flight crews to provide a margin of safety comparable to that for dry runways.
> > CASB 87-46

Transport Canada's response to the above recommendations was as follows:

> Notwithstanding the amount of information available at present, Transport Canada will request the Transport Development Centre to initiate a research project to investigate the effect of wet runways on aircraft performance.

In a return letter to Transport Canada, CASB expressed regret that Transport Canada's response was limited to a long-term study. CASB further expressed concern that overruns can continue to happen whenever a rejected takeoff occurs at or near V_1 on a performance-limited wet runway and requested that Transport Canada reconsider its position on this important issue.

The following information is from CASB report no. 86-P64053. On July 14, 1986, a Boeing 737 landed at Kelowna, British Columbia, shortly after a torrential rain storm. During the landing roll, the aircraft hydroplaned, the thrust-reversers and ground-spoilers did not deploy, and the aircraft overran the runway. CASB determined that the pilot's landing procedures on the wet runway, combined with limitations imposed by the aircraft's air-ground logic system, prevented deployment of the ground-spoilers and reversers. As a consequence, the crew was unable to stop the aircraft on the runway.

With regard to wet runway performance, the "safety action" portion of this report contains the following rather startling information:

> The CASB has knowledge of 16 occurrences involving aircraft weighing more than 12,500 pounds overrunning the runway on landing in Canada between 1980 and 1987. Most of these involved runways where the braking action was reduced by water or other surface contaminants. Canadian operators routinely conduct flight operations on wet or otherwise contaminated runways that are at or near the certified performance limits of aircraft within their fleets. The latitude for error is small. The anticipated stopping distances contained in aircraft flight manuals will not be achieved if braking action is poor.

CASB pointed out in the report that existing certification standards used for determining the landing distance applicable to transport-category aircraft certified under Federal Aviation Regulation 25 require that the tests be conducted on bare, dry, smooth, hard-surfaced runways. Without detailing the issues brought to light in this occurrence, other than the wet runway performance, I will recite the CASB recommendation made as a result of this investigation. CASB recommended that:

> The Department of Transport ensure that the recurrent training of flight crews of transport-category aircraft emphasizes the cumulative performance penalties and the uncertainties of expected stopping distances associated with operations on wet or contaminated runways. Particular emphasis should be placed on the need for a timely decision to effect a successful go-around.
>
> CASB 88-05

Although not making a recommendation regarding the lack of certification requirements for aircraft-stopping performance on wet or contaminated runways, CASB did state a concern on this issue as follows:

> The Board is equally concerned that the aircraft certification criteria currently in existence for ascertaining contaminated runway landing performance data do not provide aircrew with sufficiently accurate data upon which to base landing decisions. Current procedures provide for safety margins that are derived from factoring the dry landing distances by arbitrary amounts. Consequently, flight crews often land on performance limited runways using performance data for which there is no empirical evidence to assure a stop on the available runway.

The response to CASB by Transport Canada regarding the above recommendation CASB 88-05 was as follows:

> Transport Canada air carrier inspectors have been instructed to monitor training for landing on contaminated runways and to be alert to any degradation of standards.

This is apparently the last correspondence between CASB (now the TSB) and Transport Canada relating to the above-noted occurrences and the issue of wet or contaminated runways.

On February 5, 1991, based on occurrence investigations, in particular that of the Boeing 737 overrun at Wabush, and on other information collected, and after evidence on this subject was heard before my Commission of Inquiry, Transport Canada issued Airworthiness Manual Notice of Proposed Amendment, NPA 91-2, File No: 5009-006-525, entitled, "Take-off from Wet and Contaminated Runways." The proposed amendment requires a change to the airworthiness requirements of chapter 525, paragraph 525.1581, by the addition of a new subparagraph (g) as follows:

> The Aeroplane Flight Manual shall contain information in the form of approved guidance material for supplementary operating procedures and performance information for operating on wet and contaminated runways.

The proposal is intended to ensure that suitable approved guidance information is provided in the aircraft flight manual by the aircraft manufacturer as part of the aircraft type design.

In the explanatory information that accompanied the proposed amendment, Transport Canada outlined the approach of the United States Federal Aviation Administration (FAA) and the European Joint

Aviation Authorities (JAA) with regard to wet or contaminated runways, and I quote from the document as follows:

> The FAA published Advisory Circular AC 91-6A on May 24, 1978 which provides information, guidelines and recommendations concerning the operation of turbojet aircraft when water, slush, and snow are on the runway. This AC discusses the performance problems, provides sample performance adjustments and states that appropriate information should be included in the operations manual of the air carrier. A proposed revision, AC 91-6B, was announced in the Federal Register on August 1, 1986, but has not yet been promulgated. This draft revision updates the AC and clarifies that the operational requirements in Part 121 (for Commercial Operators of Large Aircraft) and Part 135 (for Air Taxi Operators and Commercial Operators) require adjustments to take-off and landing data when operating on wet or contaminated runways. The revised AC also states that the information should be included in the AFM [aircraft manufacturer's aircraft flight manual] or in the [aircraft] operations manual but that if the information is provided in the AFM then it need not be FAA approved.
>
> In November 1987, the FAA published NPRM [Notice of Proposed Rulemaking] 87-13, Standards for Approval of a Reduced V_1 Methodology for Take-off on Wet and Contaminated Runways. The proposal introduces the concept of using a 15-ft screen height (in lieu of 35 ft) for wet and contaminated runways with a corresponding reduction in V_1. Although actual accelerate-stop performance is not required, it is implicit in the proposal that rejected take-off safety would be improved on wet or contaminated runways at the expense of a reduced screen height. To date there has been no new regulations arising from this NPRM.
>
> The European JAA have published JAR 25X1591 which requires supplementary performance information to be furnished by the manufacturer in an approved document in the form of guidance material to assist operators in developing suitable guidance recommendations or instructions for use by their flight crews when operating on wet or contaminated runway surface conditions. It further states that if the information is in the [aircraft manufacturer's] AFM, then it must be segregated, identified as guidance material, and clearly distinguished from the operating limitations specified in JAR 25.1533 and 1587.

It is apparent that at this time no regulatory body is prepared to go so far as to make it mandatory for aircraft to comply with balanced field criteria when operating on a wet or contaminated runway. There is, however, consensus that guidance material is required. It is stated in the Transport Canada amendment document that, since the information will be provided as guidance only, non-compliance will not affect airworthiness approval; it will remain an operational decision covered by the appropriate operating regulations and/or procedures for each operator. Because of the difficulty in defining the exact state of a contaminated runway surface, in practice an aircraft may or may not perform as predicted in the guidance material. However, the mandatory inclusion in a manual, AFM or other, of approved guidance material relating to operations on a wet or contaminated runway will, in my view, go a long way towards improving the safety of such an operation. Operational decisions should be based on expected performance and not on guesswork, as is the case at present.

It appears that various regulatory bodies are working actively towards a solution to the problem of operating aircraft safely from wet or contaminated runways, and that their proposed amendments to the regulations, if they are in fact all promulgated, will improve passenger and crew safety.

However, it is doubtful that mere guidelines will produce the desired safety results. Although operators may endorse the approved guidance material, in the absence of any compulsion to follow it they have the option of ignoring it. As well, because of the previously mentioned difficulty regarding the definition of the state of the runway surface, adherence to guidelines will not necessarily ensure that a particular aircraft can be operated safely on a particular wet or contaminated runway. I believe that the regulators, in cooperation with manufacturers and operators, should continue to search for a technically accurate means of defining runway surface conditions and their effects on aircraft performance, and for an equitable means of requiring operators to adhere to balanced field criteria when operating on wet or contaminated runways. I recognize that economic penalties on air carriers would be imposed, but only through the regulatory process can a uniform and high level of safety be assured for all operating conditions.

Notwithstanding the efforts being made by the regulators with regard to aircraft performance on wet or contaminated runways, airport operators should make a concerted effort to ensure that runways are not contaminated when aircraft are landing and taking off.

Information and Procedures Available for Safe Operation in Cold Weather Conditions

This section outlines the information and procedures regarding operation in cold weather conditions that were accessible to Air Ontario F-28 pilots, including the crew of C-FONF. Chapter 1.7.5.1, Section 1, Volume 1, of Fokker's F-28 Flight Handbook provides the following information and procedures for a safe operation of the F-28 in cold weather conditions:

1.7.5 <u>ADVERSE WEATHER</u>

1. COLD WEATHER OPERATION

This chapter contains information and procedures for a safe operation of the F-28 in cold weather conditions. For performance criteria see subsection 2.

1.1 General

Small and apparently insignificant ice and snow deposits on the aerodynamic surfaces, accumulated during stand-over, can seriously affect the maximum lift of the wing, the controllability and the performance of the aircraft.

During a normal take-off the angle of attack reaches approx. 9 deg at rotation.

Thin layers of ice resulting from, for instance, frost or freezing fog, may cause a certain sandpaper roughness of the wing and tail upper surfaces.

This roughness may cause airflow separation at angles of attack below 9 deg resulting in control problems, wing drop or even a complete stall shortly after rotation.

Relatively "warm" fuel uplifted during a ground stop may cause dry snow falling on the wing to melt. After a subsequent cooling period this water may refreeze, forming an invisible ice coating underneath the dry snow.

When the tanks contain sufficient fuel of sub zero temperatures as, for instance, may be the case after long flights at very low ambient temperature, water condensation or rain will freeze on

> the wing upper surfaces during the ground stop forming a smooth, hardly visible ice coating.
>
> During take-off this ice may break away and at the moment of rotation enter the engine causing compressor stall and/or engine damage.
>
> Snow falling on "warm" leading edges will melt and may form, under certain wind conditions, "run back ice" on wings and stabilizer, causing possible lift loss and/or controllability problems.
>
> IN VIEW OF THE ABOVE IT IS OF VITAL IMPORTANCE THAT FUSELAGE, WINGS, ENGINE INTAKE AREAS, TAIL SURFACES, CONTROL SURFACES, HINGES AND IN PARTICULAR WING AND STABILIZER LEADING EDGES ARE COMPLETELY CLEAR OF ICE OR SNOW BEFORE TAKE-OFF.
>
> It is recommended that, when operating in slush conditions, de-icing grease or fluid is applied to the lower and upper surfaces of the flap vanes and the wing shroud and flap areas which come in contact with the vane surface.
>
> The effectivity of pre-flight application of de-icing fluid is influenced by several factors such as the amount of snow or ice deposits, outside air temperature, relative humidity, aircraft skin temperature and the water/glycol mixture used.
>
> Arrange the departure so that a minimum of time elapses between the moment of de-icing and take-off.
>
> When spraying with passengers and/or crew on board, switch off the airconditioning units to prevent glycol fumes from entering the cabin and/or cockpit.
>
> (Exhibit 314, Fokker F-28 Flight Handbook, p. 1.7.5.1)

Both the Piedmont and the USAir F-28 operations manuals repeat much of Fokker's information and provide the following under the title "Cold Weather Operations":

> This section contains information and procedures for a safe operation of the F-28 in cold weather conditions. Most recommendations mentioned are a result of experience gained during winter operation in Northern Europe, Canada and the Northern States of the USA.
>
> Small and apparently insignificant ice and snow deposits on the aerodynamic surfaces, accumulated during stand-over, can seriously

> affect the maximum lift of the wing, the controllability and the performance of the aircraft.
>
> During a normal take-off, the angle of attack reaches approximately 9° at rotation. Thin layers of ice resulting from frost or freezing fog cause a certain sandpaper roughness of the wing and tail upper surfaces. This roughness may cause air-flow separation at angles of attack below 9° resulting in control problems, wing drop or even a complete stall shortly after rotation.
>
> Relatively warm fuel uplifted during a ground stop may cause dry snow falling on the wing to melt. After a subsequent cooling period this water may re-freeze, forming an invisible ice coating underneath the dry snow.
>
> When the tanks contain sufficient fuel of sub zero temperatures as may be the case after long flights at very low ambient temperature, water condensation or rain will freeze on the wing upper surfaces during the ground stop forming a smooth, hardly visible ice coating.
>
> During take-off this ice may break away and at the moment of rotation enter the engine causing compressor stall and/or engine damage.
>
> Snow falling on warm leading edges will melt and may form run back ice on wings and stabilizer, causing possible lift loss and/or controllability problems.
>
> IN VIEW OF THE ABOVE IT IS OF VITAL IMPORTANCE THAT FUSELAGE, WINGS, ENGINE INTAKE AREA'S, TAIL SURFACES, CONTROL SURFACES, HINGES AND IN PARTICULAR WING AND STABILIZER LEADING EDGES ARE COMPLETELY CLEAR OF ICE OR SNOW BEFORE TAKE-OFF.
>
> (Exhibit 307, Piedmont F-28 Operations Manual, p. 3A-24-1; Exhibit 329, USAir F-28 Operations Manual, p. 3-125-1)

Both the Piedmont and USAir operations manuals discuss de-icing procedures under identical headings: "Fluids for De-Icing and Anti-Icing." I quote the Piedmont provisions in their entirety as follows:

> It is recommended that, when operating in slush conditions, de-icing fluid is applied to the lower and upper surfaces of the flap vanes and the wing shroud and flap areas which come in contact with vane surface.

For different de-icing fluids the times of protection (the holdover times) vary considerably. Furthermore, these times depend to a large extent on the meteorological conditions and methods of application.

The time of protection will be shortened, for instance, by snow, increasing content of moisture, wet airplane surface, relative high temperature of airplane surface and of the fluid being used, or high wind velocity and unfavorable wind direction. All these conditions cause an unwanted dilution of the protective film. If these conditions accumulate, the time of protection can be shortened considerably.

CAUTION: PRIOR TO EXTERIOR DE-ICING, THE APU AND PACK SHOULD BE SHUT DOWN.

If possible, ground power should be used to satisfy electrical needs during de-icing. Prior to de-icing, an announcement should be made to the passengers advising them that de-icing will be accomplished and slight fumes or smoke may be present following the de-icing operation. After de-icing is accomplished, start the APU and permit it to operate approximately two (2) minutes prior to turning on a pack.

Engine Anti-ice must be ON during all ground and flight operations when in icing conditions and/or the ice detect light is illuminated.

When penetrating or operating in icing conditions in-flight maintain a minimum of 83% HP RPM to ensure full and simultaneous Engine and Airfoil Anti-icing operation.

Icing conditions exist when OAT is 50°F/10°C or less and visible moisture in any form is present (such as clouds, fog with visibility of one mile or less, rain, snow, sleet, ice crystal); or standing water, slush, ice, or snow is present on the ramps, taxiways or runways.

(Exhibit 307, Piedmont F-28 Operations Manual, p. 3A-24-2)

None of the above information contained in Fokker's F-28 Flight Handbook or set out in the Piedmont and USAir F-28 operations manuals is contained in the Air Ontario Draft F-28 Operations Manual dated June 1, 1989. The only provisions contained in the Air Ontario Flight Operations Manual (September 15, 1987) dealing with wing contamination while on the ground and its effects is contained in section 7, "Operational Directives." One short sentence under 7.1.1, "Icing Conditions," states: "Take-off shall not be attempted when frost or freezing precipitation is adhering to the surfaces of the aircraft" (Exhibit 146, p. 73). This prohibition is included in the broader operational directive dealing generally with in-flight operating procedures in icing conditions. As a flight operations directive, this prohibition applies to all aircraft, including the F-28. However, no information and procedures by way of advice and cautions, as appear in the Piedmont, the USAir, and the Fokker manuals, are provided.

The obvious lack of information, advice, and direction relating to ground-accumulated wing contamination in the Air Ontario Draft F-28 Operations Manual and the Air Ontario Flight Operations Manual suggests a lack of thoroughness, rigour, and understanding on the part of the drafters of these manuals. There was unambiguous information in the Piedmont and USAir operations manuals as well as in the Fokker F-28 Flight Handbook available to both Captain Morwood and First Officer Mills. (It is normal for pilots to carry their own operations manuals and for the flight handbook to be on the aircraft at all times.) It is the evidence of a number of Air Ontario pilots that the ground school course provided by Piedmont was excellent: the effects of contamination on the aerodynamic performance of the F-28 were discussed in detail, and the pilots were appropriately cautioned.

The Phenomenon of "Cold Soaking"

The portion of the Fokker F-28 Flight Handbook chapter that I have quoted warns about small and apparently insignificant ice and snow deposits seriously affecting the lift capability and controllability of the aircraft, possibly causing, in turn, a complete stall shortly after takeoff. Fokker also warns about the possibility of dry snow falling on a wing containing warm uplifted fuel, potentially resulting in a thin-ice coating on the upper wing surface. Fokker speaks of wing-tank fuel at subzero temperatures causing water condensation or rain to freeze to the upper surfaces of the wing while the aircraft is on the ground. Finally, Fokker Aircraft insists that it is of vital importance that the aircraft be completely clear of ice or snow before takeoff. The Piedmont and USAir F-28 operations manuals reiterate Fokker's information, cautions, and instructions.

As noted above, the F-28 manuals are referring in part to a phenomenon that may be understood by most pilots but is by no means fully understood by all pilots; that is, cold wing-tank fuel causing precipitation to freeze to the aircraft surfaces. "Cold soaking" is a term used to indicate that an object has been in a cold temperature long enough for its temperature to drop to, or near to, the ambient temperature. Temperature at altitude is almost always colder than at ground level, and, although the outer skin of an aircraft in flight will cool quickly, the fuel in the wing tanks, because of its latent heat properties, will cool more slowly. The longer the aircraft remains at altitude, the closer the temperature of the fuel will be to the ambient temperature. On landing, the reverse occurs. The skin of the aircraft will warm quickly to ambient temperature, while the fuel will warm more slowly. However, the aircraft skin that is touched by the cold-soaked fuel will remain close to the temperature of the fuel touching it.

A well-known phenomenon frequently occurs on an aircraft that has landed with cold-soaked fuel in the wing tanks: moisture from the air deposits in the form of frost on the surfaces that are touched by the cold fuel. These frost deposits form under the wing tanks. On landing, the fuel in the wing tanks is normally depleted; since there is no tank fuel to touch the skin on the top of the wings, there usually will not be a frost deposit on the upper wing surface.

On occasion, however, there will still be enough cold fuel in the tanks on landing to touch the skin on the top of the wings. Addition of fuel at a warmer temperature will raise the level of fuel to touch the upper surface of the wing but may not bring the resultant temperature of the fuel above the freezing level. Frost can then form on the upper surface of the wing that is touched by the cold fuel. Rain can freeze to the upper wing surface in the form of a smooth, transparent sheet of ice, often virtually invisible; falling wet snow can also freeze to the upper wing surface, and the resulting ice surface may not be smooth.

As shown in the study by Dr Oleskiw and as evidenced during his testimony at the Inquiry, the cold-soaking phenomenon was at work at Dryden during the time C-FONF was on the ground prior to the crash. There can be little doubt that wet falling snow froze to the upper surfaces of the wings and ultimately prevented the aircraft from flying.

During the Inquiry, Air Ontario pilots were asked of their knowledge of cold soaking. Most were aware of the phenomenon, but some pilots had no knowledge of it prior to the crash of C-FONF. As shown above, all the F-28 manuals to which the Air Ontario pilots had access contain some information regarding the cold-soaking phenomenon, although the term "cold soaking" is not used.

The Piedmont and USAir F-28 operations manuals also present information to pilots on the use of de-icing fluids and include a caution that the time of protection against freezing provided by such de-icing fluids can be shortened considerably, depending on type of snow, moisture content, temperature of aircraft surfaces, and type of fluid being used. The Piedmont and USAir F-28 operations manuals in particular warn that icing conditions exist when the outside air temperature is +50°F/+10°C or less and visible moisture in any form is present, or standing water, slush, ice, or snow is present on the ramps, taxiways, or runways.

In view of all the cautions, warnings, and instructions provided by the Fokker F-28 Flight Handbook and the Piedmont and USAir F-28 operations manuals, one wonders what more information should have been provided to the pilots of C-FONF to convince them that takeoff in weather conditions which are conducive to the formation of ice or frost on the wing can be completed only when such conditions have been assessed and dealt with appropriately. Although de-icing and anti-icing are available, I am of the view that, for safe aircraft operations, a thorough understanding of all aspects of wing contamination is necessary, including its formation, removal, and prevention, and its effects on the aerodynamics of aircraft. This understanding can be accomplished only through education and training.

Assessing the Condition of the Outside of the Aircraft

The requirement to take off with a "clean aircraft" necessitates that the aircraft be inspected before takeoff if weather conditions are such that there is any suspicion of the wings and tail being contaminated.

In my *Second Interim Report*, dealing with aircraft ground de-icing and related flight safety issues, I noted, however, that several senior airline pilots gave evidence that it is difficult, indeed impossible in some aircraft, for a pilot-in-command to determine from inside the aircraft whether the wing and the tail surfaces are clean at the time takeoff clearance is received. Darkness, precipitation, dirty or crazed windows, physical distance limitations, and aircraft design can all influence the ability of a flight crew member to observe accurately from the flight deck or the cabin the condition of the aircraft's lifting and control surfaces.

Similarly, the upper surfaces of the wings and tail of large aircraft are impossible to see from the outside without the use of elevated structures such as ladders, ground vehicles, and cherry-pickers. Although the upper surfaces of the wings can be seen to a degree from inside the aircraft, one still cannot see the upper surfaces of the horizontal stabilizer, particularly in "T-tailed" configured aircraft such as the DC-9, B727, F-28, and F-100. The distance from the windows to the ends of the wings also makes it difficult to discern detail. As well, to look out of the windows a pilot would have to leave the flight deck – obviously an undesirable activity, especially while waiting for takeoff.

Similarly, without elevated devices one cannot see from the outside the upper surfaces of the wings and the horizontal stabilizer on high-wing aircraft such as the Dash-8, ATR42, or BAe 146, and, because the windows are below the level of the wings, it is impossible to see such surfaces from inside these aircraft.

A number of expert witnesses were asked to give their views on means to allow flight crews to assess the condition of the outside of the aircraft, in particular the upper surfaces of the wings and tail, without the use of outside personnel or of equipment external to the aircraft. The need for flight crews to observe the upper surfaces of wings and fuselages is not a recent idea. Mr Murray Morgan, a research pilot with NAE at NRC, drew on his experience as a pilot in the Royal Air Force. A former pilot of the large British delta-winged Vulcan "V" bomber, he stated that it had a retractable periscope installed in the roof of the aircraft. Mr Morgan explained that the crew was able to use this articulating periscope to observe the various upper surfaces of the aircraft.

Mr Gary Wagner, an Air Canada pilot and an aeronautical engineer, in testimony suggested that research be conducted into sensory equipment for detecting contamination. Mr Wagner also suggested that a video camera could be used for looking for ice (contamination) and for assessing the outside state of the aircraft, including the flaps.

Mr Eugene Hill, the manager of certification development of Boeing Aircraft's Renton division, in testimony suggested that, as an alternative to a person on a cherry-picker at the end of the runway giving an assessment to the pilot, a video camera mounted in the aircraft could be used to assess the outside of the aircraft. Mr Hill suggested that a closed-circuit television system including a camera with a telescopic lens and a spotlight would be appropriate for inspecting both the wings and the tail of the aircraft.

Mr Jack Lampe, the manager of cargo services and the de-icing commissioner for United Airlines out of O'Hare Airport in Chicago, provided this Commission with informational material from the Vibro-Meter Corporation with respect to a wing ice-detection system for aircraft. The system consists of a sensing device, about the size of a quarter, located on the wing. It has a conduit that goes from the sensing device through the fuel cell and into the fuselage to a black box that is hard-wired to a meter in the cockpit. The sensor detects when ice is adhering to it and activates a display in the cockpit.

Mr Lampe testified that McDonnell Douglas had dedicated an aircraft for the testing of this system. The company spent 22 days in Alaska, testing under various conditions, and agreed that this ice-detection system is the acceptable candidate to address the clear-ice problem on the MD-80 airplane. Mr Lampe, who stated that McDonnell Douglas intended to outfit all new MD-80 productions after mid-1991 with the unit, said that a retrofit kit would be available for installation on all existing MD-80s. The kit was being marketed at that time, principally by McDonnell Douglas, to address the clear-ice problem on the MD-80 aircraft.

Speaking as a United Airlines manager, Mr Lampe stated:

> A. It's something we're going to specify on any new airplanes that we buy, and we expect to retrofit existing airplanes with it after Boeing approves its installation.
>
> ... I think it's the only sane way, perhaps, to address inspection prior to takeoff, with the exception, perhaps, of a camera that might be mounted, which would give you some visibility of your leading edges.
>
> We've done some experimentation with that using existing cameras that we have on buses, for example, that operate quite well in low light to see if that might offer some surveillance to the cockpit so they could make a better call on whether they have contamination on the wing or whether they don't.
>
> (Transcript, vol. 82, pp. 85–86)

There is merit to all these approaches. Without well-developed procedures and adequate facilities, it is impractical and potentially dangerous to inspect externally an aircraft near the end of the runway prior to takeoff. I comment on this subject to bring to the attention of those in the aviation industry the fact that there are alternatives to the problems of external aircraft inspection.

Findings

- While the aircraft C-FONF was on the ground at Dryden on March 10, 1989, heat conduction into the wing fuel tanks (the cold-soaking phenomenon) permitted the lower portion of the water in the wet snow layer that accumulated on the wings to freeze, while leaving the upper portion in a partially liquid state. It is probable that the freezing of the water in the lower portion of this snow layer would have left a rough interface between the lower and upper portions of the precipitation layer on the wings.

- As the aircraft rolled down the runway during takeoff, pressure variations outside the wing boundary layer and the aerodynamic forces of air flowing over the wings probably forced the remaining water in the upper portion of the precipitation layer to drain away, carrying with it some of the slush, wet snow, and ice, and leaving behind a rough ice surface on the wings. This condition would have significantly degraded the aerodynamic performance of the aircraft.

- In addition, it is probable that snowflakes that were in the path of the aircraft wings during the takeoff roll stuck to the leading edge of the wings, in a band extending from approximately 3 per cent to about 19 per cent of the wing chord, thereby contributing to the degradation of the aerodynamic performance of the aircraft.

- During the takeoff of aircraft C-FONF from the Dryden airport, the wings of the aircraft were contaminated to a critical level, resulting in the degradation of the aircraft's aerodynamic performance by reducing its lifting capability and increasing the drag on the aircraft to the extent that, as the aircraft climbed out of ground effect, the performance loss caused the aircraft to descend and crash.

- During the takeoff run of aircraft C-FONF at the Dryden airport, slush thrown up from the runway probably did not enter the engines.

- If, during the takeoff run of C-FONF at the Dryden airport, contamination from the wings of the aircraft entered the engines, the contamination did not cause either a failure of the engine(s) or a reduction in thrust sufficient to tangibly affect the takeoff performance of the aircraft.

- Although there was some evidence of denting and chipped paint on the leading edges of the wings of aircraft C-FONF, neither of these factors contributed appreciably to the performance degradation of the aircraft during its takeoff from the Dryden airport, excepting that they may have been a minor factor in the amount of contaminant that remained on the wing.

- Wing anti-ice air leakage, such that it would cause control difficulties, was not a factor during the takeoff of C-FONF from the Dryden airport.

- Wing contamination is equally dangerous on jet-powered aircraft and propeller-powered aircraft.

- Wing contamination is equally dangerous on hard-wing aircraft and aircraft with wing leading-edge lift devices.

- The draft F-28 Operations Manual submitted by Air Ontario to Transport Canada did not contain a takeoff limitation and correction chart for contaminated runways (otherwise referred to as slush correction charts).

- Some Air Ontario F-28 pilots used the USAir F-28 Operations Manual while others used the Piedmont F-28 Operations Manual, both of which contained a takeoff limitation and correction chart (labelled for guidance only) that was considerably more restrictive than the chart and graph contained in the Fokker F-28 Flight Handbook (Aircraft Flight Manual), which was also available to F-28 pilots.

- Air Ontario had no policy in place to guide its F-28 pilots as to which slush correction charts were to be used by them for takeoff on a contaminated runway, and there was no consensus among the F-28 pilots as to which charts should be used, a highly unsatisfactory situation.

- The takeoff limitation and correction chart and graph contained in the Fokker F-28 Aircraft Flight Manual available to Air Ontario F-28 pilots was time consuming, and difficult and impractical to use in the cockpit of the aircraft.

- Had the pilots of flight 1363 followed the guidelines contained in the Piedmont/USAir takeoff limitation and correction charts at Dryden, they would have been restricted from taking off unless the runway had first been cleaned of contamination or the aircraft weight had been reduced to 54,300 lbs for takeoff. (The aircraft's actual weight at takeoff was estimated to be 64,440 lbs, just under the limit allowed by the Fokker chart.)

- Had the pilots of flight 1363 used the chart and graph contained in the Fokker F-28 Aircraft Flight Manual, the takeoff at Dryden on March 10, 1989, would have been permitted.

- Approval of slush correction charts is not presently a requirement of Canadian, Dutch, or United States regulatory bodies.

- A lack of certified data regarding aircraft takeoff performance requirements on contaminated runways makes it impossible to calculate whether the aircraft could have been stopped on the runway had an engine failure occurred at or prior to V_1.

- Neither United States FAA regulations nor Canadian Air Regulations and Air Navigation Orders address the issue of aircraft performance on takeoff from contaminated runways.

- Transport Canada and the Transportation Safety Board of Canada, and its predecessor CASB, have been aware of the lack of certified data regarding aircraft performance requirements on contaminated runways for a considerable period of time.

- Because of the absence of regulations with regard to the determination of aircraft performance requirements when operating aircraft from slippery or contaminated runways, the degree of risk that an aircraft's passengers and crew members are exposed to when the aircraft takes off from a slippery or contaminated runway is different from that when the aircraft takes off from the same dry runway.

- Initiatives already taken by regulatory bodies, including Transport Canada, with regard to the determination and provision of guidelines to aircraft operators for operations from contaminated runways, will, if promulgated, improve passenger and crew safety.

- Air Ontario F-28 pilots had access to numerous cautions, warnings, and instructions not to take off unless all of the aircraft lifting surfaces were completely clear of ice or snow.

- In general, personnel involved in the aviation industry are not sufficiently aware of the nature and effects of wing contamination.

- In general, pilots are not sufficiently aware of the effects of cold soaking of fuel in relation to precipitation and frost adhering to the wing surfaces, and the conditions that lead to this phenomenon.

RECOMMENDATIONS

It is recommended:

MCR 40 That Transport Canada ensure that all operations personnel involved in air carrier operations, including managers, operations officers, maintenance personnel, and pilots, be made fully aware of the nature and the danger of wing contamination on both jet- and propeller-driven aircraft.

MCR 41 That Transport Canada ensure that all personnel involved in air carrier operations, including managers, operations officers, maintenance personnel, and pilots, have, and be able to demonstrate, a thorough understanding of all aspects of wing contamination, including its formation, removal, and prevention, and its effects on the aerodynamics of aircraft, with particular emphasis on the insidious nature of the "cold-soaking" phenomenon.

MCR 42 That pilots be informed in writing by Transport Canada how the application of non-standard handling techniques, as described in the "Flight Dynamics" report prepared for this

Commission and included in the Final Report as technical appendix 4; as described in the Fokker F-28 Flight Handbook; and as described in testimony by expert witnesses, may assist a pilot to deal with an abnormal or emergency situation discovered during takeoff. It is stressed that this Commission does not advocate the use of non–standard handling techniques to operate aircraft in adverse weather conditions as an alternative to the proper preparation of the aircraft for flight.

MCR 43 That Transport Canada require that aircraft flight manuals and related aircraft operating manuals contain approved guidance material for supplementary operating procedures, including performance information for operating on wet and contaminated runways.

MCR 44 That Transport Canada, in cooperation with aircraft manufacturers and operators, expedite the search for a technically accurate means of defining runway surface conditions and their effects on aircraft performance.

MCR 45 That Transport Canada require air carriers to provide adequate training to flight crews with respect to the effects of contaminated runways on the performance of aircraft in the context of landings, takeoffs, and rejected takeoffs.

MCR 46 That Transport Canada, in cooperation with aircraft manufacturers and operators, expedite the search for an equitable and practical means of requiring operators to adhere to balanced field criteria when operating on wet or contaminated runways.

MCR 47 That Transport Canada, in cooperation with airport operators, expedite the search for more efficient methods of ensuring that runways are maintained free of contaminants that affect the takeoff performance of aircraft.

MCR 48 That Transport Canada participate in and encourage research concerning devices that can allow pilots to assess the external state of the aircraft from within the flight deck. In addition to assisting pilots in assessing possible contamination of the aircraft, such devices would assist pilots in assessing any mechanical or technical problems on the exterior of the aircraft.

FINAL REPORT

TECHNICAL APPENDICES

1 Occurrence No. 825-89-C0048: Structures/Site Survey Group Report LP 38/89: Accident: Fokker F28, Mk 1000, Registration C-FONF, 10 March 1989
Canadian Aviation Safety Board Investigation Team

2 Fokker Aircraft B.V. Amsterdam, Fokker Aerodynamics, Report No. L-28-222: Note on the Aircraft Characteristics as Affected by Frost, Ice or Freezing Rain Deposits on Snow

3 Fokker Aircraft B.V. Amsterdam, Report No. VS-28-25: Flight Simulator Investigation into the Take-off Performance Effects of Slush on the Runway and Ice on the Wings of a Fokker 100

4 A Report on the Flight Dynamics of the Fokker Mk 1000 as They Pertain to the Accident at Dryden, Ontario, March 1989
J.M. Morgan, G.A. Wagner, R.H. Wickens

5 Wind Tunnel Investigation of a Wing-Propeller Model Performance Degradation due to Distributed Upper-Surface Roughness and Leading Edge Shape Modification
R.H. Wickens and V.D. Nguyen

6 Freezing Precipitation on Lifting Surfaces
Myron M. Oleskiw

7 Human Factors Aspects of the Air Ontario Crash at Dryden, Ontario: Analysis and Recommendations to the Commission of Inquiry
Robert L. Helmreich

DSS cat. no. CP32-55/4-1992E
ISBN 0-660-14383-6

COMMISSION OF INQUIRY INTO THE AIR ONTARIO CRASH AT DRYDEN, ONTARIO

Final Report

Volume II

The Honourable Virgil P. Moshansky
Commissioner


ADEN
C.3

COMMISSION OF INQUIRY INTO THE AIR ONTARIO CRASH AT DRYDEN, ONTARIO

This Final Report consists of three volumes: I (Parts One–Four), II (Part Five), and III (Parts Six–Nine and the General Appendices). The table of contents in each volume is complete for that volume and abbreviated for the other two volumes. Seven specialist studies prepared for this Commission have been published separately in a volume entitled Technical Appendices; the contents of the Technical Appendices are given at the end of this volume.

COMMISSION OF INQUIRY INTO THE AIR ONTARIO CRASH AT DRYDEN, ONTARIO

Final Report

Volume II

Part Five

The Honourable Virgil P. Moshansky
Commissioner

Printed in Canada
Cat. No. CP 32-55/2-1992E

This volume has been translated by the translation services of the Secretary of State, Canada, and is available in French.

The aerial photograph reproduced in the endpapers was taken by CASB investigators on March 11, 1989, the day following the crash of Air Ontario flight 1363. It depicts the area of the Dryden Municipal Airport (upper right), surrounding road system, and crash site. McArthur Road runs vertically up the middle of the photograph, curving to the right at about the centre of the book on the right-hand page. (The cleared straight line is a hydro right of way.) Middle Marker Road angles to the left off McArthur in the lower left-hand section. The path of Air Ontario flight 1363 through the trees begins not far from the end of runway 29, and the crash site can be seen just above Middle Marker Road. Many survivors walked out to Middle Marker Road immediately after the crash.

CANADIAN CATALOGUING IN PUBLICATION DATA

Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario (Canada)

Final report
Issued also in French under title: Rapport final.
Includes bibliographical references.
ISBN 0-660-14382-8 (Vol. 1–3)
DSS cat. no. CP32-55/1992E (Vol. 1–3)

1. Aeronautics — Ontario — Accidents — 1989.
I. Moshansky, Virgil P. II. Title.

TL553.5.C65 1992 363.12′492 C92-099547-0

CONTENTS

VOLUME I

VOLUME II

VOLUME III

PART SIX *TRANSPORT CANADA*

PART SEVEN *HUMAN FACTORS*

PART EIGHT *LEGAL AND OTHER ISSUES BEFORE THE COMMISSION*

PART FIVE

THE AIR CARRIER – AIR ONTARIO INC.

13 CORPORATE HISTORY

Air Ontario Inc. is Canada's third largest regional air carrier in terms of revenue. With a fleet of fifteen Dash-8 series 100 and four Dash-8 series 300 turboprop aircraft, and approximately 670 employees, Air Ontario provides scheduled and charter service to 15 destinations throughout central Canada and the northern United States. Its most travelled scheduled routes were, as of May 1991, Toronto (Pearson) to Sudbury, Toronto (Pearson) to Windsor, and Toronto (Island) to Ottawa.

Air Ontario Inc. is the product of a functional merger between Austin Airways Limited and Air Ontario Limited. The origins of Air Ontario Inc. are described in the following section and in figure 13-1.

Austin Airways Limited

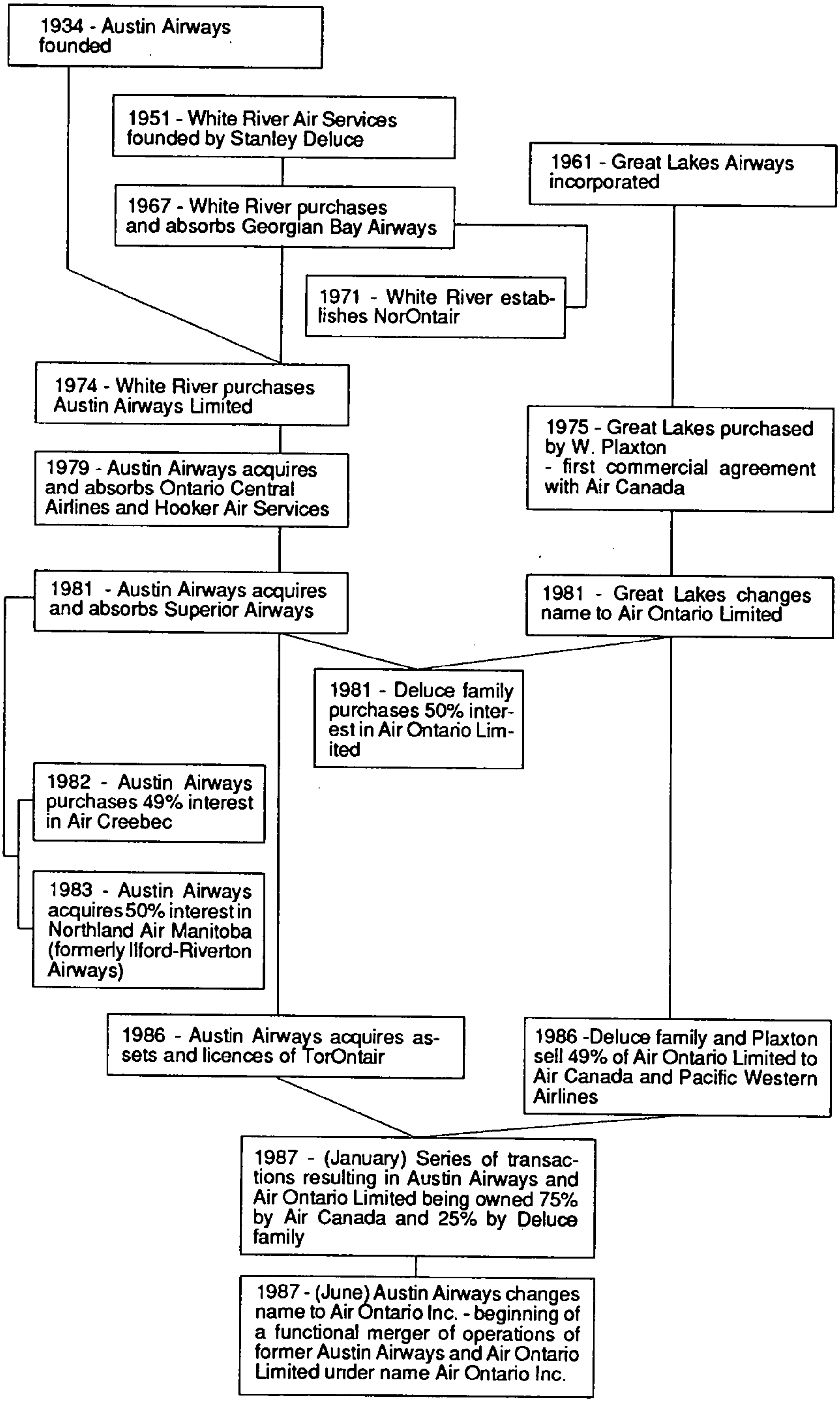
Austin Airways Limited, a largely northern operation, was founded in 1934 by Jack and Charles Austin. In 1974, all of the shares of Austin Airways were purchased by White River Air Services, which had been founded by Stanley M. Deluce in 1951. From its earliest days of operation, White River was run as a family business, with Stanley Deluce employing his seven sons in various capacities.[1] In the early days, White River was an exclusively visual flight rules (VFR) charter operation flying single-engine Cessna, Beaver, and Otter float-equipped aircraft in the summer months in Northern Ontario.

In 1967 White River purchased Georgian Bay Airways, then operating a scheduled service between Timmins and Kapuskasing, using twin-engine aircraft and with the capability of conducting flights in accordance with instrument flight rules (IFR). Thus White River acquired its first licence to operate a scheduled service. Approximately 95 per cent of the White River traffic between Timmins and Kapuskasing connected with Air Canada flights at Timmins. Although on a small and informal scale, this was the first feed service that White River provided to Air Canada routes.

---

[1] Stanley and Angela Deluce have seven sons, William, Robert, Joseph, James, Bruce, Gerald, and Terrance, each of whom has been employed at various times in various capacities in the aviation business.

Figure 13-1 Air Ontario Inc. Corporate History



In 1971, White River won a competition for a Government of Ontario contract to establish and operate NorOntair airlines. NorOntair, under the direction of Mr William Deluce, provided scheduled service in Northern Ontario using Twin Otter aircraft. Eventually, NorOntair would operate four to five Twin Otters employing between 20 and 25 pilots and 10 aircraft maintenance engineers (AMEs). It provided scheduled service to northern communities including Chapleau, North Bay, Sudbury, and Sault Ste Marie, with its main base of operation being Sudbury and later Timmins.

Mr William Deluce described how, as the vice-president and general manager of NorOntair, he oversaw the development of this new airline:

> A. ... NorOntair was a new ... service. It was the provision of scheduled service ... utilizing Twin Otter, new Twin Otter, aircraft that had been ordered and purchased from de Havilland by the Ontario government and leased to us for a dollar.
>
> It was our obligation and responsibility to hire people, to set up the systems and to manage the operation and in so doing, provide a highly reliable service to the people of northern Ontario. And at that time as well, we integrated the scheduled service very closely with that of Air Canada. We tied in with Air Canada. They were basically our handling agent at any point that we had dual operations.
>
> (Transcript, vol. 151, pp. 23–24)

Mr Deluce described his reporting relationship:

> A. I had two reporting streams at that point. I reported again back to Stan Deluce and aside from that, I also reported to the Ontario government from a fiscal point of view. It was a subsidized operation in the early days and the fiscal responsibility basically was one that the Ontario government was very much interested in and involved in.
>
> (Transcript, vol. 151, p. 26)

In all, Mr William Deluce and White River operated NorOntair for approximately three-and-one-half years.

In October 1974, after approximately one-and-one-half years of negotiations, White River acquired all the shares of Austin Airways. Mr William Deluce described how his family acquired existing airlines and their licences as a method of expanding its operation in a tightly regulated airline industry:

> A. It was the fact that in order to expand back in those days in a highly regulated environment which the transportation – air transportation business was, you had to either expand through

> the licensed application route which was a very time consuming, tedious and usually not very successful route.
>
> The easier way or the way that we certainly had expanded in the '70s was to acquire other companies that already had licences and all of this came together ... after working quite vigorously with Mr Austin in about a year and a half – in about a year and a half's time of negotiation with Mr Austin for the purchase of Austin Airways in October of 1974.
>
> (Transcript, vol. 151, p. 35)

In Austin Airways, the Deluce family acquired an airline operation that was four to six times larger than White River. Austin Airways flew DC-3 and Canso aircraft on predominately IFR, scheduled service. These aircraft were larger than anything flown by White River at that time and brought the Deluce family within the regulatory regime of Air Navigation Order (ANO) Series VII, No. 2, which governed air carriers operating aircraft heavier than 12,500 pounds.

Approximately 80 per cent of Austin Airways' business was scheduled service while 20 per cent was charter work. Austin serviced communities on both sides of Hudson Bay as far north as Cape Dorset and Baffin Island. Austin had no significant presence in southern Ontario at that time.

One of the first priorities for the new ownership of Austin Airways was to modernize its equipment. Mr William Deluce testified that they sought to replace the Austin DC-3 and Canso aircraft with turbine aircraft, which were able to operate more effectively in the harsh northern environment. Hawker Siddeley HS-748 aircraft were eventually acquired to fulfil this role.

Austin Airways and White River were initially operated as separate entities; eventually, however, the two operations were integrated under the name of Austin Airways. It was the objective of Austin management to phase out the single-engine VFR operation and move exclusively to a multi-engine IFR operation.

In 1979, Austin Airways, under the ownership and management of the Deluce family, continued its expansion of operations by acquiring the assets and licences of Ontario Central Airlines and Hooker Air Services Limited. These airlines' extensive scheduled licences for northwestern Ontario and Manitoba complemented the existing Austin service in northeastern Ontario and Quebec. With these acquisitions, Austin Airways added some 25 additional scheduled points, 75 to 80 employees, and 20 to 30 single-engine, light twin-engine, and DC-3 aircraft. The Ontario Central and Hooker Air operations were immediately integrated into the operations of Austin Airways.

In 1981 Austin Airways acquired Superior Airways Limited, which was based in Thunder Bay, Ontario. In so doing, Austin Airways acquired an established operation in Thunder Bay (the largest city in northwestern Ontario), six or seven aircraft of varying types, and a number of licences including one linking Thunder Bay and Minneapolis, Minnesota. For Austin Airways, the Minneapolis licence represented its first scheduled service to the United States.

In 1981 the Deluce family made an additional acquisition of significance – namely a 50 per cent ownership interest in Air Ontario Limited, the dominant regional carrier in southern Ontario. Mr William Deluce testified that it had been his family's intention to purchase 100 per cent of Air Ontario Limited, but its owner, Mr James Plaxton, would surrender only one-half of his company. In Air Ontario Limited, the Deluces saw an opportunity to expand their operation further into southern Ontario. At this stage, there was no attempt to integrate the operations of the two companies since the Deluces were not involved in the day-to-day management of Air Ontario Limited.[2]

In 1982 the Deluce family became involved in establishing and managing Air Creebec, a scheduled service to settlements on the lower eastern shore of James Bay. The Deluce family maintained a 49 per cent equity interest in the airline with the Cree community owning a 51 per cent interest. While Air Creebec was an independent entity, Austin Airways did provide some management and maintenance services to it on a contract basis.[3]

In 1983 Austin Airways acquired a 50 per cent interest in Ilford-Riverton Airways Limited, which later became Northland Air Manitoba. This acquisition coincided with an Austin Airways sale of some of its northern Quebec assets to Air Inuit. Because of the sale to Air Inuit, Austin Airways had surplus personnel and equipment which were deployed in Northland Air Manitoba. Although it was an independent airline, Northland Air Manitoba, like Air Creebec, was operated by imported Austin management.[4]

In 1986 Austin Airways acquired the assets and licences of TorOntair, which enabled it to provide service out of Toronto to Trenton, Kingston, and Elliot Lake. These routes were served by Hawker Siddeley HS-748 and Beech 99 aircraft. With this additional service, Austin Airways'

---

[2] Though Mr William Deluce was the vice-president of Air Ontario Limited and a member of its board of directors, he and his family were not involved in the day-to-day management of the company. Mr James Plaxton, as president and CEO of Air Ontario Limited, maintained managerial control over his company until he sold off all of his interest in 1987.

[3] The Deluce family divested itself of its interests in Air Creebec in 1988.

[4] Mr James Morrison was brought into Air Creebec as the general manager. Mr Morrison would later become the vice-president of flight operations of Air Ontario Inc. Captain Robert Nyman was brought into Northland Air Manitoba as the director of flight operations, a position he would later assume at Air Ontario Inc.

already comprehensive northern operation was linked to Canada's busiest airport, Pearson International.

Air Ontario Limited

Air Ontario Limited was originally incorporated in 1961 as Great Lakes Airlines. Based in Sarnia, Ontario, Great Lakes operated Convair 440 aircraft in southern Ontario. A partnership, including Mr James Plaxton, purchased the company out of receivership in 1975, and shortly thereafter Mr Plaxton became the 100 per cent owner of Great Lakes. At approximately the same time, Great Lakes entered a commercial agreement with Air Canada whereby Great Lakes took over Air Canada's money-losing Toronto-to-London, Ontario, route, servicing it with four newly acquired 55-passenger Convair 580 turboprop aircraft.

Mr Thomas Syme, formerly the Air Ontario group vice-president of operations and marketing, described this early commercial arrangement that existed between Great Lakes and Air Canada as the first "feeder-trunk" relationship involving Air Ontario and Air Canada.[5] In addition to Great Lakes taking over Air Canada service between London and Toronto, the two carriers' schedules were arranged so that passengers flying from London to destinations beyond Toronto could make a coordinated connection onto Air Canada at the international airport in Toronto.

During the late 1970s, Great Lakes provided scheduled service between Sarnia, London, Toronto, Peterborough, and Ottawa, Ontario. Mr Syme explained that the regulatory environment in Canada inhibited the expansion of Great Lakes during these years:

> A. At that time, any new routes had to be approved in terms of the licensing to operate into those routes, and licensing was – was often very difficult to get, and on a number of occasions, Air Ontario had applied for ... various licences, which would have allowed them to operate into new areas and had been declined.
>
> (Transcript, vol. 97, pp. 14–15)

---

[5] "Feeder-trunk" or "trunk-feed" refers to the relationship between a national/international carrier and its regional affiliate. In a deregulated environment, where an air carrier has greater flexibility in adding and abandoning routes, a trend developed in the United States in the 1970s whereby large national and international carriers would purchase equity interests in established regional carriers. The parent, or "trunk" carrier, would typically abandon its short-haul regional routes, which were picked up by the established regional affiliate, operating on a more cost-effective basis. It would "feed" the national carrier at significant "hub" airports. Following the deregulation of the Canadian airline industry in the mid 1980s, similar trunk-feed arrangements were developed.

In the spring of 1981, Great Lakes changed its name to Air Ontario Limited. At this time Mr Plaxton sold a 50 per cent interest in the company to the Deluce family of Timmins, Ontario, the owners of Austin Airways Limited, then the largest airline serving Northern Ontario.

From 1982 to 1986, in spite of the difficulties with regulation described by Mr Syme, Air Ontario Limited expanded its routes to include service to Winnipeg, Thunder Bay, Sault Ste Marie, Windsor, North Bay, Montreal, Cleveland, Ohio, and Hartford, Connecticut. To service these expanded routes, Air Ontario added more Convair 580 aircraft to its fleet.

In 1986 Air Canada and Pacific Western Airlines Corporation each acquired 24.5 per cent of the shares of Air Ontario Limited. The Deluce family and Mr Plaxton held the outstanding 51 per cent through a holding company called Delplax Holdings Limited. This was the first time that Air Canada held an equity position in Air Ontario Limited.

The commercial arrangement with Great Lakes and later Air Ontario Limited was regarded by Air Canada as successful, and an ownership interest in the feeder airline was one way to ensure that the relationship remained intact. Mr William Rowe, formerly the Air Canada senior vice-president of associated airlines and Air Canada shareholders' representative on the board of directors of Air Ontario Inc., explained in testimony that, in the United States, some feed carriers had changed allegiances, causing disruption for the "trunk" carrier. By purchasing an equity interest, rather than simply relying on a contractual arrangement, Air Canada was able to exert some control over the feeder.

Austin Airways and Air Ontario Limited: Pre-Merger

At the time of their merger, Air Ontario Limited and Austin Airways had annual sales of approximately $35 million each. The two companies were, however, different in almost every other respect. Their fleets, operating environments, employee groups, and management styles are contrasted in the following section.

Austin Airways had approximately 30 aircraft of seven different types. Many of these aircraft were acquired through the different airline acquisitions previously described. Its fleet included the Cessna 402, a light twin-engine aircraft seating seven passengers; the Beech King Air 200, a light twin-engine aircraft seating approximately nine passengers; the Beech 99, a light twin-engine aircraft seating 14 passengers; the de Havilland Twin Otter, a twin-engine aircraft seating 19 passengers; the Douglas DC-3, a larger twin-engine piston aircraft used primarily for flying cargo in the north; the Cessna Citation, a small straight-wing jet aircraft used for air ambulance services; and the Hawker Siddeley HS-748, a turboprop aircraft seating from 40 to 43 passengers.

Air Ontario Limited operated a fleet of 11 Convair 580 aircraft, a turboprop aircraft with a passenger capacity of 55. It had operated Convair 580 aircraft exclusively since the upgrade of its fleet from Convair 440 aircraft following its first commercial agreement with Air Canada in 1975.

Austin Airways provided a diverse range of commercial airline activities. It had a scheduled passenger service, complemented by a charter passenger and cargo service. In addition, it operated an air ambulance service with the Cessna Citation jet aircraft. Although Austin did operate some scheduled service out of Toronto, it primarily served northeastern and northwestern Ontario.

Air Ontario Limited provided, almost exclusively, scheduled passenger service in southern Ontario. With its Convair 580 aircraft, it serviced communities like Sarnia, Windsor, London, Ottawa, Montreal, and Cleveland.

The demands placed on pilots and crews flying in the Canadian North were and are qualitatively different from those encountered by pilots flying in the southern, and for the most part controlled, airspace. These differences were reflected in the experiences of pilots flying for Austin Airways and Air Ontario Limited.

The Austin Airways operating environment was generally harsher than that of Air Ontario Limited. Many of the communities served by Austin had airport facilities that would be described as marginal by southern standards. Gravel airstrips in the summer and fall could be covered with mud in the spring and snow in the winter. Navigation aids and weather reporting are, by and large, less reliable in the north than they are in the south. Austin Airways, in many respects, was still a "bush"-type operation as it entered its merger with Air Ontario Limited. Air Ontario Limited, conversely, served the busier southern centres and had the benefit of long, paved runways, controlled airspace, and superior navigation aids.

Mr Martin Brayman, a retired Transport Canada regional superintendent of large air carrier inspectors for Ontario Region, was shown the accident statistics for a number of carriers, including Austin Airways, operating in northern and remote regions. In discussing the accident rates of these carriers, he stated that there is "a direct relationship between the number of accidents or incidents that a carrier has and the condition under which the carrier operates" (Transcript, vol. 131, p. 63). He pointed out that in northern Canada, in mountainous areas like British Columbia, in northern Quebec, and in the Arctic, there are a number of factors that have to be taken into account with respect to operations.

Mr Brayman expressed his opinion with respect to the element of risk involved in the hostile environment of northern operations:

> A. ... there is no question that in remote areas where the population demands a reasonably high level of air service, and in Canada, our native peoples surely do that, the carriers are hard-pressed often to meet those demands.
>
> You are working in areas of bad weather, poor runways, little in the way of runway markings or approach aids, weak beacons often covered with ice. So it's a – it is a hostile environment.
>
> And if you take it even further to operations that extend out onto the sea ice, for instance, a lot of the northern operators land and take off from frozen lakes, from frozen sea ice, they touch down on frozen cracks in the sea ice. There is no question there's an element of risk.
>
> (Transcript, vol. 131, pp. 63–64)

He elaborated upon the difficult conditions habitually faced by pilots in northern operations:

> A. You are getting in an area that has a paucity of aids to the pilot. You are dealing with basic single runway strips. You are dealing with heavy snowfalls, high snowbanks, drifting snow, white-outs.
>
> It's a very difficult area to fly in successfully. Extremely cold temperatures, heavy icing during transitional periods, spring and fall. Yes, it's a very, very difficult area to fly in.
>
> (Transcript, vol. 131, p. 65)

Aside from this difficult flying environment, northern operators are also typically faced with personnel problems that Mr Brayman, a person from that environment, outlined succinctly:

> A. The basic structure of Austin's, Bradley's, any company in the north, is fairly constant. They have a hard-core group of people who stay with the company for a long period, and these people are very well qualified, especially in the management ranks.
>
> There is always a high turnover of junior people in companies. In the pilot world, the normal progression is upward. And we don't have a system similar to the National Hockey League where they remunerate minor leagues when they take players.
>
> In the aviation world, it's very common to see a complete migration from the very bottom up to the very top carriers in a

> very short period. Pilots are jumping ship and going to bigger and better equipment.
>
> So carriers in the north do have trouble holding onto their flight crews.
>
> (Transcript, vol. 131, p. 66)

Austin Airways had approximately 600 employees and, at the time of the merger, no active unions. In the Austin Airways non-unionized, northern environment, employee responsibilities were relatively unstructured. If support facilities were not available at a station stop, flight crews would do whatever was required to complete the mission at hand. For example, it was not unusual for pilots at northern outlying bases to assist in loading or fuelling aircraft. This was the nature of bush flying, and it is not uncommon in the Canadian North today.

Air Ontario Limited, in contrast, had approximately 250 employees who were largely unionized. The pilots of Air Ontario Limited were represented by the Canadian Air Line Pilots Association (CALPA); the flight attendants were represented by the Canadian Air Line Flight Attendants Association (CALFAA) and later the Canadian Union of Public Employees (CUPE); and the station agents, ground handlers, and mechanics were represented by the Canadian Auto Workers (CAW). In this unionized environment, employee tasks were clearly delineated. Pilots flew the aircraft, ground handlers loaded and serviced the aircraft, and AMEs were responsible for the repair and maintenance of the aircraft.

Mr Syme described the management of the two companies as reflecting their different operating environments. He described the non-unionized Austin Airways environment as less structured than that of Air Ontario Limited. He noted that the Austin management was more interactive with its employee group than was the Air Ontario Limited management. In the unionized Air Ontario Limited, collective agreements with the employee groups defined the structure of labour-management relations.

The Merger into Air Ontario Inc.

Change in Ownership: January 1987

As at January 1987, prior to the increased ownership by Air Canada, Austin Airways was wholly owned by the Deluce family while Air Ontario Limited was 51 per cent owned by the Deluce-Plaxton holding company (Delplax Holdings), 24.5 per cent owned by Air Canada, and 24.5 per cent owned by Pacific Western Airlines. Through a series of transactions in late 1986 and early 1987, the shares of Austin Airways and Air Ontario Limited were purchased by numbered company 152160 Canada Inc., which was owned by Air Canada (75 per cent) and the Deluce family (25 per cent). With these transactions Mr James Plaxton and Pacific Western Airlines divested themselves of all interest in Air Ontario Limited. After the transactions, via the numbered company 152160 Canada Inc., the Deluce family owned 25 per cent of each of Austin and Air Ontario Limited.

Mr William Deluce, in explaining the rationale for the sale of part of the family's holdings to Air Canada, pointed to trends in the United States regarding the so-called "trunk-feed" relationship. Mr Deluce noted that the American experience indicated that the trunk-feed phenomenon would become increasingly important in Canada as deregulation took hold. He recognized that his family was the dominant force in Ontario regional air carriage. However, to take full advantage of their positions, Austin and Air Ontario Limited needed a significant amount of capital investment to expand and upgrade their operations. For these reasons, Mr Deluce explained, his family was willing to relinquish a degree of ownership in its businesses in exchange for the needed investment.

From the perspective of Canada's two national airlines the Deluce assets were extremely attractive. The Deluce dominance of Ontario regional air carriage would necessarily feed either of the two major airlines. An added attraction was the Deluce purchase of 50 de Havilland Dash-8 aircraft and spare parts on very favourable terms.

In late 1986, the Deluce family entertained offers from both Air Canada and Canadian Pacific Airlines, ultimately entering into an agreement with Air Canada. Following the change in ownership of Austin and Air Ontario Limited, Mr William Deluce was retained by Air Canada to act as the president and chief executive officer (CEO) of its newly acquired regional carrier. The boards of directors of each company consisted of nominees of the two owners, Air Canada and the Deluce family, reflecting their proportionate ownership interests. Apart from a common board of directors and CEO, Austin and Air Ontario Limited continued to operate as separate entities in the early months of 1987. Austin Airways provided passenger feed to Air Canada pursuant to the terms of a commercial agreement dated January 7, 1987. Air Ontario Limited continued to feed Air Canada, as it had since the 1977 Great Lakes agreement.

Merging Austin Airways and Air Ontario Limited

Although it was initially the intention of the Austin/Air Ontario Limited ownership to maintain the two companies as distinct entities, discussions were held regarding the future of both throughout early 1987. Economic and labour concerns were identified as the principal factors that motivated their merger. On the economic side, Mr Syme described the "synergies" that could be taken advantage of by joining the two companies and rationalizing less productive departments (Transcript, vol. 97, pp. 47–48).

Addressing labour concerns, Austin/Air Ontario Limited senior management believed that the separate operation of the two companies under common ownership might not be economically or operationally viable. Following the change of ownership, CALPA filed an application for certification before the Canada Labour Relations Board to become the bargaining agent for the Austin Airways pilot group. Mr Syme testified that there was a possibility of the Canada Labour Relations Board imposing Air Ontario Limited working conditions on the less structured and non-unionized Austin Airways employee group. This lack of structure was viewed as necessary for Austin's northern bush flying. The imposition of Air Ontario Limited collective agreements on the Austin group – which was a real possibility according to Mr Syme – would threaten the economic viability of the outlying Austin routes. Rather than wait for the imposition of such conditions upon Austin, it was the decision of the combined Austin/Air Ontario Limited board of directors to join the two companies with one integrated employee group, and proceed with their business planning accordingly.

At the meeting of the joint Austin/Air Ontario Limited board of directors held on April 29, 1987, the merger of the two companies was addressed. The following minutes of that meeting provide an insight into the discussions at this level:

> Mr. Deluce pointed out that while initially it had been the intention to maintain the separate operations of the companies until all labour relations issues had been resolved, it had now become apparent that there were in fact certain advantages to merging the two companies from a labour relations point of view. In addition thereto, there were numerous employee relations, operational and financial advantages in merging the two companies immediately.
>
> ...
>
> William S. Deluce elaborated upon the current status of labour relations matters at both companies. In particular, Mr Deluce advised the meeting that as of March 11, 1987 CALPA had the right to strike Air Ontario Limited however there were no indications at the present time that a strike would, in fact, take place. The Air Ontario CUPE Agreement expires in September of 1987 and the Air Ontario CAW Agreement expires in September of 1988. Mr Deluce also advised the meeting that certification proceedings were continuing before the Canada Labour Relations Board with respect to the Austin Airways Limited pilots.
>
> (Exhibit 934, tab 1, pp. 2–3)

The merger of the two companies was approved in principle at this meeting of the combined board. The merger was effected as of June 19, 1987, and Air Ontario Inc. commenced business as of that date.

Mr Brayman, who occupied the position of regional superintendent, large air carriers, at Transport Canada during the period of the merger between Austin Airways and Air Ontario Limited, commented upon the reaction of the regulator to the merger and the steps taken to ensure that the new operation met with the regulator's approval. He indicated that the areas of concern included "the smooth transition brought about by hostilities associated with seniority lists, displacement of personnel" and "the integration of the training programs, to make sure that where cross-training is required, it follows a legitimate normal process, and that the files are kept up to date" (Transcript, vol. 131, p. 67).

Mr Brayman testified that "there was no doubt that the Austin group of supervisors displaced the Air Ontario [Limited] group of supervisors" (p. 68). He stated that Air Ontario Limited was basically a commuter operation which for a number of years operated at major airports on hard-surface runways with one type of airplane, the Convair 580. He described Air Ontario Limited as "a nice, neat, tidy operation" while describing Austin Airways as "a sprawling organization which flew in quite a few spectrums," including charter type, non-scheduled operations (p. 68).

Mr Brayman stated that there was concern at Transport Canada about how the two management groups would meld, and that "it was an awkward period" with the old staff from Air Ontario Limited being displaced and new people from Austin Airways taking over. Although he described the merger outcome as being "not as drastic as we thought it might be," he stated that Transport Canada had concerns regarding a smooth transition of operational control from one group to another:

> A. In fact, from management down, the Austin's group, the principals of the White River group, which were the Deluces, they came in in senior management positions and they brought with them the operational people and the airworthiness people from the Austin group to take over.
>
> (Transcript, vol. 131, p. 69)

Mr Brayman expressed the concerns of Transport Canada about a carrier that operated in a very broad area of Northern Ontario, spread out over large distances with a large number of aircraft, coming down to southern Ontario and "operating in a nice, tight little commuter environment":

A. Yes, we had some concern. Austin's had been operating 748s on scheduled routes, so we knew they had the infrastructure to take over. But there was other factors.
For instance, at the same time the Dash 8 was being introduced into service, the Convair 580 was – which had been the backbone of the Air Ontario fleet was going out.
Yes, we would have to say that there were some concerns.
Q. And what were those concerns?
A. We were concerned about the smooth transition of operational control from one group to the other.
(Transcript, vol. 131, p. 70)

Mr Brayman spoke of flight following as being one of the focal points of Transport Canada's concern about the operational control within the newly merged company. As the events have borne out, the Air Ontario flight dispatch and flight-following system proved to be a valid concern indeed. This subject is discussed further in chapter 23 of this Report, Operational Control.

Air Ontario Inc.

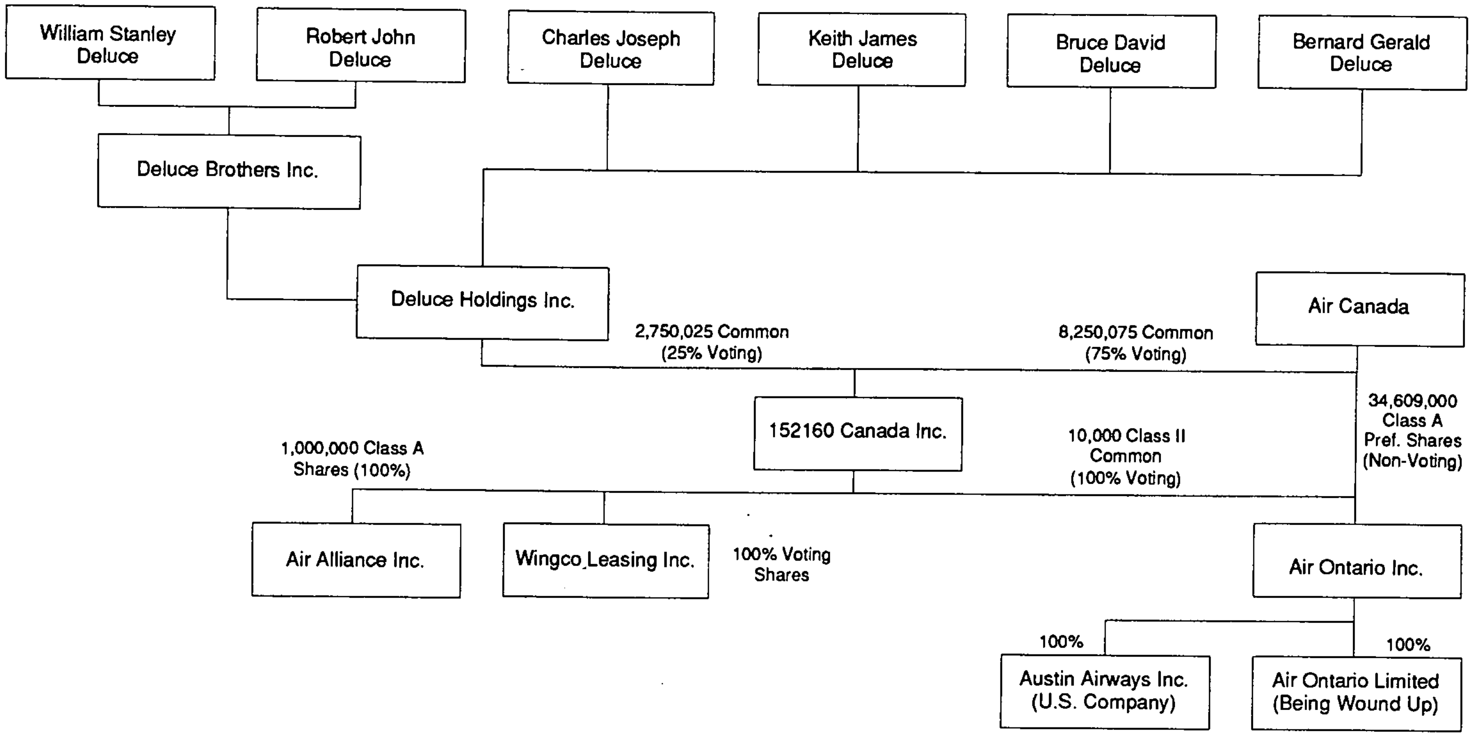
Air Ontario Inc. (Air Ontario) was wholly owned by a numbered company 152160 Canada Inc. which, in turn, was owned by the Deluce family and Air Canada (see figure 13-2).[6]

Immediately following the merger, Air Ontario Inc. operated the combined Austin/Air Ontario Limited routes, which went north to Fort Severn and Great Whale on Hudson Bay, west to Winnipeg, east to Montreal, into large southern Ontario cities like London and Toronto, and into three American centres, Minneapolis, Cleveland, and Hartford (see figure 13-3). In the period after the merger, Air Ontario Inc. had approximately 800 employees – the former Austin employees who were not yet unionized and the former Air Ontario Limited employees who were largely unionized. The new company operated a combined fleet of approximately 40 aircraft of eight different aircraft types.

Following the merger the entire combined operation of the two companies continued for some months. Air Ontario's head office and main base of southern operations was in London. The northern

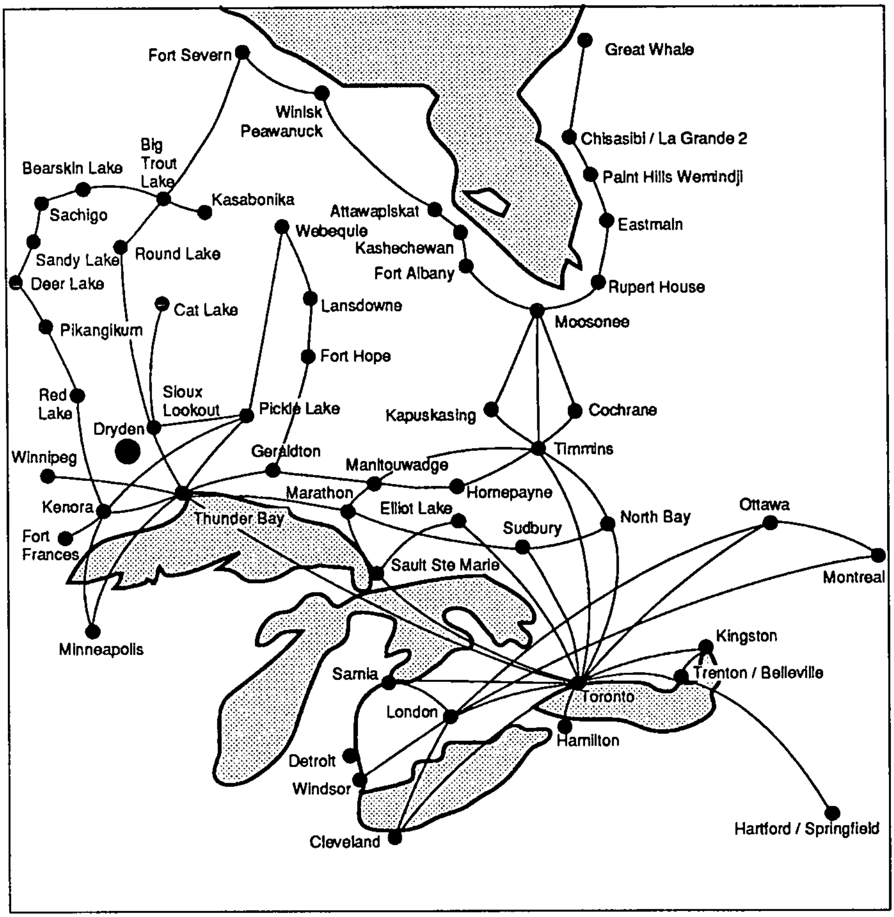
[6] In addition to its 75 per cent interest in the voting common shares, Air Canada purchased a substantial number of non-voting preference shares. Though they represented a substantial equity interest, the preference shares were "debt-like" in that they were to be redeemed by Air Ontario according to a set schedule. Therefore Air Canada, with its combined common and preference shares, had at any given time following the merger an equity position in Air Ontario of more than 90 per cent.

Figure 13-2 Air Ontario Inc., Ownership Structure, March 10, 1989



Source: Based on Exhibit 782

Figure 13-3 Air Ontario Inc., Route Map, June 1987



Source: From Exhibit 778

operation was managed in Timmins by Mr Bruce Deluce, the company's vice-president of charter sales and northern operations. As the administrative departments of the new company were consolidated in London, there was a contemplated immediate loss of 25 to 30 jobs from the Austin employee group.

With the functional merger of the two companies, the combined Air Ontario Limited / Austin employee groups took various steps to establish common collective representation by the various unions. The two pilot groups were merged under the representation of CALPA with a common seniority list. Upon completion of the merger of the pilot lists, CALPA began negotiating the first collective labour agreement for the combined pilot group. The negotiations, which commenced in the fall of 1987, broke down in the spring of 1988, resulting in a pilot strike from March until May 1988. The ultimate settlement of the labour-management dispute was a collective labour agreement which applied common work rules to all Air Ontario pilots.

As a consequence of the changes in working conditions, the continued viability of northern routes became questionable. Mr William Rowe, Air Canada representative on the Air Ontario board, explained the effects of the unionization of the northern pilots and the application of southern working conditions on the entire operation:

> A. The two entities were not compatible ... as separate entities under one management structure. It was obvious they had to be merged. They were.
>
> At the time of the merging, the unions of Air Ontario petitioned, and in particular, CALPA, the pilots' association, was successful in receiving authority to organize the Austin pilots.
>
> The work rules for Austin at the time of the merger were that essentially of a charter and bush operator, where there were – a multiplicity of duties were performed by various individuals, including the flight crew, who would frequently and as part of their normal duties be called upon to load the aircraft, et cetera, perform multiple duties other than just flying.
>
> At the time of the organizing, a delineation of duties took place, and the multiple duties that the pilots once had were not carried forward any further. They had refused to continue in that line.
>
> Also at the time, there was an increase in competitive flying by other non-union operators, and very much smaller operators than Austin, on several of their routes, and it became apparent that the smaller operators were going to erode the economic position that Austin once enjoyed in the area where indeed, in many cases, they had a monopoly service and were able to provide this service at very good rates, but still at reasonable cost, but that whole cost structure was now going to be eroded

> by virtue of the union contract and the merger contract – or merging, results of the merger, and be attacked from a competitive position of much less expensive operators and smaller entities.
>
> We then decided that it would be best to divest ourselves of the routes of Austin as much as possible, while they ... still had value, and while there was a buyer available for them.
>
> There was a buyer available, and negotiations took place, and subsequently, we agreed to transfer those operations to the new owner, new owners.
>
> (Transcript, vol. 121, pp. 148–49)

The decision to divest Air Ontario of its northern assets was first conceived in June 1988 with a divestment plan being formulated in July and August. The sales of the northern assets were completed in the last quarter of 1988 and the beginning of 1989.

Air Ontario Inc. maintained scheduled service to Winnipeg, Dryden, Kenora, Fort Frances, Thunder Bay, Sault Ste Marie, Elliot Lake, Sudbury, Kapuskasing, Timmins, North Bay, Ottawa, Montreal, and points south. All Air Ontario routes north of the named locations were discontinued.

The principal purchasers of the northern hard assets and routes of the former Austin Airways were Air Creebec and Bearskin Airlines. Although the Deluce family and Air Ontario did not maintain an equity interest in these airlines, they maintained commercial relationships with them. The northern service remained integrated in the Air Ontario system via commercial agreements with these carriers. Northern passengers were fed into the Air Ontario system by Bearskin and Air Creebec. Air Ontario then fed these passengers into Air Canada's national and international transportation network.

By late 1988, Air Ontario had approximately 550 to 600 employees, a decrease of approximately 200 to 250 employees (or 25 to 30 per cent) from the period immediately following the merger. Some of the displaced Austin personnel were able to find employment with the newly expanded Air Creebec and Bearskin Airlines.

As would be the case with any major corporate rationalization, there were anxieties among the employee group regarding their future with Air Ontario. At least one manager associated low employee morale with poor job performance, which potentially compromised flight safety. Certainly, in any time of great change and dislocation within a company, it is the task of management to remain focused on operational imperatives; in the case of an airline, the operational imperative is flight safety.

Without a doubt, Air Ontario's managerial resources were greatly taxed during the functional merger of the two regional carriers. The divestment of northern operations, the reduction of employees by almost one-third, the consolidation of its operation in London, Ontario, the merger of two disparate pilot and flight attendant groups, a lengthy pilot strike, the cultivation of a relationship with the new controlling shareholder, Air Canada, the rationalization of its aircraft fleet, and the introduction of a new aircraft type all represented significant challenges to Air Ontario management in the 18 months following the merger. The issue to be examined is whether Air Ontario management was able to support the flight safety imperative during this period of distraction.

14 MANAGEMENT ORGANIZATION

Following the merger of Air Ontario Limited and Austin Airways, the management of Air Ontario Inc. was faced with the challenge of integrating the two somewhat disparate companies. Quite understandably, there were many management changes at Air Ontario as this integration proceeded. Adding to the demands on management was a pilot strike from March 11 until May 1, 1988. It was within this environment of significant management change, company integration and rationalization, and management preoccupation with labour relations that Air Ontario undertook its first jet transport operation.

In the review of the F-28 program that follows it is apparent that operational deficiencies which were linked to the crash of flight 1363 were attributable, at least in part, to inattentive management. To understand fully the circumstances that led to this accident, it is necessary to consider the operational deficiencies of the air carrier management component of the air transportation system.

This section describes the operational management of Air Ontario during the material period from June 1987 until January 1990.[1] There is a discussion of significant changes in operational management and the events that were occupying the attention of management during this period (see figure 14-1).

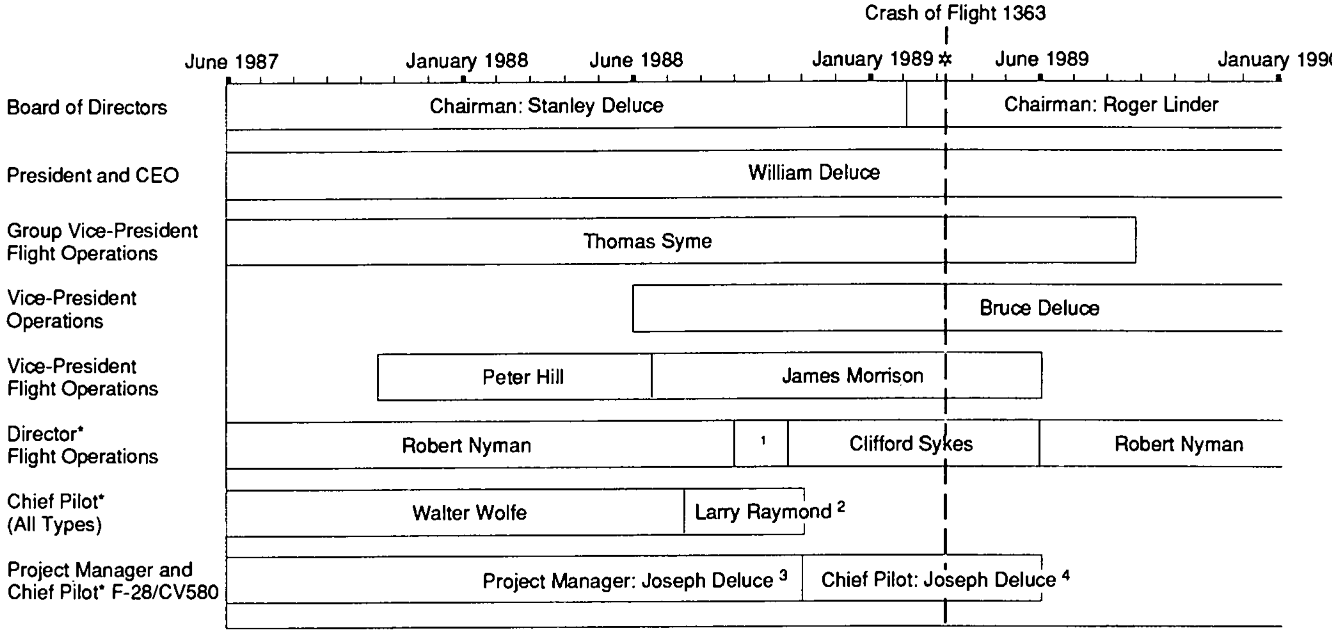
Management Structure

The management structure of Air Ontario is not unusual. Its corporate hierarchy consisted of lower level supervisors and managers reporting to middle management directors, who in turn reported through one or two levels of vice-presidents to the president and chief executive officer (CEO). The president and CEO reported to the board of directors.

The board of directors met at least four times per year and was ultimately responsible for the overall direction and management of the company. Decisions affecting the company fundamentally, such as the selection of Air Ontario officers at the vice-president or president level or the acquisition of new aircraft, required approval of the board of

[1] Operational management includes flight operations and maintenance management.

Figure 14-1 Air Ontario Inc., Senior Operational Management, June 1987–January 1990



* Appointments of director of flight operations and chief pilot require the approval of Transport Canada.

1 James Morrison, acting director of flight operations.
2 Acting chief pilot.
3 The duties and responsibilities of the project manager were not formally defined. Because there were items that were not complete from the F-28 Project Plan when Captain Deluce was formally appointed F-28/CV580 chief pilot, the duties of the project manager are said to overlap with those of the F-28 chief pilot.
4 Although the evidence suggests that Captain Deluce was fulfilling the role of F-28 chief pilot as early as June 1988, he was not formally appointed to the position until November 1988.

directors. Air Ontario's 12 board members were nominated by the company's two shareholders, 9 by Air Canada and 3 by the Deluce family, reflecting their respective ownership interests. Mr Stanley Deluce was chairman of the board from June 1987 until February 1989, when he was succeeded by an Air Canada nominee, Mr Roger Linder.

There were several committees of the board of directors; of particular significance was the executive committee, which met on a monthly basis and included as members Mr Stanley Deluce, Mr William Deluce, and Air Canada nominees William Rowe, John McMurtry, and later Roger Linder. Because it met frequently, the executive committee was able to review proposals and decisions of more immediate significance to the day-to-day management of the company. The Air Ontario F-28 project was one proposal that was discussed at length at the executive committee and at the board of directors.

Mr William Rowe served as Air Canada's "shareholder's representative" on the Air Ontario board and executive committee. Mr Rowe, who was also Air Canada senior vice-president, associated airlines, reported directly to Air Canada's president and chief executive officer regarding Air Ontario. Although in testimony Mr Rowe described his role as primarily one of protecting Air Canada's financial interest in Air Ontario, he stated that he also served as a liaison between Air Canada and Air Ontario management and, to the extent that Air Canada wanted to influence Air Ontario, he would introduce matters of interest to Air Canada at the Air Ontario board meetings.

Air Canada, as the majority shareholder of Air Ontario, had effective control of the board. Thus, Air Canada's interests were, or ought to have been, reflected in every decision of the board of directors of Air Ontario.

Reporting to the board of directors, and directly responsible for the day-to-day management of the company, was the president and CEO, Mr William Deluce. Mr Deluce was 38 years of age when he became president of Air Ontario Inc. in June 1987. He has a degree in chemical engineering from the University of Toronto and is a licensed pilot. As is evident from the description of the history of the company, Mr William Deluce has performed many roles in his family's businesses. He handled baggage and fuelled aircraft as a boy, at the age of 19 he managed a northern base, as a young man he built NorOntair "from scratch," and finally, at a still relatively young age, he became the chief executive officer of Canada's third largest regional airline. In addition to being a member of the Air Ontario board and executive committee, Mr William Deluce has been a member of the boards of directors of a number of other companies including Canada 3000 Airlines and the Canadian Tire Corporation. He was also a director of the Air Transport Association of Canada (ATAC) from 1985 to 1988 and its chairman for 1987–88.

Mr William Deluce, as CEO, was directly involved in the selection and approval of managers at the level of vice-president and director. In some instances he would make management choices himself; on other occasions management changes would be presented to him for consideration by his group vice-president, Mr Thomas Syme.

Throughout the material period, Mr William Deluce only attended at Air Ontario's head office at London, Ontario, approximately two to three days per week; however, he was in daily telephone contact with Mr Syme there. When he was not directly involved in the management of Air Ontario, Mr Deluce attended to his other business interests. He relied upon Mr Syme as the senior officer responsible for the day-to-day management of Air Ontario Inc. Both Mr Syme and Mr Deluce equated the role of Mr Syme to that of a "chief operating officer," although he was not formally given that title until a recent reorganization in 1991. Mr Deluce elaborated on his working relationship with his group vice-president:

> Q. Were you relying very heavily on him in day-to-day matters of running the corporation, sir?
> A. I was relying upon Tom [Syme] and Tom had assembled under his wing other suitable support staff.
> Q. To what extent, would you say, had you delegated your duties and responsibilities to Tom Syme?
> A. Well, when it came to day-to-day operational types of things, Tom was responsible for it. If it was a strategic matter, those would be areas that I would be involved, very much involved in. If it was a policy matter, Tom would ... normally bring it to me and we would sort it out either between Tom and I or with our senior vice-president group.
>
> (Transcript, vol. 151, p. 128)

Mr Syme's experience was primarily in the fields of finance and accounting. He graduated from the University of Western Ontario Business School with an honours business administration degree in 1976 and he is a certified general accountant (CGA). Following graduation, he worked in the insurance and accounting business until 1981, when he joined Great Lakes Airlines as its chief accountant. In 1983 he was appointed corporate comptroller of the company (by then Air Ontario Limited) and was responsible for finance and accounting functions, information systems, personnel, and payroll. In late 1985 Mr Syme was appointed assistant to the president, Mr James Plaxton, taking on the additional responsibility of strategic planning. This involved operational, commercial, and fleet planning, including the acquisition and disposition of aircraft.

After less than one year Mr Syme was appointed director of operations for Air Ontario Limited. With this new position – his first in airline operations – Mr Syme was directly responsible for the flight operations and maintenance functions of Air Ontario Limited; in addition, he carried on as director of strategic planning and coordinator of the corporate business plan. In early 1987 Mr Syme became the vice-president of operations for Air Ontario Limited and, in June 1987, he was appointed the group vice-president operations of the newly merged company, Air Ontario Inc.

For the material period, from June 1987 until March 10, 1989, Mr Syme had reporting to him the vice-president of operations, the vice-president of maintenance and engineering, the vice-president of flight operations, and the vice-president of marketing. Mr Syme was involved in all managerial appointments within the flight operations and maintenance departments.

Mr Syme is neither a licensed pilot nor a licensed aircraft maintenance engineer. He testified that, because he had no technical background, he relied upon the advice of his senior technical people on operational matters.[2]

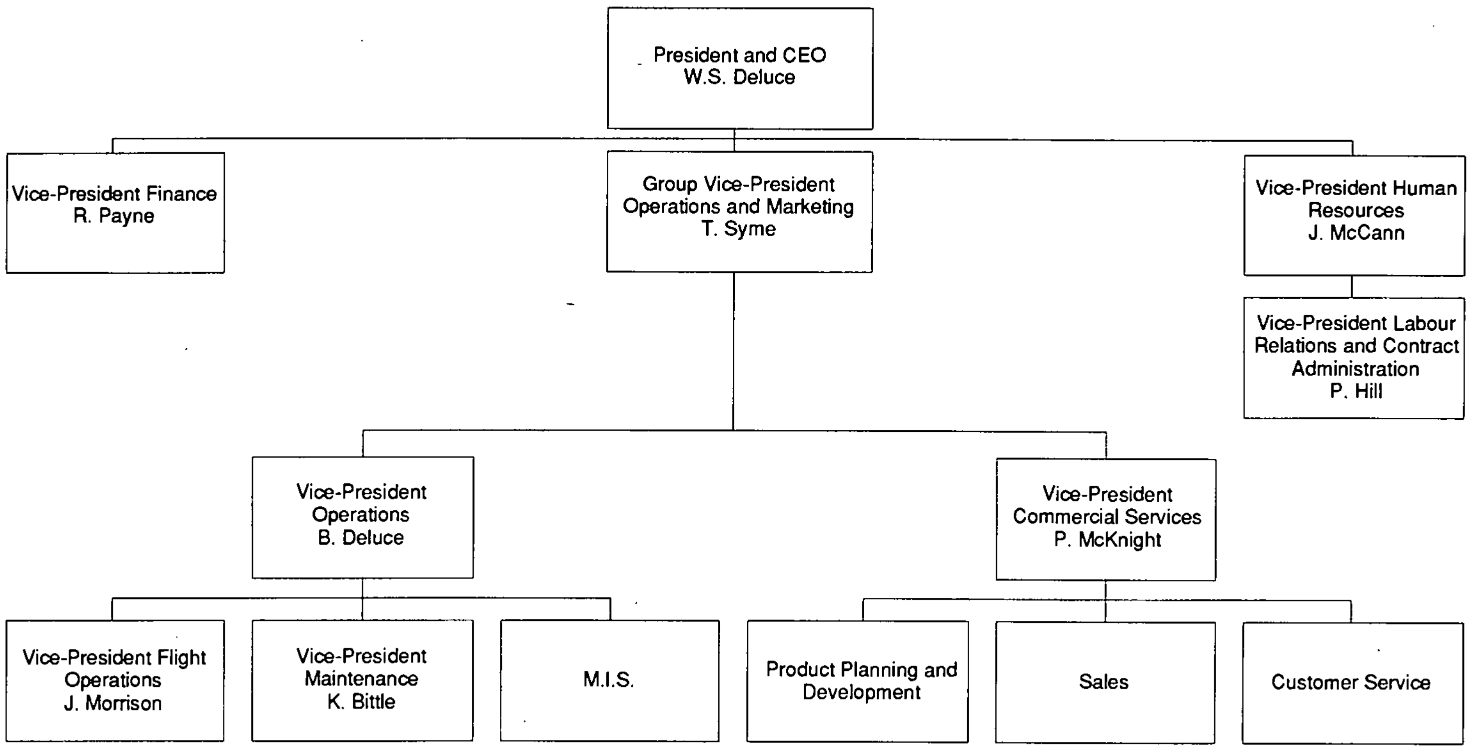
In June 1988 Mr Bruce Deluce was appointed vice-president of operations reporting to Mr Syme. With this organizational change, Mr Syme was, for the first time, one step removed from direct line authority over the flight operations department. Six months later, in December 1988, Mr Syme's line authority over the maintenance department was interrupted by an expansion of Bruce Deluce's role. The senior management organization at Air Ontario on March 10, 1989, is portrayed in figure 14-2.

Mr Syme continued as chief operating officer until mid-1989, when Mr Bruce Deluce as vice-president of operations was given a direct reporting relationship to his brother, William Deluce. Mr Syme's responsibilities were then limited to commercial services. With this change, Mr Bruce Deluce became responsible for the entire operational side of Air Ontario and Mr Syme concentrated strictly on commercial matters.

---

[2] The issue of technical and operational proficiency of senior airline managers is discussed in chapter 25, Management Performance.

Figure 14-2 Air Ontario Inc., Senior Management Organization, March 10, 1989



Source: From Exhibit 793

Operational Management: Flight Operations and Maintenance

Regulatory Requirements

To obtain an operating certificate, an air carrier operating large aircraft must have a flight operations and maintenance organization that meets the requirements of Air Navigation Order (ANO) Series VII, No. 2, which states:

> 5.(1) An applicant for an operating certificate shall show that he has the qualified managerial personnel necessary to operate the proposed commercial air service and that such personnel are employed on a full time basis in the following or equivalent positions:
> (a) Managing Director;
> (b) Director of Flight Operations (or Operations Manager);
> (c) Director of Maintenance and Engineering (or Maintenance Manager);
> (d) Chief Pilot; and
> (e) Chief Inspector.
>
> (2) Where because of the nature of a commercial air service, positions other than those specified in subsection (1) would, in the opinion of the Director, be more appropriate, the Director may
>
> (a) approve different positions or a different number of positions; and
> (b) authorize the allocation of more than one position to one person.
>
> 6.(1) No person shall serve as a Director of Flight Operations (or Operations Manager) or as a Director of Maintenance and Engineering (or Maintenance Manager), unless his qualifications, background and experience are satisfactory to the Director.
>
> (2) No person shall serve as a Chief Pilot or Chief Inspector unless he meets the requirements set forth in Schedule A.

Candidates for the chief pilot and chief inspector positions must fulfil the following qualifying criteria in Schedule A to ANO Series VII, No. 2:

1. Every Chief Pilot shall
   (a) hold a valid airline transport pilot licence or a senior commercial pilot licence with a Class I instrument rating with full privileges;
   (b) have at least three years experience as a pilot-in-command of a large aeroplane with an air carrier;
   (c) know the contents of the air carrier's Operating Certificate, Operations Specifications and Operations Manual; and
   (d) know the provisions of the *Air Regulations* necessary for the proper performance of his duties.

2. Every Chief Inspector shall
   (a) hold a valid aircraft maintenance engineer licence Category "A" and shall have held such licence for at least three years;
   (b) have at least three years experience on large aeroplanes with an air carrier or an approved maintenance organization, one year of which was as a maintenance inspector;
   (c) know the appropriate parts of the air carrier's Operating Certificate, Operations Specifications, and Maintenance Manual necessary for the proper performance of his duties; and
   (d) know the provisions of the *Air Regulations* necessary for the proper performance of his duties.

The ANO contemplates separate maintenance and flight operations organizations. The director of flight operations and the chief pilot are the two flight operations management positions required by the ANO, and the director of maintenance and the chief inspector are the two required maintenance management positions.

The air carrier's flight operations organization and practices are described in its operations manual while its maintenance organization and practices are described in its maintenance manual. An air carrier is required to produce both manuals for Transport Canada's approval as a condition of operation. Both manuals must describe the duties, responsibilities, and reporting relationships within the flight operations and maintenance organizations. (The approval of manuals is discussed in chapter 19, F-28 Program: Flight Operations Manuals.)

Although Transport Canada is to review and approve the contents of the carrier's operations manual and maintenance manual, there are no clear regulatory descriptions of the duties, responsibilities, or qualifications of the required management personnel.

Air Ontario Flight Operations Management

A flight operations organization, in the simplest terms, is responsible for the planning and execution of aircraft movements. This responsibility encompasses operational control and flight following; operational standards and practices; initial and recurrent training of pilots; and, in the case of Air Ontario, the initial and recurrent training of flight attendants. The Air Ontario flight operations organization and practices were described in the Air Ontario Flight Operations Manual (issue date September 15, 1987). As at March 10, 1989, three amendments to the manual, dated December 23, 1987, April 13, 1988, and May 1, 1988, had been approved and incorporated. This manual was submitted to Transport Canada in fulfilment of the requirements of ANO Series VII, No. 2.

The Air Ontario flight operations management experienced considerable change in organization and personnel during the period June 1987 to September 1989. For the most part, this organizational change was not reflected in any amendments to the Flight Operations Manual.

Flight Operations: Summary of Structural Changes[3]

In June 1987 the director of flight operations, Captain Robert Nyman, was reporting directly to the group vice-president of operations, Mr Thomas Syme, who reported to the president. In late 1987 the position of vice-president of flight operations was created, a position initially occupied by Mr Peter Hill.[4] The director of flight operations reported to the vice-president of flight operations, who reported to the group vice-president.

In June 1988 the position of vice-president of operations was created. This position was occupied by Mr Bruce Deluce. The vice-president of flight operations reported to the vice-president of operations, who reported to the group vice-president. This is the organizational structure that was in place on March 10, 1989, and is reflected in figure 14-3.

Eventually, in September 1989, the positions of vice-president of flight operations and group vice-president would be eliminated so that the director of flight operations reported directly to the vice-president of

---

[3] Please refer to figure 14-1.

[4] Amendment #1 to the Air Ontario Flight Operations Manual, dated December 23, 1987, describes Mr Hill as the vice-president of operations. This seems to be the only reference to Mr Hill having had that title. The position filled by Mr Hill at that time (and later by Mr James Morrison) was known internally at Air Ontario as the vice-president of flight operations. The position of vice-president operations, later occupied by Mr Bruce Deluce, was considerably different from Mr Hill's position as referenced in the Flight Operations Manual (Exhibit 146).

operations, who reported directly to the president. Thus, in the 27 months from June 1987 until September 1989 Air Ontario either added or subtracted layers of operational management on three occasions. In addition to these structural changes, there were changes in the senior management personnel of the Air Ontario flight operations department.

Personnel Changes

Director of Flight Operations Captain Robert Nyman In June 1987, following the merger of Austin and Air Ontario Limited, Captain Robert Nyman became the director of flight operations for Air Ontario Inc. He had held this position at Air Ontario Limited for two months prior to the merger.

Since obtaining his commercial licence in 1958, Captain Nyman has accumulated in excess of 20,000 hours of flying and has been employed for most of his career by companies owned in whole or in part by the Deluce family. Captain Nyman worked in various capacities for Austin Airways including pilot, check pilot, chief pilot, and director of flight operations. From 1984 until April 1987 he was employed by Northland Air Manitoba as director of flight operations.

In early 1987 Captain Nyman indicated to Mr William Deluce that he would like to move back to Ontario. Mr Deluce advised him of the possibility of replacing Captain Robert Murray, who was the head of the flight operations department at Air Ontario Limited. On Mr Deluce's suggestion, Captain Nyman met with Captain Murray to discuss the position that Captain Murray was voluntarily leaving. Shortly thereafter, on April 1, 1987, Captain Nyman began in his position as the director of flight operations.

Captain Nyman acknowledged that his duties and responsibilities were those set out in section 3.2 of the Air Ontario Flight Operations Manual. These are as follows:

> 3.2 DIRECTOR OF FLIGHT OPERATIONS – DUTIES, RESPONSIBILITIES AND AUTHORITY
>
> 1. The Director of Flight Operations is responsible to management for overall direction and supervision of Company Flight Operations and the development of policy governing these functions, and shall ensure that all such operations, under all Licenses and Certificates held by the Company will be conducted in accordance with the general and specific policies and instructions contained in this Manual, as approved by the Department of Transport.
> 2. He will develop and apply new flight operations policy and procedures in keeping with changing conditions, equipment, experience and competency of personnel.

3. He will have available for immediate communication to rescue co-ordination centres, lists containing information on the emergency and survival equipment carried on board any Company aircraft.
4. He will ensure that all flight crew are familiar with the regulations and procedures pertinent to the performance of their duties prescribed for the areas to be traversed, the airports to be used and the air navigation facilities relating thereto. He shall ensure that other members of the flight crew are familiar with each of these regulations and procedures as are pertinent to the performance of their respective duties in the operation of the aircraft.
5. He will also be responsible for the preparation of amendments to this Manual and for the briefing of all Operational Personnel regarding the reasons for, and effects of all amendments and shall keep a permanent register of acknowledgements by Operational Personnel ensuring they are fully and currently informed.
6. Although some of the above duties may be delegated to other supervisory personnel, i.e., Assistant Director of Flight Operations, Chief Pilot the responsibility for the safe and efficient operation of all Company flight operations remain with the Director of Flight Operations.
7. He will report directly to the Vice-President of Operations.

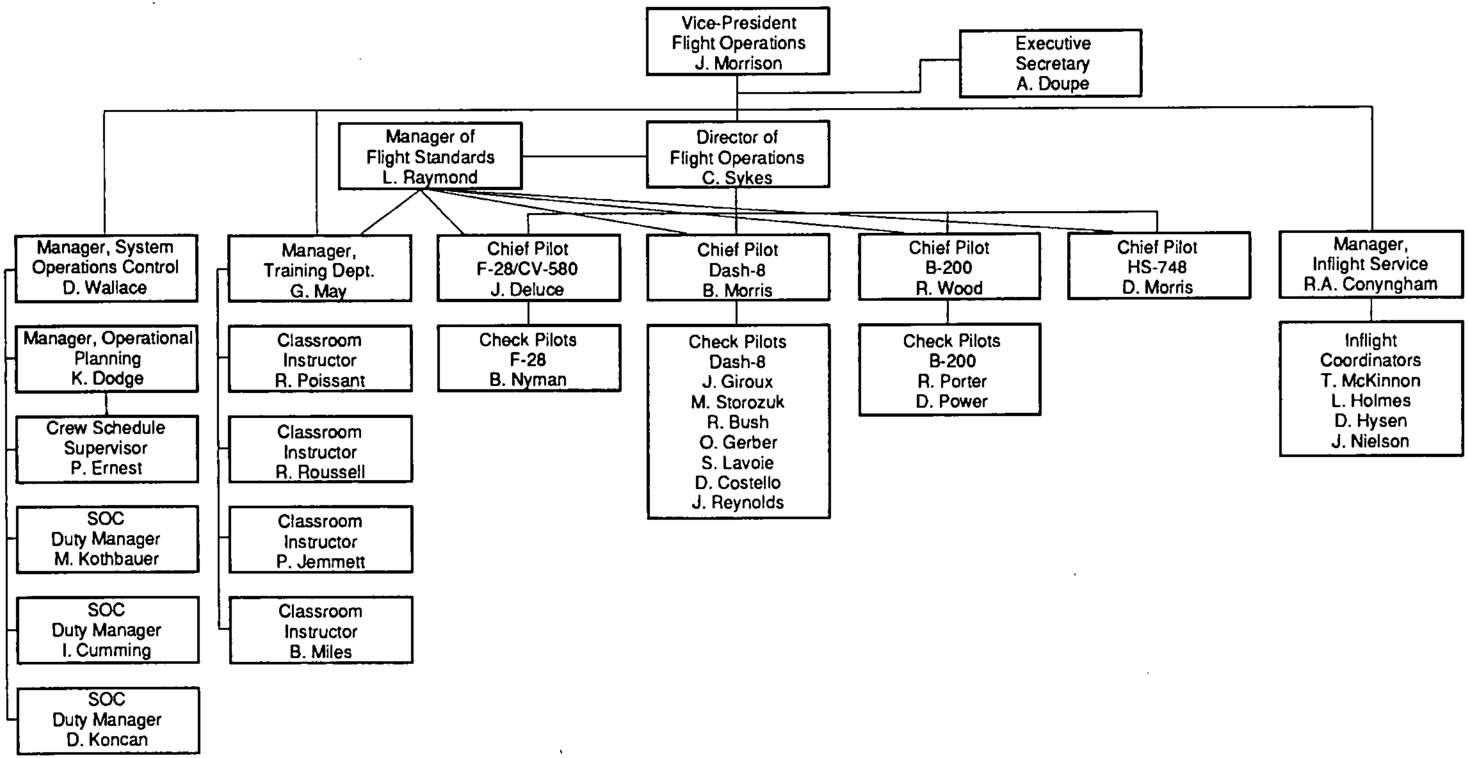
(Exhibit 146, p. 3-6)

Initially, Captain Nyman reported to the group vice-president of operations, Mr Thomas Syme. From November 1987 until June 1988, Captain Nyman reported to the vice-president of flight operations, Mr Peter Hill. Contrary to the description in the Air Ontario manual, there was no individual with the title of vice-president of operations until Bruce Deluce took on the position in June 1988.

Air Ontario's pilots went on strike in March 1988. Captain Nyman testified that from the fall of 1987 until the strike began, he assisted Mr Hill in negotiations with the pilot group. Captain Nyman described the labour negotiations and background research as occupying approximately 50 per cent of his time during this period. His involvement with negotiations ceased at the commencement of the strike, as he and other management pilots were then engaged in line flying responsibilities.

After the strike Captain Nyman carried on as the director of flight operations for several months. He testified that he preferred to return to line flying, and on August 24, 1988, Air Ontario announced that Captain Nyman would be stepping down and Mr James Morrison would become, after a transitional period, acting director of flight operations. By the end of September 1988 Captain Nyman was out of the director of flight operations position completely, and flying as a line pilot.

Figure 14-3 Air Ontario Inc., Flight Operations Organization, March 10, 1989



Source: From Exhibit 793

In July 1989 Mr Bruce Deluce informed Captain Nyman that Mr Morrison had accepted a position with Air Creebec and asked that Captain Nyman take over from Mr Morrison, vice-president of flight operations, as an interim director of flight operations. Captain Nyman agreed on condition that the appointment would be for no longer than six months to one year, at which time he would return to line flying. Captain Nyman continued in the position of director of flight operations, reporting to Mr Bruce Deluce, vice-president of operations, until July 1990.

Vice-President of Flight Operations Peter Hill The creation of the position of vice-president of flight operations and the appointment of Mr Peter Hill to it was initiated in late 1987 by the group vice-president, Mr Syme. Mr Syme explained that he wanted to consolidate some of the operations functions which were previously reporting directly to him. Mr Hill was selected for the position because of his previous experience with system operations control (SOC) and airport services. As the vice-president of flight operations, Mr Hill oversaw both the flight operations department and SOC.

Mr Hill's qualifications were described in the "Air Ontario Inc. Corporate Overview and Historical Financial Statements Fleet Plan":

> Following the Aviation and Flight Technology course at Seneca College, where he obtained a commercial pilots licence, Mr Hill spent three years with Toronto Airways and Air Canada before joining Air Ontario in 1974 as a dispatcher.
>
> Mr Hill has been involved in all labour negotiations and developed the present dispatch system, as he worked up through Chief Dispatcher and Assistant Director of Operations. When Mr Hill was appointed Director of Stations and Contracts in 1984, he took responsibility for all airports, handling agreements, facilities and petroleum purchasing.
>
> (Exhibit 778, p. 12)

It should be noted that Mr Hill's role as the vice-president of operations is referred to on at least three occasions in the Transport Canada–approved Flight Operations Manual. There are no defined duties and responsibilities for the vice-president of operations position, although it appears at the top of the approved flight operations organization chart at page 3-3 of the manual. At page 3-4 Mr Hill is listed as the vice-president of operations, and, at page 3-6, the director of flight operations is said to report directly to the vice-president of operations. On each of these pages was the Transport Canada seal of approval.

Although Mr Syme testified that "Mr Hill was not holding an approved flight operations position from the perspective of Transport," it appears to me from the evidence that Mr Hill in fact had a very definite senior supervisory role in Air Ontario's flight operations department (Transcript, vol. 97, p. 159). From October 1987 until the commencement of commercial service of the F-28 in June 1988, the jet program fell within Mr Hill's realm of responsibility. In June 1988 Mr Hill was named the vice-president of employee relations and contract administration. At that time Mr James Morrison was appointed vice-president of flight operations and Mr Bruce Deluce was appointed to the newly created position of vice-president of operations.

Vice-President of Flight Operations James Morrison In early June 1988 Mr William Deluce announced the replacement of Mr Hill by Mr James Morrison as the vice-president of flight operations. In a memorandum to Air Ontario employees, Mr William Deluce described Mr Morrison's new role with the company:

> Jim's responsibilities will encompass all flight operations activities including administration of SOC, Technical Training and the pilot group. Jim brings a wealth of previous aviation experience to Air Ontario and most recently was employed as General Manager of a Quebec based regional carrier. Jim will report to the Vice President, Operations, Bruce Deluce.
>
> (Exhibit 791)

The Quebec-based regional carrier referred to was Air Creebec, a company 49 per cent owned by the Deluce family.[5] Mr Morrison had had an involvement with the Deluce family since 1981. After flying light aircraft for several years throughout northern Canada, Mr Morrison began flying with Austin, first as a contract Twin Otter captain, then as an HS-748 first officer. In 1982 he was appointed general manager and operations manager of Air Creebec. As such he was responsible for establishing a management structure for the new airline. In 1987 he was appointed vice-president and general manager of Air Creebec. During the startup phase at Air Creebec, Mr Morrison reported to Mr William Deluce; later, he reported to Mr Billy Diamond, president and CEO of Air Creebec.

Later in 1987 Mr Morrison advised Mr William Deluce and Mr Diamond of his intention to leave Air Creebec and his interest in joining Air Ontario. Towards the end of the Air Ontario pilot strike (March–May 1988) Mr Morrison flew as a management pilot for Air Ontario. At the

[5] The Deluce family divested itself of its interest in Air Creebec in 1988.

same time, with the approval of Mr William Deluce and Mr Diamond, he wound up his responsibilities with Air Creebec.

During this period Mr Bruce Deluce advised Mr Morrison of the possibility of his becoming the Air Ontario vice-president of charter sales and airport services.[6] Later, Mr Bruce Deluce advised him that, owing to a restructuring at Air Ontario, this position was no longer available but the position of vice-president of flight operations was. Mr Morrison took the position and formally left Air Creebec to join Air Ontario on July 1, 1988.

Reporting to Mr Morrison in his new position was Captain Nyman as director of flight operations. Mr Morrison in turn reported to Mr Bruce Deluce, who was appointed vice-president of operations in June 1988. On August 24, 1988, Air Ontario announced that Mr Morrison would assume the additional responsibilities of "acting director of flight operations." Mr Morrison was vice-president of flight operations at Air Ontario for approximately one year, during which time he effected a complete reorganization of the flight operations department. In July 1989 he left Air Ontario and returned to Air Creebec as executive vice-president and chief operating officer.

Director of Flight Operations Clifford Sykes After interviewing a number of in-house candidates, Mr Morrison appointed Captain Clifford Sykes to succeed Captain Nyman as director of flight operations in mid-October 1988. Captain Sykes had worked for Air Ontario Limited and Great Lakes Airlines since 1973. He flew the Convair 440 and later the Convair 580 aircraft. At various times, he had been the chairman of the master executive committee for CALPA and the chief pilot for Air Ontario Limited. Prior to being appointed director of flight operations, Captain Sykes was a line captain on the F-28 aircraft.

As director of flight operations, Captain Sykes was responsible only for the pilot group. The manager of system operations control, the manager of training, and the manager of in-flight service all reported directly to the vice-president of flight operations, Mr Morrison.

A large part of Captain Sykes's tenure as director of flight operations was devoted to administering the new CALPA contract and assisting in the integration of the two pilot groups – those formerly employed by Austin Airways and by Air Ontario Limited. In addition, Air Ontario was divesting itself of many of its northern assets during this period and

---

[6] The proposed organization of Air Ontario that included Mr Morrison as the vice-president of airport services and charter sales was presented to the Air Ontario executive committee on May 6, 1988, and was rejected by the Air Canada representative, Mr Rowe.

Captain Sykes helped to facilitate the transition of many of the pilots who were displaced from the north.

Captain Sykes left his position as director of flight operations in May 1989, when he joined another airline.

Vice-President of Operations Bruce Deluce In June 1988 the position of vice-president of operations was created and Mr Bruce Deluce was appointed to it. Like his brother William Deluce, Mr Bruce Deluce had been involved with his family business since he was a boy. Starting as a high school student in 1975, he worked for White River Air Services performing various tasks including those of a station agent, refueller, radio operator, and flight attendant. He worked as a load master in cargo operations and as an apprentice maintenance engineer in the maintenance department.

In the fall of 1979 Mr Bruce Deluce began to fly commercially with Austin Airways. During this period he was endorsed to fly the Twin Otter, the Cessna 402, the HS-748, and the Cessna Citation. Much of his early flying was as a first officer, but he did fly the Cessna 402 as a captain. Throughout this period he also worked on special business projects for his brothers William and Robert Deluce.

From 1981 to 1983 Mr Bruce Deluce studied electrical engineering at Lakehead University in Thunder Bay, Ontario. While attending university, he continued to fly the HS-748 out of the company's Thunder Bay base. In the summer of 1982 he was temporarily assigned to be the Thunder Bay base manager. He was also endorsed as a captain of Twin Otter aircraft.

In the spring of 1983 Mr Bruce Deluce continued to work in various capacities for the family business. From August until December 1983, he worked in Thompson, Manitoba, where he acted as Austin's regional manager for northern Manitoba. From December 1983 until August 1985, he worked as the computer services manager for Austin at Timmins, Ontario. From the autumn of 1985 until February 1987 he worked as the director of finance and administration for Austin, reporting to his brother Robert who was vice-president and general manager. From February until June 1987, Mr Bruce Deluce was the vice-president of operations for Austin.

Following the merger in June 1987, when he was 28 years old, Mr Bruce Deluce was the vice-president of charter sales and northern operations for Air Ontario Inc. In June 1988 he was appointed vice-president of operations reporting to the group vice-president, Mr Thomas Syme. This reporting relationship continued until September 1989, when Mr Bruce Deluce began reporting directly to the president, Mr William Deluce.

Changes in the Flight Operations Department

In the two years from June 1987 until July 1989, there were significant changes in the management of the Air Ontario flight operations department. These changes coincided with Air Ontario's divestment of northern assets and the resultant dislocation of northern personnel. Air Ontario's employee group, based on the testimony of Mr Thomas Syme, decreased by "almost one-third" during this period (Transcript, vol. 97, p. 195). Also, at this time, labour relations in the company strained to the point that an eight-week pilot strike occurred from March 11 until May 1, 1988.

Of the senior flight operations managers, Captain Nyman held his position for the longest period of time. He was initially the director of flight operations from June 1987 until September 1988 and then on an interim basis from August 1989 until July 1990. During his initial appointment as director of flight operations, Captain Nyman was ultimately responsible for all flight operations aspects of the F-28 implementation plan, indeed all aspects of flight operations at Air Ontario.

In a 1988 year-end memorandum to his employees, Mr William Deluce addressed the changes that his company was experiencing:

> As we approach the end of 1988, I think that all employees will look back at the past year as having been a time of continued change within Air Ontario Inc.
>
> The implementation of change is a difficult undertaking for any company. It creates instability for the corporation, and in particular, for the employee group. The management of change is a complex process which requires a well coordinated effort by all departments within the corporation. The necessity for fairness and equitability in the administration of the employee group is matched by commercial realities and economic efficiencies which must be addressed to preserve the viability of the company as a whole.
>
> Air Ontario Inc. is a company which, although rich in the traditions of its predecessor companies, is itself less than two years old. The approximate eighteen months since the formation of Air Ontario Inc. has seen a level of evolution within the industry as a whole, from a commercial, regulatory and technological perspective that is unparalleled in the history of Canadian aviation. Against this background the primary focus of Air Ontario has remained unchanged, that being the providing of high quality scheduled passenger services on a regional basis in central Canada and the northeast U.S.
>
> Since the formation of Air Ontario Inc., management has been committed to a resource rationalization programme which culminated in the recent sale to Air Creebec of most of the company's non-scheduled service assets. Air Ontario Inc. is now much less

> complicated and better focused company than it was eighteen months ago. It is management's strong belief that this positions the company very favourably going into 1989 from a commercial, operational and competitive perspective.
>
> ...
>
> We can look back to 1988 as a year of necessary change, however, management is committed to realizing 1989 as a year of stabilization.
>
> (Exhibit 793)

Reading this document and hearing the evidence of its authors, Mr William Deluce and Mr Thomas Syme, I was struck by the clarity with which the difficulties encountered by the company were articulated. Four points from this memorandum are worth emphasizing for the purposes of my study of the F-28 program:

- The implementation of change ... creates instability for the corporation.

There was great instability within the flight operations department at Air Ontario. I have already described the ongoing internal changes at Air Ontario, particularly at the level of vice-president of flight operations and director of flight operations. Also significant were the number of key operational individuals who left Air Ontario to pursue opportunities elsewhere. Captain Robert Murray was supposed to play a major role in the F-28 program; yet, within weeks of the commencement of F-28 service, he left the company. At approximately the same time, the company's chief pilot, Mr Walter Wolfe, also left to go to another airline. Captain Larry Raymond replaced Captain Wolfe as acting chief pilot until the flight operations restructuring was completed and new chief pilots were appointed some five months later.

- The management of change is a complex process which requires a well coordinated effort by all departments within the corporation.

A well-coordinated effort was indeed required by all departments. It is revealed, however, that the implementation of the F-28 program was characterized by a troubling lack of coordination and effective management. Deficiencies in project coordination were significant to the crash of flight 1363.

- The approximate eighteen months since the formation of Air Ontario Inc. has seen a level of evolution within the industry as a whole, from a commercial, regulatory and technological perspective that is unparalleled in the history of Canadian aviation.

Mr Deluce's allusion to deregulation and the commercial imperatives it brought about is significant to the company's drive to provide its first transport jet service.

- [M]anagement is committed to realizing 1989 as a year of stabilization.

At approximately the same time as this memorandum was written, Air Ontario lost access to the F-28 simulators it was using at Piedmont Airlines. In chapter 20, F-28 Program: Flight Operations Training, I explain how this event was destabilizing and how it contributed to a further unravelling of the F-28 program.

Within one year of joining Air Ontario, and following the CEO's commitment to "1989 as a year of stabilization," Mr Morrison – the architect of a complete restructuring of the flight operations department – left Air Ontario to pursue an opportunity at another airline.

In my view, it is significant that the senior managers at Air Ontario understood that the forces of change were creating dislocation within their company and that they would have to redouble their management efforts for the company to operate effectively. In later sections, I examine how the F-28 program was allowed to deteriorate seriously in the absence of meaningful operational management.

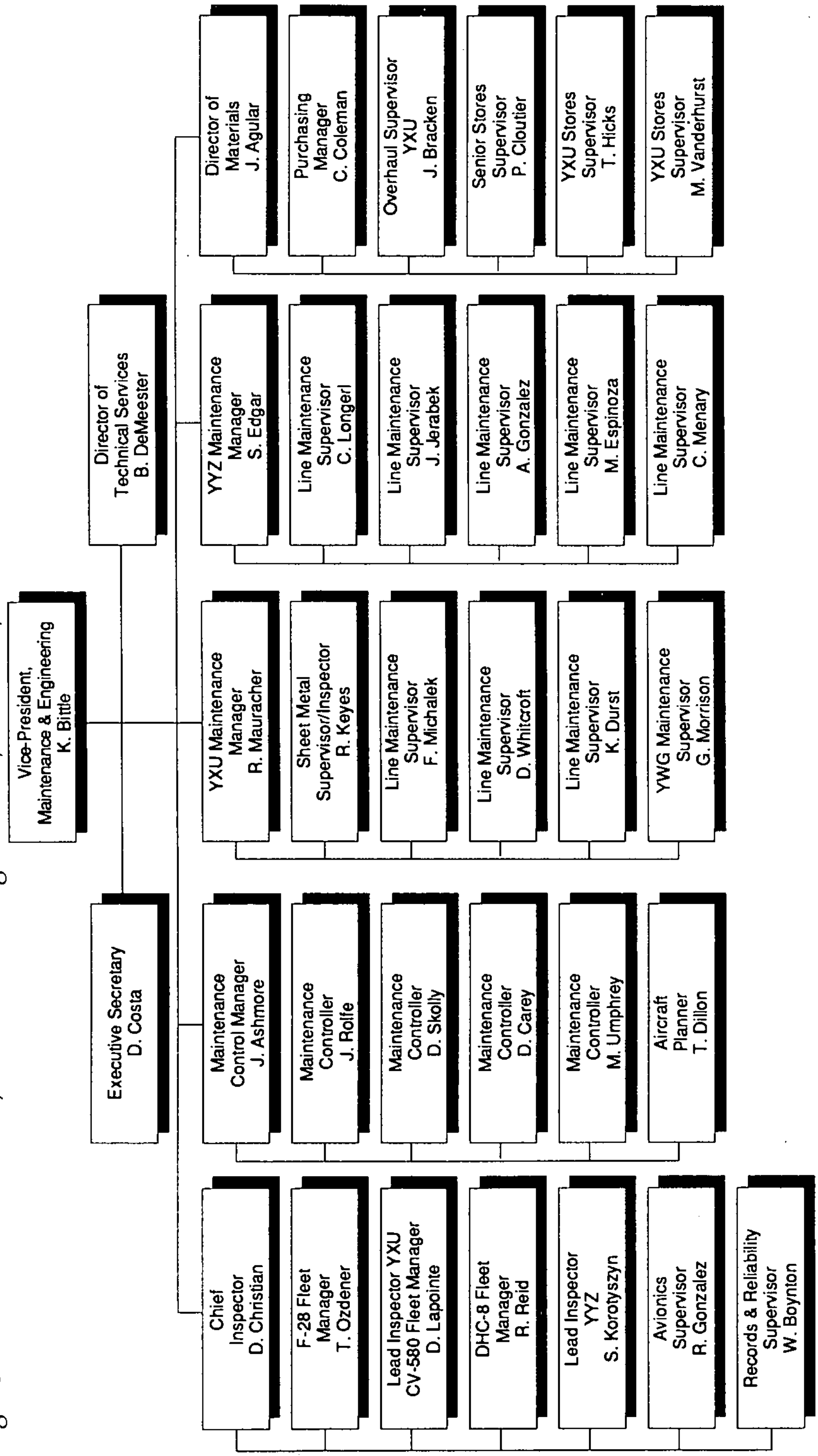
Maintenance and Engineering Management

The Air Ontario maintenance organization and practices were described in its Maintenance Control Manual (Exhibit 319). Unlike the flight operations management, the senior management of maintenance was relatively stable during the period June 1987 to July 1989. Mr Kenneth Bittle was vice-president of maintenance and engineering at Air Ontario during that material time.

Mr Bittle began his aviation career in 1975 as an apprentice mechanic with Patricia Air Transport (Pat Air) of Sioux Lookout, Ontario, a small northern airline flying primarily float aircraft. In 1978 Pat Air went into bankruptcy and Mr Bittle moved to Hooker Air Services as an AME. When the Deluce family acquired the assets and licences of Hooker Air Services in 1979, Mr Bittle joined Austin Airways as a base engineer in Sioux Lookout.

Mr Bittle worked in many operational capacities at Austin Airways. At various times he held the positions of base manager, chief parts storeman, materials manager, director of support services, operations manager for northeastern Ontario, and, finally, director of maintenance and engineering. In the last position he reported to Mr Robert Deluce, who was then vice-president and general manager. Mr Bittle had held

Figure 14-4 Air Ontario Inc., Maintenance Organization, March 10, 1989



Source: From Exhibit 793

this position for two years when Austin and Air Ontario Limited merged.

Mr Bittle then was selected to be vice-president of maintenance and engineering of Air Ontario Inc. in preference to Mr Peter DaCosta, former head of maintenance at Air Ontario Limited. Mr Bittle held this position until August 1990, when he became president and chief executive officer of Northland Air Manitoba.[7]

The Air Ontario maintenance organization in place on March 10, 1989, is depicted in figure 14-4.

The two principal operational departments at Air Ontario Inc. – flight operations and maintenance – were dominated by former Austin Airways management personnel during the material period: Captain Robert Nyman, the director of flight operations, Mr James Morrison, the vice-president of flight operations, and Mr Kenneth Bittle, the vice-president of maintenance and engineering. That former Austin Airways personnel came to dominate the operations of Air Ontario Inc. is, in my view, significant and is discussed later in the Report.

Management Selection

The Selection Process

The appointment of any officer of the company, including the CEO, required approval by the board of directors of Air Ontario.

Mr William Deluce was president and CEO of Air Ontario Inc. pursuant to his earlier employment agreement with Austin Airways Limited and Air Ontario Limited. He discussed his role as CEO with Mr Leo Desrochers and Mr Ray Lindsay of Air Canada during the negotiations for Air Canada's purchase of 75 per cent of Air Ontario Limited and Austin Airways. Mr William Deluce testified that, although his being the president of Air Ontario was not a condition of the sale to Air Canada of a majority interest in his company, his acceptance of the position of CEO was predicated upon very definite conditions:

> A. ... part of the prerequisite on ... my part that I set out with Air Canada was that I was prepared to take on the job on the basis that I had a normal board reporting responsibility. I was not interested in running a division of Air Canada. I was interested

[7] Northland Air Manitoba is a regional airline that is owned 50 per cent by the Deluce family and 50 per cent by Ilford-Riverton Holdings Incorporated.

> in running a company or a couple of companies but on a very independent basis. Independent to the ... extent that I would have ... to report as a normal C.E.O. would do to a board.
>
> (Transcript, vol. 151, pp. 111–12)

Mr William Deluce testified that he would normally select all senior management personnel and he was occasionally involved in the placement of managers at a lower level. The selection of managers at Air Ontario typically involved his consulting with Mr Syme and the human resources department. All changes in management structure discussed above would have required at least the approval of Mr William Deluce and, in some cases, would have been an initiative of Mr Deluce.

Mr William Deluce brought with him the entrepreneurial management style of a man who had built his company up from a small family business. While his style of management changed somewhat as his company grew, differences in his corporate culture and that of the majority shareholder resulted in some disagreement at the board level. Mr Rowe, an Air Canada representative on the Air Ontario board, provided insightful evidence on the clashing of Air Canada and Air Ontario corporate cultures:

> A. ... This was my first encounter with a small entrepreneurial style of operation, and, as a consequence, I had some personal adjustments and difficulties in that adjustment in ... getting used to the style of a smaller management group and, in particular, the entrepreneurial style of a chief executive officer.
>
> Q. Now, an entrepreneurial style, could you just either explain that term generally or explain how that differs from the management that you were used to.
>
> A. Well, I think, in that context, Counsel, I would define it basically as being able to make a lot of decisions often by one's self very quickly as opposed to, in our corporation, where most decisions were run through various committees with a lot of studies to back them up and that type of thing, often a gut-feel-type decision-making as opposed to one backed up by extensive study and – and vetting of – at various levels by various experts, because there simply weren't the experts around and the experts weren't needed in that environment. It was a much smaller, closer-in environment where the experience of the individuals could be brought to bear and the right decisions generally made very quickly.
>
> I, on the other hand, came from an organization where consensus, extensive study, various levels of approval, checks and balances existed, and that was simply not ... necessarily the style in an entrepreneurial environment, which, incidentally, we

felt, Your Honour, we wished to foster because it was one of the things we had purchased that we couldn't supply ourselves in relation, Counsel, to a previous question of yours, is why didn't we build our own house ... that we felt that we could purchase this particular style of operation, which would be germane to the size of community and the routes being served and would allow a much better style of operation than we ourselves could provide.

So I went through a lot of personal adjustment in that regard, and that's no secret, that, as a board member and executive committee member, I frequently had disputes with management on how they arrived at decisions and how they sometimes carried them out, and I was generally somewhat a thorn in management's side as I grappled with understanding how they operated and how that translated into my environment, and also the expectation of my superiors in the role I played on behalf of our corporation and how they would interpret the actions.

So, Counsel, I spent some considerable time within our corporation counselling our senior management members on why decisions were taken and what was behind them. Similarly, I would spend some considerable time with Bill Deluce, in particular, but other members as well on their style and testing as to why things were done.

So I was generally in the position more frequently of ... probing – not being antagonistic, I hope, but I suppose so on several occasions, because we had some fairly hot sessions, of really probing the thing, because it was a different environment to me ... things were done very much faster, usually – often without consultation that I thought might have taken place or should have – in my world, would have taken place.

Q. Consultation with whom, sir? ...

A. Oh, with the board, with other members. I had to understand how a board operated at that particular level.

Our own board of directors had a particular consultative style and management, their executive management relationships, and I was – initially, at any rate, I was very concerned that the boards of these smaller companies behave in a similar fashion, and that the chief executive officer behave as ... responsibly as our chief executive officer behaved to his board.

I guess the difficulty arose in the style. Chief executive, Bill Deluce, was an entrepreneur, family-style operation which I knew nothing about, never encountered before. And he ... had been projected into an environment that he wasn't used to either, and from an entirely different background, what we had expected of him, and I had come from a background that was different than what he was experiencing as well, so the two of us had to dance around and get used firstly to each other, our expectations, and the environment that was growing up at the

> time. And incidentally, these ... companies were generally our first real encounter with small companies that we had not created in our own image and managed with our own personnel.
>
> Heretofore, many of the companies that we had created ... had Air Canada management seconded to them. So the corporate culture was quite complete all the way through, whereas in the case of these smaller companies, it was anything but the same.
>
> And so we both had to get used to each other's demands, and that was part of my role, to bring the smaller company up to some of the standards of reporting and expectations and behaviour from an executive point of view that we expected.
>
> I had to translate back to our corporation the need for the freedom to act and the entrepreneurial flair that was required to keep the companies viable in the atmosphere in which they existed.
>
> So there was a dichotomy back and forth, and that took place over a period of several years.
>
> (Transcript, vol. 121, pp. 81–85)

An example of disagreement between Mr William Deluce and Mr Rowe is seen in discussions surrounding Mr Deluce's selection of his brother Bruce Deluce as vice-president of operations for Air Ontario.

The Appointment of Bruce Deluce as Vice-President of Operations

The proposed appointment by Mr William Deluce of his brother Mr Bruce Deluce as the vice-president of operations was the subject of considerable discussion at the Air Ontario executive committee meeting of May 6, 1988. This is reflected in the following minute from that meeting:

> Material was distributed to the members of the Executive Committee at the meeting with respect to the proposed change in the management structure of the Company.
>
> William Deluce spoke to this issue. Considerable discussion took place with respect to the appointment of Bruce Deluce as Vice President, Operations.
>
> It was agreed that the appointment of Bruce Deluce as Vice President, Operations would be deferred until the next meeting of the Executive Committee.
>
> (Exhibit 934)

The new position of vice-president of operations had authority over the vice-president of airport services and charter sales, the vice-president of flight operations, and the vice-president of maintenance. Under this proposal, Mr Bruce Deluce, who was 29 years old at the time, would have had direct responsibility for three of the largest departments in the company.

Mr Rowe explained his concern with the possibility of nepotism and his objection to the proposed management change:

> A. Well, Your Honour, I was concerned about the degree of experience that the individual had, and I ... wished to be satisfied – because I did not know too much about ... the individual at the time, I wanted a further explanation as to his capabilities.
>
> I also was somewhat perturbed that the appointment had been put forward without consultation with the executive committee prior to it appearing almost a fait accompli, and I was trying to make the point that that sort of procedure was not acceptable and it was not compatible with the way we did things in Air Canada, somewhat tying in, Counsel, to my remarks earlier about the differences in the two organizations.
>
> Secondly ... I was concerned about the possibility of nepotism within the organization, not that it was bad or wrong necessarily but that I did not want it to appear that Air Canada would condone any structure of that nature in ... this company.
>
> I was quite sensitive to the fact that the family had owned and operated Austin Airways in their own manner and as a family, and I was particularly concerned, as were several others in our company, that it not appear as if, quotes, "the family," end of quotes, were running Air Ontario, that promotions should be on merit.
>
> And, again, because of my background and experience in management, I was concerned about the development of a successor to the president, not that he was leaving or anything like that, but that ... there be a clear – fairly clear line of development for all people within Air Ontario and that career possibilities be protected and excellence of management be encouraged and rewarded on its own merit.
>
> (Transcript, vol. 121, pp. 135–36)

After some discussion over a number of weeks, a less ambitious appointment for Mr Bruce Deluce was implemented. The initial proposal of May 1988 would have made Mr Bruce Deluce responsible for flight operations, maintenance, charter sales, and airport services. The organization implemented in June 1988 made Mr Bruce Deluce responsible for flight operations, airport services, and charter sales. The vice-president of maintenance remained in a direct reporting relationship with the group vice-president, Mr Syme. Further, Mr Morrison was named vice-president of flight operations instead of Mr Hill. Mr Morrison had more experience in flight operations than Mr Hill, and this change was seen as assisting Mr Bruce Deluce in his transition to the new position. In addition, Mr Bruce Deluce maintained a reporting relationship with Mr Syme.

During the weeks between the initial proposal and the ultimate appointment of Mr Bruce Deluce, Mr Rowe made several inquiries about his experience and competence. In particular, Mr Rowe spoke with Mr John McMurtry, another Air Canada nominee on the Air Ontario board, who was apparently more familiar with the Deluce family than was Mr Rowe. Mr Syme testified that Mr McMurtry had expressed his opinion that the appointment of Mr Bruce Deluce, as originally contemplated, represented too much of a change at that time. Further, Mr Syme testified that the executive committee thought a staged transitioning of Mr Bruce Deluce into the senior operating position within the company would be desirable.

Mr Rowe testified further that, on the advice of the Air Canada personnel department, he considered requiring Mr Bruce Deluce to undergo independent "executive testing" prior to approving his appointment as vice-president of operations. However, after at least two discussions with Mr William Deluce, Mr Rowe "came to believe that the candidate was satisfactory ... [and that] there were enough safeguards given to proceed" (Transcript, vol. 121, p. 141). Mr Rowe testified that he expressed concern at the board level that executive talent was scarce within Air Ontario, with the exception of the Deluce family, and, in the future, they should look outside the company for appointments at a senior executive level. His inquiries, combined with the proposal to bring Mr Bruce Deluce into the senior operational position in the company by stages, satisfied Mr Rowe that the appointment of Mr Bruce Deluce was acceptable.

Following his June 1988 appointment, Mr Bruce Deluce was given increasing responsibility. In December 1988 the maintenance department was brought within his area of responsibility, as was management information systems. In July 1989 system operations control and in-flight service began reporting directly to Mr Bruce Deluce.[8] Finally, in September 1989, Mr Thomas Syme was appointed executive vice-president commercial services and Mr Bruce Deluce, as vice-president operations, reported directly to Mr William Deluce, the president and CEO. With this final change, Mr Bruce Deluce became the senior executive manager responsible for the entire operational side of Air

[8] Previously, system operations control and in-flight service reported to the vice-president of flight operations. In July 1988, with the departure of Mr James Morrison, Mr Bruce Deluce took on direct responsibility for the flight operations department, in addition to his responsibility over maintenance.

Ontario. Mr Syme's area of responsibility was restricted to commercial matters.

In summarizing this description of the air carrier, the following points should be emphasized:

- The operational management of Air Ontario Inc. was dominated by individuals who received their aviation experience in the northern environment of Austin Airways.

- Air Ontario Inc., as a scheduled passenger carrier providing a regional feed to Air Canada in a deregulated environment, was a very different operation from that of Austin Airways. Air Ontario management was confronted by demands that were materially different from anything they had previously encountered.

- Significant demands were placed on Air Ontario management by:

  - the merger of the two employee groups – the non-unionized Austin Airways with the unionized Air Ontario Limited – including the merger of the pilot seniority lists;
  - the negotiation of the first collective agreement of the newly merged pilot group;
  - the continuation of commercial service on a limited basis, by management pilots, during an eight-week pilot strike;
  - the management of the orderly commencement of services after the strike;
  - the administration of collective labour agreements that delineated employee working conditions and the relationship between management and labour;
  - the rationalization of operations which involved an abandonment of northern routes, a sale of northern assets, and a reduction in size of the company's workforce by one third; and
  - the cultivation of a new trunk-feed relationship with the parent company, Air Canada, which involved among other things the operational demands of providing a reliable coordinated connecting service with the national carrier at its Toronto and Winnipeg hubs.

- Frequent changes to the operational management at Air Ontario, in addition to a high turnover of key management personnel, characterized the company during the period from June 1987 until March 10, 1989.

It was in this environment of high stress on a frequently changing operational management group that Air Ontario commenced its first transport jet operations.

Chapters 15–22 of this Report provide a detailed analysis of the F-28 program. It will be shown that operational deficiencies which were significant to the crash of flight 1363 were attributable, at least in part, to deficient and inattentive management.

15 THE F-28 PROGRAM: PLANNING

Introduction

As stated in the opening pages of the Report, the ultimate goal of this Inquiry is the prevention of future aviation accidents. From the outset I have accepted the premise that accident prevention is best served through a properly functioning commercial aviation system. Generally, when accidents do occur, it is because the aviation system has broken down; accordingly it is the purpose of accident investigation to identify the causes of the system malfunction so that appropriate corrective action can be taken.

In this system analysis I must describe the immediate operational environment in which the crew of flight 1363 operated. That operational environment included the following factors:

- the improper deferral of the maintenance of the aircraft auxiliary power unit;
- the dispatch of the aircraft with an unserviceable APU out of a maintenance base;
- the dispatch of the same aircraft into Dryden, where there were no ground-start facilities for the F-28;
- general serviceability problems with the aircraft;
- the limited F-28 training of ground-handling staff at Dryden; and
- the erroneous flight release for flight 1363.

These and other factors are indicative of systemic problems with the Air Ontario F-28 program. In this section there is an examination of that program.

In October and November 1987, after a period of assessment and planning commencing in approximately June 1987, Air Ontario entered negotiations to lease two F-28 aircraft from the French air carrier, Transport Aérien Transrégional (TAT). Air Ontario was to receive these two aircraft in the spring of 1988, but a number of events intervened to result in its taking delivery of the first F-28 aircraft, C-FONF, in late May 1988 and the second, C-FONG, in November 1988. It was the intention of Air Ontario management to build its F-28 fleet eventually to as many as eight aircraft.

When Air Ontario embarked on its F-28 program, it was the first time that its management had operated a transport category jet aircraft in commercial scheduled service. As the F-28 aircraft was new to its personnel, Air Ontario management, with the express approval of parent company Air Canada, sought to access the expertise of individuals and organizations having experience with the aircraft. In this regard it contracted for ground school and flight simulator training for its pilots with Piedmont Airlines of Winston-Salem, North Carolina, which had one of the world's largest fleets of F-28 aircraft in commercial service. Air Ontario pilots were given their ground school training by Piedmont in Winston-Salem, and their simulator training in Tampa, Florida. In December 1988, because of the Piedmont takeover by USAir of Arlington, Virginia, and the increased training demands experienced within those two merging airline operations, Air Ontario lost access to the F-28 simulator in Tampa. Accordingly, Air Ontario flight operations management implemented alternative arrangements for training its F-28 pilots. Apart from its involvement with Piedmont/USAir, Air Ontario did little to employ any individuals with either F-28 experience or transport category jet experience in its new F-28 operation.

Air Ontario introduced its commercial F-28 aircraft service in June 1988.

The analysis that follows begins with a description of the business rationale behind Air Ontario's first foray into scheduled jet transport operations. I describe the marketing imperatives that apparently motivated the acquisition of the F-28s, the early operational planning, and, ultimately, the implementation of the program. The information contained in this initial description is gleaned largely from the testimony of Air Ontario and Air Canada executives who were involved in the decision making, as well as relevant Air Ontario corporate minutes and planning documents that were tendered into evidence.

I then contrast Air Ontario's plan to introduce the F-28 aircraft with what actually occurred during the implementation of F-28 service. What emerged from the evidence was that a reasonably sound plan went awry in its implementation. The derailing of the plan occurred under the management of an overburdened individual who had no experience in the certification and introduction of a scheduled jet transport operation. The difficulties encountered by the F-28 project manager were exacerbated by the fact that his immediate operational supervisors were occupied by labour relations matters and other concerns related to the integration and rationalization of a newly merged company. These management problems manifested themselves in undesirable operational practices within the F-28 operation and in specific flight safety shortcomings, each of which is considered below.

Air Ontario, as a commercial air carrier, was not operating in a vacuum. Transport Canada, as the regulator, had a duty to prevent the serious operational deficiencies in the F-28 program. Before commencing its jet service, Air Ontario had to obtain the approval of Transport Canada in the form of an amendment to Air Ontario's operating certificate to include the F-28. The evidence convinced me that the granting of the amendment to the operating certificate in June 1988 was the pivotal point in the commercial air transportation system relative to this accident. This regulatory requirement represented the best opportunity, in my view, for Transport Canada to impose its regulatory will upon Air Ontario's proposed introduction of the new aircraft type. It was at this point that Transport Canada should have satisfied itself that Air Ontario was fit to offer jet service, with the requisite degree of safety, to the travelling public. Had the regulator been more diligent in scrutinizing the proposed F-28 implementation at Air Ontario, many of the operational deficiencies that had a bearing on the crash of flight 1363 could have been avoided. The Air Ontario operating certificate amendment to include the F-28 is, accordingly, a focal point for much of the analysis of the F-28 program.

Apart from the scrutiny that should precede an amendment of an operating certificate, the ongoing monitoring role of Transport Canada should also be emphasized. After a proposed operation has been approved, Transport Canada is responsible for ensuring that what was represented in the air carrier application for amendment is in fact implemented and that any startup problems are dealt with promptly and professionally.

As Air Ontario endeavoured to make the F-28 program operational, Air Canada (Air Ontario's majority owner) remained largely uninvolved. Air Canada's role was kept to a minimum for reasons discussed in chapter 26, Role of Air Canada. What little operational consultation there was amounted to a cursory look at the F-28 Project Plan by Air Canada's senior technical personnel. There was neither a monitoring of the progress of the Air Ontario F-28 program nor a review of the support structure for that operation by Air Canada.

It is in the context of this air carrier and regulatory activity that the operational deficiencies are analysed. Although for the purposes of analysis I have structured the story of the F-28 program in light of the defined roles within the operational and regulatory environments, I must stress that safety awareness should not be so limited. The evidence convinced me that concern about safety must transcend that which is defined as a minimum "legal requirement."

Planning the F-28 Program

Fleet Rationalization

In the period following the merger, Air Ontario management undertook an immediate assessment of its fleet composition. At the time of the merger, Air Ontario had 51 aircraft of nine different types, representing the combined Austin–Air Ontario Limited fleet. Air Ontario Limited had flown one type, the Convair 580. Austin Airways operated a fleet of different aircraft types.[1]

It was acknowledged by Air Ontario and Air Canada witnesses that Air Ontario had to reduce the number of aircraft types in its fleet. Mr Syme described how a multi-type fleet is operationally more expensive and complicated for an air carrier because each type requires specific training for pilots and maintenance personnel. Each type also requires its own equipment and spares inventory and, although some common equipment might be used, differentiated equipment is also necessary. He explained that "a larger management and administrative support base" is required. He went on to elaborate:

> A. ... in general, in a multi-type fleet environment ... the tendency would be for the company to be less flexible. Change is more difficult to implement because of the training requirements, and in a unionized environment, when there's a structured process of flowing pilots, for instance, from aircraft type to aircraft type. If you upgrade one captain on the senior piece of equipment, there's a waterfall effect, that you are upgrading all – in order of seniority, you are upgrading – you could be upgrading eight captains through eight different types. And enhanced product quality, again, is focusing on the increased flexibility that we contemplated achieving through the rationalization of the fleet.
>
> Q. So from an operational point of view, then, is it fair to say that the more types you have, the more burdensome it is for the flight operations organization?
>
> A. I think that's a fair statement.
>
> (Transcript, vol. 98, pp. 22–23)

---

[1] The nine aircraft types in the Air Ontario fleet were: Dash-8 series 100, Convair 580, HS-748, DC-3, DHC-6 (Twin Otter), Beech 200, Beech 99, Cessna Citation, and Cessna 402. It should be noted that the Dash-8 series 100 was introduced to the combined Austin-Air Ontario Limited fleet following the change in ownership of the two companies in January 1987.

Selecting the F-28

The first documentary reference to the F-28 aircraft at Air Ontario is found in the June 1987 Air Ontario Inc. business plan, where it was stated:

> Air Ontario faces no less competition in the charter sector of its operations, both from aggressive, low-cost carriers in Northern Ontario, and from other regional airlines who traditionally operated with turboprop equipment but are now introducing jet aircraft. Air Ontario will not only need to introduce a cost-efficient small aircraft but will also need to consider larger aircraft in order to be competitive. The answer in the latter case may be the 56-seat Dash 8 series 300, or it may lie in acquiring a small (60–70 seats) jet aircraft of the F-28 variety.
>
> (Exhibit 938, p. 2)

The rationalization of the Air Ontario fleet and the possible acquisition of the F-28 were again discussed in the context of the Air Ontario five-year business plan at the board of directors' meeting of August 12, 1987.

In a document entitled "Fleet Rationalization Discussion Paper," written in July–August 1987, the importance of reducing the number of aircraft types was discussed:

> The existing aircraft fleet at Air Ontario comprises eight[2] different aircraft types. A recent survey of the top fifty regional carriers in the United States indicates no carriers with more than 5 aircraft types and the vast majority with less. The diversity of revenue services which Air Ontario enjoys is a factor in the fleet mix; however, the optimization of the service/resource mix is undoubtedly the most significant opportunity for enhancement of Air Ontario's long term profitability.
>
> (Exhibit 796, p. 1)

In this fleet rationalization discussion paper, there was a preference expressed to reduce the fleet to four aircraft types: a 7- to 19-passenger aircraft, a 27- to 44-passenger aircraft, a 55+ seat aircraft, and a cargo aircraft capable of carrying 6000 to 12,000 pounds.

In the 55+ seat category, management's intention was to replace the ageing Convair 580 aircraft, whose residual resale values were deteriorating. Included among aircraft types considered in the replacement program were the de Havilland Dash-8 series 300, the Aerospatiale

---

[2] There is a discrepancy between the number of aircraft types cited in Exhibit 938 and Exhibit 796: the former listing nine and the latter eight.

ATR72, the British Aerospace ATP and BAe 146, and the Fokker F-28 Mk1000. Of these aircraft the Dash-8 series 300, the ATR72, and the ATP were turboprop aircraft; the BAe 146 and the F-28 were jet aircraft.

Air Ontario was already committed to the delivery of new Dash-8 series 300 aircraft; however, because of delivery delays and a reassessment of manufacturer promises with regard to aircraft capacity, Air Ontario was looking for faster and larger aircraft.

Partially because the ATR72 and the British Aerospace ATP were not readily available, either of the two jet aircraft – the BAe 146 or the F-28 – was favoured. In reviewing the document entitled "F-28 Acquisition Proposal," which was presented to the Air Ontario board of directors for consideration, I note that particular emphasis was directed to the competitive attractiveness of a jet aircraft:

> Air Ontario has begun operation on a number of routes (namely Toronto–Sault Ste Marie, Thunder Bay–Winnipeg, Toronto–Cleveland, London–Ottawa) where competitors are offering larger, faster jet equipment in the 100–200 seat range. Thus far, Air Ontario has managed to capture a modest share of the market through scheduling and using the "AC" flight designator to its best advantage. The time has arrived for introduction of a larger, faster aircraft into the fleet.
>
> (Exhibit 800, p. 4)

It is interesting that these Air Ontario internal documents, intended for the board of directors, underlined the words *"larger"* and *"faster"* for emphasis. Without a doubt there was a great deal of enthusiasm as Air Ontario embarked upon its first transport category scheduled jet airline service.

Along with the practical size and speed advantages of jet aircraft was a certain prestige. Mr Rowe, the Air Canada representative on the Air Ontario board of directors, testified that many communities exerted political pressure on the airlines to provide jet service. On the subject of "jetitis," as it was sometimes described, Mr Rowe gave the following evidence:

> A. [C]ommunities were vying for economic development, and airline service was deemed to be a prime ingredient for economic development. Furthermore, with the advent of the ... jet aircraft, that was deemed to be ... one of the prime elements of economic development for any city. So various cities and towns would exert considerable pressure to find carriers available for providing jet service for economic development, and, hence, there was quite an intensive interplay between a city, the province, and the federal government on a member-of-parliament level and the regulatory body on the federal side itself.

> There was considerable influence as to finding carriers and getting them to serve the area itself.[3]
>
> (Transcript, vol. 121, p. 16)

The prestige of jet service described by Mr Rowe was borne out by comments of the chief administrative officer of the Town of Dryden, Mr John Callan:

> A. When Air Ontario announced that they were looking at reinstating jet service to the Dryden Airport, that really thrilled us to no end, because it was seen as a feather in our hat to have jet service ...
>
> (Transcript, vol. 4, p. 69)

Given delivery problems with the Dash-8 series 300 and the desire to sell off their ageing Convair 580 aircraft, there appears to have been a sense of urgency in getting the jet acquisition program under way.

With regard to the delay in Dash-8 300 delivery and a concern regarding Dash-8 300 passenger capacity, the following comments in the F-28 Fleet Acquisition Proposal (November 1987) are significant:

> A response from Air Ontario in light of the above two events has yet to be formulated. But what has emerged is *a pressing need* for a faster, larger-capacity aircraft in the Air Ontario system in advance of the spring of 1989.
>
> (Exhibit 800, p. 9, emphasis added)

Further evidence of Air Ontario's pressing need to commence the jet acquisition is seen in the following passage from the F-28 acquisition proposal:

> Air Ontario must examine larger aircraft in the 50+ seat range and select one for use in its system in the *earliest possible timeframe.* Unfortunately, other than the ATR-72 and the British Aerospace ATP, there are no larger turboprop aircraft which will meet the mission requirement. Both of these aircraft are rejected at this point, largely on the basis of acquisition time. The only other practical alternative lies with smaller, used jet aircraft in the 65–90 seat range, namely the F-28 and the BAe 146.
>
> (Exhibit 800, p. 10, emphasis added)

[3] Mr Rowe went on to explain that in recent years the preoccupation with jet service has waned. This has resulted from the advent of a reasonable alternative in modern, large, pressurized turboprop aircraft.

Having narrowed the list of possible replacements for the Convair 580 to two aircraft types, a comprehensive comparative aircraft evaluation was performed. On an economic basis, the F-28 was judged to be a more viable aircraft for Air Ontario than the BAe 146.[4]

Marketing Considerations

After the economic rationale for choosing the F-28 was established, a marketing study was performed to determine how best to utilize the F-28 within the Air Ontario route structure. Again the competitive attractiveness of a jet aircraft was emphasized from the marketing perspective. Noted among the advantages to deploying the F-28 on the Winnipeg–Thunder Bay–Sault Ste Marie–Toronto route was the following:

> Maximum competitive impact vs. Canadian Airlines, with respect to CP overlap with Air Ontario routes, and through direct jet-to-jet competition.
>
> (Exhibit 800, p. 40)

Mr Syme testified regarding the meaning of this particular passage:

> A. In the markets that were mentioned, we were competing, in the Canadian market-place, with Canadian, who were operating 737s on those markets, and with USAir who was operating – the Cleveland route that he referred to, USAir operates DC-9s on the market. And as we expanded into these types of markets, it was the first time that we had really competed head to head with jet operators, and ... this section was put together by our vice-president of marketing and ... that was a major concern, from a competitive factor, to him.
>
> (Transcript, vol. 98, p. 135)

The marketing implications of having Air Ontario take over some routes previously serviced by Air Canada DC-9 aircraft were also considered:

> In addition, acquisition of F-28 aircraft by Air Ontario presents certain longer-term benefits to Air Canada in its route rationalization efforts. Air Canada's reduction in frequency or even eventual withdrawal from certain markets in Ontario would be far more

---

4 Exhibit 800, Air Ontario Inc. Acquisition Proposal (November 1987), states: "The comparative aircraft evaluation clearly indicates a substantial profit/cash flow benefit for the F28-1000 alternative, relative to the BAe 146 and the Dash 8-300."

> palatable in both a commercial and political sense if Air Ontario could offer a mixed jet/turboprop replacement service.
>
> (Exhibit 800)

Again, Mr Syme elaborated upon the effect of local politics on the proposal:

> A. I guess the underlying issue there is that at that time, there existed a very – a fairly strong bias in the market-place for jet equipment over turbo prop equipment. And ... the statement just reflects that.
>
> Q. In particular, what is meant by "political sense"? What are the political considerations?
>
> A. The airline industry seems to be one that attracts a lot of political attention. And as Air Canada pulled out of markets in northern Ontario, that was of great interest to the local politicians. And one of the issues that they raised was the loss of jet service, and what is being suggested here, that if we are able to offer alternate jet service, that that will thereby reduce the political sensitivity.
>
> (Transcript, vol. 98, p. 136)

Air Ontario's attention to the marketability of a jet service to replace the former Air Canada DC-9 service is consistent with the marketing emphasis in the Air Ontario–Air Canada commercial agreement.[5] While the agreement is discussed in chapter 26, Role of Air Canada, for present purposes I note that one of the stated objectives of the agreement is to deliver a "homogeneous product" to Air Ontario and Air Canada passengers (Exhibit 783). The agreement establishes Air Canada–Air Ontario commonality in many of the marketing aspects of air carriage. This indicates to me that both companies understood a consumer preference for an "Air Canada-like" service. The cited evidence of Mr Syme regarding the marketability of jet service can be viewed as another example of delivering a product that looked like an Air Canada product. Notwithstanding, it was the evidence of Mr William Deluce that the F-28 program was "entirely an Air Ontario initiative ... conceived and orchestrated by Air Ontario" that he took to the Air Ontario Board for approval (Transcript, vol. 152, p. 129).

---

[5] Mr Syme testified that this commercial agreement survived the merger of Austin Airways and Air Ontario Limited and defined the relationship that existed between Air Canada and Air Ontario Inc.

Approval of the Plan

It would appear that the board of directors' acceptance of the F-28 program came in its review of the Air Ontario five-year business plan, which contemplated the F-28's introduction. Although this plan and the Fleet Rationalization Discussion Paper were discussed at the August 12, 1987, Air Ontario board meeting, there was no documentary evidence indicating formal board approval of the program at that date.

Mr William Deluce testified that, in August 1987, he attended an auction at the Turkish national airline Turk Hava Yollari (THY) with the intention of purchasing two F-28 aircraft. He stated that it was fortuitous that he lost in his bidding on the aircraft to the French airline Transport Aérien Transrégional (TAT), because the final sale price was too high to make the aircraft economically attractive for Air Ontario. Having been unsuccessful in purchasing the aircraft, Mr Deluce, while he was at the auction in Turkey, made initial contact with TAT regarding the possibility of Air Ontario leasing the two F-28 aircraft. Further discussions with TAT took place in September 1987 and formal lease negotiations occurred in October–November 1987.

Mr Deluce testified on his involvement with the aircraft identification and acquisition:

> Q. And I believe that you then took steps to contact TAT in order to lease these two same aircraft, is that right?
> A. Yes.
> Q. And when did you do that, sir?
> A. That would have been done in September of '87 ... I actually made the initial contact while I was at Turkey at the auction. Followed it up in September and October and then actually went over ... for some formal meetings with the TAT representatives. I think it was October–November of '87.
>
> (Transcript, vol. 152, p. 141)

Mr Deluce also testified about the involvement of the executive committee and the board:

> A. Well, they were not involved in the detail. They were very much aware that we had a detailed implementation plan, but ... they were not in a position and they were not following the detailed orchestration of the plan.
>
> As significant events took place, i.e., the securing of aircraft either through lease or acquisition, they would be informed of those types of events. But we had a plan along which we were proceeding, along which management was proceeding, and if there was any significant change to that plan, we would highlight it for them and their main interest was that, you know,

> where was the plan that we had set out, did it still ... basically represent the line along which we were tracking.
>
> So, they weren't into the detail but they were following it on an overall basis.
>
> (Transcript, vol. 152, pp. 141–42)

At the October 8, 1987, meeting of the Air Ontario executive committee, a proposal to lease two F-28 aircraft from Transport Aérien Transrégional was reviewed. In the minutes to that meeting it was noted:

> After much discussion, upon motion duly made seconded and unanimously carried, The Executive Committee approved the leasing of two F-28 aircraft from TAT subject to obtaining approval from the Board.
>
> (Exhibit 935, p. 2)

The members of the executive committee who unanimously approved the F-28 lease were John McMurtry and William Rowe on behalf of Air Canada and Stanley Deluce and William Deluce on behalf of the Deluce family.

It appears that Mr William Deluce was very active in an attempted purchase and then lease of the aircraft in August 1987, prior to any board of directors or executive committee approval of an aircraft acquisition. Mr Deluce testified regarding board approval for the aircraft acquisition which was referred to in the October 8, 1987, minute of the executive committee:

Q. And lastly, sir, it does say that,
"... the leasing arrangement is subject to obtaining approval of the Board."
So the board approval seemed to be a condition precedent to arriving at a final decision, is that right?
A. That's correct.
Q. So this was not something which you, Bill Deluce, would do on your own and then have rubber stamped, is that right?
A. No, it required board ratification.
Q. Now when we say "board ratification," would you view that ratification as a rubber stamp or something which you still had to leap through?
A. It was ... something that I still had to go through, however, I guess historically, I can say ... that the executive committee was very thorough in ... the programs that we brought forward and there was no precedent for the executive committee recommending or approving something and the board not approving it.
Q. So de facto it would have been a fait accompli upon a recommendation emanating from the executive committee?

A. I could never count 100 percent on that, but historically that was the way it was.

(Transcript, vol. 152, pp. 144–45)

A minute of the January 18, 1988, meeting of the Air Ontario executive committee noted that:

> Material was also distributed with respect to the proposed acquisition of F-28 aircraft by the Company and a discussion took place with respect to this issue.
>
> (Exhibit 939, p. 3)

The material referred to was the Air Ontario F-28 acquisition proposal (Exhibit 800). Although it was termed a "proposal" it would appear from the evidence of all witnesses involved that the project was well under way prior to the discussions of January 1988.

At the meeting of the Air Ontario board on March 29, 1988, the Air Ontario 1988 business plan[6] was tabled, discussed, and approved, subject to some amendment. In that business plan, the F-28 is one of the aircraft types referred to as part of the Air Ontario fleet. Although there was no documentary evidence clearly specifying the approval by the Air Ontario board of the F-28 program, at least by March 1988 there is clear acceptance by the board of the program.

The F-28 Project Plan

Once the acquisition of the F-28 aircraft was approved, steps were taken to develop a detailed implementation plan. The development of this plan was coordinated by Mr Thomas Syme, the group vice-president of operations and marketing.

The first implementation plan, The Air Ontario Inc. F-28 Project Plan (Exhibit 799), was finalized some time in September or October 1987 and was included in the F-28 acquisition proposal (Exhibit 800). The Project Plan consisted of identification of four broad categories of tasks that would have to be completed prior to the commencement of commercial service of the aircraft. These categories were:

- *administration*, which included tasks such as the preliminary inspection of the aircraft, the acceptance of the aircraft, and the negotiation of the aircraft lease with TAT;
- *maintenance*, which included all aspects of maintenance planning, such as the recruitment of F-28 maintenance specialists, the development of

---

[6] Exhibit 936, Air Ontario Inc. 1988 Business Plan (Revised), March 1988

a workable minimum equipment list, and the provisioning of spare parts for the aircraft;
- *flight operations,* which included all aspects of flight operations planning, such as the recruitment of experienced F-28 specialists and pilots, the preparation of an F-28 pilot training program, and the preparation and amendment of operating manuals; and
- *marketing,* which included tasks such as the preparation of schedules for the F-28, and the planning of the F-28 promotional launch.

Included with the description of the tasks was a schedule of completion dates. Mr Syme characterized the date of Transport Canada's approval of the inclusion of the F-28 on Air Ontario's operating certificate as the target date against which they scheduled the timing of all aspects of the plan.

A comprehensive revision to the Project Plan, dated December 28, 1987, was prepared by Captain Joseph Deluce (Exhibit 802). Although Captain Deluce had been working on various aspects of the F-28 plan since October 1987, he was formally appointed the F-28 project manager in January 1988. The Revised Project Plan reflected slippage in some of the previously projected dates for completion of the various implementation tasks. However, the projected commencement date of commercial service for the F-28 remained the same. Both the F-28 Project Plan and the Revised Project Plan anticipated a startup of late April to early May 1988.

The Air Ontario pilot strike from March until the beginning of May 1988 ultimately delayed the introduction of the F-28 into commercial service. While the original implementation date was to be May 1, 1988, commercial service for the F-28 actually began on June 1, 1988. Mr Syme commented on the delay in the introduction of the jet program:

> A. ... the ultimate test of the program being on track is the successful certification of the aircraft. The target date for implementation of the aircraft with the initial October plan was May 1. In the ... late December revised plan, the target date was May 1. After taking an almost three-month strike [sic], we put the aircraft into service early in June. From my perspective, that's a reasonable indication that the program, prior to the strike, was on track. We implemented the aircraft almost 30 days from the original target date, experiencing a three-month strike [sic] in between, which impacted on ... obviously, many areas of the operation.
>
> (Transcript, vol. 98, pp. 161–62)

Mr Syme was specifically asked to comment on the suggestion that the F-28 was introduced into commercial service at Air Ontario with several operational deficiencies in the F-28 program. He replied:

> A. Well, from my perspective, the aircraft was implemented under the approval of the appropriate regulatory agencies, which is an external test ...
>
> (Transcript, vol. 98, p. 162)

Having reviewed the Project Plan and the Revised Project Plan, I am of the view that Air Ontario had properly identified the significant tasks that had to be performed prior to commercial operation of the F-28. Further, Mr Syme's evidence suggests that Air Ontario intended these tasks to be performed before the F-28 was added to the Air Ontario operating certificate. The Commission investigation revealed, however, several material tasks identified in the Project Plans that either were not completed at all or were completed much later than scheduled and following the introduction of the F-28 into commercial service.

In the discussion of the implementation of the F-28 program, there is an analysis of various deficiencies in the program. Such deficiencies could have been prevented if the F-28 implementation had proceeded according to the Project Plan.

F-28 Project Team

An operational "F-28 Project Team" was assembled to acquire the aircraft and bring it into service. The members of the project team were Air Ontario director of flight operations Robert Nyman, Air Ontario vice-president of maintenance and engineering Kenneth Bittle, and pilots Joseph Deluce and Robert Murray. Each member of the project team was given responsibility for different aspects of the implementation plan.

On the recommendation of Mr William Deluce, Captain Joseph Deluce was appointed the project manager. As the project manager, Captain Joseph Deluce was the "prime coordinator of the plan,"[7] and it was his role to monitor the progress of the plan and ensure that its various elements were completed according to a timetable.

Mr Bittle was primarily responsible for the maintenance aspects of the Project Plan, which included, among other things, F-28 training of maintenance personnel, provisioning of spare parts and support equipment for the F-28, and developing a maintenance program for the F-28, including the development of a minimum equipment list for the aircraft.

[7] Thomas Syme, Transcript, vol. 98, p. 53

Captain Murray worked with Captain Joseph Deluce and Mr Bittle in formulating the various elements of the revised Project Plan. Captain Murray was also responsible for ensuring that some aspects of the plan were completed. Captain Joseph Deluce and Captain Murray were the first Air Ontario pilots trained on the F-28 and, at the commencement of commercial service in June 1988, Captain Murray was the only Air Ontario F-28 pilot with company check pilot (CCP) authority. It should be noted that Captain Murray left Air Ontario in July 1988, approximately one month after commercial F-28 service commenced, to pursue an opportunity at another airline.

Although Captain Joseph Deluce was the F-28 project manager, it was the view of Mr Syme, confirmed by Captain Nyman, that the responsibility for all flight operations aspects of the Project Plan rested with Captain Nyman as director of flight operations. Given Captain Nyman's other activities during the implementation period, as shown below, it seems unlikely that he could have been supervising the project manager in any meaningful way.

It was the evidence of Captain Nyman that, in the months of October 1987 to March 1988, he and the vice-president of flight operations, Mr Peter Hill, devoted up to 50 per cent of their time to labour relations in an attempt to avert a pilot strike. When the strike commenced, it was the evidence of Captain Nyman that he returned as a management pilot to "essential flying" out of Pickle Lake in the North. The strike lasted from March 11, 1988, until May 1, 1988. The airline recommenced its normal scheduled operations on May 7, 1988. Throughout the month of June 1988 Captain Nyman was at the Piedmont F-28 course in Tampa, Florida. At the same time, as he would in the normal course, Captain Nyman was responsible for overseeing the entire flight operations of the airline, which included, as described earlier, the operation of many different aircraft, from small twin-engine aircraft to the HS-748 and the Convair 580, over a mix of scheduled and charter service spanning a very substantial route network.

Therefore, from October 1987 until July 1988, Captain Nyman was devoting the majority of his time to labour relations, essential flying, and F-28 training, in addition to his very substantial duties as the director of flight operations. It was precisely during this period when Captain Nyman was to have supervised all flight operations aspects of the F-28 plan. It is apparent from this evidence that the senior managers at Air Ontario retrospectively ascribed to Captain Nyman a supervisory function over Captain Joseph Deluce and the F-28 implementation which, owing to competing demands for his time, he did not effectively fulfil. I am of the view that the director of flight operations should have been overseeing closely the progress of the F-28 Project Plan.

The Role of Transport Canada: Amending Air Ontario's Operating Certificate

Section 700 of the Air Regulations states that:

> No person shall operate a commercial air service in Canada unless he holds a valid and subsisting certificate issued by the Minister certifying that the holder thereof is adequately equipped and able to conduct a safe operation as an air carrier.

The operating certificate is the document that certifies that an air carrier has been permitted to operate in Canada. Included in the operating certificate are a description of the air carrier's operation and a listing of the types of aircraft operated.

It is the responsibility of Transport Canada to scrutinize applications for operating certificates and to ensure that air carriers comply with their operating certificate and operations specifications. The Transport Canada Air Carrier Certification Manual describes the importance of the operating certificate:

> The public's protection ... is safeguarded by the *Aeronautics Act*, the *Air Regulations*, the *Air Navigation Orders*, operating certificates and Operations Specifications forming part thereof. These statutory requirements are the main instruments for ensuring that aircraft operations are conducted safely.
>
> (Exhibit 1026, p. 3)

To amend the operating certificate, the air carrier must obtain authorization from the minister. When Air Ontario sought to introduce the leased F-28 aircraft to its operation, it was required to apply to Transport Canada for an amendment to its operating certificate. In this regard, Air Ontario forwarded to Transport Canada a package of documents dated January 24, 1988. They included a number of required Transport Canada standard forms that detailed the specifications of the aircraft, the airports into which Air Ontario planned to operate the aircraft, the operations personnel involved with the program, and the maintenance facilities at Air Ontario.

In addition to its filing of these required standard forms, Air Ontario included a package of documents nominating Captain Claude Castonguay as a "B Authority" company check pilot. (See the discussion regarding the role of Captain Castonguay in chapter 20, F-28 Program: Flight Operations Training). Finally, in appendices A and B to the application, Air Ontario described the proposed F-28 deployment at Air Ontario.

This application was reviewed by Transport Canada, Ontario Region. Mr Martin Brayman, regional superintendent of large air carrier inspection, testified that it was his group at Ontario Region which initially reviewed the Air Ontario application. An approval checklist was tendered into evidence indicating that, between February 2, 1988, and May 30, 1988, Mr Brayman and others in Transport Canada were reviewing various aspects of the Air Ontario application (Exhibit 1024). Mr Brayman testified that the Certification Branch within Ontario Region identified on the checklist the tasks that must be completed by Air Carrier Branch in its review of Air Ontario's application. It was Mr Brayman's responsibility to ensure that the tasks were completed. The checklist was signed as completed on May 30, 1988, by Mr Wilf Bradbury of Ontario Region.

The various components of the Air Ontario application were signed and recommended for approval by Mr A. Bryson of Ontario Region Airworthiness Branch and Mr R.J. McKnight of the Certification Branch. On June 2, 1988, Mr McKnight and Mr Donald Sinclair, Ontario Region manager of the air carrier operations branch, recommended to Transport Canada headquarters that the requested amendment to the Air Ontario operating certificate be granted.[8] It was noted by Mr McKnight and Mr Sinclair that Air Ontario was given a temporary operating certificate valid from May 31, 1988, to July 31, 1988, pending the formal approval of the amendment by Transport Canada headquarters (Exhibit 968).

On June 10, 1988, the Air Ontario operating certificate was amended to include F-28 operations.

Amending the Operating Certificate: Related Issues

The application submitted by Air Ontario and approved by Transport Canada promised that certain steps would be taken by the company in support of the F-28 operation. These statements of intention may well have reflected Air Ontario planning as of January 28, 1988, the date of application. However, as of June 2, 1988, the date of approval, certain of the promises had not been fulfilled and, with respect to at least one undertaking, I am of the view that the omission was material to the crash of flight 1363.

The application states that:

> Operations Officers will receive training by Air Ontario supervisory pilots who are qualified on the F-28 to familiarize them with the

[8] The recommendation was made by Ontario Region to the Office of the Superintendent Air Carrier Certification, Standards and Legislation, at Transport Canada headquarters.

> aircraft and its systems with a special emphasis on flight planning, performance and MEL procedures.
>
> (Exhibit 855, p. 32)

It must be noted that, although it may have been their intention to train the operations officers fully as per the information contained in this application, in fact only duty operations managers (i.e., dispatch supervisors) received any F-28 training. The dispatchers, including the dispatcher responsible for flight 1363, received no F-28 training and acknowledged a lack of familiarity with F-28 systems.

The issue of dispatch and flight following is examined in detail in chapter 23, Operational Control, but for present purposes I note that in the three areas emphasized in the application to Transport Canada – flight planning, performance, and MEL procedures – there were serious deficiencies. Had these deficiencies been prevented it is unlikely the aircraft C-FONF would have been dispatched to Dryden on March 10, 1989. It appears from the application that Air Ontario properly identified the dispatch and operational control issues that required attention. The error was in failing to implement training in the manner promised.

Air Ontario's failure to fulfil an undertaking material to the application for an operating certificate amendment raises a number of issues:

- Was it the responsibility of the air carrier to advise Transport Canada of any change, or was it the regulator's responsibility to ensure the validity of the information contained in the application?

In my view, the regulator clearly should have scrutinized all aspects of the application to ensure that material changes would be detected prior to the approval of the application. Having stated this, I would also note that common sense would dictate that the air carrier should have informed the regulator of any such changes.

- Given that the regulator did have a group assigned to review the application, why did the group not identify a material deficiency regarding dispatch training?

It is observed by me in a subsequent chapter of this Report that operational control and dispatch are areas that were generally neglected by the regulator. The failure by the regulator to confirm that these undertakings had been discharged prior to the issuance of the amended operating certificate is simply another example of such neglect. If the regulator had regarded operational control and dispatch as important, then, at this early stage, many serious problems could have been avoided.

- Was the validity of the approved operating certificate amendment compromised by the incorrect information in the application?

In my view, even though the representations made by Captain Nyman were correct at the date of application, it must have been apparent to Air Ontario management prior to their receipt of the amended operating certificate that the information submitted in support of the requested amendment was erroneous. Further, there was nothing in the application that stated, though it may be implied, that the promised action would occur prior to the commencement of commercial services. Having stated this, I am of the view that the regulator should not have granted the requested amendment unless it assured itself that all aspects of the application were in place.

Throughout my assessment of Air Ontario's F-28 program, the role of Transport Canada and the certification process is examined. It becomes apparent that there is considerable room for improvement in Transport Canada's scrutiny and licensing of prospective air carrier operations.

Air Canada and the F-28 Program Planning

By correspondence dated November 19, 1987, Mr Thomas Syme forwarded to Mr Bruce Aubin, Air Canada vice-president of facilities and supply and chief technical adviser, a copy of the F-28 Project Plan for his review and comment. Mr Syme did this at the suggestion of Mr William Rowe, an Air Canada representative on the Air Ontario board.

Mr Syme testified as to his sending the F-28 Project Plan to the chief technical adviser at Air Canada:

> Q. Was the Project Plan itself reviewed at all by anyone at Air Canada, currently in situ at Air Canada?
> A. Yeah ... it was either raised at the executive committee or at the board. The shareholder rep of Air Canada suggested it might be helpful to forward a copy of the implementation plan or invited me to forward a copy of the implementation plan to one of their senior technical vice-presidents for review and comment.
> Q. And first of all, who was the shareholders' rep who made that recommendation?
> A. Bill Rowe.
> Q. And the senior technical vice-president to whom you sent the plan, who was that?
> A. Bruce Aubin.
>
> (Transcript, vol. 98, pp. 141–42)

Mr Rowe confirmed that it was he who suggested that the F-28 Project Plan be forwarded to Mr Aubin:

Q. And it seems we have a mention of the board on the 12th of August. Let's start there, and I will ask you who was doing the discussing at the board level and what was discussed with regard to the – and what literature, if any, was shown, or information given to the board at that time?
A. The subject would have been introduced by the chief executive officer, and supported by his staff. The discussion would have centred around the use of the aircraft, the economics and the expected return to the company.
Q. All right. And I take it it's – in the context of a five-year plan, it was considered a viable operation, from your point of view?
A. Yes.
Q. As a board member?
A. Yes, it was.
Q. The fact that it was a jet being introduced into a turbo prop and piston fleet, was that ever the ... the subject of any discussion?
A. Yes, it was. We were concerned that it be done in the proper manner and that the necessary adjustments to the operation of Air Ontario take place to allow the introduction of the aircraft itself.
Q. Was any thought given to the lack of jet expertise within the Air Ontario executive or operations group?
A. It would have formed part of a discussion, general discussion, on the introduction of jets in total.
Q. Do you remember anything specific about that discussion?
A. No specific concern, no.
Q. Was it a subject that was raised and dispelled or was it a subject that was considered worthy of further pursuit?
A. No, it was part of general discussion on the whole subject of introduction of the jet itself, because it was a major move on the part of the company.
Q. Was any thought given at the board level of going to Air Canada for any expertise?
A. I believe I referred Bill [Deluce] to Bruce Aubin of our company, that he would be available to Bill [Deluce] ... to consult with him if required.
Q. And indeed, we have Mr Aubin's correspondence before the Commission, and to summarize it, Mr Syme wrote to Mr Aubin, Mr Aubin wrote back to Mr Syme and Mr Aubin was provided with the F-28 Project Plan for his comment.
A. Right.

(Transcript, vol. 121, pp. 229–31)

By draft correspondence dated January 14, 1988, Mr Aubin provided his comments on the Air Ontario Project Plan. Mr Aubin provided constructive comment on various specific aspects of the plan, and in general his assessment of the plan was positive. Mr Aubin wrote:

> The overall scheduling of the program looks good, however, do you have anyone following-up progress which each division apart from yourself and does each division have its own set of jobs identified. Some of the above are specific activities. Very often a close follow-up can help a division solve some problems early and prevent delays.
> (Exhibit 804, p. 3)

It should also be noted that there was no flight operations input solicited from Air Canada, the area within which most of the operational deficiencies occurred.

By correspondence dated February 16, 1988, Mr Syme thanked Mr Aubin for his comments on the plan and provided further details on the F-28 implementation.[9] Mr Syme reported that:

> A project manager is in place to follow up and coordinate all the activities of the various divisions and has indicated that the program is well on track, including the following:
> a) Personnel Selection
> b) Pilot Training
> c) Spares Provisioning
> d) Test Ground Equipment and Maintenance Equipment Provisioning
> e) Transport Canada Paperwork Processing
> f) Aircraft Preparation
> g) Aircraft Ferry Flight Preparation
> h) Scheduling of Aircraft
> i) Program Training for Ramp, Counters and Dispatch
> (Exhibit 803, p. 2)

Evidently, between the correspondence of February 16, 1988, and the commencement of commercial service on June 1, 1988, events intervened to cause the Project Plan to go off track. The F-28 was added to the Air Ontario operating certificate and commercial service did begin June 1, 1988, yet several material components of the Project Plan were incomplete. Chapters 16–22 of this Report examine deficiencies in the F-28 program that were revealed by the accident investigation.

---

[9] This was the last correspondence exchanged between Air Ontario and Air Canada on the subject of the F-28 Project Plan. In addition to Mr Aubin's review of the plan, it was the evidence of Mr Syme that a Mr Clayton Glen of Air Canada reviewed the Air Ontario commercial and financial analysis of the alternative aircraft candidates.

The Post-Accident F-28 Pilot Survey

In the period immediately following the crash of flight 1363, Air Ontario's flight safety officer, Ronald Stewart, decided to conduct a survey of the Air Ontario F-28 pilots to assess the F-28 program. Captain Stewart testified that, because he was not an F-28 pilot, he wanted to get some background information on the F-28 operation and, in particular, he wanted specific information on de-icing and hot refuelling procedures. Captain Stewart had attended at Dryden as an observer on the CASB investigation team, and de-icing and hot refuelling had emerged as two areas of immediate safety concern. Of further interest to him were rumours persisting at Air Ontario regarding various operational practices in the F-28 program. Captain Stewart testified that he "wanted to get to the bottom" of "fairly strong rumours that indicated a ... fairly poor operation" (Transcript, vol. 74, p. 98; vol. 95, pp. 153–54).

It had been Captain Stewart's intention to contact a large number of Air Ontario F-28 pilots for his survey. Over a period of approximately two weeks, Captain Stewart was able to interview five pilots.[10] These were Captain William Wilcox, Captain Erik Hansen, First Officer Christian Maybury, First Officer Monty Allan, and First Officer Deborah Stoger. Captain Stewart described this group of pilots as a random sampling of the F-28 pilot group.[11]

Captain Stewart canvassed the pilots' views on a variety of areas, including:

- the quality of the F-28 training program
- F-28 de-icing procedures
- fuelling practices
- F-28 standard operating procedures
- F-28 safety, and
- possible differences in operating practices of former Air Ontario Limited pilots and former Austin Airways pilots.

In addition to these fairly specific areas of inquiry, Captain Stewart asked the pilots if they had any additional concerns or comments about the F-28 program.

---

[10] There were 25 Air Ontario pilots who received ground school and flight training on the F-28 aircraft. When Captain Stewart was conducting his survey in April 1989, he attempted to contact 18 active Air Ontario F-28 pilots. He was able to contact five pilots – two captains and three first officers – before the survey was terminated following Captain Stewart's discussions with the vice-president of flight operations.

[11] The F-28 pilot survey-related issues are discussed at length in chapter 42, Incident and Accident Reporting and Pilot Confidentiality.

It was in respect of these additional comments and concerns that I heard telling evidence regarding deficiencies in the F-28 program. Each of the five pilots was called as a witness before me to explain his or her answers to Captain Stewart's questionnaire. I found all the pilots to be forthright in their evidence and I commend them for their honesty in testifying under somewhat trying circumstances.

Certainly care must be taken in considering any post-accident assessments of the F-28 program. In this case, however, there was ample independent evidence to corroborate the assessments made by the pilots. After having considered the circumstances surrounding their testimony and the substance of the testimony itself, I place great weight on the observations of the five pilots regarding the F-28 program.

It is not my intention to review the details of the pilots' testimony at this point. Instead, such evidence is referred to throughout the analyses of the various operational deficiencies that follow.

16 THE F-28 PROGRAM: THE AUXILIARY POWER UNIT, THE MINIMUM EQUIPMENT LIST, AND THE DILEMMA FACING THE CREW OF FLIGHT 1363

By way of introduction to the discussion of the operational deficiencies facing the crew of flight 1363 on March 10, 1989, it is necessary to return to the circumstances leading up to the dispatch of the aircraft into Dryden. As described in Part Two of the Report, the evidence revealed that aircraft C-FONF was scheduled for operation on the day of the accident with its auxiliary power unit (APU) unserviceable. In this section there is a full explanation of the importance of the APU on C-FONF and the use of the minimum equipment list (MEL) by Air Ontario pilots, system operations control (SOC), and maintenance personnel.

The APU

Description

An APU is a small gas turbine engine installed on an aircraft to provide auxiliary power independent of the aircraft main engines or ground power sources. The APU can supply compressed air for engine-start purposes. It can also supply electrical power for the aircraft's electrical systems by way of a generator. On the F-28, the APU generator is designated as the number 3 generator, and it is used as a backup to generators 1 and 2, which are powered by the main aircraft engines.

The APU on C-FONF was manufactured by Garrett-Air Research Company. It was designated as model GTCP-36-4A with serial number P-37531.

The APU on the F-28 Mk1000 is installed at the rear of the aircraft fuselage behind the rear pressure bulkhead in a fireproof enclosure that is ventilated during APU operations (figure 16-1). APU operation is virtually automatic, and it may operate unattended because of an automatic shutdown capability in the case of an "overspeed" situation,[1] low oil pressure, or fire.

The APU normally supplies compressed air for starting the aircraft engines and supplies the air-conditioning system while the aircraft is on the ground. The APU can be used in flight as a standby power source in the event of main generator failure.

Engine Starts

As previously stated, a source of compressed air is required to start the engines on the F-28. Normally this compressed air is supplied by the APU; however, when the APU is unserviceable, an external source of compressed air is required.

External compressed air can be supplied by three sources. First, an air bottle can be used (figure 16-2). This is a rechargeable source of compressed air which is often used at outlying stations where there may be only an occasional need for compressed air. Once spent, an air bottle may take several hours to recharge to a point where it can again start a jet engine.

Second, a ground air cart can be used. This is the method most often used at large airports. A ground air cart normally contains a small turbine engine from which compressed air can be bled to start an aircraft turbine engine.

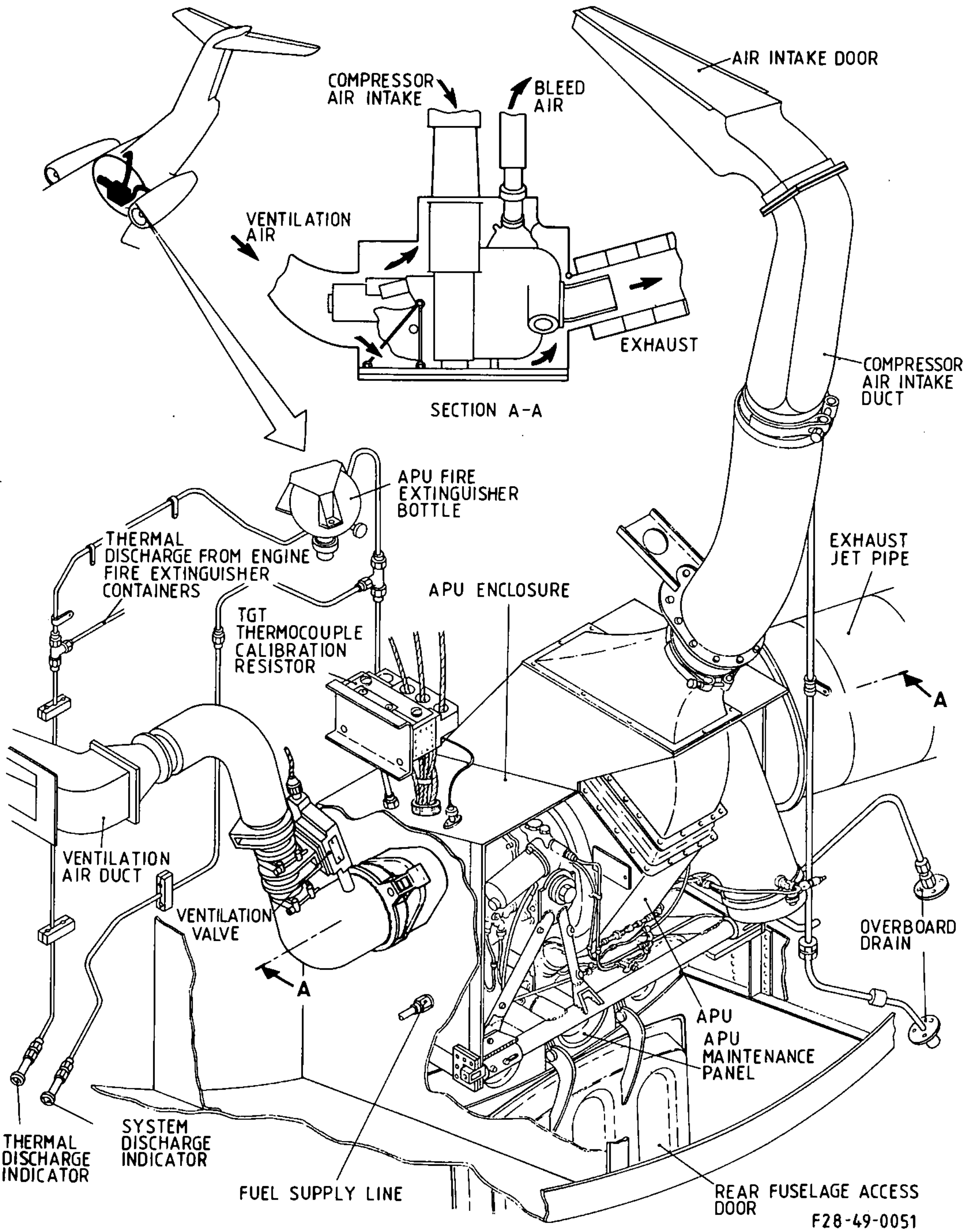
Finally, in the absence of an air bottle or an air cart, another turboprop or turbojet aircraft can supply compressed air to an aircraft by way of a "buddy-start" method. The already running jet engines can be connected, with appropriate hoses and couplings, to an engine of another aircraft to provide the necessary compressed air for startup. Such hoses and couplings are not usually carried on board the aircraft and were not available to the crew of C-FONF at Dryden.

Auxiliary Electrical Power: Anti-Skid System

One important function of the APU is the provision of backup electrical power to the aircraft anti-skid system – particularly for landing or for a rejected takeoff on a contaminated runway. If there is a possibility of an overrun in either situation, an F-28 pilot will immediately reduce power to idle and apply full braking. If this procedure will not stop the aircraft before it reaches the end of the remaining runway, the pilot will shut down the main engines to eliminate the residual thrust of the idle

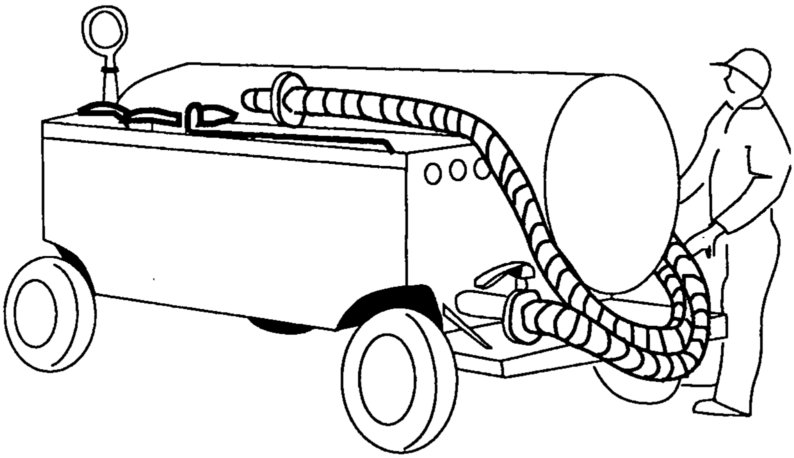
[1] When the APU exceeds 100 per cent of rated RPM

Figure 16-1 APU Installation



Source: Exhibit 322

Figure 16-2 Air Bottle: Single-Engine Air-Start Unit



power.[2] Shutting both engines down will result in a loss of electrical power from generators 1 and 2. In this critical situation, the electrical power from generator 3, which is powered by the APU, is necessary to operate the aircraft anti-skid system.

The significance of idle thrust to emergency stopping is specifically addressed in both the Piedmont F-28 Operations Manual and the USAir F-28 Operations Manual:

> When braking action is poor it is recommended to have the APU running and generator 3 on during takeoff and landing. When during a rejected takeoff or during landing skidding occurs which may result in a possible overrun of the available stopping distance consider shutting down the engines (idle thrust is approximately 800 lbs). In this case, generator 3 supplies the necessary electrics.
>
> (Exhibit 307, Piedmont F-28 Operations Manual, p. 3A-24-4; Exhibit 329, USAir F-28 Operations Manual, p. 3-125-7)[3]

A rejected takeoff or a landing on a contaminated runway where there is a possibility of an overrun is potentially more hazardous with an unserviceable APU. In the final moments of preparation for takeoff or

2 On a dry runway, the normal application of brakes on the F-28 will more than overcome the effects of residual idle thrust.

3 The Piedmont manual and the USAir manual were used, respectively, by Captain Morwood and First Officer Mills. The use of F-28 manuals at Air Ontario is discussed in chapter 19.

for landing, the flight crew must assess its options in anticipation of a potential overrun. With an unserviceable APU, this assessment would include a choice between an anti-skid capability or the elimination of residual idle thrust to prevent overrun.

Fire Protection: Fire Detection versus Fire Extinguishing

Fire protection for the APU is provided by two independent systems. First, there is a fire-detection system, consisting of a continuous detector loop within the APU unit that activates an electrical relay when it is exposed to excessively high temperatures within the APU enclosure or the unit itself. Second, there is a fire-extinguishing system, consisting of an extinguisher bottle that is discharged into the unit. The extinguisher bottle can be discharged either by the automatic activation of the fire-detection relay or, manually, by way of the pilot's activation of a guarded APU fire switch located in the cockpit.

In the case of the fire-detection relay being activated, a fire-warning lamp on the glare shield of the cockpit will illuminate; a cockpit fire-warning bell will ring; the APU will shut down; the air intake door and ventilation valve of the APU will close; and, after five seconds, the extinguisher bottle will discharge.

Fire-Protection System Test

Prior to starting the APU, there is a procedure for ensuring that the fire-detection and fire-extinguishing systems are operable. The test is performed in the cockpit by means of a "test/reset" toggle switch located on the cockpit secondary instrument panel. The switch is spring-loaded and, when held in the "test" position for five seconds, the APU fire-warning light illuminates and the APU fire-warning bell rings, indicating that the system is serviceable. If the fire-protection system proves serviceable, the system is reset and the APU start sequence can commence.

In the absence of a successful check of the APU fire-protection system, the APU cannot be operated except under the conditions specified in the minimum equipment list (MEL). Simply stated, an MEL is a Transport Canada–approved document that permits air carriers to operate aircraft with certain "essential equipment" inoperative. In order to fly an aircraft with such inoperative equipment, the air carrier must make certain operational accommodations that are clearly specified in the approved MEL.

Significance of an Unserviceable APU for Flight 1363

An unserviceable APU, when considered in conjunction with the unsettled area weather on March 10, 1989, and the fact that the Dryden line station did not have a ground-start capability for F-28 aircraft, caused operational irregularities that had to be considered by the flight crew of Air Ontario flight 1362/1363 and Air Ontario system operations control (SOC). These operational considerations were:

- The unsettled weather necessitated the use of a more distant than normal alternate,[4] Sault Ste Marie. Because of the greater distance, a scheduled fuelling in Dryden was necessary.
- In the absence of a ground-start capability at Dryden and the unserviceable APU, the fuelling in Dryden had to be performed with one of the F-28's main engines running.
- Because one main engine had to remain running, any extended ground delay at Dryden would necessitate ongoing revision of fuel consumption calculations.
- If for any reason both engines on the F-28 had to be shut down, the only readily apparent way the aircraft could be restarted would be to transport into Dryden air-start facilities or an air cart from another airport, as well as qualified personnel to make the appropriate hose connections and to support the start.[5]
- Air Ontario policy stipulated that main engines on the F-28 had to be shut down during de-icing.[6]
- During takeoff from a contaminated runway, the APU generator provides backup power to the aircraft anti-skid system. A rejected

---

[4] "Alternate" or "alternate airport" is a required alternative landing location to accommodate an en route change in conditions at the destination airport such that landing is not possible. By law, flight crews that file IFR flight plans must specify, among other things, at least one alternate (Air Navigation Order Series VII, No. 2, s.21). A turbojet aircraft must carry sufficient fuel to execute an approach and a missed approach at the destination airport, then fly to an alternate airport, and thereafter fly for a period of 30 minutes (ANO Series VII, No. 2, s.26). Further, the aircraft must carry sufficient reserve fuel to take into consideration meteorological conditions, anticipated air traffic control routings, and any other conditions that may delay the landing of an aircraft (ANO Series VII, No. 2, s.29).

[5] Although Air Ontario had performed "buddy starts" using air from a running Convair 580 aircraft to start another Convair aircraft, the necessary equipment to perform such a start on an F-28 was not readily available.

[6] Exhibit 317, Air Ontario F-28 de-icing memorandum, dated September 28, 1988, contained the following statement: "NEVER: Spray while main aircraft engine's are running!!!" The limited dissemination of this memorandum and the issue of whether pilots Morwood and Mills were aware of it are discussed in chapter 21, F-28 Program: Hot Refuelling and Ground De-icing.

takeoff from a contaminated runway with an unserviceable APU is more hazardous given that the anti-skid system would be inoperative in a two-engine shutdown situation. The stopping performance of the aircraft is less without the benefit of anti-skid.

- When Captain Morwood and First Officer Mills commenced their takeoff roll on the contaminated runway 29 in Dryden, they did not have the benefit of the APU generator backup to the anti-skid system. Prior to the takeoff roll, they would or should have known that in a rejected takeoff their stopping capability would have been diminished, either because of the inoperative anti-skid or the residual main-engine thrust.

Events Leading up to the Unserviceability of the APU

March 5 to 9, 1989

On the evening of Sunday, March 5, 1989, aircraft C-FONF arrived in Toronto after returning from a weekend charter flight to the western United States. The aircraft was under the command of Captain Bradley Somers. During one of his station stops of the trip, Captain Somers experienced difficulty getting sufficient air pressure from the APU to start the aircraft's main engines.[7] Captain Somers made the following entry in the aircraft journey log book for March 5, 1989: "For first start in morning air pressure was only 14 PSI with pack on and would not start engines. In MSP the pressure was normal and start was okay" (Exhibit 309, p. 09647). The entry would be interpreted by maintenance personnel to mean that, although Captain Somers had difficulty on his first start in the morning of March 5, the APU did produce sufficient air pressure to start the main engines later in Minneapolis–St Paul (MSP).

---

[7] The aircraft C-FONF was scheduled to "turn-around" in Idaho Falls, Idaho, on the evening of March 4. The aircraft was late in arriving and, because of a misunderstanding, the tour operator sent the passengers back to their hotel. As a result, their departure was delayed until the following morning and the aircraft remained out on the tarmac in Idaho Falls throughout the night with its APU running. Captain Somers testified that he kept the APU running because it was a very cold night and he wanted to keep the interior of the aircraft warm. This procedure was authorized by SOC. On the morning of March 5, when the return trip was to get under way, the APU was not producing sufficient air pressure to start the main engines. Aircraft C-FONF departed Idaho Falls on the morning of March 5 and overflew its scheduled fuelling stop at Sioux Falls, Iowa, because there was no air-start unit there. Because of the lack of air start at Sioux Falls and the unserviceable APU, Captain Somers rerouted to Minneapolis–St Paul, where ground start was available, for his refuelling.

Captain Somers noted one other problem with the aircraft that day. His second entry in the journey log read: "On first takeoff of morning cabin fills with oily smell from air pack after approx. 5 min. smell dissipates and normal for rest of flight" (Exhibit 309, p. 09648).[8]

The aircraft, C-FONF, with these two noted defects, arrived in Toronto at 4:33 p.m. on March 5. The aircraft was to be "turned around" quickly since it was scheduled to depart from Toronto to Winnipeg. In fact, from the journey log, the "turnaround" in Toronto took 57 minutes.

As a matter of course, the defects entered by Captain Somers would be examined by Air Ontario maintenance personnel. In this case, Mr John Jerabek, a line maintenance supervisor, considered the snags. Mr Jerabek testified that he discussed the two journey log entries with Captain Somers. With regard to the first entry, Mr Jerabek confirmed that Captain Somers used an air cart to start the main engines on the Idaho Falls station stop because the APU was not producing sufficient air pressure. After conferring with Captain Somers, Mr Jerabek examined the APU. He could not duplicate the snag because he found that the air pressure output and pressure gauge readings were normal. Accordingly, he made the following entry under the "defect rectified" section of the journey log: "APU was left running all night. Suspect stuck valve. Normal in YYZ" (Exhibit 309, p. 09647).[9]

With regard to the second journey log entry, that dealing with an oily smell, Mr Jerabek made the following entry in the "defect rectified" section: "Suspect residual oil in air ducts after ACM change. Please advise future operation" (Exhibit 309, p. 09648).[10] By checking previous snags, Mr Jerabek found that the air-cycling machine had been changed because it was leaking oil, and he suspected some of this residual oil found its way into the ducting that connects the ACM with the cabin ventilation system. He believed this residual oil was being heated and causing an oily smell in the cabin.

Mr Jerabek did not actually check the ducting for residual oil. A check of this nature would take many hours of work and the aircraft had a scheduled departure out of Toronto at 5:30. Moreover, because Captain Somers had reported that the oily smell dissipated after five minutes, Mr Jerabek felt it sufficient to advise subsequent crews to notify mainten-

---

[8] Flight attendant Sonia Hartwick also referred to an oily haze in the cabin at the beginning of flights on March 6 and March 8, 1989. She reported that the oily haze activated the smoke detectors in the rear of C-FONF.

[9] The designator YYZ indicates Toronto. Although Mr Jerabek had suspicions about the cause of the noted APU defects, it is inconclusive whether the low air-pressure production on the morning of March 5 was in any way related to the operation of the APU throughout the night of March 4.

[10] The acronym ACM stands for air cycle machine, which is part of the aircraft air-conditioning system used to cool the very hot air coming from the engines.

ance if the problem recurred. Mr Jerabek did no other work on C-FONF between March 5 and March 10, 1989.

Mr Jerabek's suspicion that residual oil may have leaked into the ducting may have been well founded; however, a review of the aircraft journey log would have revealed that a similar problem had been reported on two previous occasions. On January 21, 1989, smoke in the cabin of C-FONF was attributed to the air-conditioning system (the maintenance of the noted defect was deferred); and on February 27, 1989, thick oily smoke filling the cabin was again reported (the defect was rectified by correcting an oil leak in the duct work) (see chapter 10, Technical Investigation). The recurrent nature of this defect should have warranted the serious attention of Air Ontario's maintenance department.

What is even more troubling was what occurred after Mr Jerabek released the aircraft into service. The next day, on March 6, Captain Morwood noted in the aircraft journey log that the cabin became smoky, a passenger complained, and the smoke detector went off. He noted further that after 5 to 10 minutes the smoke dissipated. These observations were confirmed by the surviving flight attendant, Mrs Hartwick:

Q. Shortly after takeoff, what happened?
A. Right after takeoff, the smoke detector sounded from the back of the aircraft ... it is in the lavatory ...
Q. And was this a fairly loud sound?
A. Yes, it's a very high-pitched noise.
Q. And, when you heard that sound, what did you do?
A. At that time, I turned around to look for the light, and it was flashing, and I [rang] my chime system to get Katherine Say's attention, and she automatically looked at me, and I told her I was going to the back, because she noticed and heard the sound of the smoke detector.
So I ran to the back to fight a fire.

....

Q. Now, when you proceeded to the back of the aircraft, did you observe any kind of smoke or smell in the aircraft?
A. Yes.
Q. And could you describe that to the Commissioner, please.
A. Yes, there was a smokeyish haze throughout the cabin. You could see from the back of the aircraft all the way to the front, it was like a haze, smoky haze, and there was a horrible smell to this smoke.

...

Q. Now, when you got to the back right at the start, what did you do?

A. When I got to the back, the first thing I did was grabbed my Halon extinguisher, and then I felt the lavatory door with the back of my hand.
Q. With the back of your hand?
A. That's correct.
Q. Would you tell the Commissioner why you felt it with the back of your hand?
A. So that ... if I were to feel it with the front of my hand, meaning my palm, and if it were hot, I could possibly burn my hand, and then I would ... have problems holding my extinguisher and actually using my extinguisher, so I felt it with the back of my hand so that, if I did burn anything, it was on the back and I could still use the palm of my hands in order to hold it.
Q. Now, did Kathy Say relay to you what her understanding was of this smoke and smell? Was something indicated to her by the captain?
A. Yes, the captain had mentioned to her that, apparently in the captain's log book, the mechanics had made a little notation saying that they had changed the oil on the compressor – or some sort of droplets or something may have fallen on the compressor and that they could assume that, if a little bit of smoke came about because of this, that that was a good possibility ...
Q. And it was her understanding – and she conveyed this to you – that this was noted in the captain's log book; is that correct?
A. That's correct.
Q. And was there also a notation that possibly smoke could result from what was happening?
A. That's correct.
Q. Now, you feel the door with the back of your hand, and you have this Halon extinguisher with you. Was the door hot?
A. No, it was not.
Q. And what did you then do?
A. I opened up the door just a crack to peek in to see if I could see a lot of smoke or flames or anything, and there was nothing, so I opened it a little further until I finally opened it, and, at that point, I threw some ice cubes down the trash can and down the toilet.
Q. Why did you do that?
A. Just in case there was something in there that was burning.
...
Q. ... Did either Captain Morwood or First Officer Mills leave the cockpit to come to the back to see what was going on?
A. No, they did not.
Q. They did not, okay. And did they indicate any instruction to Kathy Say on what she should do?
A. Not to worry about it, that we can go about our duties.
Q. Okay. And how long did you stay at the back of the aircraft?

A. I stayed there about ten minutes, until the smoke cleared.
Q. What did you then do?
A. I then reset the fire alarm – or the smoke detector system.
(Transcript, vol. 10, pp. 126–32)

Maintenance rectified this snag as noted in the aircraft journey log by cleaning oil out of the APU outlet duct (see chapter 12, Aircraft Performance and Flight Dynamics).

Mrs Sonia Hartwick testified that on the morning of March 8, 1989, shortly after takeoff from Winnipeg to Dryden, the aircraft C-FONF, piloted by Captain Robert Nyman and First Officer Keith Mills, again filled with an oily smoke that triggered the smoke detector. Captain Nyman testified that he attributed the cause of the oily smoke – which he described as an "oily haze" – to the APU, and stated that it was a fairly common problem with that aircraft. He adopted the evidence of Mrs Hartwick that a circuit breaker was pulled to deactivate the smoke detector and that the circuit breaker was inadvertently not reset until they reached Thunder Bay, two flight legs later. Mrs Hartwick testified that smoke filled the cabin and the alarm again sounded during the return flight from Thunder Bay to Winnipeg. Captain Nyman did not note the cabin smoke incidents in the aircraft journey log because, as he put it, it was a recurring, intermittent problem of which maintenance was aware.

On five separate occasions – January 21, February 27, March 5, March 6, and twice on March 8, 1989 – an oily smoke, smell, or haze was reported in the passenger cabin of C-FONF. Maintenance attempts at rectifying the problem were obviously unsuccessful, and I am not at all confident that maintenance ever properly identified the cause of the problem.

I am not satisfied with Captain Nyman's explanation for not reporting the March 8 cabin smoke problems in the aircraft journey log. His failure to report the defects suggests that there may have been a breach of Air Navigation Order (ANO) Series VII, No. 2, the Aircraft Journey Log Order. The deactivation of the smoke detector on the morning of March 8 was a poor practice, and the evidence of Captain Nyman operating the aircraft with this essential aircraft equipment inoperative suggests that there may have been a violation of ANO Series II, No. 20, the Aircraft Minimum Equipment List Order.

I found Captain Nyman's characterization that the deactivation of the smoke detector was against "the legal letter of the law" (Transcript, vol. 109, p. 130) to be flippant and, at the least, ill-advised. While Captain Nyman was not the director of flight operations on March 8 when the incident occurred, he was recognized and respected among Air Ontario pilots as one of the most senior and experienced pilots in the company. All of the Austin Airways pilots would have worked for Captain Nyman at one time or another, and First Officer Mills had worked in Captain Nyman's flight operations department for years prior to the incident. This mishandling of the cabin smoke incident reflects shoddy, lax flight-operations practices, and, coming from a pilot of Captain Nyman's stature, it most certainly would have sent the wrong signal to First Officer Mills, flight attendants Katherine Say and Sonia Hartwick, and anyone else in the organization who learned of it.

At the time of the occurrences, it was mandatory to report any in-flight incident involving smoke or fire to the Canadian Aviation Safety Board pursuant to sections 2 and 5 of the *Canadian Aviation Safety Board Act*. There is evidence that none of the described cabin smoke incidents were reported to CASB (Transcript, vol. 64, pp. 135–37).

The low APU air pressure for engine starts was again noted on March 8, 1989, while the aircraft was flown by Captain Robert Nyman and First Officer Mills. Captain Nyman made the following journey log entry: "[Entry] 164 APU air press low (MC042)" (Exhibit 309, p. 07104).[11]

Captain Nyman passed the aircraft over to Captain Alfred Reichenbacher in Winnipeg at the noon hour on March 8. Captain Reichenbacher carried on with First Officer Mills, flying the balance of the scheduled route for March 8. After arriving at Winnipeg, First Officer John Robinson replaced First Officer Mills. From Winnipeg, Captain Reichenbacher flew to Dryden, to Thunder Bay, to Sault Ste Marie, and finally to Toronto. The aircraft arrived at the Toronto maintenance base at 9:23 p.m. In the aircraft journey log, Captain Reichenbacher made the following notation regarding his March 8 flying segment: "Further to snag #164: engine starts are becoming more and more difficult (TGT 450°, normally would be 300–350°)" (Exhibit 309, p. 07105).

This journey log entry elaborates on Captain Nyman's earlier entry on low APU air pressure.[12] The entry describes an abnormally hot turbine gas temperature (TGT) during main engine start. This may have been symptomatic of an engine start where the engine compressor was not rotating fast enough at the point the fuel was ignited. The result would be an insufficient cooling airflow during the start sequence, causing high turbine gas temperatures. A reason that the compressor blades were not rotating fast enough may have been insufficient APU startup air pressure. Therefore, the observed high turbine gas temperatures were

[11] The notation MC042 denotes the assignment by Air Ontario Maintenance Control in London of a maintenance control number. This allows the aircraft to be flown back to the Toronto maintenance base with the APU unserviceable. This procedure is laid down in the Air Ontario Maintenance Control Manual (Exhibit 319).

[12] Defect number 164 was addressed by maintenance personnel in Toronto on March 8 and 9.

apparently a result of deficient air pressure generated by the APU on startup.

The Events of March 9, 1989

The aircraft, C-FONF, arrived back at the Toronto maintenance base at 9:23 p.m. on March 8, 1989. It was scheduled to fly on the morning of Thursday, March 9.

Mr Channan (Ken) Ramnarine, a maintenance crew chief at Air Ontario Toronto maintenance base, gave evidence regarding the rectification of the low APU air-pressure defect. He testified that he arrived for work at approximately 7 a.m. on March 9. After having reviewed the APU problem, he proceeded to change the APU load control valve. This valve controls the pneumatics of the APU, and it was believed that a replacement of the valve would rectify the low-pressure problem. After changing the valve, he made the following entry in the aircraft journey log: "Control valve replaced SN ON P92 SN OFF, P-515" (Exhibit 309, p. 07104).[13]

Mr Ramnarine and Mr Steven Korotyszyn, an Air Ontario lead inspector at the Toronto maintenance base, then started the APU. Mr Korotyszyn testified as to the APU startup:

> A. Well, the aircraft was towed out of the hangar, and it was parked. Ken [Ramnarine] and I walked over, and I did a walk-around, got in the airplane, and we prepared to start the APU.
> Q. And where were you physically located when the APU was started?
> A. I was in the co-pilot's seat.
> Q. And where was Mr Ramnarine?
> A. Ken was in the captain's seat.
> Q. Was the fire shield on the APU at this time?
> A. The fire shield was off.
> Q. So was there a fire picket outside?
> A. Yes, there was.
> Q. Now, did you proceed or Mr Ramnarine proceed to fire up the APU?
> A. Well, we went through the checklist, and we did the fire test first.
> Q. Right, and what happened when you did the fire test?
> A. Well, we got the light and the audible horn.
> Q. Right. And then did you commence to fire up the APU?
> A. We started to – we fired up the APU.
> Q. And did it run successfully?

[13] The entry means that the existing valve – serial number P-515 – was removed and replaced by valve serial number P-92.

A. It did not.
Q. Now, we're talking sometime after 10 o'clock in the morning at this point?
A. Yes.

(Transcript, vol. 42, pp. 17–18)

The APU was still delivering the low air pressure, and Mr Ramnarine and Mr Korotyszyn continued troubleshooting. They electrically disconnected the load control valve, and the APU ran successfully. When they reconnected the load control valve, the APU did not operate successfully. On the suggestion of Mr Korotyszyn, Mr Ramnarine reinstalled the original load control valve, and the APU then ran successfully. He shut the APU down and had one of the maintenance helpers reinstall the fire shield to enclose the APU compartment. Mr Ramnarine noticed that three camlock fasteners were missing from the fire shield. He again performed a fire test and restarted the APU. Then he put a load on the APU by starting one of the F-28 engines. This would be the last time that the APU and the APU fire-detection system on aircraft C-FONF both tested serviceable.

After running the engines, Mr Ramnarine instructed his men to reinstall the fire shield. With his confirmation that the fire shield was installed with all fasteners in place, Mr Ramnarine and his crew completed their work on C-FONF on the morning of March 9, 1989.

Mr Kostas (Gus) Athanasiou was an Air Ontario crew chief at the Toronto maintenance base and an aircraft maintenance engineer (AME) endorsed by Transport Canada to work on the F-28 aircraft.[14] Mr Athanasiou was on duty at the base from 7:30 a.m. until 7:30 p.m. on March 9. His first involvement with C-FONF occurred at approximately 4:00 p.m., when he was asked to proceed to the hangar and to pick up the F-28 aircraft for a scheduled departure. Prior to startup he reviewed the aircraft journey log and satisfied himself that there were no outstanding defects. He then commenced the startup procedure. When he performed the preliminary step of testing the APU fire-detection system, Mr Athanasiou found that it was not operable – he testified that "it would not fire test at all" (Transcript, vol. 42, p. 90).

Mr Athanasiou then attempted to rectify the observed defect in the fire-detection system. He opened the APU enclosure and discovered a loose wire. After spending some time reconnecting the wire, he still could not get the APU fire test to work. He did not perform a systematic

[14] In order to get an F-28 endorsement, Mr Athanasiou took a course of approximately two weeks in duration at Piedmont Airlines in Winston-Salem, North Carolina, as did both Mr Korotyszyn and Mr Ramnarine. The amount of time on the course dealing with the APU was, to Mr Athansiou's recollection, about half a day.

tracing of this electrical defect, explaining that the electrical trouble-shooting could have taken hours and the aircraft was scheduled to depart. In his testimony, Mr Athanasiou was not able to identify the function of the loose wire or confirm whether it related at all to the serviceability of the APU fire-detection system. He simply explained that he observed a loose wire and he tightened it.

There was some speculation during the course of the hearings that, when Mr Ramnarine's crew tightened the fire shield for the final time, they may have pinched a wire in the fire-detection loop, which would render the fire-detection system unserviceable. Mr Ramnarine testified that, while he did not think this was the case, it did provide a possible explanation for the unserviceability observed later by Mr Athanasiou.

Given that Mr Athanasiou was not able to rectify the malfunctioning APU fire-detection system, Air Ontario maintenance and the scheduled flight crew were left with two options. They could ground the aircraft until the problem was solved. This option would have involved getting a substitute aircraft and crew for the displaced passengers. Alternatively, they could defer the maintenance of the APU fire-detection system pursuant to the minimum equipment list (MEL).

The option to defer the maintenance of the APU fire-detection system was discussed by Mr Athanasiou, Mr Korotyszyn, and Captain Robert Perkins in Toronto. They also discussed the matter by telephone with both Air Ontario system operations control (SOC) and maintenance control in London.[15]

The decision was to defer rectification of the APU fire-detection system malfunction pursuant to section 49-04 of the MEL, and an appropriate entry was made by Mr Athanasiou in the aircraft journey log. Mr Athanasiou's defect description reads, "APU will not fire test." He added under the "defect rectified" section, "Deferred as per MEL 49-04" (Exhibit 309, p. 07108).[16] After making the deferral entry,

---

[15] Maintenance control and SOC perform complementary functions within the maintenance and flight operations departments of Air Ontario. It is the responsibility of Maintenance control to monitor the state of serviceability of the aircraft and to ensure that the required scheduled maintenance programs for the various aircraft are followed. It is the responsibility of SOC to coordinate crew, aircraft, and station facilities. Maintenance control and SOC work closely together to coordinate commercial scheduled service with scheduled and unscheduled maintenance of the company's aircraft. Reflecting this close integration is the fact that maintenance control and SOC are located in adjacent offices at Air Ontario.

[16] There were two possible deferral numbers under the APU section of the MEL (Exhibit 310): 49-01, which was a general section appropriate for an unserviceable APU; and 49-04, which was specifically designated for an unserviceable APU fire-extinguishing system. Mr Korotyszyn explained that because the unserviceability was the *fire-detection* system, 49-01 would have been a more appropriate deferral number than 49-04.

Mr Athanasiou placed a red placard on the cockpit APU panel of C-FONF that read "INOP."

It must be noted that Mr Korotyszyn, who was responsible for the deferral of the maintenance of the APU, was under the misapprehension that Dryden did have ground-support facilities. His testimony in this regard is significant:

> Q. You are the only one that is clothed with the responsibility of deferring this maintenance, right?
> A. That is right.
> Q. That is your decision?
> A. Right.
> Q. And I am putting it to you, in order to do that, in order to reach that decision, on an informed basis, you have to ask questions of other people such as the captain and SOC; don't you?
> A. I would have.
> Q. ... And specifically now on March the 9th, you did put questions to Captain Perkins about what kind of conditions the F-28 might run into, is that right?
> A. Well ... I made sure that there was equipment to support the aircraft.
> Q. ... Did you ... know that the aircraft might be going into Dryden where there was no air start?
> A. I knew the aircraft was going into Dryden. I did not know there was no equipment there.
> Q. ... Were you under the impression that there was equipment there?
> A. Yes.
>
> (Transcript, vol. 42, pp. 68–69)

Although Captain Perkins accepted the aircraft with the deferred maintenance of the APU fire-extinguishing system, he in fact used the APU to start the aircraft engines in Toronto prior to his departure. This was permitted by MEL section 49-04, which required that, with an inoperative fire-extinguishing system, the captain must arrange for constant monitoring by ground crew. In this case Captain Perkins had maintenance personnel standing by to act as a "fire picket."

It is clear, therefore, that when Captain Perkins accepted aircraft C-FONF on the afternoon of March 9, 1989, the APU was producing sufficient air pressure to start the main engines, although the APU fire-detection system was inoperative.

Events Following the Departure of C-FONF from Toronto

The aircraft, with Captain Perkins in command, left Toronto for Winnipeg via Sault Ste Marie, Thunder Bay, and Dryden at 6:49 p.m. EST on March 9. The aircraft was to remain overnight in Winnipeg and to commence flying under the command of Captain Morwood at 7:30 a.m. on March 10.

Though he used the APU to start the engines on the aircraft in Toronto, Captain Perkins testified that, because the fire-detection system was inoperative, the APU was to be regarded as unserviceable and not to be used on line operations. Captain Perkins was questioned on his flight planning for the evening of March 9, 1989, given that his aircraft had an unserviceable APU and he would be flying through Dryden, where there was no ground-starting capability:

> Q: And maybe you can tell us at this point in time that being aware of no ground start capability in Dryden, did that have any bearing on your thought process at the time?
> A: It had not a lot, because we were not going to be required to fuel in there. As long as the ground people were aware of the fact that they were going to be operating through there with the one engine in operation. It was more of an advisory state for that station as opposed to a request for ground support.
> Q Assuming that weather would remain constant and favourable?
> A: Yes.
> Q: And you didn't have to de-ice?
> A: Yes.
> Q: Right?
> A: The weather was quite reasonable for our trip out, yes.
> Q: So essentially, Captain ... provided that the aircraft would be released from maintenance, you made a conscious decision that you would take it out on that flight, knowing that there was no ... ground serving capability at Dryden?
> A: That's correct.
>
> (Transcript, vol. 43, pp. 144–45)

Captain Perkins arrived with C-FONF in Winnipeg at 10:53 p.m. CST. He testified that he did not phone Captain Morwood to advise him of the problem with the APU because it was late and he did not want to wake him to "tell him something that he theoretically should already know" (Transcript, vol. 43, p. 182). He testified further that he would have expected SOC to have relayed the details of the APU unserviceability to Captain Morwood. I note that Captain Perkins, having been involved with the APU problem throughout the afternoon of March 9, was in the best position to give Captain Morwood a complete and accurate briefing regarding the APU problem. Instead, Captain Morwood had to rely on the limited and somewhat conflicting notations in the aircraft journey log and on a brief telex message from SOC the following morning.

The Role of SOC

As previously mentioned, one of the options available to Air Ontario SOC on the evening of March 9, 1989, was to replace the aircraft C-FONF with another aircraft. In fact, while maintenance grappled with the APU problems, a Convair 580 had already replaced C-FONF on its scheduled morning return flights to Sudbury and its afternoon return flight to Sault Ste Marie. According to Mr Danilo (Dean) Koncan, SOC duty manager working the afternoon and evening of March 9, the same Convair was available to carry on as a replacement for the balance of the day's flying to Winnipeg, but its crew would have exceeded its maximum duty day by the time they reached Dryden and therefore could not have completed the segment. Mr Koncan testified further that he would have had some difficulty in getting two Convair crews – a replacement crew to fly to Winnipeg on the night of March 9, and an additional crew to fly the aircraft back to Toronto the next morning – on short notice at that time.

The F-28 was not replaced for the evening flight to Winnipeg; instead, the decision was made to dispatch the aircraft with the unserviceable APU. Mr Koncan stated that prior to SOC and the flight crew agreeing that C-FONF would be dispatched to Winnipeg, they telephoned the line stations at Sault Ste Marie, Thunder Bay, and Winnipeg to confirm that ground-support equipment was serviceable. Mr Koncan testified that, because he was aware that there was no ground-support equipment at Dryden, he did not call Dryden prior to the dispatch of the aircraft on March 9.

The aircraft left Toronto for Winnipeg via Sault Ste Marie, Thunder Bay, and Dryden. Prior to the aircraft landing at Thunder Bay, Mr Koncan checked the Dryden weather. He explained his reasons for doing this:

> A. Prior to the aircraft landing in Thunder Bay from Sault Ste Marie, we had looked at Dryden weather, pulled up the last eight-hour history on it and alternates down line as far as Winnipeg and Thunder Bay still being the alternate for the last flight, all conditions were good. And based on the fact that as a standard on that particular flight between Thunder Bay and Winnipeg via Dryden, we tankered fuel ... in Thunder Bay.
>
> Q. By tankering fuel, could you just explain that for the record, please?
>
> A. Tankering fuel was carrying in excess of what was required so that in Dryden, no fuel uplift was required, based on economics of Thunder Bay being cheaper than Dryden.
>
> Q. That is, cheaper fuel in Thunder Bay than Dryden?
>
> A. That is correct ... And based on the passenger count and cargo that it would not exceed the max payload carrying so much fuel.

Q. ... Now, you say you were checking the weather for Dryden. Why?
A. Any indications that we would have any problems as a standard going so far down line to review the operation if there were any operational problems with the weather that we would not be dispatching it to Dryden, we would be overflying it.
Q. And what operational considerations would come into your mind with regard to dispatching to Dryden with no air start?
A. Runway conditions, the weight of the aircraft, adverse weather, the equipment available at Dryden.
Q. ... Did the possibility of having to de-ice in Dryden ever enter your calculations?
A. On that particular flight, no, it did not.

(Transcript, vol. 47, pp. 22–24)

Mr Koncan was asked about the dispatch of the F-28 aircraft under circumstances where there was the possibility of having to de-ice the aircraft. In particular, he was shown an Air Ontario memorandum of September 28, 1988, addressing the subject and asked for his comment on its contents. The document, a memorandum from Mr Robert Mauracher of London maintenance to the reliability committee of Air Ontario, dealt with winter operations generally and with de-icing of the F-28 specifically. A copy of the document was kept in London SOC and had been seen previously by Mr Koncan. Mr Koncan understood the document to be an instruction from Air Ontario management regarding de-icing practices for the F-28 aircraft. On page 3 of the document there is the following warning:

NEVER: <u>Spray while main aircraft engine's are running!!!</u>

(Exhibit 317)

Mr Koncan explained his understanding of F-28 de-icing policy:

A: Engines are to be shut down, as well as APUs are to be shut down while de-icing.
Q: Was there any further instruction given to you about the dispatch of aircraft, F-28s, [with] unserviceable APUs, into line stations where there was no air starts and the possibility of de-icing?
A: No, there was not.

(Transcript, vol. 47, p. 39)

Based on this understanding, Mr Koncan testified that he would not dispatch a jet aircraft with an unserviceable APU into a station where there was no ground-start unit if there was any possibility that the aircraft had to be de-iced.

With regard to the operation of C-FONF on March 10, 1989, Mr Koncan testified about the possibility of repairing the APU during the Winnipeg overnight stop:

> Q: ... Was the repair or maintenance to this APU on C-FONF in Winnipeg ever discussed?
> A: Yes, it was.
> Q: Could you describe that for the Commissioner, please.
> A: The Maintenance Controller had advised us that the trouble-shooting portion of that APU was not completed, they still were looking for the component, and, because of lack of parts, they were going to see if, overnight, maintenance in Winnipeg could repair.
>
> (Transcript, vol. 47, pp. 31–32)

It appears that Mr Koncan was misinformed. Mr Steven Brezden, the Air Ontario aircraft maintenance engineer on duty that evening in Winnipeg, testified that when he noted the APU snag in the aircraft journey log he considered no further action. He explained that "Winnipeg, being a line station and the type of job we were doing, we didn't normally do deferred defects" (Transcript, vol. 46, p. 116). Mr Brezden stated that his work on the F-28 was limited to routine service checks.

Prior to leaving work at 11:30 p.m., Mr Koncan left a note for Mr Martin Kothbauer, duty operations manager on the morning of March 10. This note advised Mr Kothbauer that the aircraft C-FONF was in Winnipeg and that he should confirm with maintenance control that the APU was serviceable. Alternatively, Mr Kothbauer should get in touch with Air Canada station operations control (STOC) in Winnipeg to ensure that an air start and AC ground power for the aircraft were available for the departure on flight 1362 on the morning of March 10.

Events of March 10, 1989

On the morning of March 10, 1989, Mr Daniel Lavery was on duty at Air Ontario SOC as a dispatcher, and Mr David Scully was on duty as a maintenance controller. When Mr Kothbauer reported for work at 5:00 a.m., he looked at the duty operations manager log that contained the note from Mr Koncan written the previous night. Further to these instructions, he asked Mr Scully to telephone Winnipeg to check on the status of the APU of C-FONF. Mr Kothbauer testified that Mr Scully made the call and advised him that the APU would be unserviceable for the balance of the day while Winnipeg maintenance awaited the arrival of a replacement part.

Mr Kothbauer then telephoned the Winnipeg, Thunder Bay, and Sault Ste Marie stations to confirm that they were able to provide air starts for the aircraft throughout the day. He provided further confirmation by sending a message to the same stations via the Reservac computer communications system. The message advised that air starts would be required in Winnipeg, Thunder Bay, and Sault Ste Marie, and that the aircraft would be operating with one engine running at the Dryden station stop. A similar message was sent at 10:57 a.m. for the afternoon operations of the aircraft. That second message read, in part:

> THE R/H ENG WILL AGAIN BE LEFT RUNNING WHILE THE ACFT OPS THRU YHD. IF [YOU] ARE UNABLE TO PROVIDE AIRSTARTS PLS ADVS US ASAP AS WE WILL THEN HAVE TO SET UP HOT-REFUELLING.
>
> (Exhibit 349)[17]

Mr Kothbauer testified that he looked at the Dryden area weather forecasts and, although they called for a risk of light freezing rain, he did not take any special steps regarding the dispatch of the aircraft into Dryden. He was aware of the company procedure not to de-ice the F-28 aircraft if its main engines were running, and he was aware of these de-icing restrictions on March 10 when he was preparing the line stations for C-FONF:

> Q. Did it come into your calculations or considerations that day with regard to the aircraft landing in Dryden?
> A. Not – not really. I was thinking later in the day, by the looks of the weather moving in from the west, that we might have a problem operating through Dryden in the evening, but not that morning.
> Q. You stated that you didn't have a concern, and what concern are you speaking of, the probability of the aircraft having to be de-iced in Dryden?
> A. Yes.
>
> (Transcript, vol. 49, pp. 39–40)

Mr Kothbauer was asked why he assumed that the freezing precipitation would occur later in the day on March 10:

> Q. Why, then, did you assume that this light freezing rain would occur later in the day?
> A. Just by the overall view that I got from the weather system that day.

[17] A copy of the first message was never located by Commission investigators. Mr Kothbauer testified that the second message (Exhibit 349) was similar to the first.

> Q. And your view of the overall weather system, I take it, included some other data than these two area forecasts in front of you?
> A. The first terminal forecast that was issued for Dryden just had light rain in the forecast.[18]
>
> (Transcript, vol. 49, p. 41)

The first terminal weather forecast for Dryden would have been received in London at SOC at about 8:45 a.m. EST. It would not have been available for consideration in the dispatch of flight 1362 out of Winnipeg at 7:35 a.m. CST.

Mr Kothbauer was questioned about the significance of forecasted freezing precipitation at a line station into which an aircraft with an unserviceable APU was operating:

> Q. If, in your opinion, there was freezing precipitation or snow or some other precipitation phenomenon that could have contaminated the wings of an aircraft, what would you do on the dispatch of that aircraft with no serviceable APU through a line station with no air start?
> A. I would have considered overflying that station.
>
> (Transcript, vol. 49, p. 43)

Events at Thunder Bay

Mr Kothbauer was informed by dispatcher Wayne Copeland of the 11:55 a.m. departure of flight 1363 from Thunder Bay Mr Kothbauer then accessed the latest station actual weather observation for Dryden (issued at 11:00 a.m. EST), which indicated VFR weather with scattered cloud at 4000 feet and overcast cloud at an estimated 8000 feet. This station actual observation would have been 55 minutes old by the time the aircraft left Thunder Bay.[19]

Significantly, an amended terminal weather forecast issued at 10:02 a.m. EST called for light freezing rain at Dryden (Exhibit 313, p. 10). Mr Kothbauer did not recall seeing the amended terminal forecast. He testified that this 10:02 a.m. amended weather forecast should have been available to him at the London SOC via the Reservac computer system prior to the departure of C-FONF from Thunder Bay at 11:55 a.m.

Mr Kothbauer was asked what the significance of the amended terminal forecast would have been had he seen it:

---

[18] The first terminal weather forecast for Dryden issued at 1330Z (7:30 a.m. CST) did not indicate freezing rain (Exhibit 360).

[19] In fact, the next station actual weather observation at 12:00 EST indicated no significant difference in the observed weather.

Q. ... If you would have had occasion to look at that document, would this amendment including ... light freezing rain ... have influenced your decision one way or the other with regard to the continuation of Flight 363 to Dryden with an unserviceable APU?
A. Yes, sir, it would have.
Q. And what ... conclusion would you have come to?
A. Normally, if it was just an occasional as it is in that terminal forecast, I would at least confer with the captain to see what his thoughts on it were, but I would plan a no-stop or to overfly the station.

(Transcript, vol. 49, p. 75)

Mr Kothbauer acknowledged that there was a breakdown in the Air Ontario SOC weather watch/flight following procedure with regard to the dispatch of aircraft C-FONF on the morning of March 10. He and Captain Morwood should have had the benefit of the amended terminal weather forecast at 10:02 a.m. calling for freezing rain at Dryden. The evidence indicates that, with this information, the flight crew may have and SOC would have taken steps to overfly Dryden. The "overfly option" is discussed at greater length in chapter 23, Operational Control.

The MEL: Use and Approval

The previous section revealed a significant error in the dispatch of the aircraft C-FONF. Given that the APU was unserviceable, the aircraft should not have been dispatched into Dryden, where there were no ground-start facilities – particularly in a situation where freezing rain was in the forecast for the Dryden area. This error, which was acknowledged in evidence by the Air Ontario personnel involved, raised serious questions in my mind regarding the ability of Air Ontario to exercise proper operational control over its scheduled flights and led to a review of the dispatch function at Air Ontario (see chapter 20, F-28 Program: Flight Operations Training). The release of the aircraft from the Toronto maintenance base with an unserviceable APU gave rise to a deeper inquiry into Air Ontario maintenance practices.

The Role of Maintenance in the Commercial Air Transportation System

The Aviation Regulation Directorate of Transport Canada is charged with the responsibility of ensuring that air carriers comply with the Air Regulations and Air Navigation Orders. This responsibility encompasses both the approval of new air carrier maintenance operations and the ongoing monitoring of existing maintenance functions.

The approval process involves the regulator reviewing the air carrier's maintenance organization, practices, and key personnel as a precondition to the granting of an operating certificate or an amendment to an operating certificate. Among the conditions precedent to the granting of an operating certificate, Transport Canada specifically requires that air carriers satisfactorily show that the director of maintenance and the chief maintenance inspector of the carrier are competent and qualified to carry out their functions. In addition, the regulations require that the regulator satisfy itself that the air carrier has sufficient ground-support equipment, parts, and adequate facilities to provide "the proper maintenance" of its aircraft (ANO Series VII, No. 2, s.12(1)).

An air carrier is required to submit to Transport Canada for approval a maintenance control manual (MCM) that

> shall contain a description of his maintenance system including the maintenance organization, inspection schedule and maintenance personnel responsibilities relating to servicing, rectification, inspection and certification.
>
> (ANO Series VII, No. 2, s.12(1))

Once approved, the MCM is intended to serve as the yardstick against which the maintenance of aircraft by an individual maintenance department is assessed and audited. In this regard the regulations state:

> No air carrier shall release for flight or operate an aeroplane unless that aeroplane has been maintained and released in accordance with the approved *Maintenance Manual* [MCM].
>
> (ANO Series VII, No. 2, s.12(3))

The regulator is able to revoke an air carrier's operating certificate for maintenance practices that contravene its MCM and hence the Air Regulations, but this sanction is extreme and not often used by Transport Canada.

As is the case with the flight operations component within the air transportation system, a strong interface between the regulator and the air carrier is required for the maintenance component to function effectively. The efforts of the carrier and the regulator meet first at the approval or certification stage and then during the ongoing monitoring of the carrier by the regulator.

In the certification stage, the regulator approves (or disapproves) a particular operation on the basis of the carrier's representations in its application for an operating certificate and on that of the regulator's independent evaluation of the carrier's ability to operate safely. This approval is finalized by the granting of the operating certificate or the amendment of an existing operating certificate to reflect a change in the carrier's operations.

After the granting of the operating certificate, the regulator must ensure compliance with the terms of the approval by way of audits and inspections. In the case of the maintenance organization, the approved MCM is the basis for audit and inspection. Throughout the hearings of this Commission, the evidence confirmed for me that a greater emphasis on regulatory approval and certification will reduce the effort required for post-certification monitoring.

Once approval for an operation has been granted and the operation is under way, the maintenance function within the carrier assumes its responsibility to ensure the airworthiness of the aircraft fleet in accordance with the MCM. Essentially those functions divide into "scheduled" and "unscheduled" maintenance.

Scheduled maintenance consists of major and minor routine checks and overhaul of aircraft components that must be done pursuant to a set schedule prescribed by the aircraft manufacturer. This maintenance represents a benchmark around which the use of the aircraft must be scheduled. The program for the Air Ontario F-28 aircraft was the Fokker "Post Analysis Program" that was approved by Transport Canada.[20]

Unscheduled maintenance encompasses the rectification of defects that result from the day-to-day operation of aircraft. The rectification of these unexpected defects may require taking an aircraft out of service, with the obvious economic consequences. It is understandable that maintenance organizations are often under implicit or explicit pressure to do whatever it takes to get aircraft back into service. This conflict between safety and profitability is addressed directly in the introduction to the Air Ontario Maintenance Control Manual, which reads:

> The standards, practices and procedures as promulgated in this Manual are provided to attain the highest standard of aircraft maintenance in keeping with safety and efficiency. Economic requirements shall not take precedence over safety in the inspection and maintenance function.
>
> (Exhibit 319, p. 1.1)

Unscheduled Maintenance: Defect Rectification and Maintenance Deferral

Unscheduled maintenance, according to the Air Ontario MCM, falls into two broad categories: defects entered into the aircraft journey logbooks by either flight crew or maintenance personnel, which had to be rectified

[20] Exhibit 319, Air Ontario Maintenance Control Manual, p. 4.18A

prior to the release of the aircraft into service; and defects whose maintenance could properly be deferred.

Maintenance deferrals are exceptions to the general rule that defects must be reported as soon as detected and rectified prior to further flight. Deferred maintenance is (or should be) taken very seriously by the regulator, since it represents regulatory permission for an operator to carry revenue passengers in aircraft that are less than completely serviceable. Maintenance deferrals of essential aircraft equipment are permitted within the Canadian regulatory scheme only if the carrier is in possession of a document known as a minimum equipment list (MEL), which is specific to each aircraft type and which must be approved by Transport Canada.

The subject of MEL approval and use received considerable attention during the course of the hearings, since the evidence disclosed not only that Air Ontario maintenance had incorrectly used the MEL in the deferral of the APU prior to the accident, but also that the F-28 had operated for the first six months of its revenue service without an approved MEL.[21] The evidence on the subject raised several questions:

- Why did it take so long for the MEL to gain Transport Canada approval?
- Bearing in mind that there is no legal requirement for an air carrier to have an approved MEL, should there have been approval of the amendment to the Air Ontario operating certificate to include the F-28 aircraft without an approved MEL in place?
- How effective was Transport Canada in monitoring Air Ontario's F-28 operation during the six-month period when there was no approved MEL in place, and the probability existed that the aircraft was being operated with unserviceable components and perhaps without a valid certificate of airworthiness?
- When the MEL was finally approved, were operational personnel at Air Ontario using it properly?
- Were Air Ontario personnel sufficiently trained on MEL use?

Description

In chapters 22, F-28 Program: Flight Attendant Shoulder Harness, and 34, Operating Rules and Legislation, I review the process behind the

[21] Air Ontario commenced its commercial F-28 service in June 1988 with one aircraft, C-FONF. The sister aircraft, C-FONG, arrived in Canada to begin service in November 1988. The MEL for the Air Ontario F-28 was verbally approved by Transport Canada on an interim basis in December 1988 and formally approved by Transport Canada in June 1989.

certification of aircraft types in Canada and how, after certification or "type approval" by Transport Canada, carriers may operate such type-approved aircraft subject to the Air Navigation Orders.

It has long been recognized by regulatory bodies that modern transport category aircraft are designed and certified with sufficient redundancies in their systems to ensure a margin of safety in their operation. It has also been recognized that, with such redundancies, it is within acceptable bounds of safety for carriers to operate an aircraft with some unserviceable components. If regulators insisted on complete aircraft serviceability prior to each flight, unnecessary groundings would occur, with a resulting loss of income to the carrier. Therefore, out of necessity and common sense, some leeway has been granted to air carriers in the operation of their aircraft with non-essential equipment in less than a completely serviceable state.

The carriers, for obvious reasons, would prefer this departure from complete serviceability to be generous and flexible. The role of the regulator within the air transportation system is to restrict variances from complete aircraft serviceability as narrowly as is necessary to ensure an acceptable level of safety in commercial air carriage.

A minimum equipment list (MEL) is a Transport Canada–approved document that authorizes an air carrier to dispatch an aircraft with specified essential equipment inoperative under the conditions specified therein. A functional definition of the MEL is provided by an internal Transport Canada policy document entitled MMEL/MEL (Master Minimum Equipment List) Policy and Procedures (January 1, 1990):

> The MEL is a joint operations and maintenance document prepared by an operator to:
> a) identify the required essential equipment to maintain the Certificate of Airworthiness in force and to meet the operating rules for the type of operation;
> b) define operational procedures necessary to deal with inoperative equipment; and
> c) define maintenance procedures necessary to maintain the required level of safety and procedures necessary to secure any inoperative equipment.
>
> (Exhibit 962, p. 21)

In order to fly an aircraft with inoperative essential equipment, the air carrier must make certain operational and/or maintenance accommodations that are clearly specified in the approved MEL.

The governing order on MEL approval and use is Air Navigation Order Series II, No. 20, CRCc.-25, *Aircraft Minimum Equipment List Order* (ANO Series II, No. 20). The essence of the order is contained in section 7, which states:

> s.7 No air carrier shall operate an aircraft if any essential aircraft equipment is inoperative unless he does so in compliance with a minimum equipment list.

A slight qualification is provided in section 8 of ANO Series II, No. 20:

> s.8 Notwithstanding section 7, no aircraft shall be operated where, in the opinion of the pilot-in-command, flight safety is or may be compromised.

"Essential aircraft equipment" is defined as:

> ... an item, component or system installed in an aircraft, that
> (a) has a primary role of providing information or performing a function required by regulation or order; or
> (b) is directly related to the airworthiness of the aircraft.
>
> (ANO Series II, No. 20, s.2[22])

In the absence of an approved MEL, a transport category aircraft cannot operate unless 100 per cent of its essential aircraft equipment is serviceable.

Using the Air Ontario F-28 MEL

An aircraft can operate on a revenue flight only if qualified maintenance personnel release it or "sign it out" as being airworthy. It is then the responsibility of the flight crew to satisfy itself that the maintenance personnel have appropriately addressed the defects noted in the aircraft journey log and either to reject or accept the aircraft for revenue service.

In the case of a defect or unserviceability, such as the problem with the APU, maintenance personnel will read the description of the problem in the journey log and assess whether the defect is one that must be fixed prior to release of the aircraft or one that can be deferred to be fixed at a later time. To determine whether defect rectification can be deferred, the MEL must be consulted.

Compliance with an MEL allows an operator to defer the repair of an aircraft component or system and to fly without all of the essential equipment operative, either to complete a flight segment or until repairs can be made. At the date of the accident on March 10, 1989, there were no specific limits on the length of time that the rectification of a defect

---

[22] There was considerable testimony regarding the lack of clarity in the definition of "essential equipment" and the absence of definition of the term "airworthiness." This language of the ANO is discussed below.

could be deferred.[23] Instead, the Aircraft Minimum Equipment List Order puts the onus on the carrier to "establish, obtain approval for and publish internal procedures for making repairs or replacements to equipment specified in the minimum equipment list to ensure that the aircraft does not operate for an unacceptable period of time with specific aircraft equipment inoperative" (ANO Series II, No. 20, s.10).

In the preamble to the Air Ontario Inc. Minimum Equipment List F-28, the matter of persistent or indefinite deferrals was addressed as follows:

> The MEL was never intended to provide for continued operation of the aircraft for an indefinite period with inoperative items. The basic purpose of the MEL is to permit the air carrier to operate an aircraft with inoperative equipment within the framework of a controlled and sound program of repairs and parts replacement. It is important that the operator consider making repairs at the first airport where repairs or replacements may be made, but, in any case, repair should be accomplished at the first opportunity, since additional malfunctions may require the airplane to be taken out of service.
>
> (Exhibit 310, pp. ii–iii)

The most important consideration when using an approved MEL is prudence. To this end maintenance departments are cautioned not to have multiple deferrals; and, when there are deferrals, they should be rectified as soon as possible. Overriding these considerations is the necessity of having personnel who are well trained in the use of the MEL. On this latter point, each of the maintenance personnel involved in the subject deferral of the APU had received the F-28 course given by Piedmont Airlines and were F-28 qualified. Their mistake, described below, was one of misinterpretation of the MEL and not necessarily one of incompetence as aircraft maintenance engineers. I was impressed with the openness with which they acknowledged their oversight; I also took note of the fact that the deferral was done with the assigned flight crew waiting to get the F-28 into service after it had already missed several scheduled departures on March 9, 1989, because of the attempted repairs of the APU.

When interpreting an MEL, maintenance personnel must be aware not only of the function of the aircraft system being deferred but also of any operating restrictions imposed because of the deferral. Even though many individual systems may be deferred separately, there are restric-

---

[23] In the wake of the accident, and after considerable evidence had been heard on the deferral of the APU on C-FONF, Transport Canada published its new MMEL/MEL Policy and Procedures Manual (Exhibit 962), which establishes specific limits on the length of time that a maintenance deferral can persist. I find this to be a sensible initiative which, if enforced, should all but eliminate indefinite maintenance deferrals.

tions on the deferral of multiple components and systems that are complementary. The MEL specifies what systems are needed as a minimum to dispatch the aircraft.

The MEL also describes the conditions under which the aircraft may be operated with specific unserviceabilities. Some operating conditions require action by maintenance personnel and are listed as maintenance (M) procedures. Other conditions require action by the pilots and are listed as operational (O) procedures. Not all items of aircraft equipment are included in an MEL. Obviously nonessential equipment such as galley equipment and interior trim are not listed. However, some essential items are also not included, as described in the preamble to the Air Ontario Inc. Minimum Equipment List F-28:

> For the sake of brevity, the MEL does not include obviously required items such as wings, rudders, flaps, engines, landing gear, etc. However, it is important to note that ALL ITEMS WHICH ARE RELATED TO THE AIRWORTHINESS OF THE AIRCRAFT AND NOT INCLUDED ON THE LIST ARE AUTOMATICALLY REQUIRED TO BE OPERATIVE.
>
> (Exhibit 310, p. ii)

What guidance exists that provides a clear definition as to which items are directly related to the airworthiness of the aircraft? This issue is addressed in detail later is this chapter in the section, MEL Approval and Use: Governing Legislation.

Deferring the Repair of the APU

The decision on March 9, 1989, to defer the repair of the APU fire-detection system pursuant to MEL number 49-04 rather than 49-01 was made collectively by aircraft maintenance engineer Kostas Athanasiou, maintenance inspector Steven Korotyszyn, and F-28 check pilot Captain Robert Perkins (see figure 16-3).

Mr Korotyszyn's evidence indicated a certain amount of confusion in his mind as to the operability of the APU, given the problem with the fire-detection system. On March 9 he agreed with Mr Perkins and Mr Athanasiou that 49-04 was the appropriate deferral number, but he advised Captain Perkins not to use the APU.

Figure 16-3 Excerpt from Air Ontario's F-28 MEL

SYSTEM & SEQUENCE NUMBERS	1. ITEM	2. NUMBER INSTALLED	3. NUMBER REQUIRED FOR DISPATCH	4. REMARKS OR EXCEPTIONS
49-01	APU	1	0	*(M)(O)May be inoperative for: (a) Air only, or (b) Electric only, or (c) Both, provided: (1) Inoperative function(s) not required for ground or flight operation, and [M] or [O] (2) If electrically inoperative, automatic bus transfer system is checked prior to each flight and found to be operating normally. (After both engines running, alternately switch generators 1 and 2 off and observe that remaining generator picks up the load.)
...				
49-04	APU Fire Extinguishing System	1	0	*(O) May be inoperative. [O] (1) Use APU for engine start only. (2) Pilot to arrange constant monitoring of APU by ground crew when operating. (3) Shut down APU immediately after engines started. (4) No passengers may be on board while APU operating.

Source: Based on Exhibit 310

Mr Korotyszyn was also concerned that some stations might not have fire pickets available, ground crew who stand by during startup with fire-extinguishing equipment. This would seem to be an operational consideration that would more properly be the responsibility of the captain. Mr Korotyszyn stated in testimony:

> Q. ... Did you obtain some information from Captain Perkins that in fact there may be somewhere along the path where there's no ground start? Did you obtain that information?
> A. I did not.
> Q. Why did you tell him not to use the APU, then?
> A. He may not have been able to get a fire picket at some of the stops.
> Q. Did you tell him that?
> A. I did not.
> Q. Was he supposed to know that?
> A. Well, he would – he would know that, yes.
>
> (Transcript, vol. 42, pp. 51–52)

During the hearings, all three individuals involved in the decision testified that the APU should have been deferred under MEL item 49-01. Mr Athanasiou explained the basis of his error:

> Q: ... In retrospect today ... after viewing the MEL and the entry in the journey log, do you remain of the opinion that 49-04 is the correct entry that the APU should have been deferred under?
> A: No, it's incorrect.
> ...
> The detection system and the extinguishing systems are actually two different systems.
> Now they fall under different ATA[24] chapters or the same ATA chapters but different subsections. So it is actually the wrong deferral, 49-04.
> (Transcript, vol. 42, pp. 107–108)

Mr Korotyszyn also acknowledged that, in the absence of any specific MEL provision regarding the APU fire-detection system, the appropriate deferral would have been under the general APU section, 49-01:

> Q. And 49-04 says what under the Item column?
> A. "APU fire extinguishing system."
> Q. It does not say, I take it, "APU fire detection system"?
> A. No, it does not.
> Q. Is there anything in section 49 relating to APU fire detection system?
> A. There is not.
> Q. And the information passed to you by Mr Athanasiou, I take it, was APU ... will not fire test; is that correct?
> A. That is correct.
> Q. And that document is the only document you relied upon that day to make the deferral; is that correct?
> A. Yes, it was.
> Q. And now, in retrospect, you say that 49-04 is not the appropriate item; is that correct?
> A. That is correct.
> Q. And is the reason you say it is not appropriate in that it doesn't say "fire detection system"; is that correct?
> A. That is correct.
> (Transcript, vol. 42, pp. 41–42)

[24] The Air Transport Association, which determines technical aircraft standards

It was normal procedure for Air Ontario pilots to operate the APU during every takeoff and landing. This was done because the APU provides electrical power backup in the case of an engine failure. Electrical power is normally provided by two generators that are driven by the main engines. The bus transfer system is designed to transfer all electrical loads automatically to the remaining generator should one generator fail. In the event of a problem with the transfer of electrical load when there is an engine or generator failure, the APU generator would be available as a backup.

When the APU is electronically inoperative or otherwise unserviceable, its maintenance may be deferred pursuant to MEL section 49-01, which requires the pilots to make certain that the bus transfer system is working prior to each flight. An F-28 cannot operate if both the APU and the bus transfer system are unserviceable.

A deferral of the maintenance of the APU fire-extinguishing system pursuant to MEL section 49-04 allows the APU to be used for engine starts only with conditions. This effectively eliminates the use of the APU to provide backup electrical power on takeoff and landing. Apart from the use of the APU on engine startup, a deferral pursuant to MEL section 49-04 renders the APU as inoperable as does a deferral pursuant to section 49-01; yet there is no provision under 49-04 requiring a pre-flight check of the serviceability of the bus transfer system.

Captain Perkins recognized the deficiency in the section 49-04 deferral and, on his own initiative, carried out a check of the automatic bus transfer system, which he referred to as a "cross-tie check." He explained this procedure:

Q. And you operated the APU as if it was MELed under 49-01?
A. We operated the APU as if it was not there.
Q. All right, you did the cross-tie check as if it was MELed under 49-01?
A. It's mentioned in 49-01, yes.
Q. And could you tell me, then, again why you did this cross tie-check before every leg of that flight?
A. Under a normal operation, the APU is considered in a standby mode; in other words, the number 1 engine generator and the number 2 engine generator are providing all the power supply for the aircraft.

In the event that one of those generators or, in fact, one of the engines should stop producing electrical power, then the standby generator, which is attached to the APU, would pick up that load from that failed engine ...
Q. And indeed, that third generator, sir, is a bit of a safety factor, is it not?
A. It is. It is a safety factor.
Q. And it is a safety factor particularly on takeoff?

> A. It's a safety factor at any time that it's on. It's an added buffer.
> (Transcript, vol. 43, pp. 166–67)

The aircraft could have been dispatched out of the Toronto maintenance base under either deferral number. However, the operational limitations facing Captain Morwood were different under 49-01 and under 49-04. A deferral under 49-01 means that the APU can be inoperative as a source of air or electricity or both only if

> (1) inoperative functions of air or electricity or both are not required for ground or flight operations; and
> (2) if electrically inoperative, the bus transfer system is checked prior to each flight and found to be serviceable.
> (Exhibit 310, s.49-01)

Section 49-04 does contemplate APU use under the following stated circumstances:

> (1) Use APU for engine start only.
> (2) Pilot to arrange constant monitoring of APU by ground crew when operating.
> (3) Shut down APU immediately after engines started.
> (4) No passengers may be on board while APU operating.
> (Exhibit 310, s.49-04)

Finally, to complete the deferral after the journey log entry was made, an "INOP" placard was stuck to the APU panel in the cockpit. An INOP placard is used by maintenance to ensure that the pilots or other maintenance personnel do not activate the affected system without checking the journey log for a description of the snag.

The INOP placard would have directed Captain Morwood to the aircraft journey log, where he would have noted the snag and the deferral via MEL item 49-04. On reading the journey log he may have discovered the inconsistency between the description of the snag ("will not fire test") and the deferral number ("Fire Extinguishing System"). How he would have reacted to this inconsistency is uncertain. It is possible he would have appreciated that the deferral was incorrect and favoured the instructions provided by 49-01 that the APU was not to be used except in the very limited circumstances described. What is known is that he did not contact SOC or maintenance to seek clarification. Further, he made no attempt at any time to use the APU. I am of the view that this latter point is most determinative of his state of mind. Had he considered that the APU was operable under the conditions described in 49-04, he would have had good reason to use the APU during the fuelling in Dryden and for de-icing if needed. Any thoughts Captain Morwood may have had that the APU was inoperable may have originated or at least been reinforced by the SOC instruction that the APU was unserviceable and that the right engine was to remain running through Dryden.

Findings

After reviewing all of this evidence, I am left with the following conclusions:

- After a protracted approval procedure during which both Air Ontario and Transport Canada supposedly examined the MEL line by line, the resulting MEL was nevertheless misunderstood and misused by two experienced maintenance engineers and an experienced airline captain.

- Two further implications are suggested by the misuse of the MEL:
  First, prudent practice would dictate that aircraft C-FONF should not have been repeatedly dispatched out of the maintenance base with the APU unserviceable.
  Second, SOC personnel should have understood (a) that there would be no rectification of the defect until the aircraft returned to Toronto, and (b) that they should have planned to cancel all operations into Dryden until the APU was operational.

I will now examine the MEL approval process, which, as it turned out, was one of the most disconcerting aspects of this investigation.

MEL Approval

In its application to include the F-28 on its operating certificate, Air Ontario represented to Transport Canada that an MEL would be in place prior to the F-28 commencing revenue service. One such representation is the following:

> Prior to the assignment of the F-28 type to Revenue Service, each Operations Officer will receive a conversion course to familiarize him/her with the F-28 with emphasis on flight planning, performance, and minimum equipment list requirements.
>
> (Air Ontario Application To Amend Operating Certificate To Include F-28 Aircraft (Jan. 24, 1988), Exhibit 855, p. 41)

The amendment to the Air Ontario operating certificate was granted as of June 1988, immediately prior to the commencement of its F-28 commercial service. The F-28 was operated commercially without an approved MEL until December 1988.

An approved MEL is at present not a requirement in Canada for transport category jet operations; however, without an approved MEL, an aircraft must be operated with 100 per cent of its essential equipment serviceable. If an air carrier does not have an approved MEL, and it operates an aircraft with unrectified defects in essential equipment, then the carrier, the aircraft maintenance engineer (AME) who released the aircraft, and the pilot who accepted the aircraft are in breach of the law. In such a situation, the carrier's operating certificate and the licences of the pilot and the AME are at risk of revocation.

The Air Ontario F-28, C-FONF, was an older aircraft[25] that had been mothballed in Turkey for two years prior to its importation to Canada. The aircraft was part of a new service that Air Ontario management – which was under some competitive marketing pressure – was intent to put in place as soon as possible. Transport Canada officials knew or ought to have been aware of these facts.

The continued commercial operation of the F-28 without any defects in its essential equipment was for all practical purposes impossible. It should have been similarly obvious that there would be a great temptation on the part of the carrier to keep the aircraft flying in spite of such inevitable unserviceabilities – even if that meant deferring the maintenance of the unserviceabilities in the absence of an approved MEL. The evidence revealed that such deferrals did indeed occur in the Air Ontario F-28 operation.

I am of the view that, from a practical flight safety perspective, the amendment to the operating certificate permitting F-28 operations should never have been granted without an approved F-28 MEL in place. In this regard, as in other instances, I found the explanation of Transport Canada and Air Ontario witnesses that it was "legal" to operate without an MEL to be entirely unsatisfactory. If an air carrier operation is not as safe and sound as the experience of an individual carrier or regulator would indicate that it should have been, then, in recognition of the duty owed to the travelling public, it is unacceptable for either the carrier or the regulator to justify its own inaction by relying upon a characterization of such an operation as "legal."[26]

The Role of the Regulator in Approving the MEL

A typical MEL approval requires the carrier to prepare an MEL for its particular operation, referencing the master minimum equipment list (MMEL) prepared by the aircraft manufacturer. The air carrier MEL

---

[25] Aircraft C-FONF was manufactured and delivered by Fokker to its first owner, THY, in January 1973.

[26] It is significant that these deferrals, in the absence of an approved MEL, would not have occurred within the parent company, Air Canada. Approved aircraft MELs are always in place at Air Canada prior to the approval of operating certificate amendments authorizing commercial service.

must at least comply with the minimum standards set out in the MMEL and be "tailored to the carrier's specific operating environment."[27]

The MMEL is approved by Transport Canada during the aircraft type certification process. The MMEL serves essentially the same function as the MEL, representing what the manufacturer considers to be a level of aircraft systems serviceability required to maintain a necessary standard of airworthiness. Because the MMEL represents the standard against which all carrier MELs will be compared, the MMEL is scrutinized with great care by Transport Canada before its approval is granted.

Transport Canada's MMEL/MEL Policy and Procedures Manual provides the following explanation regarding the prohibition against carrier use of the MMEL:

> While the MMEL is for an aircraft type the MEL is tailored to the carrier's specific operating environment and may be dependent upon the route structure, the geographic location, and number of airports where spares and maintenance capability are available etc. It is for this reason that a MMEL cannot be approved for use as a MEL by an air carrier.
>
> (Exhibit 962, p. 21)

As described by Mr Martin Brayman of Transport Canada's Ontario Region, once the air carrier completes the MEL in the prescribed form, two copies are then submitted to Transport Canada, where it is reviewed by airworthiness personnel, who review the maintenance aspects of the MEL, and air carrier personnel, who review the flight operations components. In addition, some input is provided from passenger safety personnel.

In the case of the approval of the Air Ontario F-28 MEL, Mr Brayman was the principal air carrier inspector from Ontario Region who was involved in the approval process. The Air Ontario F-28 MEL was first submitted for approval on February 3, 1988, by Captain Robert Nyman, Air Ontario's director of flight operations. Within Ontario Region, the MEL was reviewed by Mr Brayman and Mr Ole Nielsen of the Airworthiness Branch. Shortly after the initial submission, the document was returned and Air Ontario was informed that the MEL had to be amended to conform with the required form. On September 15, 1988, more than seven months later, Air Ontario submitted a second draft of the proposed MEL to Transport Canada's Ontario Region. By this time, Ms Jacqueline Brederlow, the passenger safety superintendent, Mr Randy

---

[27] ANO Series II, No. 20, section 5, and Exhibit 962, Transport Canada MMEL/MEL Policy and Procedures Manual, January 1, 1990

Pitcher of the Air Carrier Branch, and Mr Alexander Brytak, an inspector in the London office of Ontario Region, became involved in the process.

On December 13, 1988, after Ontario Region and Air Ontario eventually agreed on its form and content, the MEL was forwarded to Transport Canada headquarters for final approval. At headquarters, Mr Ian Umbach and Mr William MacInnis reviewed the document. Shortly thereafter, Captain Nyman of Air Ontario and Captain Joseph Deluce received a verbal "interim" approval of the F-28 MEL from Mr Pitcher. Captain Deluce then issued a memorandum dated December 19, 1988, to Air Ontario F-28 pilots advising that the F-28 MEL had received interim approval and that MEL manuals had been placed on board the two aircraft.

The precise status of the interim approval was unclear from the evidence. Captain Nyman testified that, in December 1988, on the request of Captain Joseph Deluce, he took steps to amend an earlier draft of the MEL to satisfy the concerns of Mr Brytak of Transport Canada. While this amendment process was continuing, Mr Pitcher telephoned to indicate that the earlier draft of the MEL was approved. This incongruous situation of one Transport Canada employee requesting changes to the MEL while another Transport Canada employee provided interim approval was apparently of no concern to Captain Nyman and Captain Deluce. After many months of waiting, they understandably seized upon Mr Pitcher's "interim approval" and, without question or criticism, took immediate steps to place the MEL in their two F-28s for the use of their crews.

Formal approval of the MEL came in the form of a teletype message dated June 9, 1989, sent from Mr Umbach, via Mr B. MacLellan of Air Carrier Operations in Ottawa, to Transport Canada's Ontario Region. A copy of the message was sent to Mr James Morrison, Air Ontario's vice-president of flight operations.

The original MEL was submitted to Transport Canada in February 1988. More than ten months later, after at least seven individuals within Transport Canada had an opportunity to review and comment on the document, Air Ontario had "verbal interim approval" to use the MEL and, in June 1989, one-and-a-half years after the process started, Transport Canada issued formal approval for the document.

In the same month that the MEL was formally approved, Air Ontario discontinued its F-28 program. Air Ontario F-28 pilots had been deferring the maintenance of essential aircraft equipment in the absence of an approved MEL since June 1988, in apparent contravention of ANO Series II, No. 20.

I calculate approximately seven months of the delay – from February to September 1988 – to be primarily attributable to Air Ontario; and nine months of the delay – from September to the December "interim approval" and from December 1988 to the June 1989 formal approval – to be primarily attributable to Transport Canada. I wish first to discuss the delay I assign to Transport Canada – particularly the period from September to December 1988, and then go on to look at Air Ontario's role in the preparation and approval of the MEL.

Mr Brayman provided the following explanation for the delay in the approval process:

> Q. Now, can you tell us why it would have taken so long, 10 months, to have an MEL approved for the F-28?
>
> A. There were two reasons. One, the original copies of the MEL as submitted by the company were unacceptable, and I can't speak for airworthiness, but I remember at the time speaking to Mr Nielsen about it several times. He had returned his copy of the MEL to the company with a specific request to change the format, and I gather the revised copy was a long time in coming back.
>
> I also believe that at that time, the responsibility for monitoring the company had been transferred from the Ontario regional office of airworthiness to the London office, and I think that the inspector down there, his name was Alex Brytak, I think he took over responsibility for ensuring the company produced a working MEL.
>
> We also had a major problem in headquarters ... I believe they had two different inspectors working on the MEL program. One was a gentleman called McInnis, and I do believe that he was so overloaded that at one time, he probably had 20 such documents sitting on his desk.
>
> An MEL is a very technical document and requires a great deal of checking. You have to go through it word for word, clause by clause, and I don't believe that there were sufficient bodies available to do the job that was needed.
>
> Q. Was there any pressure at your level from region to expedite the approval process of the MELs?
>
> A. Well, there was a considerable pressure from operations at Air Ontario. This is an ongoing process. And I'm sure Mr Nyman was on the phone numerous times asking me, you know, what was happening with the MEL.
>
> But we could only refer him to his own maintenance department, who were partly responsible, and basically tell him we would follow up and see what we could get for him. We weren't very successful a lot of times.
>
> Q. In attempting to assist Mr Nyman?
>
> A. In attempting to get these documents pushed through so they were approved.
>
> (Transcript, vol. 131, pp. 131–32)

With great respect to Mr Brayman, whom I found to be a forthright and credible witness, I am not at all persuaded by the reasons offered for the delay. It seems to me that the problem was not simply one of "overloading" any one individual, but was also one of an unnecessarily complicated and bureaucratic approval process.[28] Mr Brayman described some seven individuals in three Transport Canada offices who were involved, communicating with each other and the carrier via written memoranda and correspondence.

I have reviewed the F-28 MEL, the MMEL, and the Aircraft Minimum Equipment List Order, and I do not believe I am being overly simplistic in saying that the entire approval process could have been finalized in the course of a single constructive meeting among an airworthiness and air carrier representative from Transport Canada and a flight operations and maintenance representative from Air Ontario. I heard the evidence of Messrs Brayman, Nielsen, Nyman, and Kenneth Bittle and I feel confident in saying that, if Air Ontario had put forth an honest effort in producing a reasonable first draft of the document, these four gentlemen could have effected its approval to everyone's satisfaction in a much shorter period of time.

The process simply should not be so complicated. Transport Canada correctly devotes much time and effort to the approval of the MMEL. Once this MMEL standard is accepted by the regulator, then the process of MEL preparation and review should be straightforward.

The MEL should be "tailored to the carrier's specific operating environment," but how idiosyncratic can such operating environments be? Air Ontario's proposed deployment of the F-28 was modest, operating initially from Toronto to Sault Ste Marie, Thunder Bay, Dryden, and Winnipeg, with Toronto representing the main maintenance base and Winnipeg providing routine line maintenance. Any peculiar accommodations for such line operations should have been narrow and easily identified.

What is particularly galling is that, in spite of this protracted process of review and amendment, the approved MEL was significantly deficient. The APU deferral sections 49-01 and 49-04 were inconsistent with each other and they contained no restriction on line operations into stations without ground-start facilities using an aircraft with an unserviceable APU.

---

[28] Transport Canada MMEL/MEL Policy and Procedures Manual, Exhibit 962

Transport Canada's MEL Approval Policy: Recent Developments

Since Commission investigators made their first inquiries about the deficiencies in the approval and use of the Air Ontario F-28 MEL, Transport Canada has published its MMEL/MEL Policy and Procedures Manual. I would like to express my support for three significant initiatives in this new policy document, which, I believe, will improve MEL approval and use.

First, a time limitation has been placed on deferrals through a program of amending approved MMELs such that maintenance deferrals are categorized according to set schedules of required defect rectification. Air carriers have 120 days to amend their own MELs to conform with the MMEL containing the new categorized repair limits. This program would eliminate the practice of indefinitely deferring the maintenance of certain items, which was discouraged but not prohibited by the former policy. I commend this initiative, and I hope that the program proceeds to a prompt conclusion.

Further, I note that the new Transport Canada MEL policy manual specifically prohibits "interim approvals" while the MEL is undergoing the review process. The confusion surrounding the verbal interim approval of the Air Ontario F-28 MEL supports the idea that an "interim approval" is really no approval at all. The regulator must satisfy itself that the MEL is acceptable, and then promptly issue a formal approval and authorization of use. This view was supported by Mr William Slaughter, director of flight standards at Transport Canada headquarters, who agreed that the verbal approval of MELs is unacceptable and has now been discontinued.

Another commendable aspect of the initiative is the delegation to regional managers of the responsibility and authority to approve MELs within their jurisdiction. In so doing, Transport Canada headquarters is removed from the decision-making process. In the case of Air Ontario's F-28, the additional step of sending the MEL to Mr Umbach would have been avoided under the new policy.

While this streamlining of the approval process is certainly a positive step, I am perplexed that Transport Canada still insists upon a review process involving so many people. Under the new policy, when the MEL is received from the air carrier, the regional manager of air carrier operations forms an MEL Review Group to assess the proposed MEL and work with the carrier until the group is able to recommend to the regional manager that the MEL be approved. The MEL Review Group is to consist of:

- a chairman who is the principal air carrier inspector for the carrier;

- the lead air carrier inspector on type;
- the principal airworthiness inspector for the carrier;
- the lead airworthiness inspector on type (if required);
- a passenger safety inspector (if required);
- a regional MEL coordinator (if required); and
- a regional airworthiness avionics inspector operators [sic].

(Based on Exhibit 962, app. E)

There are therefore anywhere from four to seven people involved at the regional level in the review of the MEL. By way of explanation the policy states that "[t]he purpose of forming such a group is two-fold. Firstly, authority; secondly, proper coordination between Airworthiness and Operations is formalized to ensure approvals can be achieved in a timely manner" (Exhibit 962, app. E).

To reiterate my earlier comment, it seems to me that the process should be fairly straightforward. The carefully approved MMEL should be the starting point, against which the carrier MEL deviates only to the extent that the carrier and the regulator seek to make operational and maintenance limitations more restrictive to reflect idiosyncrasies in the carrier's operation. On the regulatory side, I do not believe that MEL approval requires the involvement of more than one individual each from air carrier and airworthiness who are familiar with the particular aircraft type.

Throughout these hearings I heard much disturbing evidence regarding the lack of resources available within Transport Canada during a period of economic deregulation of the airline industry. For the reasons elaborated upon below, there were undoubtedly resourcing problems within some areas of Transport Canada. In the present case, however, I am firmly of the view that staffing problems were not the root cause of delays in the MEL approval process; rather, the delays were attributable to an unnecessary duplication of effort. Why have eight people reviewing each other's work when two competent individuals can do the job?

Air Ontario's Role in the Preparation and Approval of the MEL

I will now deal with Air Ontario's involvement in the MEL preparation and approval. More specifically, I am concerned with the actions of Air Ontario management prior to the February 1988 submission of the first-draft MEL to Transport Canada and during the months from February to September 1988 when the rejected first draft was back in its hands.

Air Ontario management recognized that it would require an MEL for the F-28 in order to operate its aircraft efficiently and effectively. Accordingly, the initial plan was to have a Transport Canada–approved

MEL in place before the F-28 aircraft was put into service. This was documented by the Air Ontario Inc. F-28 Project Plan 1987, which stated:

> The Vice President of Maintenance and the Director of Flight Operations would develop workable MEL for our environment and obtain MOT approval. Fokker's, Piedmont's Norcan Air's and Quebecair's MELs will be used as reference.
>
> (Exhibit 799, p. 3)

According to the original October 1987 Project Plan, the MEL was to be developed and approved by the final week of March 1988. In the Revised Project Plan of December 28, 1987, the projected completion of the development and approval of the MEL was advanced four weeks to February 29, 1988.[29]

Captain Robert Nyman was director of flight operations during this period and, as such, had co-responsibility with the vice-president of maintenance, Mr Kenneth Bittle, for production and approval of an MEL. By correspondence dated February 3, 1988, Captain Nyman submitted the first draft MEL for approval to Transport Canada. Mr Brayman testified that this first document was immediately sent back to Air Ontario for rewriting because it was unacceptable (Transcript, vol. 131, p. 131).

Captain Nyman, while acknowledging responsibility for production of the F-28 MEL, stated that he delegated the task to Captain Joseph Deluce. Captain Nyman provided no clear reason why there was such a delay in the production of the second draft of the MEL (Transcript, vol. 107, p. 199). He testified that, having delegated the task of producing the MEL to Captain Deluce, he did not monitor the progress regularly. His recollection of the events surrounding the MEL approval was vague:

> Q. So you knew that ... operating the aircraft without an MEL would be a problem, and it was a full year from the striking of the implementation plan to the approval of the MEL –
> A.. Yeah.
> Q. – and, yet, you recall no specific steps taken to monitor the progress of the MEL ... [I]s there an explanation for that?
> A. ... I do not recall personally taking specific steps. There was during that time, of course, the pilot strike, during which – I think it was for a couple of months. That certainly would have occupied much of my time and much of Joe Deluce's time also.

[29] Exhibit 802, Air Ontario Inc. Revised F-28 Project Plan, p. 104 (December 28, 1987)

> I'm not sure what progress maintenance may have been making on the MEL during that period. I really can't say.
> (Transcript, vol. 107, p. 200)

Captain Nyman acknowledged that, although the plan was to have an MEL in place prior to commencing F-28 service, Air Ontario was "a little bit optimistic" in its projections (Transcript, vol. 107, p. 201).

Captain Deluce's evidence on his involvement with the production of the MEL was equally unclear and seemingly not forthright. He acknowledged that, as F-28 chief pilot, he was concerned with the timely production of F-28 standard operating procedures and the F-28 MEL (see chapter 19, F-28 Program: Flight Operations Manuals). He provided the following explanation: "I pursued the MEL and the standard operating procedure in the best manner that I could" (Transcript, vol. 111, p. 183). Captain Deluce also pointed out that he officially became the F-28 chief pilot in December 1988, the same month that the MEL was verbally approved on an interim basis. He seemed to be suggesting that he believed he had no responsibility over the MEL until he officially became F-28 chief pilot. This would contradict the evidence of Captain Nyman that the matter had been delegated to Captain Deluce; and it would also contradict Captain Deluce's own correspondence as the "F-28 Project Manager" to Mr Brayman dated September 15, 1988, wherein he enclosed the second draft MEL for approval (Exhibit 818). In any event, Captain Deluce did not provide any satisfactory explanation as to why the draft MEL remained at Air Ontario from February until September 1988.

Mr James Morrison took over as vice-president of flight operations in July 1988. He testified that, within weeks of his arrival at Air Ontario, Captain Nyman advised him that the F-28 had no approved MEL and that a revised draft was in the hands of Transport Canada. Mr Morrison stated that he did nothing to follow up on the status of the F-28 MEL, though he was aware that Air Ontario's two F-28 aircraft were operating without an MEL until the verbal interim approval came in December 1988 (Transcript, vol. 115, pp. 110–11).

Mr Bittle testified that, in early March 1988, he delegated to Mr Teoman Ozdener, the Air Ontario F-28 maintenance manager, the responsibility of working with flight operations to produce an MEL (Transcript, vol. 103, pp. 134–41). Mr Ozdener testified that he attended at Norcan Air/TimeAir on March 29–30, 1988, to observe their facilities. He was advised by personnel at that airline that their MEL was being approved by Transport Canada and that, when approval was obtained, they would forward a copy of the MEL to Air Ontario for reference. Mr Ozdener advised Mr Bittle that they would be in receipt of the Norcan

Air MEL by the end of April 1988.[30] Mr Ozdener testified that as of June 1988, Captain Robert Murray of Air Ontario asked him for assistance in the "finalization" of the MEL. Mr Ozdener stated that Captain Murray had rewritten the February 1, 1988, version of the MEL, which was "no good," to produce a second draft dated May 14, 1988. Mr Ozdener, with the assistance of Mr Murray Keith of Transport Aérien Transrégional (who was in London, Ontario, to assist with the importation of C-FONF), prepared their maintenance-related restrictions on the MEL. Mr Ozdener had no further evidence on the status of the MEL other than his best recollection that, based on "second-hand information," he understood that verbal approval of the MEL was achieved in late October or early November 1988 (Transcript, vol. 101, pp. 86–87).

These five individuals within the Air Ontario flight operations and maintenance departments – Messrs Nyman, Deluce, Morrison, Bittle, and Ozdener – had varying degrees of responsibility for the timely completion of the MEL. Their evidence on the subject was vague and somewhat contradictory.

Findings

After considering all the evidence on the subject, I make the following findings:

- The F-28 project plans of October and December 1987 identified the director of flight operations, Captain Robert Nyman, and the vice-president of maintenance, Mr Kenneth Bittle, as being responsible for the production of the F-28 MEL.

- Captain Nyman delegated the flight operations component of the MEL to Captain Joseph Deluce. Mr Bittle, as of March 1988, delegated the maintenance component of the MEL to Mr Teoman Ozdener.

- A first draft MEL was submitted by Captain Nyman to Transport Canada in February 1988 and was found to be unacceptable.

- In June 1988, on the eve of the introduction of the F-28 into commercial service, Captain Robert Murray, with the assistance of Mr Ozdener and Mr Murray Keith of TAT, rewrote the February MEL to produce a second draft of the document.

- Mr Morrison became the vice-president of flight operations in July 1988 and was advised by Captain Nyman that the second draft of the

[30] Transcript, vol. 101, p. 68. See also Exhibit 817, Report of Mr Teoman Ozdener re: trip to Norcan Air/TimeAir March 29–30, 1988.

MEL was in the hands of Transport Canada. In fact it was not until September 15, 1988, that Captain Joseph Deluce, as the F-28 project manager, submitted the second draft of the document to Transport Canada.

- Witnesses Nyman, Deluce, Morrison, Bittle, and Ozdener were questioned at length on the subject, yet no one could offer an explanation for the delay between the rejection of the first-draft MEL in February 1988 and the increased activity of Captain Murray and Mr Ozdener in June 1988. Similarly, no explanation was offered for the delay following the rewrite by Captain Murray and Mr Ozdener and the submission of the second-draft MEL to Transport Canada in September 1988.
- I am left with the conclusion that the timely production of the F-28 MEL was simply one of many items that were neglected in the F-28 implementation plan. In spite of Captain Deluce's claim that he pursued the MEL in the "best manner" he was able, I am of the view that, as F-28 project manager, he bears a large measure of responsibility for the delay.
- Further, as Captain Nyman and Messrs Morrison and Bittle were the senior managers in the flight operations and maintenance departments, they knew or ought to have known that maintenance deferrals on their F-28 aircraft were occurring between June and December 1988 in apparent violation of ANO Series II, No. 20. Each of these individuals should have independently taken whatever steps were necessary to ensure that
  - the MEL was prepared in a timely manner; and
  - there were no deferrals of the maintenance of essential aircraft equipment in the absence of an approved MEL.

An Alternative Approach: Air Canada Procedures

Among all the evidence I heard regarding the operational procedures of the parent company, Air Canada, there were two practices that are particularly germane to this discussion on the APU and the MEL:

Air Canada Practice: Operating with an Unserviceable APU
Captain Charles Simpson, Air Canada vice-president of flight operations, testified that it is the policy of his company that an aircraft with an inoperative APU will not be dispatched to a station where ground-start equipment is not available. This restriction is clearly described in the sections dealing with APU unserviceability in each individual aircraft MEL.

Air Canada Practice: Operating without an Approved MEL

Captain Simpson testified further that Air Canada would never operate a transport jet aircraft in commercial service without an approved MEL. The MEL is submitted by Air Canada to Transport Canada for approval at the same time that Air Canada applies for approval of a new aircraft type within its operations. Captain Simpson provided the following evidence on the importance of the MEL to Air Canada's operations:

> Q. Sir, why is it important for an airline to have an MEL at the time an aircraft is put into operation? Why is that important?
> A. Well, in order to be able to operate the airplane, you from time to time will have some minor deviations on it where you may want to move the airplane back to a main station to get it fixed. It may be something of an insignificant nature, but without any document that allows you to do it, you're not allowed to operate the airplane.
>
> So it's a straight case of – and, as far as the pilot is concerned, both pilots and maintenance personnel need some guidance, so this is the document by which they can look at their airplane and decide if it can be dispatched in that condition.
>
> For example, you might ... have a problem with the reverse mechanism on an engine. It's not required, it's not part of the certification, but to operate the airplane, there are certain things that have to be checked.
>
> So you go to the MEL list. It says what maintenance have to do. It says what operations have to do. And then the airplane may be moved.
>
> Q. To the best of your knowledge, sir, has Air Canada ever operated an aircraft in revenue service without an approved MEL?
> A. Not to the best of my knowledge.
>
> ...
>
> Q. Captain, with your background and knowledge and experience, how would you view the operation of a new aircraft for six months with no MEL?
> A. Well –
> Q. When I say the operation, I'm talking revenue operation.
> A. Yeah. Well, I would be surprised that Transport Canada would allow that to go on, as the regulatory authority.
> Q. Would you permit that as a senior officer ... of your airline?
> A. No. We would not accept that, as an airline.
>
> (Transcript, vol. 118, pp. 112–13, 116–17)

The evidence is that Air Canada had no involvement with the production of the proposed F-28 MEL first submitted for approval by

Air Ontario. Given the experience that Air Canada has in the production of MELs for transport category jet aircraft, any assistance to its regional feeder would certainly have expedited the process. In particular, to the extent that the first draft was as deficient as was represented by Mr Brayman and Mr Ozdener, some Air Canada assistance would have helped enormously in producing a document that would have been acceptable to Transport Canada. Further, Air Canada assistance in the drafting of the MEL would, in all probability, have included the standard Air Canada operational restriction on deferred APU maintenance: that aircraft with unserviceable APUs are not to be operated into stations without ground-start facilities.

MEL Use and Approval: Governing Legislation

ANO Series II, No. 20, prohibits the operation of an aircraft if any "essential aircraft equipment" is inoperative unless such operation is in compliance with an approved MEL. In reviewing the deferral practices of Air Ontario, I was struck by the confusion and uncertainty among commercial pilots and Transport Canada air carrier inspectors regarding the interpretation of "essential equipment." Such confusion is not surprising when the regulatory definitions are considered.

Essential aircraft equipment is defined as:

> an item, component or system installed in an aircraft, that
> (a) has a primary role of providing information or performing a function required by regulation or order; or
> (b) is directly related to the airworthiness of the aircraft.
> (ANO Series II, No. 20, s.2)

Although "airworthiness" is not defined, "airworthy" is defined in the Air Regulations as "in a fit and safe state for flight and in conformity with the applicable standards of airworthiness" (Air Regulations, s.101(1)).

These are the only definitions found in the *Aeronautics Act*, the Air Regulations, or the Air Navigation Orders that have any bearing on the term "essential aircraft equipment." The evidence revealed that these definitions are of little practical assistance to pilots and aircraft maintenance engineers in their consideration of maintenance deferrals. In the absence of an approved MEL, which, in effect, describes what is essential aircraft equipment for the purposes of that aircraft type, most of the pilots who testified had difficulty describing what they considered essential equipment.

Mr Randy Pitcher, Transport Canada's air carrier inspector assigned to Air Ontario, provided the following evidence on "essential aircraft equipment":

A. As a matter of fact, Mr Commissioner, my interpretation is that any component that was required for certification in terms of interior, in the cockpit, be it an instrument, a light bulb, et cetera, must be serviceable at all times if the aircraft is to be operated, whether it's private or commercial.

Q. And where did you get this understanding of essential aircraft equipment?

A. I practised it, when I was an operating pilot.

(Transcript, vol. 127, p. 102)

Mr Ole Nielsen, Transport Canada's principal airworthiness inspector who assisted in the importation of Air Ontario's F-28 aircraft, explained the difficulty in working with the term "essential aircraft equipment":

Q. ... How does the guy on the shop floor know what is essential equipment in the absence of an MEL?

A. Very difficult. As a matter of fact, in certain cases, it's quite possibly impossible to tell for the AME on the floor.

If you look at the definition of "essential," depending on whose definition you use, our definition within airworthiness will be that it is that equipment called up by the type approval for the product as being essential for flight, and also, those regulatory statutes that require operation of certain equipment, such as a third horizon in turbo jet aircraft and the installation of lavatory smoke detectors and that sort of thing. Those are all essential for flight.

But the primary one that is hard to assess for the AME is the certification basis of the airplane, because ... all the essential equipment is called up in the certification basis, either CAR 4(b) or FAR 25.[31]

(Transcript, vol. 129, pp. 194–95)

An example of the Air Ontario F-28 operating with unserviceable "essential aircraft equipment" concerned the master warning light. This component is located on the instrument panel within the pilot's area of primary scan. When illuminated, it alerts the pilot that a warning light on the enunciator has been activated. The pilot would then reset the master warning light and look to the enunciator panel located down and to the side for more specific information about the problem. It was universally agreed among the experienced pilots who appeared before me that the master warning light fell within the definition of "essential aircraft equipment." In other words, even with the approved Air Ontario

[31] Aircraft certification is discussed in chapter 22, F-28 Program: Flight Attendant Shoulder Harness.

F-28 MEL in place, an unserviceable master warning light requires the aircraft to be grounded. Nevertheless, it became clear from the evidence that on April 5, 1989, Captain Robert Perkins operated the F-28 on a revenue flight from Winnipeg to Toronto without a serviceable master warning light. When questioned about this, Captain Perkins gave the following evidence:

> Q. ... you have said that, but in fact, if there was a problem, you have also told us that the first thing that would alert you to the problem likely would be the master warning light, is that right? That is the first thing that would warn you?
> A. Under normal condition, yes.
> Q. Right. You have also testified that you would want to know as soon as possible that you had a problem, right?
> A. That's correct, yes.
> Q. Correct, and you have also told us that the enunciator panel does not fit within your normal scan when you are in clouds?
> A. That's correct.
> Q. So I don't understand how you can say that the absence of a functioning master warning light does not affect the airworthiness of the aircraft.
> A. I'm saying today that as far as I'm concerned, it does.
> Q. Fair enough.
> A. Yes.
> Q. How could you understand it otherwise a year ago?
> A. That is a very good question. I don't have an answer for it.
> Q. When were you made a line check pilot? When was that?
> A. February of '88.
> Q. So you would be operating as a line check pilot with this misapprehension about the importance of the master warning light, is that right?
> A. I guess that's correct, sir.
>
> (Transcript, vol. 44, pp. 105–106)

This improper deferral came to the attention of Mr Morrison. The ensuing investigation by Mr Morrison prompted Captain Joseph Deluce to write a memorandum of April 25, 1989, to Mr Morrison defending Captain Perkins's decision on the basis that Captain Perkins was "comfortable with the warnings that were available" and "comfortable with maintenance decision to defer this item as he did not consider it an airworthiness item" (Exhibit 337). Captain Deluce went on "with hindsight" to question whether the item should have been deferred. He further undertook "to get a better interpretation from Transport Canada on what and how items can be deferred and when they cannot."

In the face of testimony of numerous experienced pilots that the master warning light is clearly an airworthiness item, I find it particularly disturbing that an F-28 line check pilot, the F-28 chief pilot, and maintenance personnel at Air Ontario were all confused about the fundamental issue of what unserviceabilities legally necessitate the cancellation of a flight.

In this context I was not surprised to learn that there may have been confusion in Captain Morwood's mind about what constituted a "no go item." Flight attendant Sonia Hartwick gave a sworn declaration to this Commission (Exhibit 742) in which she said that on the morning of March 10, 1989, she and her colleague, Mrs Katherine Say, conducted a preflight check of the cabin emergency equipment on board C-FONF. Among others, the following defect was found:

> Katherine Say then proceeded to switch on the switch of the emergency lights and then we proceeded to check the emergency exit lights over the main entry door of the aircraft and the cabin entry door (passenger side). The emergency exit lights over both these doors were not working.

In her sworn statement, Mrs Hartwick also attested:

> Katherine Say then switched the emergency light switch back to the normal position and proceed to the flight deck. I followed her.
>
> Katherine Say informed Captain Morwood of the emergency exit lights which were not working, that there were three missing altitude compensating oxygen masks, and that there was two-way tape on the handle of the main entry door. I overheard Katherine Say mention these matters to Captain Morwood.
>
> Captain Morwood was not visibly impressed, and said words to the following effect "Oh God more snags.". At this time, Captain Morwood reached for a book which I believe was the Minimum Equipment List for the aircraft.

Captain Perkins was questioned about the significance of such an unserviceability:

Q. And I referred you to item number 33 in the MEL which is in front of you to see if we could both find emergency exit lights. Do you remember we went through that, Captain Perkins?
A. Yes.
Q. And when we had a look at item 33 in Exhibit 310, we couldn't find emergency exit lights, right?
A. That's correct.
Q. And I asked you what happens then, and you said that means it's a "no-go item"; that's the phrase you used?
A. Yes.
Q. Now, what does a "no-go item" mean? Could you tell the Commissioner that, please.

A. Well, that would mean that it would have to be rectified prior to the next flight.

(Transcript, vol. 43, pp. 116–17)

It is apparent from Captain Perkins's evidence that he considered the emergency exit lights to be essential aircraft equipment for which there were no alleviations in the MEL, yet the aircraft was flown on March 10 without repairs first being made to this essential equipment.

Captain Joseph Deluce testified that, in the absence of an approved MEL, pilots would rely on maintenance personnel to make the determination of what is and is not essential aircraft equipment for the purposes of maintenance deferrals (Transcript, vol. 113, p. 131).

These varying views on the interpretation of ANO Series II, No. 20, are significant in that, from June until December 1988, Air Ontario pilots accepted F-28 aircraft into service with inoperative components. Whether such deferrals were legal depended on an interpretation of the term "essential aircraft equipment." As it happened, many of the deferrals during this period appear to have violated ANO Series II, No. 20, and the pilots, their supervisors, and Transport Canada inspectors knew or ought to have known about it.

Operating without an Approved MEL

During the period from June until December 1988, when Air Ontario was operating its F-28 without an approved MEL, personnel in maintenance and flight operations devised their own methods of maintenance deferral – methods which appear to have been in clear violation of ANO Series II, No. 20.

Mr Ozdener testified that maintenance deferrals became a problem almost immediately following the introduction of C-FONF into commercial service in June 1988. He recalled that "on the 9th of June there was a panic in Toronto" because there was a pilot snag and the maintenance group did not know how to deal with it without an MEL (Transcript, vol. 101, p. 72). Mr Ozdener testified that maintenance personnel began a practice of using a section of the Fokker F-28 Flight Handbook[32] known as a list of "allowable deficiencies" to defer the maintenance of essential aircraft equipment (Exhibit 825). If the allowable deficiencies document did not provide a ready solution to the deferral problem, maintenance personnel would telephone Transport Canada airworthiness

[32] The Fokker F-28 Flight Handbook (Exhibit 314) is also referred to as the F-28 Aircraft Flight Manual, or AFM. See chapter 19, F-28 Program: Flight Operations Manuals.

personnel, on an ad hoc basis, for verbal approval.[33] Mr Ozdener testified that it was his understanding that these deferral practices were sanctioned by Transport Canada; however, he conceded that this was somewhat of a grey area (Transcript, vol. 102, p. 113), and I heard no other independent evidence that corroborated such a regulatory approval. In any event, Mr Ozdener testified that the allowable deficiencies document was used by Air Ontario maintenance as a resource document to assist in the deferral of maintenance in the absence of an approved MEL (Transcript, vol. 101, pp. 72–83).

The evidence revealed that the allowable deficiencies document was, in fact, section 10 of volume 1 of the Fokker F-28 Flight Handbook. This section was described as an embryonic MEL that was superseded in 1983 by the Fokker F-28 MMEL. By a manufacturer's amendment dated April 15, 1983, the allowable deficiencies section was deleted from the F-28 Flight Handbook. On August 1, 1983, the F-28 MMEL was issued by Fokker as a separate document approved by Dutch Aviation Authorities. The MMEL functionally replaced the allowable deficiencies section of the F-28 Flight Handbook. This allowable deficiencies section, which was circulating throughout the Air Ontario maintenance department, was four years out of date when the company took delivery of the C-FONF and should never have formed any part of the documentation governing the operation of the aircraft.

Mr Ozdener stated that he and other maintenance personnel photocopied the allowable deficiencies section from the aircraft flight manual that arrived with the aircraft C-FONF. Unfortunately, that original document was destroyed in the wreckage; however, if Mr Ozdener's recollection was accurate, the Fokker F-28 Handbook on board C-FONF was likely not amended since at least April 1983. This fact would call into question the thoroughness of Transport Canada's certification of C-FONF prior to its importation into Canada.

Mr Bittle gave evidence on maintenance deferrals that were ongoing in his department during the period from June until December 1988:

---

[33] It should be noted that Mr Ozdener originally testified that maintenance deferrals were conducted pursuant to a document entitled the "CDL" or Conformity Deviation List (Transcript, vol. 101, pp. 74–75). Later in his testimony he corrected himself, stating that the document which was used for maintenance deferrals during this period was a section from the Fokker F-28 Flight Handbook entitled "Allowable Deficiencies" and not the CDL (Transcript, vol. 102, pp. 119–24). Mr Ozdener was shown a copy of the "Allowable Deficiencies" section and I am satisfied from his evidence and the later evidence of Mr Bittle that, indeed, some maintenance personnel were using that document for the purposes of maintenance deferrals during the period prior to the approval of the MEL.

Q. Now, it was Mr Ozdener's evidence that Exhibit 825, which is in front of you, was indeed this Deficiencies List that was being referred to.
Now, Mr Ozdener did not make the entry, obviously, but that was his understanding –
A. Right.
Q. – of the volume that was being referred to.
A. Right.
Q. Now, do you remember this practice being done at Air Ontario, using this particular volume for deferrals?
A. I don't have a clear memory of that particular situation. This exact volume being used ... since briefing myself for this testimony, it became evident that people were using it. At the time, was I aware of it? I am sorry, I cannot recall.
Q. You don't recall whether or not there was an approved MEL?
A. I know there was no approved MEL.
Q. Okay. And you did not know what deferral practices were going on?
A. I – I knew what the rules said, yes.
Q. No, no, did you know what actual deferral practices were going on in your department?
A. Not every one of them, no.
Q. Okay, which ones did you know about?
A. Well, I didn't check every log book of every airplane, if that's what you mean. And we had a system in place whereby people were delegated to do that. And, if someone felt something was going on that shouldn't have been going on, they had the option to bring it to my attention.
Q. Did anybody ever bring to your attention the use of Exhibit 825 for deferrals?
A. No, not that exhibit.
Q. Did anybody bring to your attention this procedure of phoning Transport and getting approval?
A. No, no, at that time, no, I – no one ever said, that I can recall – now, someone may say, well, they told me or I knew about it, and if that's the case, I'm sorry, I've just forgotten that.
And it's quite possible that someone told me, it's quite likely someone told me, but I can't remember who or when.

(Transcript, vol. 103, pp. 155–57)

In spite of his uncertain recollection, I am of the view that Mr Bittle knew or ought to have known that such deferral practices were ongoing in his department. He, along with Captain Nyman, was charged with the responsibility of preparing an MEL for the F-28 program. He clearly knew that the aircraft was operated from June until December 1988 without an approved MEL; and he should have known that if the strict rules of ANO Series II, No. 20, were followed, it would have been virtually impossible to maintain any regular operations of the aircraft without an MEL.

On the flight operations side of Air Ontario, there were similarly innovative solutions to the dilemma of jet aircraft operations with no MEL. I have already recounted the evidence of the F-28 project manager and chief pilot, Captain Joseph Deluce, who testified that his pilots relied on maintenance personnel to determine what items might properly be deferred (Transcript, vol. 113, p. 131); and it is clear from the evidence that the maintenance group was relying on an unapproved, out-of-date document to assist them in deferrals. The evidence also revealed that the F-28 pilots, when flying the line, took the initiative in deciding how to operate the aircraft with unserviceable essential equipment.

Some Air Ontario F-28 pilots testified that they relied on their common sense and experience in assessing whether the aircraft was safe to fly with certain items unserviceable. Captain William Wilcox of Air Ontario explained his recollection of the situation:

> Q. You were happy just to exercise your own judgement and determine whether or not, if you had a landing light out or an APU not working or anti-skid not working, you were happy just to exercise your own judgement and decide whether or not the aircraft could safely be flown with that item not working, correct?
> A. That's correct, yeah.
> Q. All right. And you thought that, even once the MEL came into being, it was just there for your guidance, you could still exercise –
> A. No.
> Q. – your own judgement?
> A. No.
> Q. All right. You now agree that, once the MEL was approved, you were bound to comply with the MEL, are you?
> A. Then it becomes your reference, source of reference.
> Q. Well, it becomes the law, doesn't it? You're bound –
> A. Yes, your source of reference, something to fly the airplane by.
> (Transcript, vol. 93, pp. 211–12)

I find that, during the six months between June and December 1988, there was an understanding among Air Ontario F-28 pilots that they required an MEL to operate with inoperative essential aircraft equipment; they understood that without some deferred maintenance their aircraft would frequently be grounded; and they made a conscious decision to rely on their experience and whatever tools were available to them to operate their aircraft safely with unserviceable components.

One "tool" that pilots used in assessing the efficacy of a maintenance deferral was the MEL that appeared in their Piedmont F-28 Operations

Manual (Exhibit 307). Pilots apparently used this Piedmont MEL as they would any approved MEL. When they were at a line station and an aircraft component became unserviceable, they consulted the Piedmont MEL to assess the seriousness of the snag and whether they could continue flying, subject to operational restrictions. If the Piedmont MEL operational restrictions were met, then they would not note the defect in the aircraft journey log and would continue flying the aircraft (see, for example, Captain Erik Hansen at Transcript, vol. 94, p. 166).

Apart from the apparent illegality of not formally recording the snags in the aircraft journey log[34] as soon as they were detected, another problem was presented – namely, how to inform subsequent flight crews of the state of serviceability of the aircraft. To overcome this difficulty, the pilots devised a system whereby one crew would record defects on loose notes that were passed on to following crews. In the course of a flying day, the crews would accumulate these loose notes containing information regarding the unserviceability of aircraft components. At the end of a flying day, or before the aircraft was due to spend the night at the Toronto maintenance base, these defects would be formally recorded in the aircraft journey log. In so doing, the flight crews avoided a written record of operating with inoperative essential aircraft equipment. While the aircraft was at the Toronto maintenance base, the maintenance crews endeavoured to rectify all of the defects. To the extent that some defects were not rectified, the maintenance crews consulted the allowable deficiencies list and formulated a deferral.

This situation was clearly described by Air Ontario pilot, Christian Maybury. Captain Maybury was questioned regarding a comment he

---

[34] The Air Regulations provide that:

s.826(1) Every owner of an aircraft, other than an ultra-light aeroplane, registered under these Regulations, shall maintain for the aircraft an aircraft journey log and an aircraft technical log.

(2) The Minister may, by order, prescribe the form of the aircraft journey log and the aircraft technical log to be maintained pursuant to subsection (1) and the particulars to be entered in such logs.

s.827 Every entry log maintained pursuant to section 826 shall be made accurately and in ink by a competent person and signed by that person as soon as possible after the events they record.

Air Navigation Order Series VIII, No. 2/CRCc.-24, the Aircraft Journey Log Order, provides that the particulars of any defect in any part of the aircraft or its equipment and the rectification of such defect must be recorded in the aircraft journey log:

> "Forthwith upon the defect occurring and upon rectification having been made" (ANO Series VIII, No. 2, Schedule s.3).

made to Captain Ronald Stewart[35] that he felt he was "fighting hard to maintain ... standards." On this point I feel it worthwhile to quote Captain Maybury at length:

A. Air Ontario Limited[36] had very high standards, and it seemed to me that we were having to maintain – when I say maintain standards, it was maintain the standards that were set by Air Ontario Limited, which I think were very good ones to be setting our eyes on.
   There were just some – just operating the airplane – we've already really discussed it, really – operating an airplane with a level of experience that we had in our supervisory and maintenance people and we just ran into a lot of stuff that just didn't go down right.
Q. In the regard of fighting hard to maintain standards, would you tell us a bit about the practice of passing snags from pilot to pilot.
A. Well, that was one thing that didn't go down well at all. We went through a period where we did not have an officially approved MEL on the airplane, and it makes it very, very difficult to operate an aircraft under these standards, because ... there is equipment on the aircraft that is not required for safe flight. It's good stuff to have, but you can still operate an airplane very safely without it, and that's what the MEL covers.
   And, according to air regulations, if you don't have an MEL, the aircraft is grounded, any snag, even a light bulb out. Like, if you wrote up the light's burned out ... down in the cabin, according to air regulations, you're grounded.
Q. If you don't have an MEL?
A. If you don't have an MEL ... So the practice started, and I don't know exactly where it – I wouldn't want to say where it started from, but some of these Mickey Mouse type snags started getting passed by little bits of paper instead of it being officially entered in the log book.
Q. When you say being passed, sir, are you saying that, when one crew would get off and another crew got on, they would pass pieces of paper noting snags on these pieces of paper so they wouldn't have to be entered into the journey look; is that right?
A. Yes, that did occur.
Q. Okay, and you're aware of that practice?
A. Yes, I –

---

[35] Exhibit 744, "F-28 Pilot Questionnaire – Summary." See chapters 15, F-28 Program: Planning; 24, Flight Safety; and 42, Incident and Accident Reporting and Pilot Confidentiality.

[36] Captain Maybury was a pilot from the Air Ontario Limited side of the merged Air Ontario Inc.

Q. And are you personally aware if this practice was adopted and followed by Captain Joe Deluce?
A. Yes, it – I – it occurred at least once with his coming off of a line indoc flight and we were taking over the flight.
Q. And who was the captain of the aircraft when this occurred?
A. I believe it was Bill Wilcox.
Q. Okay. In hindsight, sir, what's your view of that practice?
A. Well, it's very frustrating. Once again, never at any time ... did we ever operate the airplane with something not operating that would have been on the MEL. ... [A]s a guideline, actually, we did have the Piedmont MEL available to us, so –
Q. That's the one in the back of the Piedmont manual?
A. That's right, yeah. So we had that available to us. It certainly isn't the way I feel comfortable flying the airplane.
It's unfortunate that these things take so much time with Transport, and once again getting into the field of Transport Canada, but why did it take months to approve an MEL ... when Piedmont already ... if they had an MEL, then they could have – it – I don't understand these things ... but I just don't understand why it has to take so long so companies and personnel working for these companies are put into this uncomfortable situation for such a long period of time.
Q. As a pilot, sir, did that make your life a little more difficult?
A. Yeah, it added to the stress level.
Q. In relation to the MEL, you noted a moment ago that you did have the Piedmont MEL to fall back on.
Did anyone at Air Ontario ever instruct you or are you aware if anyone in Air Ontario ever instructed F-28 pilots to use the Piedmont MEL?
A. No, no, it –
Q. This simply grew up?
A. This is something that just kind of grew within the system.
Q. Okay. And just to come back one more time, the passing of snags on pieces of paper, then, would mean that these snags would not be noted in the journey log; is that right?
A. That is correct.
Q. And if they're not noted in the journey log, then there is no continuity of snag deferral and rectification?
A. Often, the last crew of the day would enter them. This was more or less done to keep the airplane flying that day, and then the last crew of the day would enter them.

(Transcript, vol. 92, pp. 35–39)

On further examination, Captain Maybury explained why the Air Ontario pilots engaged in these deferral practices:

Q. Captain, my friend Mr Jacobsen asked you about why you didn't report to anyone within the company that these notes, these maintenance notes, were being passed, and I want to ask you:

Did the fact that Joe Deluce, a member of the management, the fact that he countenanced – or appeared to countenance this activity, did that influence your decision somewhat about whether or not you should complain about it and report it?

A. It influenced it somewhat, but I think the – to be quite frank, the main motivation was the fact that we as a pilot group wanted the operation to be a success.

(Transcript, vol. 92, pp. 206–207)

Captain Deluce provided a lengthy explanation as to the use of the "yellow sticky pads" in Air Ontario F-28 operations. I will refer to his testimony on the subject:

THE COMMISSIONER: Go ahead and explain.

THE WITNESS: We used, it was these yellow sticky pads, for a number of things in the aircraft. We used them for communicating information between the crews.

For example, they would write down clearances or weather or stuff like along those lines, and stick them on the console between the two pilots, and what that enabled crews to do was to, you know if while one person was flying, the other one was taking a clearance or weather, it would enable that information to be readily available to the other pilot. With time he could read it rather than – so we used it for those types of purposes.

We also used the note pads to note observations and at times, defects. It was a quick way en route to jog it down, and it was something that a person could use to write in the snags when they are on the ground in more detail with more explanation that would be of better assistance to maintenance in troubleshooting the particular snag.

So it was convenient that way to keep track, because you always – at times, you would write them right into the book, if it was that phase of flight where you could do that. At other times, you would just make note of it.

Now, the normal practice was to enter these defects, if they were defects, into the log book. At times, maintenance would meet the aircraft and you would review it with them there and they would in fact write it in the log book.

At times, you would write it into the log book and go in to see maintenance on your way home and you would ... bring this sticky pad in to review it with maintenance to make sure ... if there was any additional information they would need before you went home.

At times ... you would slip it in your pocket. You would also use it if you bumped into a crew to just review with them what kind of problems you were having. It might enable them to –

alert them to the fact that they may need a little more time to ensure that maintenance clears something off before ... they take the aircraft.

So there was a number of uses ... of these note pads.

At times, I passed on what I considered observations that were not necessarily – or that weren't what I considered a defect yet, and at times, I may have even passed on other information that I did not consider essential operating equipment, and I had a reason when I did that, because I recall one specifically.

But I think before we get into the questioning much further, I would also like to take a moment to describe, in my estimation, what a snag or a defect is, because I think it's a very complicated thing, and I think some people might feel that it's really something that's black and white, and I don't believe that it's that case.

So I have heard some testimony with regard to snags and defects, and I have done a lot of thinking about it to try and ... recall what we did and to help, but I think, if you don't mind, I will take a few minutes to describe what ... I believe a defect to be.

THE COMMISSIONER: All right. We will hear you.

THE WITNESS: The reason why a defect is a complicated thing, because you have to – it's just not black and white. It's ... actually a decision-making process.

And basically, you can have a continuum whereby the pilot is flying and he is observing things, he is making observations, and at times, the observations and the evidence that he has from that observation is very cut and dry ... there's no question about it, we've got a defect, and that may be at one end of the spectrum.

There's another part of the spectrum where pilots are observing things, but the fact that they are not really at the point of time where they would consider that observation an actual defect.

An example of that might be – you might be doing an approach ... or you might be flying along and one of your VORs,[37] for example, flags.

Now, at that moment in time, you know that you are not getting information from that unit, but you don't know whether it's a problem on the ground or a problem with the unit itself. And it comes back on.

Now, you ... still don't know whether it was a problem on the ground or whether it was an intermittent problem with your

[37] VOR: very high frequency omni-directional range, a navigational aid used in the cockpit of aircraft

unit, so there's some realm here of what I consider strictly observations.

At some point in time, you reach a line where the evidence is that you have a defect. For me, the evidence might be here. For another pilot, it might be there. (Indicating.)

I believe, and ... from going through the testimony and going through the log sheets, I believe that in fact, I did pass on some information that was what I considered observations.

And I believe that in one particular case, that I passed on something as information, but it wasn't essential operating equipment, and I did that because we were troubleshooting the particular unit, and I had just done one flight and maintenance had wanted some troubleshooting information on that unit, and I felt it would be more useful for – and I talked it over with the crew, and they could have considered it a defect at that point in time, but there was a purpose for it, so –

But there wasn't what I considered a practice where crews passed on essential operating equipment.

I have been through the testimony and some crews – some crews indicated that they might have carried some snags. I don't believe that it was a practice.

I know for certain, on occasion, I carried some things that were observations, and I do admit on – I believe that I have, on occasion, maybe even carried something that was in the realm of a defect, but in that realm, I believe that it was something that was deferable.

You know, I'm trying to ... I have gone through log sheets and tried to jog memories of what happened, and I listened to people say things, and that's the best way I can describe what we had done.

At the time, I understood that we could operate the aircraft ... without an MEL if we did not fly it with a defect that was ... essential operating equipment, and I had expected ... because of the nature of part of that which is the airworthiness items, that that was a decision that maintenance would make technically, that I would also satisfy myself that it was safe.

If in fact they deferred something that was – and I accepted it as being non-airworthiness, I would ... probably consult the – I know I would consult the Piedmont MEL to see if there were any procedures covering ... that particular deferral.

I don't believe that just because something is in the MEL, that it's necessarily airworthiness or essential operating equipment. Or I don't believe that it's essential operating equipment.

That's – I don't know if that helps, but I'm trying to tell you how it worked now.

The use of those notes was something that we observed, and it seemed quite handy, when we were at TimeAir. I think ...

> – as far as conveying information ... it worked well. The paper – the information was handy.
>
> Anyhow, I will leave it at that, if you want to ask me some questions about whatever ...
>
> THE COMMISSIONER: All right. Thank you for giving us an overview –
>
> (Transcript, vol. 113, pp. 135–41)

Captain Deluce's lengthy explanation of the deferral practices at Air Ontario is revealing. The following points are particularly significant to this analysis:

- He conceded that he may well have deferred something via the "yellow sticky paper" that was "in the realm of a defect," but he stated that at no time did he operate the aircraft with essential aircraft equipment that was inoperative.
- When he made such deferrals, he would consult the Piedmont MEL to see if there were any special operating procedures covering the particular problem.
- He expressed his view that equipment listed in the MEL is not necessarily essential aircraft equipment.
- When he testified he understood that some crews may have carried forward snags via the note passing, but he did not think it was a practice.

The law requires that all defects be noted in the journey log as soon as they are detected. If Captain Deluce was consulting the Piedmont MEL for instruction on accommodating an operational problem, then clearly this was something that was more than "in the realm of a defect." It was a defect, and the practice acknowledged by Captain Deluce appears to have been in violation of ANO Series VIII, No. 2.

Indeed, there is some scope to include items in an MEL that are not essential aircraft equipment. If such were the nature of Captain Deluce's note deferrals, there should have been no reason why they were not immediately recorded in the aircraft journey log. The explanations offered by Captain Maybury and others were more plausible. The note deferrals were made because the pilots wanted to keep the aircraft flying.

In chapter 10, Technical Investigation, there is a detailed review of the aircraft journey log of C-FONF. In that analysis, I concluded there were many maintenance deferrals involving essential aircraft equipment during the period when there was no approved MEL. This suggests that there may have been violations of ANO Series II, No. 20. On the basis of the evidence reviewed in this chapter, I find that there were instances when the F-28 was operated with essential aircraft equipment inoperative, and the description of such inoperative equipment was contained on the loose notes passed by Captain Deluce and others.

Captain Nyman testified that he was not aware that such note deferrals were going on. He stated that the practice was not a good one and, had he been informed of it, he would have ordered that it be discontinued (Transcript, vol. 107, pp. 191–94).

Mr Morrison stated that he knew the maintenance department was deferring snag rectification pursuant to "some sort of document," but he was not fully aware of the deferral procedure ongoing when the F-28 was operated without an MEL (Transcript, vol. 115, pp. 111–12). Mr Morrison testified that he was not aware of the practice of note passing, as described by Captain Maybury, and he acknowledged that such a practice would have jeopardized the operating certificate of Air Ontario. If he had known the practice was ongoing, he would have put a stop to it and Captain Deluce would have been severely disciplined for having participated in the practice (Transcript, vol. 116, pp. 158–60).

During the period from June to December 1988 there were three significant non-standard and apparently illegal practices ongoing at Air Ontario with respect to maintenance deferrals. These were:

- the practice by maintenance personnel of deferring the maintenance of aircraft unserviceabilities pursuant to the obsolete "allowable deficiencies" section of the Fokker F-28 Flight Handbook;
- the practice by some F-28 pilots of writing up aircraft defects on pieces of paper and passing them along from crew to crew instead of recording them in the aircraft journey log; and
- the practice by some F-28 pilots of relying upon the MEL appearing in their Piedmont F-28 Operations Manual in the operation of the aircraft with inoperative equipment.

These practices were not officially sanctioned by the company, but the F-28 chief pilot and project manager knew of and took part in at least two of them. While the pilots and maintenance personnel were relying on their experience as they improvised solutions to the problems of operating without an MEL, this situation was clearly unacceptable in a properly functioning commercial air transportation system.

I must presume that the procedures established by the Air Regulations and the Air Navigation Orders are founded upon sound operational experience. The regulator is attempting to ensure standardized practices of timely defect rectification and prudent maintenance deferrals.

What is most troubling is that Air Ontario put its operational personnel in a position where they felt obliged to improvise these solutions to the MEL problem. The evidence revealed that Air Ontario personnel, in particular the pilot group, were enthusiastic about their first jet transport operation and they wanted to make it a success. In their enthusiasm, they carried out operational practices that were in apparent violation of ANO Series II, No. 20, and ANO Series VIII, No. 2. When faced with these practices, it was the responsibility of flight operations and maintenance management to step in and put an end to them. They did not.

Findings

- Problems with the APU of aircraft C-FONF were recurring throughout the week from March 5 to March 9, 1989, and maintenance control personnel in London and personnel at the Toronto maintenance base were aware of the situation.

- On March 5, 1989, Captain Bradley Somers made note of two problems connected with the APU:
  - he noted that the APU was not producing sufficient air pressure to start the aircraft main engines; and
  - he noted that an oily smell filled the cabin shortly after takeoff.

- Maintenance supervisor John Jerabek addressed the snags as follows:
  - he could not duplicate the air pressure problem, and made an appropriate notation in the journey log;
  - he suspected that the cause of the oily smell was residual oil in the duct work connecting the Air Cycle Machine with the cabin ventilation system; and
  - he did not attempt to rectify the problem because it would have taken several hours to do so, and the aircraft was scheduled for imminent departure.

- Mr Jerabek's suspicion may have been well founded; however, a review of the aircraft journey log would have revealed that a similar problem was noted on two previous occasions. On January 21, 1989, smoke in the cabin of C-FONF was attributed to the air-conditioning system (the maintenance of the noted defect was deferred); and on February 27, 1989, thick oily smoke filling the cabin was again reported (the defect was rectified by correcting an oil leak in the duct work). The recurrent nature of this alarming defect should have warranted the serious attention of Air Ontario's maintenance department.

- What is even more troubling was what occurred after Mr Jerabek released the aircraft into service. The next day, on March 6, Captain

Morwood noted in the aircraft journey log that the cabin became smoky, a passenger complained, and the smoke detector went off. Maintenance did respond to Captain Morwood's journey log entry, noting that the defect was rectified by removing oil from the APU outlet ducting.

- Flight attendant Sonia Hartwick testified that on the morning of March 8, 1989, shortly after takeoff from Winnipeg to Dryden, aircraft, C-FONF, piloted by Captain Robert Nyman and First Officer Keith Mills, again filled with an oily smoke which triggered the smoke detector. Captain Nyman testified that he attributed the cause of the oily smoke – which he described as an "oily haze" – to the APU, and stated that it was a fairly common problem with that aircraft. He adopted the evidence of Mrs Hartwick that a circuit breaker was pulled to deactivate the smoke detector and that it was inadvertently not reset until they reached Thunder Bay, two flight legs later. Flight attendant Hartwick testified that smoke filled the cabin and the alarm again sounded during the return flight from Thunder Bay to Winnipeg. Captain Nyman did not note the cabin smoke incidents in the aircraft journey log because, as he put it, it was a recurring, intermittent problem of which maintenance was aware.

- On five separate occasions – January 21, February 27, March 5, March 6, and twice on March 8, 1989 – an oily smoke, smell, or haze was reported in the passenger cabin of C-FONF. Maintenance attempts at curing the problem were obviously unsuccessful, and I am not at all confident that maintenance properly identified the cause of the problem.

- I am not satisfied with Captain Nyman's explanation for not reporting the March 8 cabin smoke problems in the aircraft journey log. His failure to report the defects appears to have breached ANO Series VIII, No. 2. The deactivation of the smoke detector on the morning of March 8 was a poor practice and the evidence of Captain Nyman, that he operated the aircraft with this essential aircraft equipment deactivated, suggests an apparent violation of ANO Series II, No. 20.

- I found Captain Nyman's characterization that the deactivation of the smoke detector was against "the legal letter of the law" to be flippant and at least ill-advised. While Captain Nyman was not the director of flight operations on March 8 when the incident occurred, he was recognized and respected among Air Ontario pilots as among the most senior and experienced pilots in the company. All of the Austin Airways pilots would have worked for Captain Nyman at one time or another and, indeed, pilot Keith Mills, who was his first officer on March 8, had worked in Captain Nyman's flight operations department for years prior to the incident. This mishandling of the cabin smoke incident reflects shoddy, lax flight operations practices and, coming from a pilot of Captain Nyman's stature, it most certainly would have sent the wrong signal to First Officer Mills, flight attendants Say and Hartwick, and anyone else in the organization who learned of it.

- At all material times, it was mandatory to report an in-flight incident involving smoke or fire to the Canadian Aviation Safety Board pursuant to sections 2 and 5 of the *Canadian Aviation Safety Board Act*. There is evidence that the described cabin smoke incidents were not reported to CASB (see chapter 10, Technical Investigation).

- The aircraft C-FONF arrived at the Toronto maintenance base on the evening of March 8, 1989, with APU air-pressure problems noted by Captain Nyman and Captain Reichenbacher. Captain Nyman contacted maintenance when the APU defect became known to him, and maintenance control assigned a maintenance control number to the defect. Captain Nyman recorded the maintenance control number in the aircraft journey log, which authorized the continued flight of the aircraft with an unserviceable APU until it reached the Toronto maintenance base. Once at the maintenance base, it was the responsibility of an aircraft maintenance engineer to rectify the defect, or, if conditions or circumstances made it impossible to rectify the defect, the supervising maintenance inspector could re-defer the maintenance of the defect.

- The evidence of the attempted repair of the APU air-pressure defect suggests that the maintenance personnel were not adequately familiar with the F-28 APU system. The evidence of Mr Athanasiou, in particular, suggests that he was never certain of the cause of the aberrant signal from the APU fire-detection light.

- Ultimately, the maintenance of the APU was deferred pursuant to the wrong MEL number.

- The handling of the two APU defects – the air-pressure problem and the cabin smoke – reflects poorly on the Air Ontario maintenance and flight operations departments:
  - The failure to rectify the snags after repeated attempts suggests a lack of expertise in the repair of the F-28.

  - The willingness to defer repeatedly the maintenance of the defects for lengthy periods suggests that the maintenance group was under some pressure to keep the aircraft flying, was simply lax in its practices, or both.
  - The handling of the cabin snag defect by Captain Nyman reflects poor judgement.
  - The ultimate deferral of the APU fire-detection defect pursuant to MEL number 49-04 instead of 49-01 suggests a lack of familiarity with both the F-28 MEL and the APU system.

- On March 10, 1989, there was poor coordination between SOC, maintenance, maintenance control, and line pilots regarding the accommodation for the lack of ground-support facilities in Dryden:
  - Mr Steven Korotyszyn, the maintenance inspector ultimately charged with the responsibility of deferring the maintenance of the APU, was under the mistaken impression that there was a ground-start unit in Dryden.
  - Mr Danilo Koncan, SOC duty operations manager, the SOC supervisor involved in the APU deferral decision, was under the mistaken impression that the Winnipeg line maintenance facility had the ability to rectify the APU defect.
  - Mr Martin Kothbauer, the SOC duty operations manager who supervised the operational control of C-FONF on the morning of March 10, 1989, and Mr David Scully, the maintenance controller on duty on the morning of March 10, 1989, were also of the view that the Winnipeg facility was working to rectify the APU defect.

- Both Mr Kothbauer and Mr Koncan were aware of the company policy not to de-ice with main engines running; and both expressed a view that if weather threatened such that de-icing was a likelihood, they would direct the crew of an F-28 with an unserviceable APU to overfly Dryden, where there was no ground-start facility. Mr Kothbauer chose not to direct flight 1362/1363 to overfly Dryden because his assessment of the area weather was such that he did not view de-icing as a likelihood. He was aware of the possibility of freezing precipitation, but it was his opinion that the freezing drizzle would not occur until later in the day. I am of the view that Mr Kothbauer's retrospective meteorological assessment was simply too restrictive. Mr Kothbauer knew the limitations of operating an F-28 with an unserviceable APU into Dryden. He knew, from the early morning area and terminal forecasts, that there was unsettled weather moving into the Dryden area from the west. He should have directed the dispatchers responsible for flight 1362/1363 to monitor developments in the Dryden weather very closely. As it happened, an amended terminal weather forecast for Dryden at 10:02 a.m. EST called for freezing drizzle. Mr Kothbauer stated that he should have been aware of this forecast and acknowledged a breakdown at Air Ontario SOC. When C-FONF was at the Thunder Bay terminal between 10:35 a.m. and 11:55 a.m., Mr Kothbauer should have directed flight 1363 to overfly Dryden on its return flight to Winnipeg.

- Complete line station ground support would have included an air-start facility in Dryden. As a regularly scheduled stop, it was less than satisfactory that there was insufficient equipment in Dryden to accommodate reasonably probable contingencies. Air Ontario may have made a reasonable commercial decision to delay the placement of ground-start equipment in Dryden. Having made such a decision, there should have been an operational accommodation for the deficient ground-start facility. Namely, it should have been operational policy at Air Ontario that an F-28 with an unserviceable APU was not to be dispatched into Dryden or any other station without ground-start facilities.

- An appropriate place for the promulgation of such a policy would have been in the APU deferral sections of the F-28 MEL. In those sections there should have been an operational limitation that aircraft with unserviceable APUs were only to be operated in stations with ground-start equipment.

- Non-standard and slipshod MEL practices were ongoing at Air Ontario almost from the inception of F-28 service.

- The F-28 C-FONF was repeatedly operated with inoperative essential aircraft equipment during the period from June until December 1988 when there was no approved MEL in place. This suggests an apparent violation of ANO Series II, No. 20.

- During this same period, there was a practice among Air Ontario F-28 pilots of recording defects on pieces of paper and handing them from crew to crew until, at the end of the day, the defects were entered in the aircraft journey log. This practice was apparently spawned by the pilots' desire to keep the F-28 aircraft flying and by a recognition by the pilots that, without an approved MEL, the proper recording of the defects in the aircraft journey log would have effectively grounded the aircraft. The failure to record defects in the journey log promptly appears to have been in violation of the provisions of ANO Series VIII, No. 2.

- These sorts of practices were or should have been known to Air Ontario maintenance and flight operations management and to Transport Canada air carrier and airworthiness inspectors.

- While there is no excuse for these operational practices, I am of the view that they were partially prompted by frustration on the part of line pilots and operational management with delays in the approval by Transport Canada of the Air Ontario F-28 MEL.

- I find that the MEL approval process is unnecessarily bureaucratic and complicated. This Transport Canada problem forms a partial explanation for the lengthy delay in the approval of the Air Ontario F-28 MEL.

- In addition, I find that Air Ontario operational management contributed to the delay in MEL approval. The need for an MEL was identified in the earliest stages of F-28 planning, yet the production of the document was disorganized and tardy.

- I find that had the parent carrier, Air Canada, taken more of an operational interest in its feed carrier, Air Ontario – and indeed its feed passengers – many of the problems associated with the MEL and the APU on March 10, 1989, could have been avoided.

RECOMMENDATIONS

It is recommended:

MCR 49 That Transport Canada proffer for enactment legislation which would require that approved minimum equipment lists be in place for all aircraft certified under United States Federal Aviation Regulation 25, predecessor regulations, or equivalent legislation, prior to the use of such aircraft in commercial service in Canada.

MCR 50 That Transport Canada not issue an operating certificate or amendment to an operating certificate to an air carrier operating aircraft certified under United States Federal Aviation Regulation 25, predecessor regulations, or equivalent legislation until required and approved minimum equipment lists are in place.

MCR 51 That Transport Canada ensure that the repair of an unserviceable aircraft auxiliary power unit be deferred only with an operational restriction requiring approved engine ground-start facilities to be available at all airports into which that commercial aircraft is expected to operate. This operational restriction should be included in the aircraft minimum equipment list.

MCR 52 That Transport Canada issue to all pilots a warning pointing out the dangers inherent in pulling circuit-breakers on board an aircraft in order to silence an alarm that may in fact be giving a valid warning.

MCR 53 That Transport Canada require that air carriers have in place appropriate policies and directives to ensure that flight crews, at the time they receive an operational flight plan, are informed of any aircraft defects that have been deferred to a minimum equipment list.

MCR 54 That Transport Canada require all air carriers that operate aircraft having minimum equipment lists (MELs) to provide approved training to all pilots, maintenance personnel, and dispatchers on the proper use of an MEL.

17 THE F-28 PROGRAM: LACK OF GROUND-START FACILITIES AT DRYDEN

On March 10, 1989, Air Ontario's F-28 jet service, flight 1363, found itself in the operational predicament of flying with an unserviceable auxiliary power unit (APU), under weather conditions that could necessitate de-icing, into Dryden, a station without F-28 ground-start capability. The lack of an F-28 ground start in Dryden is an important link in the chain of events that ended in the crash of C-FONF. Indeed, had there been a ground start in Dryden on March 10, 1989, all other things being equal, the accident might have been averted.

In order to start the main engines of the F-28, a source of compressed air, normally supplied by the APU, is required. Should the APU be unserviceable, an external source of compressed air, referred to as a ground start or an air start,[1] is required to start jet engines.

There are no Canadian regulations requiring an air carrier to keep ground-start equipment at stations through which they operate. Instead, it is left to the individual carrier to decide, based on operational and commercial factors, whether its operation requires a ground-start facility at all of its scheduled station stops.

By way of a documentation package dated January 24, 1988, Air Ontario applied to Transport Canada to amend its operating certificate to reflect the addition to its fleet of the two F-28s. The application to amend the operating certificate included the following reference to ground support:

> The company has determined that existing terminal facilities, buildings, lighting, ground support, power units, refuelling facilities, communications and navigation aids, dispatch, weather service and ATC are adequate for the proposed operations. However, the company may require certain improvements as F-28 operations develop.
>
> (Exhibit 855, p. 33, para. N)

---

[1] The terms "ground start" and "air start" were used interchangeably in the hearings of this Commission. In actuality, a ground start can be either air powered or electrical, depending on the type of aircraft. The F-28 requires an air start. Alternative methods of air start are discussed in chapter 16, F-28 Program: APU, MEL, and Dilemma Facing the Crew.

It was not as a result of an oversight that there was no ground start at Dryden. Evidence presented before this Inquiry indicated that prior to making application to amend the operating certificate, Air Ontario had indeed considered, and decided against, acquiring ground-start equipment for Dryden. Chief operating officer Thomas Syme testified that in late 1987, which was prior to acceptance of the first F-28, Air Ontario's F-28 implementation team, including representatives from the airports, marketing, maintenance, and flight operations groups, considered the matter of a ground start at Dryden airport. The matter was also considered by Mr Syme in his capacity at that time as group vice-president, operations and marketing. Because of the high cost of a ground-start unit, approval by Mr Syme and the president, Mr William Deluce, would have been required. According to Mr Teoman Ozdener, former F-28 maintenance manager at Air Ontario, a ground-start unit would have cost approximately "$60–$70,000" (Transcript, vol. 102, p. 37).

In his testimony before the Commission, Mr Syme recalled that the cost of acquiring a ground-start unit for Dryden, along with the operational considerations discussed below, had been a factor in the decision not to furnish Dryden with ground-start equipment:

> Q. Do you recall specifically why it was decided not to put a ground start unit in Dryden?
>
> A. The rationale was that the aircraft had an APU ...
>
> Dryden was a through stop which meant the aircraft was on the ground for a very short period of time. And that with a serviceable APU, there wasn't a requirement for a ground start unit.
>
> ...
>
> A. ... I was made aware that without an air-start unit, if the APU was unserviceable and in circumstances if weather forecasts were extreme, that the aircraft would not operate into Dryden.
>
> (Transcript, vol. 98, pp. 82, 83–84)

It is indisputable that the safer practice would have ground-starting facilities at all scheduled station stops for all aircraft that might require them. (In the case of a turbojet such as the F-28, a ground air-start unit would be required.) With such facilities, a flight crew would have the option of shutting down the aircraft for any reason – including de-icing – without fear of stranding its passengers. However, commercial realities being what they are, it is understandable that, for a number of reasons, a carrier may not want to invest in ground-power units for all of its scheduled stations. Having stated this, I would hasten to add that, if a carrier makes such a commercial decision, there clearly must be an operational accommodation for the lack of ground-start facilities at the individual stations.

According to Mr Syme, Air Ontario's operational accommodation for not providing a ground start in Dryden was to overfly that station in "extreme" weather (Transcript, vol. 98; p. 84). If indeed this was the policy at Air Ontario, its failure was in not committing this "operational accommodation" to a standardized, unambiguous directive contained in all appropriate manuals and communicated to all flight crews and dispatchers. In testimony, Mr Syme, Captain Robert Nyman, and Captain Joseph Deluce each conceded that there was no written policy directing pilots to overfly Dryden in circumstances where their APU was unserviceable.

Although there was no written policy, Captain Deluce was of the view that Air Ontario pilots were well enough equipped to respond to operational situations of this sort:

> Q. ... Now, as chief pilot, would you not agree with me that, if it was your view that, in a given situation, pilots could overfly Dryden, that that situation should be brought to the attention of the pilots?
>
> A. ... I think that there's no question about it, that I did not provide them with specific direction on that specific issue. But ... [by] the same token, I don't think it would be reasonable for me to document every possible scenario that – and make every possible decision that a pilot would ever be expected to make. To me, that is a reasonable decision for a pilot to make
>
> ...
>
> A. I believe that all pilots would know that they could do whatever they had to do to operate in a safe manner.
>
> (Transcript, vol. 111, pp. 204–205)

Captain Deluce's statement ignores the very real, and usually competing, choices with which an airline pilot is often confronted. On the one hand there is the corporate goal of getting passengers to their destinations on time and, especially, avoiding groundings. On the other hand, there is the imperative to operate as safely as possible. Recognizing this basic conflict, it is the air carrier's responsibility, within the air transportation system, to provide clear advice to its pilots for all reasonably foreseeable operational contingencies. The Dryden scenario, in my view, was reasonably foreseeable.

Captain Nyman, Air Ontario's director of flight operations and an F-28 company check pilot, was not aware of any company policy, written or otherwise, in this regard, and his view, in contrast to that expressed by Captain Deluce, was that company guidance was required. Moreover, Captain Nyman admitted that at Air Ontario the pilots were alone when it came to these crucial, stressful decisions:

> Q. ... So just as a circumspective line pilot, if you had been faced with a decision of either, A, overflying Dryden, or B, possibly getting stuck in Dryden because you don't have an APU and it's snowing and so on, that's something that you just simply would have considered on your own, is that right, without any guidance from the company?
> A. I think that there should have been guidance from the company. That's not what I'm saying.
> Q. No, I understand that.
> A. I – yes, I would have considered that on my own, and I have often wondered, in fact, what I would have done.
>
> (Transcript, vol. 109, p. 236)

It is of utmost importance, as illustrated by the events of the Dryden accident, that maximum support be afforded flight crews in making difficult operational decisions. Clear policies must be put in place by air carriers to ensure that flight crews are not left to decide, in stressful, Dryden-type situations, whether to overfly a scheduled stop or ground an aircraft and strand a planeload of passengers, or to attempt a potentially hazardous takeoff. Having well-developed and understood company policy on which to base their decisions, pilots would be more easily able to make correct choices.

The preferred policy in my view, and the one employed by Air Canada, is simply not to dispatch a turbojet aircraft with an unserviceable APU into an airport lacking appropriate ground-start capability. Captain Charles Simpson, Air Canada's vice-president of flight operations, testified that Air Canada did not operate aircraft with unserviceable APUs into Fredericton, New Brunswick, a station with no ground-start facilities. This policy is in place in order to avoid the possibility of being unable to restart the aircraft engines if for some reason they had to be shut down.

In keeping with my earlier comments regarding the APU and the minimum equipment list (MEL), it is my view that this policy could be clearly stated in individual aircraft MEL sections dealing with APU unserviceability. For example, where the MEL provides relief to operate with an inoperative APU, the MEL could include a precondition of operation that necessary ground-start facilities be available at destination airports.

Findings

- Air Ontario failed to ensure that an operational policy was in place and communicated to all operational personnel so as to prevent the dispatch of an F-28 with an unserviceable auxiliary power unit into a station without ground-start facilities.
- Given the Air Ontario F-28 support facilities that actually were in place at Dryden, Transport Canada failed to ensure that there was an operational accommodation in place at Air Ontario. Such an operational accommodation would have prevented the dispatch of an F-28 aircraft with an unserviceable APU into Dryden.

RECOMMENDATIONS

It is recommended:

MCR 55 That Transport Canada ensure that air carriers have operational policies that require the availability of appropriate ground-support facilities at individual airports where the air carrier intends to operate.

MCR 56 That Transport Canada ensure that the operational policies referred to in Recommendation MCR 55 above be contained in the air carrier's operations manuals, such as its flight operations manual and its route manual, and/or the individual aircraft minimum equipment list.

MCR 57 That Transport Canada ensure that, when it is reviewing an air carrier application for an operating certificate or an amendment to an operating certificate, there be a scrutiny of the air carrier's intended aircraft support facilities. Transport Canada then should satisfy itself that operational policies contained in the air carrier's operations manuals adequately accommodate the air carrier's identified and existing aircraft support facilities. No operating certificate or amendment to an operating certificate should be issued unless Transport Canada is so satisfied.

18 THE F-28 PROGRAM: SPARE PARTS

From the evidence it became clear that one of the requisites for the safe and efficient operation of an aircraft in scheduled commercial service is an adequate supply of supporting spare parts (spares). This is particularly true with regard to the introduction of a new aircraft type into a carrier's fleet.

Transport Canada, through its legislation and airworthiness inspectorate, is charged with the responsibility of ensuring adequacy of spares before approving an aircraft type for operation by any carrier. Prior to the licensing by Transport Canada of an air carrier's proposed aircraft operation, the carrier must establish that it has either an adequate in-house supply of spares or ready access to another supply of spares sufficient to support the intended operation.

Evidence was called both from Transport Canada as to the necessary compliance with the governing legislation and from Air Ontario as to the adequacy of its planning for spares to support the F-28 program.

Governing Legislation

Air Navigation Order (ANO) Series VII, No. 2, Part II, entitled "Aircraft Maintenance," sets forth the requirements of support equipment for the proper maintenance of aircraft. Section 12(1) reads:

> An air carrier shall provide adequate shelter, workshops and facilities, and such equipment as may be necessary for the proper maintenance of aeroplanes and auxiliary equipment in use.

Mr Ole Nielsen, superintendent, Air Carrier Maintenance Division, Airworthiness Branch, of Transport Canada's Ontario Region, was principal inspector for Air Ontario from mid-1987 until June 1988, when he became superintendent. (The introduction of the F-28 into the Air Ontario fleet occurred in June 1988.) Mr Nielsen was asked to describe his understanding of section 12(1):

> Q. Now, is my understanding correct that your authority, the authority imposed on you, is to look at the governing ANO for large air carriers in commercial operation and make this determination?

A. Yes. We make a determination of the air carrier's ability to maintain the airplane based on these requirements.
Q. Right. And I take it that equipment, et cetera, means that they will have enough spares to run?
A. Equipment runs the gamut from ground support equipment through the spares inventory that the air carrier maintains.
Q. Right. And can I take it from your answer that ... before this thing gets put on the operating certificate ... you have to be satisfied that there are adequate spares to provision it?
A. That is correct.
Q. Right. And indeed, it's in evidence that it was put on the operating certification on the 3rd of June of 1988.
A. Yes. Although they did have problems with the spares as you are aware.

(Transcript, vol. 129, pp. 110–11)

Serviceability Difficulties

A number of the pilots employed by Air Ontario were asked questions about the reliability of the F-28 and the availability of spare parts.

Captain Christian Maybury, a commercial pilot since 1968 with 15,000 hours' experience, stated his understanding of the availability of spares for the F-28, as follows:

Q. ... What was your view as an operating F-28 pilot of the degree and level of expertise of maintenance that was helping you?
A. Not very good. There were some ongoing problems, and I think they – for one thing, there was a great shortage of spare parts. It seemed to be an ongoing problem.

(Transcript, vol. 92, p. 43)

Captain Erik Hansen, an Air Ontario pilot with more than 19,000 hours' experience, was questioned on the adequacy of spare parts for the F-28. He testified that Air Ontario "didn't have very many [spares for the F-28]," and cited the ongoing unserviceability of the F-28 radar altimeter and autopilot pitch control as examples of the inadequacy of the F-28 spare parts supply (Transcript, vol. 94, p. 139).

Captain Monty Allan, an Air Ontario pilot with more than 6000 hours' flying experience, gave testimony on the subject of the maintenance and reliability of the F-28:

A. ... As a result, we had some snag deferrals that seemed to lag on for quite awhile. The deferrals were perhaps based on in part that they were troubleshooting it which is not unusual or in part more often the case is a lack of parts.

Since at the outset, we were only operating one aircraft and even at the end just two, it's very expensive, I guess, for the company to keep a large inventory of spare parts for the aircraft. And quite often, legal deferrals were made related to nil parts available which meant that they did not have the part in stock and they would have to look to other carriers or manufacturers to secure the part, which took any length of time, a day or several days or weeks, I guess, in some cases.

Q. From time to time, sir, during the time that you were flying the F-28, was it your view that there were excessive deferred defects?

A. I don't think excessive defects would appropriately reflect the way I felt. I think it was defects that were deferred for an excessive amount of time, so specific defects which probably exceeded that reasonable time period for being rectified.

(Transcript, vol. 91, pp. 47–48)

Plan to Provide Spares

Captain Joseph Deluce formally became the F-28 project manager in January 1988 and, in this capacity, oversaw the implementation of both the original and the revised F-28 project plans. Both project plans called for the provision of spares to have been the responsibility of the vice-president of maintenance and engineering, Mr Kenneth Bittle. Nevertheless, president and CEO William Deluce, because of his experience in aircraft and spare parts procurement, initially took charge of this aspect of the F-28 implementation project.

The critical path of the original F-28 Project Plan indicated that the provisioning of spares would be completed by the twenty-sixth week of the program or by the fourth week of April 1988. In the Revised Project Plan of December 1987, parts and equipment provisioning was described as simply "ongoing."

The original plan was to purchase a package of spares from the Turkish airline Turk Hava Yollari (THY), which was the previous owner and operator of the Air Ontario F-28s. This spares package was understood by Mr William Deluce to be sufficient to maintain up to a six-aircraft fleet, which was the number of F-28s that Air Ontario eventually planned to acquire.

A second option was to purchase a spares package from Transport Aérien Transrégional (TAT), the lessor of the Air Ontario F-28s and itself an F-28 operator having spares for sale. Mr William Deluce confirmed that the TAT spares option would have been more expensive than the THY spares package.

THY Spares Package

On October 30, 1987, Mr Kenneth Bittle wrote to Mr Alex Bryson of Transport Canada, informing the regulator of Air Ontario's intention to acquire the THY spares and requesting that a Transport Canada inspector go to Turkey, audit the THY parts overhaul facility, and approve the THY certification of its spare parts.[1] In the letter it was anticipated that, although the purchase was still under negotiation, this inspection should be done prior to the end of 1987.[2]

Upon receipt of this letter, Transport Canada replied to Air Ontario that it was not in a position to have an inspector travel to Turkey; however, advice was given as to the steps that would have to be taken if Air Ontario intended to import these THY spare parts.

Mr Bittle, when questioned on his October 30, 1987, correspondence to Mr Bryson, testified that he understood the carrier had to show that spare parts were available as part of the operating certificate application; however, he did not consider this letter to have been official notification of spares availability.

Mr Bittle accompanied Mr William Deluce to Turkey in January 1988 to survey the spares. By the end of their trip, Mr Bittle understood from William Deluce that the deal for the THY spares was so imminent that both Mr Bittle and Mr Deluce contemplated chartering a DC-8 cargo aircraft in England to facilitate the transfer of the parts to Canada.

On March 4, 1988, Mr Teoman Ozdener, who had been hired as an F-28 maintenance specialist, outlined for Mr Bittle what options were open to Air Ontario management with regard to the spare parts situation. Mr Ozdener explained to Mr Bittle that, if the THY deal were completed, the spares problem would be solved. If the THY deal did not

---

1 In order for spare parts to be used in Canadian-registered aircraft, it is necessary for Transport Canada to satisfy itself of the soundness and integrity of the parts. Regulatory authorities of most countries will inspect and certify domestic maintenance and overhaul facilities as capable of maintaining and reconditioning parts to a sufficiently high standard for use in domestic aircraft. Canada and other countries have bilateral arrangements whereby one country has confidence in and will rely upon another country's inspection and certification of its domestic maintenance and overhaul facilities – and the spare parts emanating from such facilities. In such circumstances, the parts will be "tagged" as having been maintained or overhauled by a facility certified by a foreign regulatory authority; and other countries, like Canada, will respect the "tags" and allow for the importation and use of such parts in domestic aircraft. There was no such bilateral arrangement between Turkey and Canada. Therefore, in order for Air Ontario to use the THY parts, it was necessary for it to request that a Transport Canada airworthiness inspector attend at the Turkish overhaul facility and provide a Canadian approval for the use of the Turkish parts.

2 It was also intimated in this letter that the first aircraft "could be ready" by January 1988 and the second by March 1988.

go through, alternative sources of spares would have to be found, either by pooling parts with other F-28 operators or by buying parts independently from another source. Mr Bittle testified that, by March 4, 1988, he was still expecting the THY deal to go through.

On March 28, 1988, Mr Ozdener once again outlined for Mr Bittle his thoughts on the spares issue. Mr Ozdener wrote in his report to Mr Bittle: "THY DEAL IS 'VERY' CRUCIAL FOR OUR OPERATION" (Exhibit 813, p. 8). Mr Ozdener continued to plan for the contingency of the THY deal failing, which in simple terms meant that if the THY deal failed, Air Ontario had to look for spares from alternative sources, either from TAT or from some other source. Mr Bittle testified that during this period of time he was in frequent contact with Mr William Deluce – the "main man," to use his words, when it came to the THY spares deal. They were expecting delivery of the first aircraft around May 1, 1988, and Transport Canada certification of the parts could have taken up to six months.

On April 4, 1988, Mr Bittle wrote to Mr John Aguiar, his materials supervisor, and to Mr Ozdener, his F-28 specialist: "It would appear that the purchase of spares and equipment from THY is at least two to three weeks away and as such we must make a firm or alternate arrangements via TAT for renting of the bare minimum of rotables and test equipment" (Exhibit 828). Mr Bittle went on to say that the consumables should be purchased in small quantities and expressed the belief that the THY inventory would eventually be Air Ontario's.[3]

Mr Bittle explained in general terms the actions taken as a result of the delay in the THY deal:

> A. ... When it became evident that the THY deal was not happening, it certainly wasn't happening under the speed that we originally anticipated, and then, eventually, maybe it wasn't going to happen, so we re-activated some of those original plans and started to source out parts and equipment from other places and in – in anticipation of either having to keep them on a long-term basis or, on a short-term basis, to cover us until these THY parts came in-house, were certified and usable.
>
> (Transcript, vol. 103, pp. 82–83)

Mr Bittle contacted TimeAir, an F-28 operator, for the purpose of accessing its spare parts inventory. After agreeing to provide Air Ontario

[3] Aircraft spare parts can be categorized under the broad headings of "consumables" and "rotables." Consumables are items such as gaskets, oil filters, hoses, or brake pads, which are used and then discarded when no longer serviceable. Rotables are items like fuel or hydraulic pumps, or generators, which can be overhauled or serviced and then used again.

with such access, TimeAir's maintenance manager, Mr Ritchie Rasmussen, at the request of Mr Bittle, wrote a short letter to Transport Canada addressed "To Whom This May Concern," dated April 19, 1988, and stating as follows:

> Time Air Inc. have an agreement to supply spare parts, including tools and equipment in reference to Fokker F28 MK1000 aircraft to Air Ontario.
>
> We have a working agreement operationally to support Air Ontario to do with the maintenance and support of the Fokker F28 aircraft in conjunction with our operation.
>
> We have also agreed to assist Air Ontario with the installation of 18 parameter FDR to meet M.O.T. requirements.
>
> (Exhibit 829)

According to the evidence of Mr Ole Nielsen, the principal Transport Canada airworthiness inspector for Air Ontario, the letter of Mr Rasmussen satisfied the spare parts prerequisites for putting the F-28 on Air Ontario's operating certificate. However, it must be pointed out that this three-sentence letter is the only documentary evidence of any such arrangement between Air Ontario and TimeAir. Mr Nielsen testified as follows on this subject:

Q. ... was this directed to you by the author of the document, Mr Rasmussen?

A. It was not specifically addressed to us, and I can't give you the specific dates when we were informed that ... there were not going to be any Turkish parts available.

And we subsequently informed Air Ontario, Mr Commissioner, that we would not add the airplane to their operating certificate without them having adequate spares to maintain the aircraft.

The determination of adequate spares is not made by us, it's made by the organization's quality control people, who certainly know the aircraft much better than we do.

But at the same time, without any spares whatsoever in the organization, we were not in a position to add the airplane to the operating certificate.

So Air Ontario subsequently went to TimeAir and requested the use of their spares while they were negotiating – I believe they were negotiating on some other spares from Europe.

But in the interim, we told them that they had to have spares, and this letter was then produced to us by Air Ontario.

Q. And this was satisfactory to you as the inspector that spares were –

A. Yes.

Q. – not an issue?

A. We ... can't advise the carrier that they must have spares at their ... base of operation. I mean, they could have it at some other base.
So for all intents and purposes, this satisfied the requirement for spares.

...

Q. ... is this a normal procedure for Transport Canada?
A. No, and it's not encouraged. This was a rather unusual circumstance where they had spares lined up in Turkey, and I believe the deal fell through. And now to operate the airplane, they needed some coverage for spares.
So this type of letter is not usually provided to us. We normally have formal contracts with other carriers. If one carrier is contracting all its maintenance to a third person, then there would be a specific contract in place for that provisioning of spares.

(Transcript, vol. 129, pp. 115–17)

After writing to Mr Aguiar and Mr Ozdener on April 4, 1988, with regard to contingency planning for spare parts, Mr Bittle wrote to chief operating officer Thomas Syme on the same subject. Mr Bittle's April 5, 1988, memorandum to Mr Syme indicated that certain decision dates had to be put in place regarding the spares situation. The memorandum emphasized that if the THY deal did not go through by May 15, 1988, "a firm order of between $1.5–$2 million" had to be placed elsewhere to ensure required provisioning for continued operation (Exhibit 814).

In his testimony, Mr Bittle described the memorandum as a timetable, given the impending delivery date of the aircraft:

A. ... [W]e requested from TAT on a rental basis a minimum stock of rotables, parts and equipment to support one airplane – and these ... should be coming over with the airplane – and that we ... also purchased, a ... minimum stock of consumables, consumables being filters, nuts, bolts, O-rings, things you use up and throw away, rotables being things you can overhaul or repair.
... April 11th ... we should be in a position to start looking at another alternate arrangement for a parts package, towards a possible firm order on May 15th.
May 15th was my final date for decision on the THY spares. If we don't have any, then we should go and start ordering – the parts that we would have started negotiating to buy on April 11th we should start ordering on May 15th.

(Transcript, vol. 103, pp. 92–93)

Parts Situation as F-28 Entered Revenue Service

As of May 31, 1988, following an inspection of the Air Ontario maintenance facilities by Transport Canada, the F-28 aircraft was included on the Air Ontario operating certificate. The inspection apparently satisfied the regulator that there were adequate equipment, parts, and facilities "necessary for the proper maintenance" of the newly acquired F-28s. As noted by Mr Nielsen in testimony, the decision on what constituted adequate spares was left to the quality control personnel of the airline.

The parts situation may have been adequate to meet the broad Transport Canada guidelines but was not sufficient to satisfy the marketing department of Air Ontario.

By June 17, 1988, Mr Bittle was very concerned about the lack of spare parts and expressed these concerns in a memorandum to Mr Syme. He stated in the memorandum:

> John Aguiar, myself and others are taking a lot of heat lately from various departments in the company with respect to the F-28 part situation. As we discussed before, it is well known that this part situation came upon us in a somewhat unusual way. The employees' belief that we "just forgot to order parts" or "didn't want to order parts" is a mistaken belief. It is causing a lot of hardship for all of us and ruining the credibility of this department. It is essential that the memo which you indicated would be issued from Bill is sent out immediately so that people understand the situation.
>
> (Exhibit 815)

According to Mr Bittle's testimony, the explanatory memorandum requested from Mr William Deluce and promised by Mr Syme was never issued.

When asked the source of the criticism of his department, Mr Bittle explained:

> A. [They were] people in marketing and – primarily in marketing ... they had sold this airplane to the public and it was on service and not reliable, and we were reporting back in a very, very concise form, you know, the airplane was late or it didn't go, parts on order or no parts or whatever, and this is where they were saying, what's the matter, Bittle you asleep at the switch, here? You forgot to order parts?
>
> And no, they don't go down to the stores and look at the shelf and see what's there. They don't have access to that.
>
> (Transcript, vol. 103, p. 109)

On the same date, June 17, 1988, Mr Bittle wrote a memorandum to Mr Aguiar and Mr Ozdener, with a copy to Mr Syme, stating that the "F-28 part situation is critical," and asking them to reply to him no later than June 22, indicating what plans they had in place to purchase an inventory of spare parts (Exhibit 816). At the date of Mr Bittle's two memoranda, the F-28 had been in revenue service for more than two weeks.

When asked why he used the word "critical" in his memorandum to Mr Aguiar and Mr Ozdener on the F-28 parts situation, Mr Bittle explained:

> A. Well, I just felt that reliability was to the point where it was not a very viable operation financially to operate the airplane as it was.
>
> We needed more parts, and so I guess the word "critical," from my point of view, was that we had reached a point where we have to make a decision here.
>
> Q. ... Or what was to happen?
>
> A. Well, I just didn't think we could operate waiting for these THY parts. It wasn't practical to keep beg[ging], borrowing and stealing from other companies. It wasn't a good way. There was too many delays, too many cancellations.
>
> (Transcript, vol. 103, p. 118)

F-28 project manager Joseph Deluce also identified the spare parts shortage as a significant cause of the poor reliability of the aircraft in its first month of commercial service. In his F-28 status report written in late June 1988, Captain Deluce wrote:

> The single most significant problem with the F28 is its reliability in our system. The various problems in this area include the following:
>
> a) Relatively inexperienced flight crews on this type of aircraft. (It will take some time for crews to learn the peculiar[ities] of operating an F28.
> b) Insufficient spares availability.
> c) Low level of expertise on the technical side in maintenance and troubleshooting the F28.
> d) Poor follow-up system of grounded F28 aircraft.
>
> (Exhibit 807, p. 044)

During this period of time, Mr Aguiar and Mr Ozdener attempted to secure a spare parts inventory from a variety of sources around the world. By mid-June 1988, Mr Aguiar and Mr Ozdener confirmed access to a supply of spare parts from sources in Norway, Sweden, and The Netherlands. On June 17, 1988 – the same day that Mr Bittle wrote to Messrs Syme, Ozdener, and Aguiar regarding the issue of spares – Air

Ontario's chief maintenance inspector, Mr Douglas Christian, wrote to Mr Ole Nielsen of Transport Canada requesting that Air Ontario be granted approval to certify and use the parts to be obtained from Norway, Sweden, and The Netherlands.

On June 27, 1988, Mr Nielsen responded to the request of Air Ontario by granting a limited approval (100 hours) for Air Ontario to use some of the parts from the named European sources.

Mr Nielsen was questioned on his impressions of the Air Ontario spares situation and his reaction to Air Ontario's correspondence to him of June 17, 1988:

> Q. When you received this letter on June 17th, Mr Nielsen, what, in a general sense, did this tell you about the parts situation at Air Ontario?
>
> A. Specifically, we knew they had the contract with TimeAir for parts, but we also knew that their – I believe about the same time that their parts situation with Turkey had come to an end.
>
> So this was ... their initial attempt at obtaining – perhaps not their initial attempt, but it was one of their attempts to obtain provisioning for the aircraft.
>
> The spares that they had obtained ... from these three facilities were not acceptable for import at the time, based on existing regulation.
>
> Q. ... And this is what I take it you told them in Exhibit 999 ... your letter dated June 27th, 1988.
>
> A. Yes, I spelled out the reasons why ... initially those spares were not acceptable. Braathens, the ones from Braathens in Norway weren't acceptable because we did not have a bilateral agreement with Norway.
>
> ...
>
> A. ... [A]nd the inventory from FFV Sweden was a similar problem. With no bilateral agreement, we could not accept the parts.
>
> The items ... from Allen Air Motive, although they came from Holland ... were not acceptable because they were released to the operator by means of Allen Air Motive's Federal Aviation Agency foreign repair station certificate. And we did not recognize ... FAA foreign repair station certificates.
>
> If they had been received with Dutch certification, we would have accepted that because we did have a bilateral agreement with Holland at the time.
>
> (Transcript, vol. 129, pp. 120–22)

When questioned further about allowing Air Ontario to operate with these now-acquired spares from Norway, Sweden, and The Netherlands, Mr Nielsen testified:

> A. – I had contacted our headquarters, Henry Dyck specifically, and we requested that – either we requested that an exemption be made to allow the use of these parts because we had actually – we had gone to Toronto and – at Pearson and witnessed the parts and we were satisfied that the parts would have been quite acceptable, but due to the regulatory requirements, they were not.
>
> So we requested that headquarters consider an exemption, which came, they allowed the use of the parts for 100 hours – we allowed the use of the parts for 100 hours ... pending the resolution of that request. And that is not outside the realm of normal day-to-day business. We do allow the use of foreign parts for up to 100 hours on any aircraft in Canada.
>
> (Transcript, vol. 129, pp. 122–23)

Mr Nielsen testified that the spares obtained by Air Ontario for the maintenance of the F-28 aircraft by June 1988 were "very limited" and that it was a "certainly limited inventory to maintain a jet type airplane" (Transcript, vol. 129, p. 124).

Ongoing Spares Provisioning

The efforts of Air Ontario maintenance to improve its spare parts supply continued throughout the period of time when the airline operated the F-28 aircraft. As stated, in the early stages of F-28 operations, while there was still a possibility that Air Ontario would acquire the THY spares inventory, Air Ontario's parts acquisition was limited to "bare minimum" renting from Fokker, ad hoc borrowing from TimeAir, leasing from parts supply companies, and small-scale purchasing from other sources.[4] When it became apparent that the THY deal would not be completed, spare parts were acquired from many international sources; and, in September 1988, Air Ontario took a significant step by exercising its option to purchase parts that it had been leasing pursuant to a June 1988 lease agreement with a company called Satair.

The evidence reveals, without any doubt, that there were insufficient spare parts to support the Air Ontario F-28 aircraft during the first weeks of commercial service. However, Mr Ozdener and Mr Bittle were of the opinion that there were adequate supporting spare parts as they expanded their inventory in the months that followed.

Mr Ozdener, in defence of the spares sourcing and acquisition that he ultimately coordinated, gave the following evidence:

---

[4] Exhibit 828, memorandum dated April 4, 1988, from Kenneth Bittle to John Aguiar and Teoman Ozdener, Re: THY Parts

A. We never grounded an aircraft. Whenever we need a part, within 24 hours, we could bring anything from any place in the world.
There's a system called AOG.[5] You just call AOG and within 24 hours, the fastest way you will have the component or piece in your hands, sir.
(Transcript, vol. 101, p. 162)

Mr Bittle elaborated upon the complaints that Air Ontario maintenance was receiving from other departments in the company regarding the spares situation:

A. In my experience, in the parts department, you never have enough parts unless you have another airplane parked right beside the one you have and everything is there because ... Murphy's law says the part you need you don't have. Doesn't matter how much you spare up for it.
And so when you are lower than you would like to be, that situation is ... amplified even more, so sure, guys say, gee, we had to cancel a flight today or delay a flight because we didn't have the part. That ... reflects back on them and they expressed that to me.
Q. And is this the "ruining the credibility of the department" you are talking about?
A. Yeah. Yeah.
(Transcript, vol. 103, pp. 110–11)

Mr Bittle was questioned further on his opinion regarding the adequacy of Air Ontario's spare parts support. Given that he accepted responsibility for the spare parts situation at Air Ontario, I feel that it is necessary to quote from Mr Bittle's evidence at length:

Q. And I take it you would agree with me that the ... two F-28 aircraft that you brought into your fleet were not new aircraft?
A. That's right.
Q. They were used aircraft?
A. That's right.
Q. They had been, for example, we have heard evidence, parked in Turkey for a considerable period of time without being used?
A. Yes.
Q. And in those circumstances, being used aircraft and aircraft that had not flown for an extensive period of time, you would agree with me that it's all the more important to have a very good

[5] AOG Aviation Supply Inc. is an international aviation parts supplier based in Scottsdale, Arizona.

spares package when you are buying such an aircraft or two such aircraft?

A. ... [A]ny airplane needs a good spares package.

Q. But particularly an older airplane where, in your own words, you have to work out the bugs?

A. It becomes useful, yes. It's – you know, I wouldn't differentiate, because on a new airplane, number 1, the cost of operating or cost of acquiring it is higher.

So if you are trying to say that a new airplane, you wouldn't need as many spares, I disagree. Because when you are down with a new airplane, it becomes even more exciting.

Q. But with an old airplane – let's leave the new airplane aside. With an old airplane that's been parked, particularly one that's been parked for two years and not used, you need a good spares package because you are going to have problems?

A. Yes.

Q. And because it's been parked for two years, you are going to have more problems than if it had been in regular use and regularly maintained?

A. Yes.

Q. And for that reason, you need – all the more reason to need a good spares package?

A. Sure.

Q. Okay. And you didn't get that, did you?

A. I had adequate spares. I felt we had adequate spares.

Q. Were not spares a problem throughout the F-28 program?

A. As I said yesterday, spares are always a problem, and someone will always say to you, we didn't have enough spares.

I felt we had the correct level of spares.

Q. Would you not agree with me that a number of other people in management positions in Air Ontario identified the lack of adequate spares as being a specific problem to the F-28 program?

A. Unqualified people, but yes.

Q. Okay. You call Joe Deluce unqualified?

A. Yes. When it comes to that, yes.

Q. He was wrong in identifying the problem of obtaining spares?

A. He was not aware fully of what the problems are associated with it.

He was not a – he is not an individual that's in that kind of business, so he doesn't – you know, if any pilot, if any person wanted to dispatch a flight and there wasn't a part, they are going to say we don't have enough parts. They don't know why, they just say that.

Q. And it's your position, then, that with respect to the F-28 program, you consider as vice-president of maintenance that that would have been one of your areas of responsibility, wouldn't it, as vice-president?

A. Yes.
Q. The buck would stop at your desk with respect to spares?
A. Yes.
Q. That you had adequate spares throughout the operation of the program at Air Ontario?
A. Yes, I do.

(Transcript, vol. 104, pp. 159–62)

These comments by Mr Bittle and Mr Ozdener regarding the adequacy of spare parts are revealing. Both men were of the view that the spare parts support for the F-28 was adequate. Yet pilots who were flying the aircraft on the line – including the F-28 project manager and chief pilot – were of the view that insufficient spare parts caused delays and cancellations of F-28 flights. The evidence certainly indicated a difference in perception between the maintenance managers and others at Air Ontario regarding this issue. I accept the evidence of Mr Bittle when he commented:

> A. ... if any pilot, if any person wanted to dispatch a flight and there wasn't a part, they are going to say we don't have enough parts. They don't know why, they just say that.
>
> (Transcript, vol. 104, p. 162)

The statement would also appear to be applicable to the perceptions of both dispatch and marketing personnel; and, in the present case, perceptions are important. In particular, I am focusing on the perceptions of line pilots who were eager to make the jet program a success and who were subject to pressure, from many sources, to maintain on-time performance. In such circumstances, the reactions of pilots to perceived inadequacies in maintenance support may certainly vary.

It would appear that in the eyes of some – for example, Mr Bittle – the maintenance department lost some credibility over the spares situation. The comments of some F-28 pilots – for example, Captain Maybury, who described the ongoing assistance provided by Air Ontario maintenance as " ... [n]ot very good" (Transcript, vol. 92, p. 43) – would indicate that Mr Bittle's concern was well founded.

In chapter 10 of my Report, Technical Investigation, I identified 28 instances when maintenance deferrals were noted in the aircraft journey logbook of C-FONF during the period of time that Air Ontario had no approved MEL for the F-28. Of the noted deferrals, on at least five occasions the absence of parts or equipment was given as the reason for the deferral. The most recent of these "parts on order" deferrals occurred on November 23, 1988.

The following defects were recorded in the journey log of C-FONF as of the morning of March 10, 1989, prior to departure from Winnipeg:

1 September 22, 1988 – Captain's panel does not have a lighted time piece. Deferred IAW ANO Series 2-20. Licence ACA 87077. (Note – This deferral had been carried for almost six months).
2 February 8, 1989 – Roll and yaw not working properly in autopilot. Licence ACA 87118. Deferred.
3 February 8, 1989 – First Officer windshield wiper creeps up in flight. Licence ACA 87118.
4 February 23, 1989 – Pilot reports LH fuel gauge still intermittent (reads full). Licence ACA 87015. Carried Forward – Deferred.
5 February 24, 1989 – Number 1 Constant Speed Drive warning light tests but won't come on after shut-down. Licence ACA 87042. Deferred MEL 02-24.
6 March 9, 1989 – APU will not fire test. Licence ACA 87101. Deferred MEL 49-04.

(Exhibit 492, para 1.2, pp. 3–4, and Appendix 17 (Records Report))

There were also other discrepancies that were brought to the attention of the flight crew by the cabin crew prior to the first flight on March 10, 1989, but were not entered in the journey logbook (or any other log as far as can be determined). These included:

1 The exit light over the main entry door was not working.
2 The exit light over the cabin door, on the cabin side, was not working.
3 The cabin emergency floor lighting was dimmer than normal and had a bluish colour rather than a bright white colour.
4 There were three altitude-compensating oxygen masks missing from the back of the aircraft.
5 There had been some difficulty closing the main entry door in Winnipeg. A plastic surclip that normally held the door handle in the stowed position when the door was closed had broken, and, as an expedient, the handle was being held in place by double-sided tape. The difficulty in closing the door could have been attributable to the fact that the door operating handle was being held in the stowed position by the tape while an attempt was made to close the door. Neither the tape itself nor the fact that the surclip was broken apparently posed any danger of the door opening inadvertently.

(Transcript, vol. 55, pp. 78–85; based on testimony of Mr Gregory Morrison)

It is not known if any other problems developed during the flights on March 10, 1989.

Whether any of these maintenance deferrals can be attributable to insufficient spare parts is not altogether clear. In some instances, as described, there is specific mention of "parts on order," while in other instances the maintenance notation is simply "carried forward" or "deferred." I believe it is likely that some of the "carried forward/deferred" notations can be attributed to the lack of a replacement part. For instance, I can think of no other reason for the captain's panel to be without a lighted timepiece for a period of more than six months, except that Air Ontario maintenance did not have a replacement timepiece to effect a rectification.

Flight attendant Hartwick was questioned on Captain Morwood's reaction to these unserviceabilities:

> Q. Now, when these things were brought to Captain Morwood's attention, what was his reaction?
> A. He said, Oh, God, more snags. He was a little – he was frustrated things weren't being fixed.
> Q. So this would have been early Friday morning, right?
> A. That's correct.
> Q. And these things were put before him, and he was frustrated, and the words, to the best of your recollection ... is something like – what did –
> A. Damn it, more snags, this type of expression.
>
> (Transcript, vol. 10, pp. 168–69)

Insufficient supporting spare parts can contribute to the protracted deferral of necessary aircraft maintenance. When aircraft are operating with the maintenance of essential aircraft equipment deferred, pilots must contend with the operational constraints inherent in the unserviceabilities. When aircraft are continually operated with unrectified unserviceabilities, pilots can lose confidence in their maintenance organization and become frustrated in the operation of their aircraft. Based on the evidence before me, it would appear that some Air Ontario F-28 pilots, including Captain Morwood, were losing confidence in their organization and were frustrated with the F-28 operation.

Spare Parts: How Much Is Enough?

The spare parts requirements set out in Air Navigation Order Series VII, No. 2, are vague and unhelpful. No guidance is provided to the good-faith operator in determining what constitutes "such equipment as may be necessary for the proper maintenance of aeroplanes" (ANO Series VII, No. 2, Part II, section 12(1)). Similarly, the regulator is given little assistance in the exercise of its discretion on this issue.

It is to be noted that there is no specific reference to "parts" or "spare parts" in the ANO. The requirement for spare parts, as identified by Transport Canada personnel, is based on the broad interpretation of section 12(1) of the order, which uses the language " ... adequate shelter, workshops and facilities, and such equipment as may be necessary."

Presumably, an airworthiness inspector will attend at an air carrier's maintenance facility to determine whether, in his or her judgement, there is an adequate supply of spare parts to support a given operation. However, the words of the ANO, "adequate" and "necessary," certainly invite diverse interpretation and defy enforcement.

Mr Nielsen, the airworthiness inspector who reviewed the Air Ontario spares situation, stated that the decision regarding sufficiency of spares was left to the quality control personnel of the individual airline because, as he put it, they know best the requirements of their operation. This may be true, but surely there should be some clearly articulated minimum standard that both Transport Canada and an air carrier could refer to in assessing whether a prospective operation has an adequate supply of supporting spare parts. Such an assessment must occur before a prospective operation is licensed; and the minimum standard would necessarily involve more than a "to whom it may concern" letter from another airline.

Mr Nielsen was questioned further on the TimeAir letter that Air Ontario produced in the purported fulfilment of its spare parts supply obligations:

> Q. Now, you are saying that this is the type of practice that is not encouraged by Transport Canada.
>
> A. No, it's not, no.
>
> We want the carriers to have their own parts. Whether through a ... contract agreement or actually purchased, that's entirely up to them, but we certainly want them to have readily available spares to conduct line maintenance at the least, and preferably those spares required to support their MEL requirements.
>
> (Transcript, vol. 129, pp. 117–18)

I note that when Transport Canada accepted the "to whom it may concern letter" as evidence of Air Ontario's ability to access " ... those spares required to support [its] MEL requirements," Mr Nielsen knew that Air Ontario had no approved F-28 MEL; and, as it happened, Air Ontario continued revenue service until December 1988 without an approved F-28 MEL.

Mr Bittle may have been absolutely right when he said that "... you never have enough parts"; however, the experienced judgement of senior maintenance management must certainly be brought to bear to determine how much is enough.

It may be argued that it is appropriate for an air carrier to make its own determination as to what constitutes an adequate supply of supporting spare parts for the purposes of operating its aircraft. Further, it may be argued that this determination is a strictly economic matter; and, if an airline wishes to risk the grounding of aircraft at inappropriate times and suffer the economic and marketing consequences of such groundings, then an airline should be able to make such an assessment and accept such a risk. I am of the view that such reasoning ignores the reality of day-to-day airline operations.

There is always a danger that the purely commercial risk of aircraft groundings and flight cancellations will be translated into operational risks taken by those immediately responsible for the safe operation of the aircraft. The evidence before this Commission indicates that inadequate spare parts support can put pressure on mechanics and pilots to defer aircraft maintenance for long periods of time in order to maintain on-time performance. I am of the view that this tendency was to a certain extent exacerbated at Air Ontario because operational personnel were themselves enthusiastic about the F-28 program and eager for it to succeed and because usual standards of scrutiny and conservatism were allowed to wane.

Findings

- Transport Canada has a legal obligation to determine whether adequate spare parts are available to an air carrier for the "proper maintenance" of aircraft used by the air carrier (ANO Series VII, No. 2, Part II, section 12(2)).

- Unless Transport Canada is satisfied that adequate spare parts are available for a given aircraft, approval of the air carrier to use that type of aircraft should not be granted.

- Transport Canada temporarily allowed Air Ontario to use spare parts from other countries although regulations did not allow those parts to be imported into Canada and approved for use on a long-term basis.

- Transport Canada personnel satisfied themselves that sufficient spares for "proper maintenance" existed by simply relying upon the judgement of Air Ontario quality control personnel and by accepting at face value a brief letter from TimeAir. This letter merely indicated that TimeAir agreed to supply spare parts to Air Ontario and gave no further details whatsoever.

- Air Ontario did not have an adequate supply of spare parts in house at the time the F-28 was added to the operating certificate and started in commercial service.

- Lack of spares, combined with enthusiasm for the F-28 project, brought pressure to bear upon Air Ontario maintenance personnel and pilots to carry maintenance snags for long periods of time.

- ANO Series VII, No. 2, Part II, section 12(2) is vague in that it does not assist Transport Canada airworthiness personnel to determine what equipment and spares are necessary for the "proper maintenance" of aircraft.

RECOMMENDATIONS

It is recommended:

MCR 58 That Transport Canada direct its airworthiness personnel to determine themselves whether an air carrier has adequate spare parts for the proper maintenance of aircraft. Under no circumstances should this decision, in effect, be delegated to any person employed by the applicant air carrier.

MCR 59 That Transport Canada proffer for enactment an amendment to Air Navigation Order Series VII, No. 2, Part II, section 12(2), that assists Transport Canada airworthiness personnel to determine whether sufficient spare parts exist. Alternatively, an approved written departmental policy should be promulgated to assist airworthiness personnel to make this determination.

MCR 60 That Transport Canada under no circumstances issue an operating certificate or an amendment to an operating certificate until it is satisfied that all spare parts requirements established by Transport Canada are fulfilled.

19 THE F-28 PROGRAM: FLIGHT OPERATIONS MANUALS

Well-developed and up-to-date flight operations manuals are necessary for the safe and efficient operation of commercial aircraft. Such manuals are required both to establish standard procedures in aircraft operations and to provide day-to-day guidance to all operational personnel in an airline in the fulfilment of their duties. For manuals to communicate standard procedures, it is necessary that they be amended regularly, incorporating changes in operational practice, and that amendments be regularly distributed to appropriate personnel.

Generally, flight operations manuals used by Canadian air carriers operating large aircraft are of two types: manuals that deal with the air carrier's flight operations, and manuals that deal with the operation of a specific aircraft type in an air carrier's fleet.

This chapter examines operations manuals that were used by Air Ontario personnel in the operation of the F-28 aircraft.

Terminology

Throughout the Commission hearings, reference was made to a number of air carrier manuals. Witnesses demonstrated inconsistency when referring to the titles of a carrier's various flight operating manuals. To assist the reader, the following are general definitions of the relevant manuals:

1 Flight operations manual (FOM). A manual prepared by a carrier and approved by Transport Canada that sets out the organizational structure of the carrier, the duties and responsibilities of flight crews, and policies and procedures for the flight crew's guidance. The FOM is referred to as an operations manual in ANO Series VII, No. 2, Standards and Procedures for Air Carriers Using Large Aeroplanes.

2 Aircraft flight manual (AFM). A manual prepared by the manufacturer of an aircraft and approved by the airworthiness authority of Transport Canada as part of the type approval of that aircraft. It contains operating procedures, both normal and abnormal, aircraft limitations, and performance data. Certain portions of the AFM are

approved by Transport Canada. During Commission hearings the AFM most often referred to was the three-volume Fokker Aircraft F-28 Flight Handbook.

3 Aircraft operating manual (AOM). A manual prepared by a carrier that sets out detailed operating procedures for a particular aircraft type. Although approval of the manual by Transport Canada is not required, the AOM must be no less restrictive than the AFM prepared by the aircraft manufacturer. During Commission hearings, the AOMs most often referred to were the Air Ontario draft F-28 Operations Manual, the Piedmont Airlines F-28 Operations Manual, and the USAir F-28 Operations Manual (Pilot's Handbook).

4 Standard operating procedures (SOPs). This term is often used interchangeably by Transport Canada inspectors and air carrier operational personnel to describe aircraft operating manuals or condensations of procedures contained in AOMs in the form of checklists for use on the aircraft's flight deck.

5 Flight attendant manual (FAM). A reference manual prepared by a carrier that sets out procedures and practices for the guidance of flight (cabin) attendants in the conduct of their duties and responsibilities in an aircraft. The FAM is referred to by Transport Canada as a cabin attendant manual.

Manuals in Use on C-FONF on March 10, 1989

On March 10, 1989, the onboard library[1] of C-FONF contained, for use by the pilots: the three-volume aircraft flight manual (AFM) entitled, Fokker F-28 Flight Handbook; an F-28 weight and balance and performance manual; a Piedmont Airlines quick reference emergency and abnormal operations handbook; and a Piedmont Airlines normal checklist.

The pilots operating flight 1363 on March 10, 1989, carried the Air Ontario Flight Operations Manual (FOM), an Air Ontario route manual, instrument flight rules (IFR) approach charts, en route charts and related IFR information, and the F-28 Operations Manual. Captain Morwood

---

[1] An onboard library, located on the flight deck of an aircraft, consists of certain manuals that Transport Canada or the air carrier requires to be carried for the purpose of operation of the aircraft.

had with him a copy of Piedmont's F-28 Operations Manual, and First Officer Mills carried the USAir F-28 Operations Manual. Each flight attendant on the flight carried her own Flight Attendant Manual (FAM) issued by Air Ontario.

Included as part of each of the Piedmont Airlines and USAir F-28 operations manuals was a minimum equipment list (MEL) produced by Piedmont Airlines and USAir for their respective operations of the F-28 aircraft. Although Fokker Aircraft provided to Air Ontario two up-to-date F-28 flight handbooks in August 1988, it is not certain if one of these updated copies was on board C-FONF on March 10, 1989.[2] Since pilot evidence (Captain Monty Allan) suggests that the flight handbooks on board Air Ontario's F-28 aircraft were "a little bit dusty, a little bit dirty" (Transcript, vol. 91, p. 247), it is unclear whether a set of up-to-date flight handbooks was placed on board C-FONF. It is also not certain if a copy of the Fokker master minimum equipment list (MMEL) produced by Fokker Aircraft was on board C-FONF on the day of the crash.[3]

At the time of the crash, Air Ontario did not have its own F-28 operations manual. The Piedmont and USAir F-28 manuals were being used by Air Ontario and its F-28 pilots in the air carrier's flight operations, without the consent of Piedmont and USAir. No amendment service was requested by Air Ontario and no revisions were provided by Piedmont and USAir for their F-28 operations manuals.

Air Ontario leased from Transport Aérien Transrégional (TAT) of France the Fokker F-28 Mk1000 aircraft that crashed, which was registered to Air Ontario in June 1988 as C-FONF. It was contemplated and indeed stipulated in the lease agreement that C-FONF would be operated in accordance with the Fokker F-28 Flight Handbook and with an approved Air Ontario F-28 operations manual. At the time of the crash, Air Ontario had not completed drafting its own F-28 operations manual for approval by Transport Canada.

Flight Operations Manual

As stated elsewhere in this Report, the *Aeronautics Act* makes the minister of transport responsible for aeronautics applying to all aircraft operations within Canada. Air Regulations and Air Navigation Orders

---

[2] Aircraft C-FONF bearing serial number 11060 was imported into Canada carrying a Fokker F-28 Flight Handbook without a complete set of revisions. In May 1988 Air Ontario maintenance requested a revision package for the out-of-date flight handbook set on board C-FONF, and at the same time it ordered one complete flight handbook for each of C-FONF and C-FONG.

[3] Because the entire cockpit was completely consumed by fire, none of the referenced manuals and documents was recovered, either in whole or in part.

(ANOs) are developed by Transport Canada for the regulation of aeronautics and aircraft operations. ANO Series VII, No. 2, is the Canadian legislation that must be complied with by an air carrier operating large aircraft in commercial air service.

As part of the flight operations requirements, section 31 of ANO Series VII, No. 2, states that "An air carrier shall provide an [Flight] *Operations Manual* for the use and guidance of operations personnel in the execution of their duties." As both the regulator and air carriers normally refer to an operations manual as a flight operations manual, I will also do so for the purposes of this Report. Section 33 of the ANO states that the contents of a flight operations manual shall include at least the items set forth in Schedule B of ANO Series VII, No. 2, and be "presented in sufficient detail to enable the operations personnel to perform their duties in a proper manner." Section 35 of ANO Series VII, No. 7, requires the air carrier to provide a complete copy of its flight operations manual or appropriate parts to each crew member. The FOM provided by Air Ontario to Captain Morwood and First Officer Mills that would have been carried on board C-FONF by them on March 10, 1989, was submitted by Air Ontario to Transport Canada for approval in September 1987 and was approved by Transport Canada on February 29, 1988.

Section 32 requires an air carrier to "provide" a copy of its flight operations manual to Transport Canada. The FOM is the primary operational document of all air carriers. I therefore consider it important to set out in its entirety what Canadian legislation requires as a minimum for an air carrier to include in its FOM. Schedule B of ANO Series VII, No. 2, states as follows:

OPERATIONS MANUAL [FOM]

1. The following items shall be contained in an Operations Manual.

(a) a true copy of the air carrier's operating certificates;

(b) a chart of the air carrier's management organization and general operating policies;

(c) the duties, responsibilities and succession of command of operations personnel;

(d) reference to appropriate Air Regulations, Air Navigation Orders, Information Circulars and operating certificates;

(e) the procedures for determining the usability of landing and take-off areas and for disseminating pertinent information thereon to operations personnel;

(f) the procedures for accident notification;

(g) the procedures for operating in conditions of ice, hail, thunderstorms, turbulence or any potentially hazardous meteorological conditions;

(h) emergency flight procedures and emergency duties assigned to each crew member;
(i) the procedures for familiarizing passengers with the use of emergency equipment during flight;
(j) other information or instructions relating to safety;
(k) details of the approved crew member training programs including ground, flight and emergency phases thereof;
(l) information pertaining to flight release and operational control, including procedures for the monitoring and control of each flight, as applicable;
(m) information pertaining to enroute operation, navigation and communication procedures, including procedures for the release or continuation of flight if any equipment required for a particular type of operation becomes inoperative or unserviceable enroute;
(n) information concerning the air carrier's approved routes including the types of aeroplanes authorized for each route, their crew member composition, the kind of operation, such as VFR, IFR or Night VFR, and any other pertinent information;
(o) information concerning airports into which the air carrier is authorized to operate, including
  (i) locations,
  (ii) the types of aeroplanes authorized to use the airport,
  (iii) instrument approach procedures,
  (iv) take-off and landing weather minima, and
  (v) any other pertinent information;
(p) take-off, enroute and landing weight limitations;
(q) the methods and procedures for maintaining the aeroplane weight and centre of gravity within approved limits; and
(r) information pertaining to the air carrier's flight watch system.

I note that sections 31 through 37 and Schedule B of ANO Series VII, No. 2, are generally similar to subparts 121.133 and 121.135 of Part 121 of United States Federal Aviation Regulations (FARs), which list the required contents of FOMs used by United States air carriers. I shall compare specific items in these subparts of the United States FARs with ANO Series VII, No. 2, later in this chapter of my Report.

ANO Series VII, No. 2, requires the air carrier to issue a copy of an approved FOM to each flight operations employee and further requires this manual to be kept up to date through the issuance of amendments reflecting changes in Canadian air regulations or in the air carriers' operating procedures.

The purpose of an air carrier FOM is unique. Not only does it provide important operational information for the flight crew, but it is also the "bible" which all operations personnel rely upon to ensure that safe flight operations are conducted by an air carrier. The FOM is also a fundamental standard by which both the air carrier and the regulator measure the effectiveness and safety of the air carrier's flight operation.

Recognizing the importance of the FOM in directing air carrier operations, and given the fact that Transport Canada uses the FOM as a standard to assess and audit an air carrier's operation, I would describe at least the portions of the FOM that detail the mandatory requirements set out in Schedule B of ANO Series VII, No. 2, to be akin to subordinate legislation to the Air Regulations and to the ANO. The degree of detail and comprehensiveness with which an air carrier sets forth the requirements mandated by Schedule B in my view reveals the thoroughness and rigour with which an air carrier not only meets the regulatory requirement but also articulates its own expectation of a safe operation. In my view it also reveals the corporate philosophy and overall image of an air carrier. It is therefore important to determine if the information, advice, and direction contained in Air Ontario's FOM were sufficient to allow operations personnel to perform their duties in a proper manner.

The evidence shows that Air Ontario Inc., the merged and successor airline to Austin Airways Limited and Air Ontario Limited, operated from June 1987 until February 1988 without an updated and approved FOM reflecting the operations of the merged air carrier. Air Ontario Inc. did not produce a consolidated FOM and submit it to Transport Canada until September 1987, and Transport Canada did not approve it until February 1988. Captain Robert Nyman, the director of flight operations, testified that Air Ontario simply continued to use the old Air Ontario Limited FOM and the Austin Airways Limited FOM for the separate operations carried on within Air Ontario Inc. The FOM approved by Transport Canada in February 1988 was the result of Captain Nyman taking parts of both the old Air Ontario Limited and the Austin Airways Limited FOMs and combining the information in one document. As a result of FOM information combined from out-of-date manuals, items in the Transport Canada–approved Air Ontario Inc. FOM continued to be out of date in such matters as flight operations management, air carrier bases, various forms, and the reporting relationships among organizations internal to Air Ontario Inc. On March 10, 1989, the date of the crash, the latest amendment in the FOM was dated May 1, 1988.

Although most of the information that was out of date would not adversely affect the operational integrity of Air Ontario, matters that I view as significant were the inaccurate descriptions of the duties and responsibilities of Air Ontario's flight-watch system dispatchers, the inconsistency between the FOM and the FAM regarding hot refuelling, and the lack of an operational flight plan for use in the F-28 operation.

The FAM directs both passengers and flight attendants to leave an aircraft during hot refuelling, but, undeniably, no such direction was provided in the aircraft fuelling subsection of the FOM. Instructions contained in both ESSO Petroleum Canada's and Transport Canada's policy documents prohibited hot refuelling of an aircraft with passengers on board. This discrepancy should have been rectified by responsible Air Ontario Inc. management, and the prohibition, accordingly, included in the FOM.

As discussed in chapter 23 of this Report, Operational Control, Air Ontario provided to its F-28 flight crew a flight release for use for the conduct of flights in Air Ontario's F-28 aircraft. ANO Series VII, No. 2, Part III, section 15(1), states as follows:

> No person shall commence a flight unless the pilot-in-command and, where applicable, the flight operations officer authorized by the air carrier to exercise operational control over the flight, has approved and signed an operational flight plan setting forth the conditions under which the flight is to be conducted.

Operational flight plan is defined in ANO Series VII, No. 2, as the "operator's plan for the safe conduct of a flight."

Mr David Rohrer, chairman of the operations group of the Commission's investigation team, in testimony referred to the operational flight plan prepared by Air Ontario for the Convair 580 aircraft as one that complied with the criteria set out in ANO Series VII, No. 2. Mr Rohrer testified that no such operational flight plan existed in Air Ontario's FOM for the F-28 aircraft. He testified that the flight release used by Air Ontario for the dispatch of the F-28 aircraft "did not fulfil what I considered to be an operational flight plan" (Transcript, vol. 87, p. 31). A copy of the flight release used by the crew of C-FONF on March 10, 1989, is set out in chapter 23. For purposes of comparison, figure 19-1 is a copy of the sample Convair 580 operational flight plan included by Air Ontario in its FOM. By comparison, the sample operational flight plan for the Convair 580 aircraft is far more complete and detailed than the flight release used by Air Ontario for F-28 flight operations. The Convair 580 operational flight plan contains information similar to that found in an aircraft flight log (referred to in testimony by Captain Claude Castonguay and discussed in chapter 20 of this Report, F-28 Program: Flight Operations Training).

The importance of an operational flight plan such as set out here is that it contains data needed by the flight crew to operate a flight. The data include magnetic tracks, distances to be flown, wind direction and velocities, outside air temperatures, true air speeds, estimated ground speeds, and estimated times to be flown on each flight leg. As well, the data contain estimated fuel flows, fuel burns, and fuel reserves for each leg of the flight. Detailed information provided for the alternate

Figure 19-1 Sample Convair 580 Operational Flight Plan

AIR ONTARIO: CONVAIR 580 OPERATIONAL FLIGHT PLAN 11/08/84
GX F918 08 NOV 84 C-GDTC

FRM	TO	AWYS	MAG HDG	DIS	W/D	W/V	TMP	TAS	EST F.F.	ACT G.S	EST G.S	ACT TIME	TIME	ETA	ATA	EST BURN	ACT BURN	EFR	REV EFR	AFR	
																					ALTITUDE: 23,000 FT.
YZR	YXU	DRCT	090	52	280	42	-29	287	1900	328	___	:14	___	___	___	618	___	9882	___	___	* CLIMB FACTOR INCLUDED
YXU	YYZ	DRCT	065	76	280	42	-29	287	1900	322	___	:14	___	___	___	447	___	9435	___	___	
YYZ	MSS	HL594	078	224	280	42	-29	287	1900	323	___	:42	___	___	___	1317	___	8118	___	___	
MSS	YJN	HL586	084	63	280	42	-29	287	1900	330	___	:22	___	___	___	612	___	7506	___	___	* APPROACH FACTOR INCLUDED
TOTAL												1:31				2994					
TO ALTERNATE																					ALTITUDE: 9,000 FT.
YJN	YUL	DRCT	341	35	280	10	-6	271	1900	264	___	:22	___	___	___	818	___	6688	___	___	* CLIMB & APPROACH INCLUDED
TOTAL												1:53				3812					

FUEL AND WEIGHT CALCULATIONS

DESTINATION FUEL:	2,994	AIRCRAFT WEIGHT:	35,110	DISPATCHER: ____________
ALTERNATE FUEL:	818	PAYLOAD	300	
RESERVE FUEL:	2,100	Z.F.W.:	35,410	CAPTAIN: ____________
	------	TOTAL FUEL	10,500	
MINIMUM FUEL:	5,912	G.T.O.W.:	45,910	
CONTINGENCY:	500	BURN:	2,994	
EXTRA FUEL:	4,088	LANDING WEIGHT:	42,916	

TOTAL FUEL:	10,500			

end of report

Source: From Air Ontario's FOM (Exhibit 146)
Note: Any errors contained in this sample operational flight plan have not been corrected

airport includes calculations for required fuel to the alternate, reserve fuel, minimum fuel, and contingency fuel. None of the above items, including the provision of aircraft landing weights and flight altitudes, is contained in the flight release used by the flight crew of C-FONF on March 10, 1989.

Mr Randy Pitcher, a Transport Canada air carrier inspector, Mr Adrian Sandziuk, an Air Canada flight dispatcher, Captain Claude Castonguay, an experienced airline pilot, and Mr David Rohrer, this Commission's operations group chairman and an investigator with the Transportation Safety Board, all testified that the information contained in the flight release for the purposes of operational control of the flight of C-FONF was "minimal," "incomplete," or did not exist. In the view of some of these witnesses, this information did not meet the requirements of ANO Series VII, No. 2, which is to provide the flight crew with a plan for the "safe conduct of a flight."

As discussed in chapter 23, Transport Canada does not prescribe either the form that an operational flight plan should take or the minimum contents. However, the sample Air Ontario operational flight plan for the Convair 580 contains significant operational information not contained in the F-28 flight release. This information, in my opinion, is necessary for a flight crew to plan and conduct their flight in a safe and orderly manner.

The flight crew of C-FONF should have received, prior to the dispatch of flights 1362 and 1363 on March 10, 1989, in addition to the flight release, an F-28 operational flight plan similar in form and content to the sample Convair 580 operational flight plan contained in the carrier's FOM.

While I need not determine that the sample Convair 580 operational flight plan complies with ANO Series VII, No. 2, I find that the flight release used by the flight crew of C-FONF on March 10, 1989, did not meet the requirements of an operational flight plan as contemplated in ANO Series VII, No. 2. Further, the evidence is clear that no operational flight plan was used on March 10, 1989, by the flight crew of C-FONF. No sample operational flight plan was contained in Air Ontario's FOM as an example to be used by the F-28 flight crews, and there is no evidence that one had ever been created by Air Ontario.

ANO Series VII, No. 2, Schedule B, sets out the items that must be contained in an air carrier's FOM. Subsection (l) requires "information pertaining to flight release and operational control, including procedures for the monitoring and control of each flight, as applicable," and subsection (j) requires "other information or instructions relating to safety."

Since there was no operational flight plan for use by the flight crews in the F-28 operation, I am of the view that Air Ontario did not comply with the requirements of ANO Series VII, No. 2, sections 2 and 15, and Schedule B. Air Ontario did not set out in its Flight Operations Manual an example of or the information necessary for an operational flight plan for F-28 aircraft operations in order to demonstrate that procedures were in place to monitor and control the flight of C-FONF and to demonstrate that Air Ontario had a plan for the safe conduct of the flights of C-FONF on March 10, 1989.

In chapter 12 of my Report, Aircraft Performance and Flight Dynamics, I observed that there was a lack of information, advice, and direction relating to ground-accumulated wing contamination in both Air Ontario's draft F-28 Operations Manual and the approved FOM. Similarly, there is little direction in the Air Ontario draft F-28 Operations Manual and the approved FOM regarding takeoff on contaminated runways. Air Canada's FOM, by comparison, although it contains only slightly more information on the prohibition against taking off with contaminated wings, does contain far more advice and direction regarding aircraft de-icing and operation from contaminated runways. A number of amendments on environmental factors are contained in the Air Canada manual, among them an article by Captain Gary Wagner on aerodynamic and performance issues in icing conditions, written as a result of his participation with this Commission of Inquiry. The Air Canada FOM is frequently updated to include new or revised matters of operational concern to flight crews and other operational personnel. While I do not suggest that the material contained in Air Canada's FOM is exhaustive, what is obvious is that the matters of icing, wing contamination and de-icing, and operation from contaminated runways are dealt with in far more depth in the Air Canada FOM than they are in Air Ontario's FOM.

Since an air carrier's operation is inherently dynamic, it is essential that there be ongoing amendments to the FOM to ensure that it reflects changes in the air carrier's operations and provides new information which will make flight operations safer and reflect changing regulatory requirements. Given the facts that Air Ontario Inc. operated for approximately eight months with no approved FOM reflecting the merged operations and that on March 10, 1989, the last major amendment in Air Ontario's FOM was dated May 1, 1988, and taking into account just a few of the deficiencies discussed herein, it is apparent that ongoing changes in Air Ontario's operations were not being reflected on a regular basis in that air carrier's FOM.

Although I am not singling out any particular flight safety deficiency as a result of the lack of currency of the manual, it is my view that failure to maintain a comprehensive FOM, reflecting the continued and current status of an air carrier's operation, has an overall flight safety implication. If it is understood by operations personnel that the FOM is constantly out of date or that it contains little important information on operational matters, then these operations personnel may discount its effectiveness and value.

Although ANO Series VII, No. 2, contemplates in sections 31 and 36 that there will be amendments in the operations manual, which is to be kept up to date, there are no criteria in the ANO, nor is there direction, with respect to how amendments are made, the frequency and dissemination of amendments, and the review of the contents of a carrier's FOM. In particular, there is no mandatory requirement that the required items in an operations manual, as listed in Schedule B of ANO Series VII, No. 2, be reviewed and amended on a regular basis.

Although the Air Ontario FOM was ultimately prepared, submitted, and approved – eight months after it should have been – I find it unacceptable that Air Ontario did not produce an up-to-date FOM, and that Transport Canada did not insist that it be produced within a reasonable period of time following the merger of Austin Airways Limited and Air Ontario Limited operations. Eight months is an unreasonably long time for an air carrier to be without an up-to-date FOM. A planned audit of Air Ontario Inc.'s operation was delayed in part because Air Ontario did not have a current FOM. This happened in spite of the fact that Transport Canada inspectors were concerned about inadequate operational control by Air Ontario over its widely located flight bases. I cannot see how Transport Canada can ensure that an air carrier's operations personnel are performing their duties in a "proper manner" without a current FOM.

Section 34 of ANO Series VII, No. 2, states that "[a]n air carrier shall provide not less than one complete copy of his Operations Manual to the Director." The ANO requires provision of the FOM to Transport Canada, but the legislation is silent as to whether it must be "approved" by Transport Canada. Since Schedule B of ANO Series VII, No. 2, sets out items to be contained in an FOM, one must assume that Transport Canada also reviews and approves at least the items required by Schedule B. Silence in the ANOs on the matter of the review and approval of the FOM by Transport Canada is, in my view, entirely unacceptable.

The fact that Air Ontario did not produce an up-to-date FOM in a timely manner, and the fact that Transport Canada made no effort to require such FOM to be produced and provided to Transport Canada, persuades me that ANO Series VII, No. 2, is inadequate. It fails to require the air carrier to prepare, and Transport Canada to review and approve, the FOM in a timely and effective manner.

Aircraft Flight Manual

Part of the Canadian certification process for new aircraft types is the requirement that the aircraft manufacturer produce an aircraft flight manual (AFM). This manual, given various names by individual manufacturers (in the case of Fokker Aircraft, it is called the F-28 Flight Handbook, described earlier in this chapter), is referred to in ANO Series VII, No. 2, as the "approved Aircraft Flight Manual." The AFM contains manufacturer's operating procedures that must be followed in order to conform to the aircraft limitations established during certification.

Two Fokker F-28 Mk1000 aircraft, one being C-FONF, which were leased by Air Ontario, were delivered with a three-volume set of the Fokker F-28 Flight Handbook manuals. These manuals were recognized by Transport Canada as the "approved Aircraft Flight Manual" for the purpose of the aircraft's certification.

Reference is made to specific portions of the Fokker F-28 Flight Handbook in various chapters of this Report. The AFM produced by Fokker Aircraft and approved by the Rijksluchtvaartdienst (RLD) is detailed and comprehensive in nature, and I do not propose to discuss this manual in detail in this section of my Report.

Aircraft Operating Manual

There is no legal requirement in Canada for an air carrier to produce and operate its aircraft using its own aircraft operating manual (AOM). ANO Series VII, No. 2, contemplates that the air carrier will use, in the operation of any of its aircraft, the aircraft manufacturer's aircraft flight manual (AFM).

An AFM is a highly detailed manufacturer-produced document, and its use on the aircraft flight deck on a day-to-day basis is often impractical, particularly because of its size and complexity. Most air carriers modify the presentation of the performance data and revise operating procedures set forth and contained in the AFM into handbooks and checklists, producing their own AOMs. These AOMs would be compatible with the air carrier's specific operation. An air carrier that operates a number of different aircraft types often endeavours to standardize as many procedures as is feasible to reduce the risk of error and to facilitate pilot transfers between aircraft types. AOMs, which incorporate the air carrier's standard operating procedures, must be at least as restrictive as the manufacturer's AFM.

Aircraft operating manuals, often referred to by witnesses in these hearings as aircraft standard operating procedures manuals (SOPs), were, in the case of Air Ontario, the Piedmont F-28 Operations Manual, the USAir Fokker F-28 Operations Manual (Pilot's Handbook), and the draft Air Ontario F-28 Operations Manual. Although, as noted, neither the ANOs nor any other relevant Canadian legislation deals with such an aircraft manual, Transport Canada in its internal policy and guidance documents refers to it as an aircraft operating manual.

Either the approved AFM (referred to in ANO Series VII, No. 2) or the AOM (informally "accepted" by Transport Canada) is carried by all pilots flying a specific aircraft and is used by them in the day-to-day operation of that aircraft type. This manual is a standard against which pilots are tested in ground school, during annual recurrent training, and in the required annual pilot proficiency checks (PPCs) conducted either in the aircraft or in an approved flight simulator.

The air carrier can, and normally does, condense portions of the AFM into checklist format and make such checklists available in the aircraft as separate booklets for ease of use by the pilots and to facilitate immediate reference. Such booklets are normally called quick reference handbooks (QRHs) and aircraft checklists.

Air Ontario did not require its F-28 pilots to use the manufacturer's AFM on a day-to-day basis. Although Transport Canada was not requested by Air Ontario to approve an F-28 AOM, the evidence indicates that it was the intention of Air Ontario to create its own AOM. It was also clear from the evidence that Air Ontario intended to use Piedmont Airlines' and USAir's F-28 operations manuals on an interim basis for the initial startup of Air Ontario's F-28 revenue operations. Apparently, Piedmont Airlines and USAir understood that their F-28 operations manuals would be used only as training tools for the purposes of aircraft ground school and simulator training provided by Piedmont Airlines/USAir to Air Ontario pilots.

In January 1988 Air Ontario sought the approval of Transport Canada to add the F-28 aircraft to its operating certificate. At the same time, Air Ontario also sought approval from Transport Canada for the use, on an interim basis, of Piedmont Airlines' F-28 ground school syllabus, simulator training, and instructors to enable Air Ontario pilots to make the transition to the F-28 aircraft. Pursuant to ANO Series VII, No. 2, Air Ontario required Transport Canada's consent for the use of such an F-28 training program, which Piedmont Airlines had agreed to provide to Air Ontario. Transport Canada anticipated that Air Ontario would submit to Transport Canada in the "near future" its own F-28 training syllabus, including an Air Ontario F-28 operations manual, for its review and approval. Neither Air Ontario nor Transport Canada clarified when the "near future" would be.

Approval for Air Ontario to use Piedmont Airlines' F-28 training syllabus, simulator, and instructors was given by Transport Canada in February 1988. No formal request was made by Air Ontario, nor was permission granted by Transport Canada, to allow Air Ontario pilots to use the Piedmont F-28 operations manuals in Air Ontario's F-28 revenue operations. The approval granted by Transport Canada was for the contract ground school and simulator training conducted by Piedmont Airlines and was considered to be "an interim measure" (Exhibits 716 and 857, Transport Canada memorandum and letters) to enable Air Ontario to make the transition to the F-28 aircraft. Transport Canada specifically advised Air Ontario that "[i]t is anticipated you [Air Ontario] will submit your own F28 syllabus of training in the near future" (Exhibit 857, letter from Transport Canada to Air Ontario, February 15, 1988). Mr Martin Brayman, at the time Transport Canada's inspector responsible for monitoring Air Ontario's operations, confirmed that he contemplated that the Piedmont F-28 Operations Manual would be part of the training package used to train Air Ontario pilots. He stressed in testimony that such use of all of the training material, including the Piedmont F-28 Operations Manual, was "on an interim basis" (Transcript, vol. 131, pp. 119-20).

The letter of authorization from Transport Canada did not mention the use of the Piedmont F-28 Operations Manual. The mere fact that Air Ontario used the Piedmont F-28 Operations Manual for the entire period it operated its F-28 aircraft appears to indicate that, in the absence of any instructions to the contrary from Transport Canada, Air Ontario assumed it could use the Piedmont manual in its F-28 revenue operations. At least one Transport Canada air carrier inspector, Mr Randy Pitcher, who was trained by Piedmont and thereafter became the designated F-28 inspector for Transport Canada, Ontario Region, felt it was acceptable for Air Ontario to use Piedmont's F-28 Operations Manual, at least for training. Mr Pitcher testified that approval by Transport Canada of the Piedmont Airlines' training program was given to Air Ontario prior to his joining Transport Canada. However, he was informed by Mr Brayman, and he understood from his review of Transport Canada correspondence, that the Piedmont F-28 manual was approved for use by Air Ontario for the purposes of training pilots on the F-28 aircraft.

Air Ontario's F-28 Project Plan contemplated that an Air Ontario F-28 operating manual would be developed under the supervision of the director of flight operations in a format similar to the Piedmont F-28 Operations Manual. The Project Plan contemplated that the development of this manual would be completed in February 1988, during the early stages of the F-28 program and at about the time it anticipated the amendment to the operating certificate to include the F-28 aircraft.

In December 1988, six months after C-FONF was imported into Canada and an operating certificate was granted by Transport Canada to operate the F-28 aircraft, a senior Air Ontario F-28 check pilot, Captain Robert Perkins, was concerned enough about the lack of an Air Ontario

F-28 operating manual to ask Captain Joseph Deluce about its status. Captain Perkins testified that when he "did not receive a favourable reply" to the question he then asked as to whether amendment information was available for the Piedmont F-28 Operations Manual (Transcript, vol. 44, pp. 93–94). Captain Perkins was advised that there would be no amendment service for the Piedmont manual. He further testified that it was his view that Air Ontario should have had either an up-to-date Piedmont manual or its own F-28 operating manual. Mr James Morrison, Air Ontario's newly appointed vice-president of operations, was aware by late December 1988 that no Air Ontario F-28 operations manual had been drafted (Transcript, vol. 115, p. 112). Captain Deluce at that time had enlisted the assistance of Captain Perkins and First Officer Steven Burton to assist him in developing the F-28 operations manual. As a result of a number of circumstances such as a pilot strike, the delay in the delivery of the F-28 aircraft, and the failure of the F-28 project manager, Captain Deluce, to attend to the production of the AOM as contemplated by the F-28 implementation plan, a draft Air Ontario F-28 Operations Manual was not submitted to Transport Canada for approval until June 7, 1989, the same month that Air Ontario discontinued its F-28 service and three months after the crash of C-FONF.

Virtually all of the operating procedures and performance data contained in the draft Air Ontario F-28 Operations Manual were extracted verbatim from Piedmont's F-28 Operations Manual. As discussed in chapter 12 of this Report, Fokker F-28, Mk1000, Aircraft Performance and Flight Dynamics, the authors of the Air Ontario AOM elected to leave out the charts contained in the Piedmont manual that provided weight restrictions to be applied to a takeoff on contaminated runways. In place of the chart was a statement referring the reader to the charts of the Fokker F-28 Flight Handbook. One of the drafters of the Air Ontario F-28 Operations Manual, Captain Perkins, testified that the use of the slush-correction charts from the Fokker AFM was an interim measure only, since it was operationally impractical to use these charts in the cockpit to make slush-correction calculations (Transcript, vol. 44, pp. 184–85). No explanation was given as to what correction charts Air Ontario planned to use as an alternative to the Fokker correction charts and the more restrictive Piedmont charts.

On June 20, 1989, Transport Canada acknowledged receipt of Air Ontario's draft F-28 AOM and advised Air Ontario that it was being reviewed. Because Air Ontario discontinued its F-28 service in June 1989, a review and informal approval by Transport Canada was never completed.

I do not propose to comment on the contents and form of the draft Air Ontario F-28 AOM. I do, however, note that it is unacceptable that Air Ontario did not have in place its own F-28 operations manual at an early stage of revenue operation with the aircraft. Captain Charles Simpson, the vice-president of flight operations for Air Canada, testified that, once approved, the AOM becomes the "bible" by which the aircraft type is flown (Transcript, vol. 118, p. 76). He further testified that in his view it is the only document that should be on board the aircraft for use as a reference to operate an aircraft type. It is the policy of Air Canada that no new aircraft type be introduced into passenger-carrying line service until an AOM for the particular aircraft type is produced. While Air Canada might use a manufacturer's AFM during initial pilot training on a new aircraft type, Captain Simpson testified, by the time the aircraft type is ready for line operation Air Canada has always developed its own AOM.

After reviewing the F-28 Project Plan of Air Ontario, the manuals used, and the testimony of many Air Ontario pilots, I have a clear impression that Air Ontario F-28 pilots were often left to learn and to discover for themselves what were the best operational flight procedures for the F-28. This was occurring at the same time that the pilots were conducting revenue flights. It can be expected that some learning will take place as pilots gain experience on a new aircraft type. To require the pilots to operate without a company-generated aircraft operating manual, however, places an additional and unnecessary burden on the pilots.

It was an obvious and serious neglect for Air Ontario not to produce, in a reasonable time, an AOM for the F-28. As well, Air Ontario did not raise and Transport Canada did not address the issue of Air Ontario F-28 pilots using, at the same time, in revenue operations, other air carriers' aircraft operating manuals, specifically the Piedmont Airlines F-28 Operations Manual and the USAir F-28 Operations Manual.

The operating methods in these manuals reflected Piedmont's/USAir's standard F-28 operating procedures and, of necessity, would have been different from the operating methods previously used by Air Ontario pilots on other aircraft.

The fact that Air Ontario did not provide its pilots with F-28 operating procedures tailored to their methods of operating was considered to be a problem by the Air Ontario F-28 pilots who testified. Additionally, permitting a different F-28 aircraft operating manual to be used by each of the pilots on the flight deck is potentially hazardous.

Difficulties can arise when an air carrier uses an AOM produced by another air carrier that may operate the same aircraft in a different environment using different flight operations procedures. Aircraft standard operating procedures developed by an air carrier from the manufacturer's aircraft flight manuals incorporate operating procedures standard to all of the carrier's aircraft types. For example, although a manufacturer's AFM describes what actions and procedures are required for a given operational situation, often it may not explain in sufficient detail how such actions and procedures are to be carried out by the flight crew. Similarly, the AFM may not designate which flight crew member should carry out which action or procedure and what, if any, verbal calls should be made in order that actions carried out can be confirmed. As was shown in the results of the pilot survey conducted by Captain Ronald Stewart, there were no pilot-not-flying (PNF) duties set out in the Air Ontario's operating procedures. This problem was in fact noted by Transport Canada during a flight inspection of the Dash-8 in its audit of Air Ontario in the fall of 1988, as discussed in chapter 33 of this Report. The following is the relevant non-conformance finding (0-15.1) from Transport Canada's 1988 audit report of Air Ontario regarding standard operating procedures (SOPs) manuals (that is, AOMs):

> Standard operating procedures between crews vary. Call outs are not standardized. There are crews doing after start check while taxiing, resulting in no lookout. There is evidence that there is no cross-checking between Captain and First Officer as to altimeter, heading, course and airspeed bug settings. Crew co-ordination and management are at times lax.

Transport Canada concluded that "These problems are due to the company not having Standard Operating Procedures Manuals" (Exhibit 1042, Transport Canada Aviation Group National Audit of Air Ontario Inc., February 1988).

The comments of the Transport Canada auditors reveal a desire by the regulator that air carriers operate their aircraft using company-produced aircraft operating manuals incorporating company standard operating procedures. Transport Canada auditors noted that the chief pilot for Air Ontario's Dash-8 aircraft fleet had not created such an aircraft operating manual. Transport Canada auditors directed Air Ontario to produce such manuals for the Convair 580 and the Dash-8 aircraft. Air Ontario's Flight Operations Manual specifies that one of the duties and responsibilities of a chief pilot is to, "[i]n cooperation with Training and Check Pilots, write and update Standard Operating Procedures Manuals for each aircraft type" (Exhibit 146, Air Ontario Flight Operations Manual, p. 3-8, para. 3.4.6.)

Captain Nyman testified that, contrary to Air Ontario's FOM, which states that aircraft operating manuals are required, and despite Transport Canada's auditors' request that Air Ontario create a Dash-8 standard operating procedures manual, Air Ontario's then Dash-8 chief pilot refused to do so. The chief pilot argued that the de Havilland Dash-8 Flight Manual was sufficient to constitute the air carrier's standard operating procedures manual. Although Captain Nyman, as director of flight operations, disagreed with the chief pilot's position, he testified that because the chief pilot was Air Ontario's expert on the Dash-8, he did not order him to create a Dash-8 aircraft operating manual. In defence of the chief pilot's position, Captain Nyman stated that the chief pilot was able to convince Transport Canada air carrier inspectors that the de Havilland Dash-8 AFM rather than a company-produced standard operating procedures manual was a suitable document to use (Transcript, vol. 109, pp. 30–33).

The position of Air Ontario's Dash-8 aircraft chief pilot may be correct, but his view differs from both what is contemplated in Air Ontario's FOM and what was viewed by Transport Canada auditors as a deficiency by Air Ontario in not having a Dash-8 standard operating procedures manual.

Mr William Slaughter, who was director of flight standards, Transport Canada, when he appeared before me, testified that Transport Canada approves the manufacturer's aircraft flight manuals and specific parts of the air carrier's FOM. He considered a company-produced aircraft operating manual to be an optional document, internal to the air carrier, with no requirement for Transport Canada to review it. Mr Slaughter stated that although some air carrier inspectors commendably insist that company-produced aircraft operating manuals be submitted to Transport Canada for review, Transport Canada had no authority to require the air carrier to submit its aircraft operating manuals. Mr Slaughter further stated that the only method that Transport Canada has of ensuring that company-produced aircraft operating manuals are acceptable in form and content "is by exception" (Transcript, vol. 144, p. 100). In explaining what he meant by this statement, Mr Slaughter stated that if an air carrier presents its own AOM for review, Transport Canada will review it and provide its informal approval. Also, if Transport Canada suspects that an air carrier's internally produced AOM is deficient, then Transport Canada will step in and review such manual.

It was Mr Slaughter's view that, if an air carrier creates its own AOM, it should be a requirement that Transport Canada review such AOM to ensure that it conforms with the manufacturer's AFM. In any event, air carriers normally produce their own aircraft standard operating procedures manuals. More importantly, because part of these manuals includes "normal" and "abnormal" checklists and handbooks used by pilots on a day-to-day basis, Mr Slaughter acknowledged that Transport Canada should have more control over the contents and use by the air carrier of such AOMs or SOPs manuals.

Mr Ian Umbach, superintendent of air carrier operations, Transport Canada headquarters, also acknowledged during testimony that although Transport Canada reviews air carriers' training syllabi and associated data, such reviews do not necessarily include the review of a carrier's AOMs. In the case of Air Ontario, Mr Umbach testified that while Transport Canada headquarters reviewed Air Ontario's training syllabus, no one at headquarters reviewed the Piedmont F-28 Operations Manual; nor was he aware of whether anyone at Ontario Region office had reviewed the manual. The evidence indicates that no one in Transport Canada in fact reviewed the Piedmont F-28 and USAir operations manuals used by Air Ontario. It also appears that no one at Transport Canada identified this fact and took steps to stop Air Ontario from continuing the practice of allowing F-28 pilots to use two different AOMs in the cockpit. Mr Umbach acknowledged that there should be some procedure in place to ensure that Transport Canada has reviewed an air carrier's operating manual and compared its contents with those of the aircraft manufacturer's AFM.

Both Mr Slaughter and Mr Umbach in testimony confirmed the inadequacies of the review and the approval process within Transport Canada regarding operational manuals. The stated position of Transport Canada is that although it reviews AOMs, it has no formal right to do so and has no authority to approve them. This position is untenable and creates an unworkable situation. It is my view that Transport Canada should review and approve all air carrier AOMs or SOPs manuals for each aircraft type in use by the air carrier. Both the regulator and air carriers believe that it is necessary for air carriers to develop their own aircraft-operating procedures to reflect the carrier's unique operational environment. However, there is no mechanism in place to ensure that the air carrier in fact develops an AOM that both reflects its operation and guarantees standardized procedures. While Transport Canada certainly does not ignore the reality that most air carriers use aircraft operating manuals specific to their operations, it is legally powerless to compel an air carrier to use such manuals. As well, current legislation provides no mechanism for Transport Canada to approve the manuals prior to their use by an air carrier.

ANO Series VII, No. 2, is silent on the entire issue of air carrier–produced aircraft operating manuals or aircraft standard operating procedures manuals. In contrast, the United States FARs, Part 121, clearly require the review and approval of such manuals. While there is no doubt that an air carrier has the right to use the manufacturer's AFM, most air carriers find it necessary to adapt the procedures and performance data in the AFM to their particular flight operational environment. It was the testimony of Captain Gert Andersson, an experienced F-28 captain with a Swedish air carrier, that performance charts and graphs such as the ones produced by Fokker Aircraft for takeoff on contamination-covered runways "should be used only by experienced performance people." The air carrier should make a "simpler chart for use in the cockpit" (Transcript, vol. 83, pp. 186–87). In reality, that is exactly what most air carriers do when they create their own AOMs: they reproduce performance data and operating procedures in a format more readily usable by flight crews in the aircraft cockpit.

To ensure that the revised operating procedures sections and the modified presentation of performance data are no less restrictive than the AFM, the regulator must have an opportunity to review and approve such revisions and modifications.

FAR 121.141 states as follows:

> (a) Each certificate holder shall keep a current approved Airplane or Rotorcraft Flight Manual for each type of transport category aircraft that it operates.
>
> (b) In each transport-category aircraft, the certificate holder shall carry either the manual required by §121.133 [FOM], if it contains the information required for the applicable flight manual and this information is clearly identified as flight manual requirements, or an approved Airplane or Rotorcraft Flight Manual. If the certificate holder elects to carry the manual required by §121.133, *he may revise the operating procedures sections and modify the presentation of performance data from the applicable flight manual if the revised operating procedures and modified performance date presentation are –*
>
> (1) *Approved by the Administrator*; and
>
> (2) *Clearly identified as airplane or rotorcraft flight manual requirements.*
>
> (Emphasis added)

I recommend that ANO Series VII, No. 2, be amended to reflect similar provisions contained in FAR 121.141, which contemplate and allow air carriers to use internally produced AOMs and require the contents of such AOMs to be approved by the regulator. Further, as air carriers will in any event modify the presentation of performance data from the AFM in the form of "normal" and "abnormal" checklists and quick reference handbooks for use by the pilots, it is my opinion that air carriers operating large transport-category aircraft should be required to produce AOMs or SOPs manuals for each type of aircraft operated by them and to obtain approval of such manuals from Transport Canada prior to commencing commercial operation with the aircraft.

I will now deal with the second practice of Air Ontario that I view to be potentially hazardous, namely that of allowing on the flight deck the use of two different F-28 operations manuals: the Piedmont Airlines F-28 Operations Manual and the USAir F-28 Operations Manual. By way of background, during the course of training Air Ontario pilots, Piedmont

Airlines' operation was merged with the operations of USAir. USAir, which did not previously operate F-28 aircraft, rewrote the Piedmont F-28 Operations Manual to reflect the operations of USAir. The new F-28 operations manual for use by the merged operation became the USAir Operations Manual (referred to as its F-28 Pilot's Handbook). Air Ontario F-28 pilots who received training following the merger of the two airline operations received ground school and flight simulator training using the USAir F-28 Pilot's Handbook.

Captain Nyman, the flight operations director, first became aware of the change when he took his simulator training course in Tampa, Florida, in December 1988. At that time, Captain Nyman discovered that certain procedures used on the flight deck, such as standard checks and callouts, had been modified by USAir to fit its operation. Captain Nyman testified that he telephoned Captain Joseph Deluce and requested that he put a copy of the Piedmont F-28 Operations Manual in the F-28 aircraft. Captain Nyman wished to ensure that only one manual was being used by the pilots on the flight deck of the F-28; that manual, in his view, was the Piedmont F-28 Operations Manual (Transcript, vol. 109, pp. 67–68).

Despite the fact that the request to place a Piedmont F-28 Operations Manual on board Air Ontario's F-28 aircraft came from the director of flight operations, Captain Deluce never took action in relation to this request. Both manuals continued to be used by pilots on the F-28 flight deck for the duration of Air Ontario's F-28 revenue operations.

The Piedmont F-28 Operations Manual and the USAir F-28 Pilot's Handbook are comprehensive and detailed, reflecting the standard operating procedures of each of these airlines. I find no fault with the individual manuals, either in form or in content.

The fault that existed was in the use of two different aircraft operating manuals to describe flight operating procedures. Captain Simpson, in addressing this problem, explained that "you can't have two pilots in the same airplane using different procedures. It will lead to trouble sooner or later" (Transcript, vol. 118, p. 82). I entirely agree with this position.

Although the Piedmont and USAir F-28 operations manuals are comprehensive, both dealing with the same aircraft type, there are sufficient differences in the operating procedures of these two air carriers to create potential problems on the flight deck. Some of the differences were explored in testimony with Captain Perkins, who was, at the time of the crash, a check pilot on the F-28 aircraft. Briefly, some of the differences are as follows:

- The time between activating the first and the second fire extinguisher in an engine where there are indications of a fire are different. Piedmont states 45 seconds, USAir states 30 seconds.

- The USAir F-28 operations manual deals with the use of the autopilot in the procedure regarding stopping a runaway stabilizer trim; the Piedmont manual does not mention the autopilot.

- Procedures used for landing with one engine inoperative reveal several differences between the USAir and the Piedmont manuals. The Piedmont manual requires lateral fuel balance to be within 1500 pounds; USAir within 1000 pounds.

- The Piedmont manual details the actions to be taken for a go-around and requires the pilots to review them prior to landing; the USAir manual does not mention the go-around, nor is there any requirement to review go-around procedures. Piedmont provides for a level-off height of 600 feet above ground level (AGL) on a single-engine go-around; the USAir manual instructs the pilots to level off at 800 feet AGL.

- The one-engine go-around procedure is found in the Piedmont emergency chapter; the same procedure in the USAir manual is found in the training chapter.

- The Piedmont manual requires a pre-flight exterior aircraft inspection, or walkaround, prior to each flight; the USAir manual requires such inspection at originating stations and crew change points.

These and other differences caused concern among first officers who received their ground school training from USAir and were given a USAir F-28 Pilot's Handbook. Two Air Ontario pilots who were F-28 first officers testified that they were concerned that there was no formal advice given pilots as to which manual was to be used as the Air Ontario F-28 Standard Operating Procedures Manual. One of these first officers was under the impression that since no Air Ontario SOPs manual existed, the Piedmont F-28 Operations Manual was to be used. The other first officer, Captain Deborah Stoger, commented that the flight profiles are different in both manuals. "Captains were expecting Piedmont profiles, but I was trained in USAir procedures" (Transcript, vol. 93, p. 28). As a result of the differences in certain flight profiles between the Piedmont and the USAir aircraft operating manuals, this first officer recalls an instance in flight where there was confusion over the procedures to be used during the approach.

It is clear that differing procedures could cause confusion, especially in an abnormal situation where a particular procedure is not often used. One example, which I have mentioned above, is the difference between the Piedmont manual and the USAir manual regarding the altitude to be maintained following a missed approach with one engine inoperative. This information, which deals with an abnormal F-28 flying procedure, is normally memorized by pilots and reinforced during training. The Piedmont F-28 Operations Manual describes the go-around procedure in chapter 2, "Emergency and Abnormal" Procedures, which states, "Level-off at 600 ft, AGL" (Exhibit 307, p. 2-11). The USAir Pilot's Handbook describes this procedure in chapter 18, "Training," which states "Climb straight ahead to 800 feet AGL or clear of obstructions" (Exhibit 329, p. 18-55-3). It was also revealed during testimony that the aerodrome approach charts for the Dryden Municipal Airport, produced by Jeppesen/Sanderson for use by Air Ontario F-28 pilots, provided a level-off height of 400 feet AGL for the F-28 aircraft. When, during testimony, the fact was put to Captain Nyman that there were three different obstacle-clearance level-off heights, he agreed that, for compatibility with the Piedmont F-28 Operations Manual, the single-engine level-off height should have been standardized and the Jeppesen charts should have been ordered with a level-off height of 600 feet AGL.

However, even if the Jeppesen charts showed a 600-feet AGL level-off height, there remained discrepancy between the Piedmont and the USAir manuals. Although a go-around procedure on one engine is an abnormal and emergency situation, seldom required to be performed except during training and proficiency checks, an actual go-around on one engine, possibly in bad weather conditions, would be an inappropriate time for the flight crew to disagree about, to be unsure of, or to attempt to clarify the differences in level-off heights.

Although Captain Nyman stated that at least the pilots whom he trained on the F-28 were made aware of the differences between the Piedmont and the USAir aircraft operating manuals, he agreed in testimony that it would have been preferable if Air Ontario had in place, prior to the commencement of revenue service of the F-28, its own standard operating procedures manual containing one set of operational data. Captain Nyman testified that on the F-28 flight deck all Air Ontario F-28 pilots used checklists and emergency quick reference handbooks produced by Piedmont. However, it is my view that commonality should have also extended to having one aircraft operating manual on the flight deck.

As was discussed in chapter 12 of this Report, Aircraft Performance and Flight Dynamics, another example of failure to standardize manuals and procedures was revealed in the confusion that existed among the F-28 pilots as to which slush-correction charts applied: those contained in the Piedmont and USAir AOMs, or the graphs contained in the Fokker F-28 AFM. On the one hand, Captain Perkins testified that he was not bound by the more restrictive Piedmont/USAir slush charts and could use the less restrictive slush-correction charts set forth in the

Fokker Aircraft F-28 Flight Handbook. Captain Nyman, on the other hand, was of the view that the slush chart contained in the Piedmont F-28 Operations Manual was the only slush chart to be used by Air Ontario pilots. Captain Joseph Deluce in testimony agreed that, in hindsight, it would have been best if all pilots referred to one chart only, that being the more limiting chart contained in the Piedmont manual (Transcript, vol. 150, pp. 75–76).

Had it been made clear that the more restrictive AOM was binding, and had the flight crew on C-FONF felt bound by the more restrictive manual, then, given the slush conditions on runway 11/29 at 12:09 p.m. on March 10, 1989, the flight crew would have been prohibited by Air Ontario operating policy from taking off on runway 29 with those slush conditions at a takeoff weight of more than approximately 53,400 pounds. I am fortified in this view by the testimony concerning the "Report of the Board of Inquiry into the Accident at Toronto International Airport, Malton, Ontario, to Air Canada DC8-CF-TIW aircraft on July 5, 1970" (Exhibit 1181, held before the Honourable Mr Justice Hugh F. Gibson, Commissioner).

This report dealt with the inquiry into an Air Canada DC-8 aircraft that crashed on July 5, 1970, while on final approach to Toronto International Airport, leaving no survivors. It was determined that the flight crew had agreed upon a procedure for operating the aircraft spoilers that was contrary to the procedure specified in Air Canada's DC-8 Operating Manual. While using the contrary procedure, an inadvertent, premature deployment of the spoilers occurred 60 feet above the ground prior to the aircraft flare. Evidence indicated that certain Air Canada pilots followed a procedure of arming and deploying the spoilers contrary to the Air Canada DC-8 Operating Manual and that this known procedure was allowed to continue unchecked. It was also determined that the manufacturer's DC-8 AFM contained misinformation regarding use of the spoilers that was not corrected in the Air Canada manual. Another Canadian air carrier had noted the misinformation and clarified it in its own DC-8 operating manual. Both Air Canada's and the other air carrier's AOMs were provided to and reviewed by Transport Canada.

In this report, the Honourable Mr Justice Gibson lists, among others, the following two "contributing circumstances":

> (viii) The failure of the Ministry of Transport to detect the deficiencies and misinformation in the manufacturer's aircraft flight manual as to the operation of the ground spoiler systems on this type of aircraft; and the failure to require the manufacturer in such manual to warn of the danger of inappropriate deployment of the ground spoilers on this type

of aircraft when in flight and especially when it is close to the ground.

(ix) The failure of the Ministry of Transport (1) to have noted the differences in the manuals of Air Canada and other Canadian aircraft operators in relation to the hazards of operating this ground spoiler in this aircraft, (2) to have alerted Air Canada of this, and (3) to have taken appropriate remedial action so that Air Canada's manual in respect thereto was not deficient in respect thereto.

(Exhibit 1181, pp. 107–108)

When questioned about these two "contributing circumstances," Mr Slaughter of Transport Canada agreed in testimony that Mr Justice Gibson attached importance to the need for Transport Canada to review air carriers' AOMs. Mr Slaughter also agreed that in 1989, 19 years after the crash of Air Canada's DC8-CF-TIW aircraft, Transport Canada, which was under no legal requirement to do so, was, owing to workloads and other priorities, still conducting only a cursory examination of air carriers' AOMs.

In my view, the reason this situation continues is that there is no regulatory requirement that air carriers produce AOMs specific to each aircraft type operated by the carrier. Partly because there is no requirement for Transport Canada to do so, these AOMs are neither thoroughly reviewed nor approved by Transport Canada prior to an aircraft type being operated by an air carrier in revenue service.

This situation must change. Legislative requirements should exist for, and inspectors should be specifically dedicated to, the process of the review and the approval of the contents of all air carriers' AOMs.

Flight Attendant Manual

Although a cabin attendant manual (designated the Flight Attendant Manual (FAM) by Air Ontario) is referred to extensively in Transport Canada's procedures document, Manual of Regulatory Audits, and elsewhere, there is no requirement in the Air Navigation Orders for the issuance of a cabin attendant manual. However, Transport Canada policy documents expect air carriers to produce manuals for the flight attendants. Most air carriers, including Air Ontario, do so. On the day of the crash, flight attendants Katherine Say and Sonia Hartwick each carried on board C-FONF an Air Ontario FAM with a last revision date of September 10, 1988.

Section 42 of ANO Series VII, No. 2, requires that an air carrier establish and maintain a ground- and flight-training program approved by Transport Canada to ensure that each crew member is adequately trained to perform his or her assigned duties. In addition, the air carrier must provide adequate ground- and flight-training facilities and qualified instructors to ensure that proper training of all crew members is carried out. By definition in ANO Series VII, No. 2, "a cabin [flight] attendant means a crew member, other than a flight crew member, assigned to duty in a passenger-carrying aeroplane during flight time."

Under the apparent aegis of section 42 of ANO Series VII, No. 2, Transport Canada reviews the cabin attendant training programs of an air carrier and compels the carrier to ensure that all flight attendants are adequately trained to perform their duties; specifically, abnormal and emergency procedures. Transport Canada is therefore mandated to approve an air carrier's cabin attendant training program. Section 34 of ANO Series VII, No. 2, requires an air carrier to provide a copy of its FOM to Transport Canada. Section 35 requires the air carrier to provide as well a copy of its FOM or "appropriate parts thereof" to each crew member.

Since crew members include flight attendants, I conclude that "appropriate parts" of an FOM will include matters that deal specifically with the duties, responsibilities and requirements of flight attendants. Inspection checklists contained in the Manual of Regulatory Audits remind audit personnel to determine if the contents of the FAMs comply with sections 31 through 37 of ANO Series VII, No. 2. I therefore conclude that, by inference, ANO Series VII, No. 2, allows, and Transport Canada, through policy documents, contemplates, that the part of an FOM dedicated to cabin attendants' duties, responsibilities, and training can be a separate document. Such a document may be a cabin attendant manual, as referred to by Transport Canada, or the Flight Attendant Manual produced by Air Ontario.

In terms of legislative requirements for cabin attendant manuals, I perceive the same problem to exist as exists at present with AOMs. Although Transport Canada reviews cabin attendant manuals such as Air Ontario's FAM if they are submitted to Transport Canada by the air carriers, there is no legislative requirement to produce cabin attendant manuals, nor is there a commensurate requirement that Transport Canada review and approve such manuals.

On the one hand, ANO Series VII, No. 2, requires that cabin attendant training programs, including training relating to abnormal and emergency procedures, be approved by Transport Canada. On the other, there is no commensurate requirement for the review and approval of cabin attendant manuals to ensure, for example, that abnormal and emergency procedures for each aircraft type operated by the carrier are delineated. Although certain abnormal and emergency procedures may be general to all aircraft types operated by an air carrier, other procedures may be specific to an aircraft type. For example, the Air Ontario FAM includes, in addition to an emergency procedures section, dedicated sections regarding four aircraft: the Hawker Siddeley HS-748, the Convair 580, the de Havilland Dash-8, and the Fokker F-28 Mk1000. The FAM, therefore, may contain procedures relevant to both the FOM and a particular AOM, such as for the F-28 Mk1000.

Since Transport Canada must approve an air carrier's cabin attendant training program and ensure that each crew member is adequately trained to perform his or her duties, and since Transport Canada reviews an air carrier's cabin attendant manual to ensure that it includes all abnormal and emergency procedures, I see no reason why Transport Canada should not also approve, either as a separate document or as part of the FOM, an air carrier's cabin attendant manual.

In directing my attention to portions of Air Ontario's cabin attendant manual relevant to its F-28 operation, I have reviewed the entire contents of the document. The following is stated in the introduction to the FAM:

> 1.1 FOREWORD
>
> This manual has been written for use by, Flight Attendants, Pursers, and In-Flight Supervisors in their perspective roles. This manual is a valid piece of emergency equipment and must be regarded as such.
>
> This manual must be in the possession of each person while he/she operates a flight. An individual will not be considered 'Emergency Qualified' in the event that he/she does not have this manual in his/her possession when reporting for flight assignments. (See Section 2, Item 2.4, Page 6)
>
> 1.2 MANDATE OF THE MANUAL
>
> The mandate of this manual is to establish definite policies and procedures for rendering a uniformly superior service to passengers. Whenever possible, the standard procedures outlined herein will be followed without deviation. However, nothing can replace good judgement in providing passengers with the finest in service and hospitality. Unusual conditions will arise that can only be met by the use of your initiative and ingenuity. Having said this, you must always be alert **never to compromise safety.**
>
> Remember the impression you create in the minds of our passengers are the impressions they will carry with them – because to them, YOU ARE THE COMPANY, you are Air Ontario..
>
> The requirements of Air Transport are such that Company Procedures must be established and maintained to ensure safe and efficient operations.

> This publication is the property of the company and is on loan to company employees. This manual must be returned to the Company upon termination of employment within the 'In-Flight' department.
>
> Trainees, Flight Attendants, and In-Flight Supervisors are required to bring this manual to all recurrent training, type training, and refresher programs that the Company conducts, and to have, on their person, this Manual at all times while completing flight assignments.

I am impressed by the position presented in this introduction by Air Ontario regarding the role and responsibilities of flight attendants. Indeed, I find the Air Ontario FAM, like the introduction, to be thorough and comprehensive in its content.

Legislative Requirements

Imprecision in the language of the Air Navigation Orders is a significant problem, which is referred to in other chapters of this Report. Imprecise language necessitates the exercise of discretion by the individual regulator, which, in the extreme case, can render an air carrier vulnerable to the caprice of an air carrier inspector who is the sole arbiter of what is "satisfactory" or "proper." Alternatively, an inspector, without any further guidance, may be vulnerable to arguments from a persuasive air carrier.

All legislative instruments, including the Air Regulations of the ANOs, must serve to give effect to some government objective. In this case, the basic objective of government in its operational regulation of air carriers is, in my view, to ensure an acceptable level of safety in Canadian commercial aviation. To achieve this objective, the ANOs should provide a minimum acceptable standard in a clear and comprehensive manner. If this were the case, then the air carrier would have unambiguous notice of what is expected from it in its operation; and air carrier inspectors would have a tool that would permit them to insist upon a definite standard of operational practice. Instead, ANOs appear to be a collection of ad hoc, unconsolidated, and in some cases discretionary standards that do not provide readily available assistance to either the regulator or the air carrier. Stated simply, ANOs at times fall short of their purpose, which is to give effect to the government's objective of ensuring an acceptable standard of safety in air carriage.

Having reviewed Air Ontario's Flight Operations Manual and Flight Attendant Manual, the Fokker F-28 Flight Handbook, and the F-28 Aircraft operating manuals used by Air Ontario, I feel compelled to review particular portions of United States air carrier legislation dealing with manual requirements. I find that FAR Part 121 provides more clearly than does ANO Series VII, No. 2, a statement of the requirement to be met by the air carrier and expected by the regulator.

For example, with respect to the issuance of an operating certificate, FAR subpart 121.59, subsection (a) states as follows:

> **121.59 Management personnel required.**
>
> (a) Each applicant for a certificate under this subpart must show that it has enough qualified management personnel to provide the *highest degree of safety* in its operations and that those personnel are employed on a full-time basis in the following or equivalent positions:
>
> (1) General manager.
> (2) Director of operations (who may be the general manager if qualified).
> (3) Director of maintenance.
> (4) Chief pilot.
> (5) Chief inspector.
>
> (b) Upon application by the supplemental air carrier or commercial operator the Administrator may approve different positions or numbers of positions than those listed in paragraph (a) of this section for a particular operation if the air carrier or commercial operator shows that it can perform the operation with the *highest degree of safety* under the direction of fewer or different categories of management personnel ...
>
> (Emphasis added)

The equivalent Canadian legislation, which is Part I ("Certification Requirements"), section 5, of ANO Series VII, No. 2, states as follows:

> 5. (1) An applicant for an operating certificate shall show that he has the qualified managerial personnel necessary to operate the proposed commercial air service and that such personnel are employed on a full time basis in the following or equivalent positions:
>
> (a) Managing Director;
> (b) Director of Flight Operations (or Operations Manager);
> (c) Director of Maintenance and Engineering (or Maintenance Manager);
> (d) Chief Pilot; and
> (e) Chief Inspector.
>
> (2) Where because of the nature of a commercial air service, positions other than those specified in subsection (1) would, *in the opinion of the Director*, be more appropriate, the Director may

> (a) approve different positions or a different number of positions; and
> (b) authorize the allocation of more than one position to one person.
>
> 6. (1) No person shall serve as a Director of Flight Operations (or Operations Manager) or as a Director of Maintenance and Engineering (or Maintenance Manager), unless his qualifications, background and experience are *satisfactory to the Director.*
>
> (Emphasis added)

Although the provisions in sections 5 and 6 of Canadian ANO Series VII, No. 2, and the United States FAR subparts 121.59 (a) and (b) are similar in intent, what is noticeably different between the two is the test specified by the respective provisions for the determination of the qualifications and standards that must be met by each country's air carriers.

In determining the degree of information, guidance, and instruction in the FOM, section 33 of ANO Series VII, No. 2, stipulates that the requirements of the items set forth in Schedule B be presented "in sufficient detail to enable the operations personnel to perform their duties in a *proper manner*" (emphasis added).

The equivalent United States legislation, FAR subpart 121.135, states as follows:

> (a) Each manual required by §121.133 [Preparation] must –
> (1) Include instructions and information necessary to allow the personnel concerned to perform their duties and responsibilities with a *high degree of safety;*
>
> (Emphasis added)

The use in the United States FARs of the words "highest degree of safety" and "high degree of safety" in my opinion is significant. These statements of the requirements expected of United States air carriers provide a benchmark for the regulator to review and audit an air carrier. These tests are, in my view, both understandable and meaningful to an air carrier industry. The requirements to meet the test "high or highest degree" of safety can be reasonably established by a regulator and met by air carriers, and are determinable in jurisprudence.

Although the equivalent Canadian legislation, section 33 of ANO Series VII, No. 2, employs the wording "in a proper manner" to determine the sufficiency of the contents of the FOM, it is my opinion that these words form an elusive test, leaving insufficient guidance to the regulator on how "proper manner" is to be interpreted. The use of this test, as does the term "satisfactory to the Director," also gives to those who apply the law a discretion akin to a mandate to interpret government policy.

The existing tests ("satisfactory," and "in a proper manner") contained in the ANO Series VII, No. 2, are, in my opinion, inadequate. These tests leave the door open to allow the air carrier to negotiate or debate with Transport Canada what the carrier views to be satisfactory and what it considers to be in a proper manner. As well, these tests do not provide Transport Canada air carrier inspectors with certainty in standards that they can rely upon in reviewing documents such as the FOMs. Applying the test "high" or "highest degree of safety" is more meaningful and determinable and should provide greater benefit and certainty to both the air carrier and the regulator.

Findings

- On March 10, 1989, on board C-FONF, Captain Morwood carried a Piedmont F-28 Operations Manual and First Officer Mills carried a USAir Fokker F-28 Pilot's Handbook.

- At the time of the crash, Air Ontario did not have its own F-28 operations manual. The Piedmont and USAir F-28 manuals were being used by Air Ontario and its F-28 pilots in the air carrier's flight operations without the consent of Piedmont and USAir.

- There were some material differences between the two manuals.

- It was the understanding of Piedmont Airlines and USAir that their F-28 operations manuals were to be used only as training tools for the purposes of aircraft ground school and simulator training provided by Piedmont Airlines/USAir to Air Ontario pilots.

- No amendment service was requested by Air Ontario, and no revisions were provided by Piedmont and USAir for the respective F-28 operations manuals.

- The flight release used by the flight crew of C-FONF on March 10, 1989, did not meet the requirements of an operational flight plan as contemplated in Air Navigation Order (ANO) Series VII, No. 2.

- Air Ontario did not set out in its Flight Operations Manual (FOM) an example of, or the information necessary for, an operational flight plan for F-28 aircraft operations so as to demonstrate that procedures were in place to monitor and control the flight of C-FONF and that the carrier had a plan for the safe conduct of the flights of C-FONF on March 10, 1989.

- No operational flight plan was made available to or used by the flight crew of C-FONF on March 10, 1989.

- Since Air Ontario did not provide the information necessary to flight operational personnel, including the flight crew, to monitor and control the flight of C-FONF, and since the FOM did not contain sufficient information to demonstrate that Air Ontario had a plan for the safe conduct of the flights of C-FONF of March 10, 1989, I find that Air Ontario failed to comply with the requirements of ANO Series VII, No. 2, sections 2 and 15, and Schedule B.

- It was contemplated and stipulated in the lease between Transport Aérien Transrégional and Air Ontario Inc. that C-FONF would be operated in accordance with the Fokker F-28 Flight Handbook and with an approved Air Ontario F-28 operations manual. At the time of the crash, Air Ontario had not completed drafting its own F-28 operations manual (AOM) for submission to Transport Canada.

- The Air Ontario F-28 Operations Manual (AOM) was not submitted to Transport Canada for approval until June 7, 1989.

- Air Ontario Inc. operated for approximately eight months, from June 1987 until February 1988, without an approved and updated FOM reflecting the operations of the merged air carrier Air Ontario Inc. During this period of time, Air Ontario did not have in place a comprehensive FOM reflecting the continued and current status of Air Ontario's operation.

- There was lack of sufficient information, advice, and direction in Air Ontario's FOM regarding aircraft ground de-icing and for operations from contaminated runways.

- Existing ANOs do not contain a requirement for the updating and amendment of FOMs or for approval of updates and amendments by Transport Canada.

- Although a copy of the FOM must be submitted to Transport Canada, ANO Series VII, No. 2, does not specify that the FOM must be approved by Transport Canada.

- Both the Piedmont F-28 Operations Manual and the USAir Fokker F-28 Pilot's Handbook are comprehensive and detailed. No fault is found with these individual manuals, either in form or in content. However, because of the differences between them, only one manual should have been designated for use.

- Air Ontario did not designate one specific F-28 operating manual to be used by the F-28 pilots. This situation created uncertainty in the application of aircraft operating limitations and procedures used by Air Ontario F-28 pilots operating the aircraft.

- Transport Canada failed to review properly and adequately either the Piedmont F-28 Operations Manual or the USAir F-28 Pilot's Handbook, failed to identify the fact that the two different manuals were being used by the pilots, and failed to take steps to stop this practice.

- ANO Series VII, No. 2, is silent on the issue of air carrier company–produced AOMs or aircraft standard operating procedures manuals (SOPs). There is no regulatory requirement that air carriers produce AOMs specific to each aircraft type, and, further, there is no legislative provision that allows Transport Canada to review and approve AOMs prior to an aircraft type being operated by an air carrier in revenue service.

- There is no legislative requirement for an air carrier to produce a cabin attendant manual, and, further, there is no commensurate legislative requirement that Transport Canada review and approve such a manual.

- The existing tests contained and used in ANO Series VII, No. 2, sections 5, 6, and 33, to determine the qualifications of operational management personnel and to determine the sufficiency of the contents of an air carrier's FOM are discretionary and open to interpretation. They do not provide to Transport Canada certainty with which to apply a standard and an adequate standard to be achieved by an air carrier.

RECOMMENDATIONS

It is recommended:

MCR 61 That Transport Canada approve a complete copy of the air carrier's operations manual prior to the granting of an operating certificate or an amendment to an operating certificate, and that it approve all amendments and insertions made to that manual.

MCR 62 That Transport Canada proffer for enactment an amendment to Air Navigation Order Series VII, No. 2, requiring Transport Canada to approve one aircraft operating manual for each type of aircraft operated by the air carrier. It is further recommended that such approval be required prior to the granting of an operating certificate or an amendment to an operating certificate by Transport Canada to the air carrier to allow the commercial use of that aircraft type by the air carrier.

MCR 63 That Transport Canada proffer for enactment an amendment to Air Navigation Order Series VII, No. 2, requiring each air carrier to provide to Transport Canada an air carrier cabin attendant manual for review and approval, either as part of the flight operations manual or as a separate manual.

MCR 64 That Transport Canada proffer for enactment an amendment to Air Navigation Order Series VII, No. 2, deleting the existing tests contained in sections 5, 6, and 33 and replacing them with tests containing the wording "high degree of safety" and "highest degree of safety." Such wording is similar to wording contained in equivalent United States Federal Aviation Regulation legislation dealing with standards and procedures for air carriers using large aircraft.

MCR 65 That Transport Canada proffer for enactment legislation requiring an air carrier to submit its operations manual as defined in Air Navigation Order Series VII, No. 2, to Transport Canada and have it approved prior to the issuance by Transport Canada of an operating certificate or any amendment thereto.

MCR 66 That Transport Canada ensure that air carriers follow and comply with those sections of the operations manuals required by Air Navigation Order Series VII, No. 2.

20 THE F-28 PROGRAM: FLIGHT OPERATIONS TRAINING

Proper operations training is as important as flight operations manuals (chapter 19) in the standardization of flight operations procedures. This chapter examines the Air Ontario flight operations training programs as they applied to F-28 operations. Three areas of training are looked at in particular: flight crew training, flight (cabin) attendant training, and ground handler training. Air Ontario dispatch training is discussed in chapter 23, Operational Control.

Terminology and Regulatory Requirements

Part IV of Air Navigation Order (ANO) Series VII, No. 2, is entitled "Crew Member Requirements." Section 2 thereof defines "crew member" as "a person assigned to duty in an aeroplane during flight time." A cabin attendant is defined as "a crew member, other than a flight crew member, assigned to duty in a passenger-carrying aeroplane during flight time." The term flight crew is defined to mean "a pilot, flight engineer or flight navigator assigned to duty in an aeroplane during flight time."

ANO Series VII, No. 2, Parts IV and V, detail crew member requirements and crew member training and qualifications that must be met by an air carrier. ANO Series VII, No. 2, Part V, details the training requirements for flight crew members and cabin attendants for each aircraft type. The general requirements set out in sections 42, 43, and 44 under the heading "Crew Member Training and Qualifications" are as follows:

> *General*
>
> 42. (1) An air carrier shall establish and maintain a ground and flight training program approved by the Director to ensure that each crew member is adequately trained to perform his assigned duties, including those relating to abnormal and emergency procedures, and knows the relationship of those duties with respect to those of other crew members.

(2) An air carrier shall provide adequate ground and flight training facilities and qualified instructors for the training required by this Part.

(3) An air carrier shall provide ground and flight training for a flight crew member with respect to each type of aeroplane on which that member serves including proper crew member co-ordination and training in all types of situations resulting from powerplant, airframe, or system malfunction or from abnormality or fire.

(4) An air carrier shall maintain a record of the initial and recurrent training and checks provided for each crew member and that record shall be certified as to the proficiency of the crew member at the completion of each training phase or check by the instructor responsible for that particular phase of training or check.

(5) An air carrier shall submit to the Director for approval, a detailed training syllabus for each crew member classification, which syllabus shall consist of

(a) programmed ground and flight training to meet the requirements of section 45 to 52 and Schedule C, as applicable, for each type of aeroplane to be operated; and

(b) a sample of the record required to be maintained pursuant to subsection (4).

43. Notwithstanding section 42, an air carrier may be granted approval to have all or a portion of the required training provided by a training organization other than his own but shall, notwithstanding any arrangement, be responsible for the proficiency of his crew members.

44. (1) No air carrier shall use a person as a crew member unless that person has satisfactorily completed

(a) the initial training phase of the air carrier's approved training program; and

(b) the appropriate recurrent training phase and any required checks at least once every 12 months following the initial training phase.

(2) Where any recurrent training phase is completed or any required check is taken either during the calendar month preceding or following the month in which it became due, it shall be deemed to have been completed or taken in the month in which it became due.

ANO Series VII, No. 2, section 42(5), requires an air carrier to submit a detailed training syllabus for each crew member classification to Transport Canada for its approval. Section 44(1) prohibits an air carrier from using a person as a crew member unless that person has satisfactorily completed the initial training phase of the air carrier's approved training program.

Sections 45 through 52 of ANO Series VII, No. 2, detail the various training requirements under the following subheadings: Emergency

Procedures Training, Pilot Ground Training, Pilot Flight Training, Flight Engineer Training, Flight Navigator Training, Cabin Attendant Training, Line Indoctrination, and Recurrent Training. The training requirements for both the flight crew and the cabin crew are set out in considerable detail. While the qualification requirements for pilots, flight navigators, flight engineers, chief pilots, and chief inspectors are also outlined, there is no provision in the ANOs dealing with qualifications for cabin attendants.

Schedule C of ANO Series VII, No. 2, details the requirements to be met by flight crew members in pilot proficiency check rides. ANO Series VII, No. 2, Schedule D, requires air carriers to obtain Transport Canada approval to use a flight simulator for pilot flight training. Schedule D also stipulates simulator features necessary for Transport Canada approval.

ANO Series VII, No. 2, requires air carriers to carry out aircraft type-specific ground school training for flight crew, followed by written examinations and flight training. It also requires flight crew members to demonstrate knowledge and proficiency in all areas of flight handling. Thereafter, pilots must receive pilot proficiency checks from Transport Canada examiners or company check pilots (CCP) who have authority delegated from Transport Canada to carry out such checks. During pilot proficiency checks, the pilots must demonstrate proficiency in preflight preparedness, takeoffs, landings, normal flight, abnormal procedures, emergency procedures, and instrument procedures. Detailed pilot proficiency check requirements are contained in ANO Series VII, No. 2, Schedule C. Air carriers are required to keep accurate records of all ground school and flight training, including pilot proficiency checks and instrument rating renewals of flight crew members.

Once a pilot has successfully completed an initial pilot proficiency check on an aircraft type, a Transport Canada inspector will endorse his or her licence for the aircraft type. This endorsement authorizes the pilot to fly the aircraft type in revenue operations under the supervision of a pilot-in-command designated by Transport Canada to carry out line indoctrination flight training. Flight crew members must perform their duties in accordance with an air carrier's line indoctrination program and in conformance with ANO Series VII, No. 2, section 51, Line Indoctrination. Normally, a flight crew member must carry out line indoctrination training until the air carrier is satisfied that the trainee is competent to operate in the designated capacity; for example, a pilot-in-command or second in command of an aircraft. On completion of line indoctrination training, a flight crew member receives a line check from an air carrier check pilot, and, if successful, training is considered to be complete and the flight crew member is assigned normal flight crew duties.

Similarly, cabin or flight attendants must receive ground and flight training sufficient to satisfy the requirements of ANO Series VII, No. 2, sections 42, 43, and 44, General, and section 50, Cabin Attendant Training. This training, provided by the air carrier, must be sufficient to ensure that cabin attendants are competent to perform the duties and functions assigned to them "in the interest of the safety of passengers." Cabin attendants are required to attend a ground school course, followed by a written examination, and to receive line indoctrination until the air carrier is satisfied they are competent to perform the duties and functions contemplated in ANO Series VII, No. 2, and as required by Transport Canada.

Finally, an air carrier is required by ANO Series VII, No. 2, section 51, Recurrent Training, to have all crew members carry out recurrent training and required checks at least once every twelve months.

Flight Crew Training

On January 12, 1988, Air Ontario made application to Transport Canada to have the Piedmont Airlines F-28 ground, simulator, and flight training program approved for use by Air Ontario until Air Ontario could submit to Transport Canada its own Fokker F-28 training syllabus. At that time, Captain Robert Nyman, director of flight operations, advised Transport Canada that two pilot candidates were attending Piedmont's ground school course and that Air Ontario expected to acquire two F-28 aircraft in the near future and to train a total of 16 pilots for its F-28 program.

On January 28, 1988, Transport Canada's Large Air Carrier Inspection Branch in Ottawa approved Piedmont Airlines' F-28 syllabus, simulator, and instructors as an interim measure to allow Air Ontario pilots to train for the F-28 aircraft. The Ontario Region branch of Transport Canada advised Air Ontario of such approval on February 15, 1988.

F-28 Ground School Training

All of the pilots who testified before this Commission about their Piedmont/USAir training considered the ground school training to have been excellent. Mr Randy Pitcher, Ontario Region's civil aviation inspector who took the Piedmont F-28 ground school course in July 1988, testified that the course was a total of 80 hours and was "very comprehensive." Operational procedures, flight characteristics, performance capabilities, slush, ice, and rain protection, and many other areas of the F-28 aircraft operation were covered "in detail" (Transcript, vol. 127, p. 22).

The testimony of Air Ontario pilots regarding certain aspects of the F-28 ground school course was of significance to this Inquiry. Of particular relevance was the handling of an F-28 aircraft in weather conditions conducive to the formation of ice on the aircraft or where there is contamination on runway surfaces.

Aircraft Contamination

Captain William Wilcox received the Piedmont Airlines ground school course in March 1988 with five other Air Ontario F-28 pilots including Captain Bradley Somers and Captain Robert Perkins, who also testified before me. Captain Wilcox testified that the pilots being instructed were told a number of times that the F-28 aircraft could not be flown with any contamination on its wings. He testified that one of the ground school instructors, who was previously an F-28 pilot with Empire Airlines, a predecessor airline of Piedmont, reinforced the proscription by way of stories of other pilots who had experiences with contamination: "I recall him telling us of two situations where their airplanes had taken off with some snow on the wings and both of them resulted in near crashes but both of them survived, so to speak. In other words, went airborne, but very scary. You know, one wing stalling, the other remaining flying" (Transcript, vol. 93, p. 112). Captain Wilcox stated that Piedmont Airlines clearly emphasized the need for a "clean wing."

According to Captain Keith Fox, the Piedmont instructors described the characteristics and sensitivity of the F-28 aircraft wing to contamination as follows: "Yes, we were advised that it was very important, critical, that you ... [depart] with a clean wing if you are in icy conditions" (Transcript, vol. 51, p. 19). As part of his introductory notes to the course on December 5, 1988, Captain Fox wrote the following statement:

> * Wing and horizontal stab leading edges – "clean" wing critical
> – refer to ice and
> rain
> protection
> 1-311 Piedmont Manual.[1]

Captain Fox testified that ice and any contamination on the F-28, with its swept wing, was "more critical than any other straight wing aircraft" he had flown (Transcript, vol. 51, p. 21).

First Officer Monty Allan testified that he was told during his course that the F-28 wing had "zero tolerance" to contamination:

[1] Exhibit 382, three-ring binder containing Captain Fox's handwritten notes and printed handout material supplied by Piedmont Airlines Contract Training Services Department

A. ... I couldn't remember whether it was specifically mentioned at the classroom ground school in Greensboro or whether it was by my simulator instructor, but I do recall the mention being, as Piedmont had operational experience, they flew up in the northeast, that you did not take off with any ice on the wings, zero.

Like, it wasn't a matter of measuring what was an acceptable amount and what wasn't.

Q. No contamination?

A. It was imparted to me that it was zero, yes.

(Transcript, vol. 91, pp. 42–43)

First Officer Allan also testified that it was generally agreed by Air Ontario F-28 pilots that there was a common understanding of "zero tolerance" in relation to wing contamination.

Captain Erik Hansen, who completed both his ground school and the simulator flight training with Captain George Morwood, commented that the ground school instructors emphasized that the wings of the F-28 aircraft should not be contaminated either for takeoff or during flight. Captain Hansen recalled Captain Morwood's participation in discussions with Piedmont instructors regarding aircraft wing contamination.

I view Captain Hansen's testimony to be significant because it demonstrates the emphasis placed by Piedmont Airlines on the need to operate the F-28 with clean lifting surfaces, and because it provides clear evidence of the advice and instruction provided by Piedmont Airlines to Captain Morwood. Captain Hansen gave the following testimony relating to Captain Morwood's participation in ground school discussions:

A. Well, it was stressed in ground school. See, I also had a recurring ground school down in, I believe it was Syracuse, same four guys. I'm talking about George Morwood, Reichenbacher, Maybury and myself went to Syracuse for recurring ground school, and that would have been November, October, November of '88.

And now we're getting into the winter operations as such, and again they were stressed with de-icing that this had a clean wing, wouldn't tolerate any contaminants of any kind, so preheat and when you are flying, if you are anticipating that you are going to be encountering icing conditions, turn on your heater or ... heat up the aircraft before entering the ice. Don't use it as a de-icing system, more as an anti-ice system.

Q. Let's digress for one moment ...

George Morwood was with you in Tampa and he was also with you on the recurrent in October or November of '88?

A. That's correct.

Q. Now, in Tampa, could you tell the Commissioner initially if he was in the classroom with you throughout the entire period of time?
A. Yeah, every, every day. Every day, he never missed a class.
Q. So whatever you heard, he heard?
A. Absolutely.
Q. ... Now, could you tell the Commissioner what you heard related to you in relation to the sensitivity of the wing and contamination of the F-28?
A. Well, just that it was ... a clean wing and it didn't tolerate any contaminants as such. And it was of the utmost importance that the aircraft was kept clean and you ensure that it was clean prior to departure.
Q. Was that stressed?
A. It was stressed so that because we, meaning the four of us, like there was 20 some odd other people in the classroom with all kinds of jet experience and also people who flew in the southern States who don't really get into the weather that we did.

But the four of us coming out of Convairs and the Convair will take ... some ice and some contaminants prior to departure before ... you're really starting to get upset about it.

We were very interested in finding out ... when he said clean, what do you mean clean. When he just said super clean, it won't take anything.
Q. Would you ask questions during these sessions, sir?
A. Oh, yes, we did.
Q. And you have indicated to us that George certainly had a propensity to ask questions?
A. To a point where it became annoying, yes, really.
Q. Would both of you or maybe all four of you have directed questions specifically in this area which was peculiar to you; namely, the winter flying?
A. Well ... George would be bringing these things up because this was George's way of getting the floor.

He would say, well, we are flying up and down the Lakes and the weather gets really bad up there, and he would relate a couple of stories in his past experience, whatever they were, flying in bad weather, and he was trying to relate that and put that into the F-28 operation and that kind of stories ... he had a couple of those.

And the instructor just said, look, the aircraft has to be clean and that's it and he won't take any nonsense. You are not flying a Convair now. This is a jet, it's got a clean wing and swept back and all these other good things, so don't.

And George also had a couple of stories of his own to relate because he flew the G-2[2] as well for Steve Roman.

Q. And what stories would he have related in that particular –

A. Well, for the G-2, he said it was so nice to fly because could go in and out of it so fast so he never really had any bad experience with icing in the G-2 and – but then he was also reminded that he wasn't flying a G-2, this was an F-28, and then to keep the aircraft clean.

Q. Was it your impression, sir, and I know that it's hard to put yourself in the position of someone else, was it your impression that you and the other three gentlemen with you including George Morwood understood what was being conveyed by the Piedmont instructors?

A. Yes, there's no doubt.

Q. No doubt in your mind on that?

A. None.

(Transcript, vol. 94, pp. 70–74)

Captain Hansen testified that because his fellow Air Ontario classmates had been flying Convair 580 turboprop aircraft prior to converting to the F-28 aircraft, and because this turboprop aircraft was able, in their view, to operate safely with a certain amount of contamination on its wings, Captain Morwood in particular was interested in discussing with the Piedmont ground school instructors the F-28's capabilities to carry contamination on its wings. Captain Hansen described the dialogue with the Piedmont ground school instructors:

A. ... At no time did they minimize the seriousness of ice or of any kind of contamination. They did not.

But when the four of us sitting in the classroom there and kept hammering on these questions about, well, how little is little ice, will it take a thin layer of frost, perhaps, how about a wet wing, and these questions, they kept on and on and on from the four of us, like I say, primarily from George, if memory serves me right.

The rest of the classmates that we had were getting perhaps a little annoyed, because to them, you know, why do you keep

[2] Captain Morwood accumulated approximately 500 flight hours on the Grumman Gulfstream G-2 executive turbojet. This aircraft has a profile similar to that of an F-28, and some models are also equipped with the same engine type. The Grumman Gulfstream G-2 is somewhat lighter and faster than the F-28, but has operational and handling characteristics generally similar to the F-28 aircraft. Like the F-28 aircraft, the G-2 has a "hard wing" with no leading-edge high-lift devices, a "T"-type configured horizontal and vertical stabilizer, and its two engines are similarly mounted at the rear of the aircraft fuselage.

hammering on this, you know. The book says keep it clean, no contaminants, and that's the end of it.

And maybe it was because that flying the Convairs, which we all did prior to this, we have been able to get away with a certain amount of contaminant on these wings and the aircraft performs well. But this was a different airplane, different wing. This was a jet, not a propeller-driven airplane, and on and on it goes.

Q. And at the end of this whole process, are you confident with George Morwood came away with that feeling, that no matter what, this wing had to be absolutely clean?

A. He had to.

(Transcript, vol. 94, pp. 148–49)

The view expressed by Captain Hansen that turboprop aircraft can handle a certain amount of contaminant on their wings is not unique. Mr Pitcher described a similar opinion, as did expert witnesses from both Fokker Aircraft and from the National Research Council Canada. The aerodynamic reasons why a turboprop aircraft might be able, in some circumstances, to carry a certain amount of contaminant are fully discussed and described in chapter 12, Aircraft Performance and Flight Dynamics.

Based on the testimony of these pilots and of others who appeared before me, and from a review of Captain Fox's handwritten notes and Piedmont's handouts provided to him, I conclude that the operation of the F-28 aircraft with contaminated wings was dealt with thoroughly at the ground school training provided by Piedmont Airlines, at least for Air Ontario pilots who took the course. Testimony of many Air Ontario pilots, including Captains Wilcox, Hansen, and Fox, was candid and revealed a cautious professional view regarding the prohibition of operating an aircraft, especially at takeoff, with contaminated lifting surfaces. The evidence leads me to conclude that all Air Ontario pilots who took the Piedmont ground school course received thorough instruction and caution that it was of utmost importance that the F-28 be operated at all times with a clean, uncontaminated wing. The evidence also leads me to conclude that Captain Morwood considered, as did other pilots, that propeller-driven aircraft, such as the Convair 580, would perform adequately with some contaminant on the aircraft wings. However, it is clear from the testimony of Captain Hansen that Captain Morwood, as one of the pilots who took the Piedmont ground school course, must also have been aware of the prohibition of operating the F-28 aircraft with any amount of contamination on the wings.

Cold-Soaking Phenomenon

Cold soaking is a term used to describe a phenomenon that sometimes occurs as a result of an aircraft operating at high altitudes. An aircraft, while flying at altitude, where the temperature is usually much colder than on the ground, will gradually be cooled to near ambient temperature. Fuel in wing tanks next to the outer skin will also be cooled to ambient temperature, although at a different rate, along with the outer aircraft wing skin surfaces. When an aircraft has landed with cold-soaked wings and fuel, frost or ice may form on the upper and/or the lower wing surfaces next to the fuel tanks, depending on the ambient temperature and the relative humidity. As discussed in detail in chapter 12, one of the relevant aspects of cold soaking concerns the way the cold-soaked wing conducts heat away from precipitation, such as wet snow and rain resting on the wing, and causes the precipitation to freeze. This freezing process was described by Dr Myron Oleskiw of the National Research Council Canada as follows:

> A. As the freezing occurs from the bottom working its way upwards because of the conduction into the fuel tank, the bottom portion would become entirely solid, still with air trapped in it, but there – the water part, of course, would be frozen. Further up, there would be this ice structure but with the water still there.
>
> (Transcript, vol. 68, p. 218)

The fact that precipitation on the upper surface of the wing freezes from the wing surface upwards is particularly insidious. It is possible for slush, which is solidly frozen to the wing, to appear to be largely wet and unfrozen. The potential for human misperception in this scenario is obvious.

In the course of this Inquiry, pilots were asked about their knowledge of cold soaking. Captain Fox testified that he was aware of the term "cold soaking," and that wing cooling at high altitude was brought up during the course. He said that the cold-soaking phenomenon occurred quite often with the HS-748 aircraft, and explained it as follows:

> A. Hawker Siddeley 748, would be high, it would be cold up north, warmer summertime in Pickle [Pickle Lake]. I would come down quickly and land and it would be warm on ground but you get out and there is a frost on the bottom and top of the wings, particularly it stays quite a bit longer on the bottom of the wing and it is from the fuel in the wings is still very cold, got cold soaked up high altitude and it hasn't warmed up yet.
>
> Q. When you say high altitude, what sort of altitudes would you be flying at with the 748?
>
> A. Twenty-four, 25,000 feet.

Q. So you were familiar with this concept of cooling of the wing by – and the fuel cooling the wing and then coming down to a lower altitude and having frost or some sort of precipitation show on the wings?
A. Yes.

(Transcript, vol. 51, p. 24)

He testified that this matter was also touched on briefly during the Piedmont ground school course and that a warning on cold soaking was in the Piedmont Airlines/USAir F-28 operations manuals.

A number of other pilots who testified indicated that they were aware of the concept of cold soaking. Captain Wilcox, one of the most experienced F-28 pilots with Air Ontario, provided general observations and his understanding of cold soaking:

A. Other ... than being aware of cold soaking affecting any airplane, this airplane in particular, although not much different than a Convair, we are basically operating at below 25,000 feet, descending into, you know, your warmer, warm, moist atmosphere, and you are always cognizant or looking for it to be occurring underneath the wing.
Q. That's the point, sir. You were aware of the concept of cold soaking?
A. Yes.
Q. And when you used your anti-icing system, you paid particular attention to the wing after that?
A. Correct. You always want to walk around, check that, you know, there's not a heavy frost layer, whatever.

(Transcript, vol. 93, pp. 121–22)

The pilots who testified before me demonstrated various levels of knowledge of cold soaking as it applied to wing contamination. One Air Ontario pilot had never heard of it prior to the crash. However, most Air Ontario pilots and other pilots who testified had a general understanding of the phenomenon. A number of them related personal experiences with cold-soaked wings causing contamination to freeze and adhere to the wing surfaces.

It should be noted that the cold-soaking phenomenon depends on the juxtaposition of various factors, including the time at altitude, the temperature at altitude, the temperature and dew point on the surface, and the amount of fuel in the wing tanks.

Captain Joseph Deluce, F-28 chief pilot, had a general understanding of the cold-soaking phenomenon. He also stated he was aware of the references and cautions contained in the manuals. He agreed that "cold soaking is critical with all aircraft" (Transcript, vol. 112, p. 28). Captain Deluce testified that he did not communicate his views on cold soaking to his F-28 pilots because, in his opinion, the issues were properly addressed in the aircraft flight and operating manuals and during ground school training. Captain Deluce further stated that cold soaking is something that pilots learn about through operational experience.

Captain Deluce's statement that cold soaking is something that pilots learn through operational experience appears to represent the current state of affairs in the aviation industry. Except for Captain Fox, no one testified that the cold-soaking phenomenon as it affects wing contamination was dealt with either in ground school or in flight training. While manufacturers and air carriers may produce circulars and publications dealing with this matter for dissemination within their own pilot groups, neither the Fokker F-28 Flight Handbook nor the Piedmont/USAir operations manuals cover, in a systematic manner, the issue of cold soaking and the potential for moisture to freeze on upper-wing surfaces. Similarly, the Air Ontario and the Air Canada flight operations manuals do not address this phenomenon either specifically or in detail. The A.I.P. Canada: Aeronautical Information Publication, which is circulated to all Canadian licensed pilots and which, at the time of the crash, contained a caution regarding takeoff with contamination on the lifting surfaces, also fails to cover the matter of cold soaking and its potential to cause contamination to adhere to wings.

It is possible that Captain Morwood and First Officer Mills, despite their collective flying experience of more than 30,000 hours, were not sufficiently aware of the insidious nature of cold soaking. Captain Morwood reported an incident to Air Ontario Flight Operations that occurred in January 1983 in Cleveland, Ohio, when he was flying Convair 580s. He stated as follows:

> Flight was 40 min late leaving the gate due to a combination of events. There was moderate snow in Cleveland temp −5° C, however, the aircraft had 7500 lbs of tanker fuel remaining that must have been relatively warm. I went out to check the wings at 10.30 and I was surprised to find the snow was melting and sticking on the wings in the area of the fuel tanks. I immediately requested a spray, then the fun began. Wright had just taken their spare over to be fuelled, then a problem occurred with fuel truck. They finally arrived at the aircraft around 1130.
>
> (Air Ontario Pilot Incident Report, January 19, 1983)

Captain Morwood in his incident report identified a heat transfer phenomenon that caused moisture to adhere to the upper-wing surface adjacent to the fuel tanks. This report shows that Captain Morwood had some exposure to a form of heat transfer, similar to cold soaking, that caused contamination to adhere to the upper surface of an aircraft wing. I can reasonably assume that First Officer Mills, who like Captain Fox had previously flown HS-748s and other aircraft in northern Canada, must also have had a fundamental understanding of the cold-soaking phenomenon.

Based upon the evidence of the pilots who testified before this Commission, I find it likely that both Captain George Morwood and First Officer Keith Mills would have had some knowledge, based on their operational flying experience, of the cold-soaking phenomenon. As discussed in chapter 12, Aircraft Performance and Flight Dynamics, ample warnings and cautions were present in the Fokker F-28 Flight Handbook and in aircraft operations manuals used by Air Ontario regarding the danger of taking off with an aircraft with contaminants on the lifting surfaces. However, a systematic and comprehensive discussion of the cold-soaking phenomenon does not appear in these manuals. Comprehensive research such as that conducted by Dr Oleskiw should be used to prepare specific information on the subject. Such information should be inserted in the air carriers' flight manuals and in government publications such as the A.I.P., in order to make all pilots and aviation operational personnel fully aware of the various factors that may cause contamination to adhere to lifting surfaces. A clear warning should be made by air carriers and by Transport Canada that the only way pilots can be certain that lifting surfaces will be clear of contamination prior to takeoff is through strict adherence to a "clean wing" policy.

Runway Contamination

As C-FONF made its last takeoff in Dryden on March 10, 1989, the runway was contaminated with slush on at least the east half of its length and was wet on the remainder. It was therefore of interest to this Commission to know what instruction had been given by Piedmont Airlines/USAir, and what direction was provided by Air Ontario to its pilots, regarding aircraft performance limitations with respect to contaminated runways.

Captain Fox testified that the Piedmont instructors took the students through the performance charts in the Piedmont/USAir F-28 operations manuals, as well as those in the Fokker F-28 Flight Handbook pertaining to contaminated runways. However, the testimony indicates that instruction regarding the Fokker F-28 Flight Handbook was brief. Although the instructors may have demonstrated to students how to use the Fokker F-28 Flight Handbook slush-correction charts, Piedmont Airlines/USAir did not use the Fokker charts for their own operational use.

Captain Fox testified that during the time he was flying Air Ontario's F-28 aircraft, he did not encounter a runway contamination situation where he would have been required to use performance and weight-reduction calculations (Transcript, vol. 51, pp. 28–29). Similarly, although

Captain Hansen did not have an occasion to take off from a contamination-covered runway with the F-28, he testified that he was familiar with both the slush-correction chart contained in the Piedmont Airlines F-28 Operations Manual and the correction chart and graph contained in the Fokker F-28 Flight Handbook.

The runway-correction chart contained in both the Piedmont and USAir F-28 operations manuals entitled "Take-off in Standing Water, Slush or Snow," and dealt with in chapter 12, provides guidance to F-28 flight crews who find themselves required to take the aircraft off from a runway covered with specified amounts of contamination.[3] These charts are considerably more restrictive than the correction chart contained in the Fokker F-28 Flight Handbook. However, the Piedmont/USAir charts are simple to use, and the reduced aircraft weight can be determined quickly.

A number of pilots were asked which slush-correction chart should, in their opinion, have been used by Air Ontario pilots in the operation of the F-28 aircraft: the chart contained in the Piedmont/USAir F-28 operations manuals or the chart and graph contained in the Fokker F-28 Flight Handbook. Captain Hansen testified that he felt bound to use the Piedmont F-28 manual because, in his words, "we were told by Transport Canada in our training that that was our Bible until we had one [an Air Ontario F-28 operating manual] approved of our own." He said that if the more restrictive Piedmont aircraft weight-penalty parameters were used, he would be "on safe ground" and would feel comfortable that he had adequate aircraft performance capability during takeoff in runway contamination (Transcript, vol. 94, p. 150). He further stated that a pilot who was looking for "a few extra pounds in order to get the aircraft off the ground" might choose to use the graph contained in the Fokker F-28 Flight Handbook.

As discussed in chapter 12, Captain Hansen's view was indicative of the position taken by most of the pilots who testified before me. This view was not, however, the view of Captain Perkins, a senior Air Ontario F-28 check pilot authorized for line indoctrination training. Captain Perkins, who was also responsible for assisting Captain Joseph Deluce in drafting Air Ontario's F-28 operations manual, was of the view that the Piedmont/USAir slush-correction chart was "fairly restrictive" and, since it was not FAA approved, he considered it to be for guidance only.

---

[3] Exhibit 307, Piedmont F-28 Operations Manual, Normal Operation Mark 1000 Takeoff in Standing Water, Slush or Snow, p. 4-1-42; Exhibit 329, USAir F-28 Pilot's Handbook, Planning & Performance, Take-off Information, Take-off in Standing Water, Slush or Snow, p. 4-1-42.

During Captain Perkins's testimony it became evident that he was under the mistaken impression that the complicated Fokker charts for takeoff from slush-covered runways guaranteed a balanced field.[4] In practical terms, Captain Perkins felt that by using these charts he could be assured that, in the event of engine failure during takeoff roll, he would be able to stop on the runway-clearway, or, alternatively, would be able to continue to a successful takeoff with one engine inoperable (Transcript, vol. 44, pp. 14–17). Mr Pitcher, among others, testified that on this important point Captain Perkins was misinformed:

> Q. ... The problem is, if you have got a slush covered runway, there's no way, from these charts, to guarantee that you have got a balanced field; correct?
> A. Absolutely.
> ...
> Q. ... So it's very clear to you as an inspector, a Transport Canada inspector, that Captain Perkins was wrong when he said that the Fokker charts concerning takeoff from contaminated runways guaranteed a balanced field?
> A. Yes, it's surprising.
> Q. ... And – well, let's take it one step at a time. Is it clear to you that he was wrong?
> A. May I say misinformed?
> Q. All right. That's fine. It's clear to you that he was misinformed; is that right?
> A. Yes.
> Q. And does it surprise you that someone who had been granted check pilot authority could be that misinformed?
> A. It does, yes.
>
> (Transcript, vol. 128, pp. 122–23)

It is also evident from Captain Perkins's evidence that assuring a balanced field requirement where the runway is covered in slush was, to his mind, a paramount consideration. On this point he testified as follows:

---

4 Balanced field length: In general terms, a balanced field length takeoff occurs when the distance required to accelerate an aircraft to decision speed (V_1), lose the critical engine, and continue the takeoff using normal pilot techniques, climbing the aircraft to a screen height of 35 feet, is equal to the distance required to accelerate the aircraft to decision speed (V1), lose the critical engine, and stop the aircraft on the runway. The first distance deals with accelerate-go and the second distance deals with accelerate-stop. These two criteria are discussed in detail in chapter 12, Performance and Flight Dynamics.

Q. ... And even though the runway is slushy, you still as a pilot, a safety-conscious pilot, want – are you still thinking about accelerate stop and accelerate go even though the runway is slushy?
A. Certainly.
Q. ... You want those options available even though the runway is slushy, is that correct?
A. Yes.
...
Q. ... but Dryden, there was only 6000 feet of runway, and ... you'd be looking more closely at whether or not the runway length was a limiting factor in takeoff with slushy conditions, would you not?
A. I can't really say you would look more closely. Obviously it would be a paramount consideration. It would also be a consideration at Toronto, though.
Q. ... out of an abundance of caution in Toronto, you would assure that you could accelerate stop even though it's fairly obvious that you could, is that what you're saying?
A. Yes.
Q. ... but in Dryden, it becomes more of a paramount consideration, to use your word, is that right?
A. That's correct.

(Transcript, vol. 44, pp. 8–10)

It should be pointed out that the observations expressed above do not reflect the complexity of the balanced field length issue.

Since it is evident that Captain Perkins felt it important to be assured of a balanced field, and since he mistakenly believed that the Fokker chart for takeoff from slush-covered runways assured a pilot of a balanced field, the foundation for his reasoning that it was acceptable for Air Ontario pilots to refer to the Fokker slush-correction charts is seriously undermined. Further, Captain Perkins's view that pilots were not bound to follow the easy reference charts contained in the Piedmont/USAir manuals is weakened by the impracticality of the only other alternative, namely, the use of the complicated Fokker charts.

Captain Gert Andersson, a senior captain with the Swedish air carrier Linjeflyg who had more than 5000 flight hours on Fokker F-28s, testified as follows concerning slush-correction charts:

Q. ... And so it's your evidence that that [Fokker] chart, really, is only properly used by the performance people in their well-lit office when they're trying to come up with an easy reference chart for the pilots to use; is that right?

> A. That is my opinion that it should be used only by experienced performance people, and they should make a simpler chart for use in the cockpit.
>
> (Transcript, vol. 83, p. 187)

Captain Perkins conceded that in the operational environment, the use of the Fokker chart for takeoff from slush-covered runways was not desirable:

> Q. ... How long would it take to use one of these complicated graphs in the Fokker manual to come up with a precise answer to a very specific scenario?
> A. It depends on the scenario that you're looking for. The one in –
> Q. Well, let's deal with takeoff in slush, then.
> A. Okay, the one scenario we had presented yesterday, yeah, I would estimate 30 to 45 minutes.
> Q. That's not the kind of procedure you would want to do in Dryden while you're faced with misconnections in Winnipeg and leaving an engine running burning up fuel on the ground?
> A. Obviously not.
> Q. Thank you. For that kind of scenario, what would clearly be more preferable would be a quick reference chart; is that right?
> A. Yes, it would.
> Q. Such as the one in the Piedmont manual?
> A. Such as, yes.
>
> (Transcript, vol. 44, pp. 89–90)

From the evidence before me, I am unable to give much weight to Captain Perkins's assertion that Air Ontario pilots were not expected to be bound by the more restrictive charts in the Piedmont/USAir operations manuals.

The draft Air Ontario F-28 Operations Manual forwarded to Transport Canada did not include a quick reference chart similar to the Piedmont and USAir slush-correction chart. Instead, it contained a statement referring Air Ontario pilots to the Fokker F-28 Flight Handbook chart and graph.

None of the Air Ontario pilots who testified had had an occasion to effect a takeoff of the F-28 aircraft with contamination on the runway. Accordingly, none of them could provide evidence as to what graph he or she had used. Most of the pilots, on the assumption that the Piedmont F-28 Operations Manual was the one to use until they were presented with an Air Ontario operating manual, testified that they would use the more restrictive and conservative weight limitations provided in their Piedmont or USAir operations manuals.

Based on their training, Captain George Morwood and First Officer Keith Mills should have been aware of the restrictive weight limitations imposed on the aircraft by the Piedmont and USAir chart. Had they felt bound to use this chart, however, C-FONF would have been weight-restricted and the takeoff by flight 1363 at Dryden on March 10, 1989, could not have been made until the runway had been cleared of slush.

F-28 Aircraft Flight Training

Captain George Morwood

Captain George Morwood received his F-28 flight training in February 1988 on Piedmont's F-28 aircraft flight simulator at Tampa, Florida. At the completion of this training, he received a pilot proficiency check from a Transport Canada air carrier inspector, and his pilot's licence was endorsed for the F-28 aircraft on February 26, 1988. Captain Morwood did not immediately fly the F-28 in revenue service, but rather went back to flying the Convair 580 aircraft for the remainder of 1988. He attended a Piedmont F-28 pilot recurrent ground school in November 1988, which consisted of 16 hours of classroom instruction. As well, he completed a further eight hours of F-28 flight training in Piedmont's F-28 flight simulator and passed his pilot proficiency check ride on January 9, 1989.

Captain Claude Castonguay, who acted as an observer during the flight simulator training of Captain Morwood and Captain Erik Hansen, testified that Captain Morwood had no difficulty with the aircraft systems or in flying the aircraft. He stated that Captain Morwood flew the aircraft within all of the parameters, was knowledgeable with all of the systems, and was "a fairly smooth pilot while flying the aircraft." Captain Castonguay provided similar observations regarding Captain Hansen's knowledge and flying capabilities (Transcript, vol. 105, p. 107). The Piedmont training record sheets indicate that all of Captain Morwood's flying was done to the satisfaction of the Piedmont flight instructor, who trained him initially; Captain Nyman, who provided his recurrent training in January 1989; and Transport Canada inspectors. Captain Nyman's comments were as follows: "Captain Morwood has not flown the aircraft for several months yet has obviously been studying the aircraft systems and flight procedures. Good training session" (Exhibit 684).

The F-28 aircraft simulator training course conducted by Piedmont consisted of five sessions, each of four hours. During each session, the pilot flew the simulator for two hours and carried out pilot-not-flying duties for the other two hours. Captain Hansen testified that he and Captain Morwood received a part of their pilot proficiency check ride on the F-28 aircraft flight simulator, and completed the remainder in a Piedmont F-28 aircraft in Tampa, Florida.

First Officer Keith Mills

The agreement for pilot training between Piedmont Airlines and Air Ontario was terminated as a result of the merged Piedmont/USAir carrier's requirement to use the flight simulator to train its own pilots. First officer trainees, such as Keith Mills and Deborah Stoger, did not receive the benefit of flight training on an aircraft flight simulator.

After he completed his ground school course, First Officer Mills received his F-28 aircraft flight training on Air Ontario's own F-28 aircraft. His instructor was Captain Joseph Deluce, and the flight training was carried out on four consecutive nights from Winnipeg International Airport in early February 1989 and totalled 8.3 hours. First Officer Mills completed a 1.2-hour pilot proficiency check ride with Transport Canada inspector Randy Pitcher, and had his pilot's licence endorsed for the F-28 aircraft on February 10, 1989, in his designated capacity as first officer.

The pilot-training reports completed by Captain Joseph Deluce indicate that First Officer Mills satisfied his instructor, with two exceptions. Captain Deluce observed during one session that First Officer Mills tended to "get overloaded when pushed a bit" and that he briefed First Officer Mills on "chasing altitude in steep turns and approaching stalls." First Officer Mills also flew the aircraft to the satisfaction of Mr Pitcher, except for minor errors in instrument flying and loss of some altitude when recovering from a demonstrated stall.

In contrast with Captain Morwood, who received 20 hours of flight simulator training during his initial F-28 course with Piedmont Airlines and who occupied the co-pilot's seat and acted as the pilot-not-flying while Captain Hansen received his training, First Officer Mills did not serve as the pilot-not-flying while he was training with Captain Joseph Deluce. Because he did not occupy this position, he did not receive the benefit of additional F-28 flight hours observing and participating in the training of another pilot.

Aircraft Flight Simulators

Pilots who testified at the Inquiry before me all agreed that the type of training received in an aircraft flight simulator is superior to that in an aircraft. For most of the Air Ontario F-28 pilots who testified before me, the F-28 simulator flight training was their first experience using a flight simulator.

The Piedmont F-28 flight simulator was capable of simulating all modes of aircraft flight, including abnormal situations, that might reasonably be expected to occur in actual aircraft operations. The simulator was programmable to allow such factors as low ceiling and visibility, the effects of slush on the runway, and wind shear to be simulated.

When describing his flight simulator training, Captain Fox testified that it was difficult to tell "the difference between flying a simulator and the actual aircraft." The aircraft cockpits are identical, and the flight simulator could even simulate "bumps on the tarmac as the aircraft was taxiing over them." By way of example, Captain Fox described the difference between a simulated engine loss in an aircraft and an engine loss in a simulator:

> A. ... In the real aircraft, for instance, in a shutdown, they say, okay, just put your hand on this lever, do not pull it ... because that will really shut the engine down, whereas, in a simulator, you actually do pull the fuel-off handles and ... actually go through actual shutdowns.
>
> (Transcript, vol. 51, p. 43)

Captain Nyman agreed that the use of a flight simulator is desirable because:

> A. ... inherently it's safer. You can't crash a simulator. Well, you can, but the results aren't quite the same.
>
> And ... you can show the emergency procedures without endangering the aircraft and more realistically than you can in the actual aircraft. For that reason, I say that it's more suitable.
>
> (Transcript, vol. 108, p. 134)

Captain Deborah Stoger, who received her first officer flight training from Captain Joseph Deluce in one of Air Ontario's F-28 aircraft during the night hours, testified that she would have preferred to have been trained during daylight hours and on the F-28 flight simulator. She testified that after discussing with other pilots what she had learned during her training, and the "variances in the training" between what she received and what was conducted in the flight simulator, she concluded that "obviously, simulator training is better" (Transcript, vol. 93, p. 13).

From a training perspective, malfunctions can be introduced in a flight simulator that would be impossible in an aircraft during flight. All emergency procedures, many of which are too hazardous to be carried out in flight, can be duplicated and practised in the simulator. A flight simulator, as a teaching tool, can be stopped at any time during a flight sequence to review and reinforce procedures, and procedures can be repeated quickly by repositioning the simulation.

More importantly, because of the high level of risk involved in conducting some of the procedures and manoeuvres during aircraft flight, not all can be demonstrated and practised in an aircraft. For example, Captain Stoger testified that she did not actually shut an engine down, but only simulated an engine failure. When asked what sort of manoeuvres she was required to do during her pilot proficiency check, Captain Stoger testified that she did "exactly the same as in training." Captain Fox and other witnesses on the other hand provided examples of emergencies such as fuselage rapid depressurization, total engine failure, and smoke in the cabin and cockpit, which can be demonstrated in a flight simulator but not in the actual aircraft.

Mr Pitcher testified that he was concerned when he found out that Air Ontario no longer had the use of the Piedmont flight simulator to conduct pilot training and pilot proficiency check rides. He said he was not in favour of Air Ontario conducting pilot training in the aircraft rather than in flight simulators. Mr Pitcher testified that, during the time Air Ontario conducted flight training on the aircraft, he called Piedmont and USAir on several occasions to determine if the flight simulator would be available for Air Ontario pilots. He stated that flight simulators are preferable to aircraft for training:

> A. Because in a simulator, you can cover the full range of emergency possibilities. You can really allow a pilot to fly. You can create scenarios that you couldn't even imagine doing on board an airplane.
>
> So from a purely practical point of view, you could get a far better picture, a far more comprehensive picture of a pilot's abilities, in relation to the airplane and to operating as a crew member, as a team, in the simulator under extenuating circumstances that you, in fact, created than you could in an airplane where you had to be very careful.
>
> (Transcript, vol. 127, p. 162)

Mr Ian Umbach, Transport Canada's superintendent of air carrier operations, testified:

> Q. Is it your view that simulators are a necessary part of training?
> A. Oh, absolutely.
> Q. Is it a – in your view, a mandatory requirement?
> A. In my opinion, it's mandatory, and I think it should be mandatory.
> Q. And why are you saying that?
> A. Because right now, it's not. You can train on the airplane if you want to. And I think that's unwise and unsafe.
>
> (Transcript, vol. 138, p. 141)

Mr Umbach was of the opinion that flight training in an aircraft, rather than in a flight simulator, should not be permitted. He agreed there is no legislation that prevents air carriers, operating large aircraft, from carrying out initial training in the actual aircraft. It was his view that legislation should prevent initial flight training from being conducted in large aircraft.

I agree with both Mr Umbach and Mr Pitcher. With the advent of modern flight simulators capable of simulating virtually all flight modes, system failures, and procedures, I believe that, to the maximum extent possible, initial flight training and recurrent training required to maintain pilot proficiency should be conducted in aircraft flight simulators.

F-28 Line Indoctrination Training

ANO Series VII, No. 2, requires that, in addition to ground and flight training, a pilot crew member must complete line indoctrination on the aircraft in the air carrier's normal commercial route structure. In this training, the trainee pilot flies regular flights under the supervision of an air carrier check pilot who provides instruction in the operation of the aircraft in normal line flying, usually on scheduled routes.

Captain Morwood conducted his line indoctrination flying between January 18, 1989, and January 25, 1989, with Captain Joseph Deluce, and received his line check from Captain Robert Nyman on the last day. He had accumulated a total of 27.5 hours of line indoctrination flying. Thereafter, Captain Morwood began flying as a line captain on the F-28 aircraft, with a total of 29 hours of F-28 aircraft and 30 hours of simulator time.

First Officer Mills conducted approximately 20 hours of line indoctrination flying between February 13 and February 17, 1989, and received his pilot line check on February 17, 1989, all with Captain Perkins. He commenced revenue flying as a qualified first officer on the F-28 aircraft on February 21, 1989, having accumulated 29.5 flight hours.

There is no evidence that either Captain Morwood or First Officer Mills had any difficulty during line indoctrination flying. Both Captain Deluce, who conducted line indoctrination flying with Captain Morwood, and Captain Perkins, who conducted the line indoctrination flying with First Officer Mills, were satisfied that Captain Morwood and First Officer Mills were competent to carry out their respective flight duties. Unlike most of the other Air Ontario pilots who converted to the F-28 aircraft, both Captain Morwood and First Officer Mills had previous experience on turbojet-powered aircraft, Captain Morwood on the Grumman Gulfstream G-2 executive aircraft and First Officer Mills on the Cessna Citation executive aircraft.

Company Check Pilot

Because of the many required training and checking demands that are part of the commercial air carrier operation, Transport Canada delegates to "approved Carrier Check Pilots" or company check pilots (CCPs), who are employed by air carriers, the authority to perform certain training and checking functions on behalf of Transport Canada. Further details regarding CCPs are dealt with in chapter 35, Company Check Pilot.

Air Ontario's Need for Company Check Pilots
In January 1988, immediately prior to Air Ontario's applying to have its operating certificate amended to allow it to operate the F-28 aircraft, there was no Air Ontario employee who could meet CCP qualifications. The first four Air Ontario pilots who were to be trained on the F-28 were Captains Joseph Deluce, Robert Murray, Erik Hansen, and George Morwood. This group attended their initial F-28 ground school course in North Carolina in early January 1988. It was not until well after that date that Captain Deluce and Captain Murray, who received line indoctrination and route flying experience on the F-28 with Norcan Air and TimeAir, were qualified to act as CCPs.

In the earliest stages of planning for the F-28 program, Air Ontario management recognized that they should bring in an individual with F-28 expertise to give line indoctrination, conduct check rides, and generally assist in the commencement of F-28 operations. As early as October 1987, in the first F-28 Project Plan, the following was noted:

> FLIGHT OPERATIONS
>
> ...
>
> 2. Director of Flight Operations will immediately recruit a F28 Specialist on a contract basis to assist and advise Air Ontario on operations of the F28. This specialist would also be available for aircraft acceptance, any airborne training and line indoctrination during our initial start-up.
> 3. Director of Operations would select the Check Pilot for the F28.
> 4. Check Pilot and Coordinator would visit and observe a number of other F28 operations and determine how Air Ontario's F28 operation should be handled. Familiarization of these operations would be useful in minimizing start-up operational problems.
> 5. After discussions with the Director of Operations, the Chief Pilot and the F28 Specialist, the F28 Check Pilot, Manager of Training and Coordinator will negotiate initial training package with selected training facility.
>
> ...
>
> 9&10. F28 Check Pilot will organize ground school and simulator training for management F28 pilots. 4 management pilots will be trained initially.

...

16&17. Chief Pilot and F28 Check Pilot will arrange ground school, simulator and rides for F28 pilots.

18. Line indoctrination of F28 pilots will be done by the F28 Operations Specialist and some contract line indoctrination pilots. The indoctrination will take place in the month prior to start-up, on ferry flights, promotional flights and in the first month of operation right on the line.

19. Some amendments to the flight manual will be done by the Chief Pilot and the F28 Check Pilot in order to bring it into line with an Air Ontario operation. DOT approval will be obtained.

...

21. The Director of Flight Operations will contract some experienced F28 pilots to assist in line indoctrination of pilots during initial start-up.

...

23. The F28 Check Pilot and the F28 Specialist will do the flight testing of both aircraft prior to acceptance.

(Exhibit 799, Air Ontario Inc. F28 Project Plan, 1987)

In order to meet the requirements of Transport Canada's Air Carrier Check Pilot Manual for its F-28 program, Air Ontario needed an experienced pilot qualified on the Fokker F-28 aircraft to conduct line indoctrination training and line checks. Neither of the Air Ontario pilots designated as F-28 captains by Air Ontario in the early stages of planning for the F-28 program, Joseph Deluce or Robert Murray, had any large turbojet aircraft experience and, in particular, previous F-28 experience.

Captain Nyman and Captain Joseph Deluce both testified that, in early December 1987, they were considering at least two individuals to fill the role of F-28 specialist and, in the early stages of operation, to act as the CCP. Although they intended that Captain Murray and Captain Deluce would eventually become the CCPs, neither pilot would have sufficient time on the F-28 to qualify as a CCP before the planned commencement of the F-28 operations. There was a need, then, to contract from outside the air carrier for F-28 expertise.

It is important to note that the F-28 Project Plan was considered at the Air Ontario executive committee, which included Air Canada's shareholder representative, Mr William Rowe, and that the plan was later forwarded to the senior technical officer at Air Canada, Mr Bruce Aubin, for his review. Mr Rowe testified that, from Air Canada's perspective, the planned reliance on outside expertise in the Air Ontario F-28 program was a positive development.

In the fall of 1987 Air Ontario contacted Captain Claude Castonguay, a retired senior pilot from Quebec Air and previously a captain on the

Fokker F-28 aircraft. He was asked to provide his flying expertise and experience on a contract basis, and to act as the carrier check pilot during the initial startup of Air Ontario's F-28 aircraft operations.

Captain Castonguay's résumé indicated a total flight time of 27,461 hours. His flying hours as a captain were in excess of 26,000, and his experience on large turbojet-type aircraft exceeded 11,000 flight hours. Captain Castonguay had approximately 3000 hours on the Boeing 737 aircraft, 1300 hours on the Douglas DC-8 series aircraft, 3000 hours on the Boeing 707 aircraft, 3700 hours on the BAC 1-11 aircraft, and, at the time of his nomination for carrier check pilot, 222 hours on the F-28 Mk1000 aircraft. As well, Captain Castonguay had extensive experience flying a number of piston and turbine propeller-powered aircraft such as the Fokker F-27 and Douglas DC-3. He had held an airline transport pilot licence since 1953, and most of his flying had been with Quebec Air, operating its various aircraft types in Canada, elsewhere in North America, and worldwide. Captain Castonguay had experience in line indoctrination training and had received a course in crew resource management from United Airlines. Without question, he satisfied the regulatory qualification requirements of ANO Series VII, No. 2, for a company check pilot.

Captain Castonguay entered into an employment contract with Air Ontario on January 23, 1988 (Exhibit 836). In the contract, his duties were described as follows: "Duties will include F28 simulator instructor and F28 line indoctrination of Air Ontario pilots. Assistance with preparation of manuals, W [weight] and B [balance] forms and other items connected with the introduction of the F28 will also be considered normal duties." The next day, January 24, 1988, Captain Nyman, as the Air Ontario director of flight operations, forwarded to Transport Canada Air Ontario's formal application for the inclusion of the F-28 on its operating certificate. In that application, Captain Castonguay is nominated as a company check pilot and is described as part of the F-28 implementation team (Exhibit 855).

As part of the application to amend its operating certificate to include the F-28 aircraft, Air Ontario was required to nominate a "carrier check pilot" pursuant to ANO Series VII, No. 2. Having contracted the services of Captain Castonguay, Air Ontario was able to fulfil the Transport Canada nomination requirement, and it submitted to Transport Canada, as part of its aircraft and air carrier operating certificate application, the nomination form signed by Captain Castonguay and Captain Nyman requesting that Captain Castonguay be approved as Air Ontario's check pilot. Included with the nomination form was Captain Castonguay's impressive résumé, a letter of reference from Quebec Air's vice-president of flight operations, a copy of Captain Castonguay's airline transport pilot licence containing an F-28 endorsement, together with a number of appendices relating to the F-28 aircraft and its operation within the Air Ontario system. The application advised Transport Canada that the first two F-28 aircraft captains would be Captain Joseph Deluce and Captain Murray, pending completion of their F-28 aircraft training.

As at the date of the Air Ontario application to amend its operating certificate to include the F-28, namely January 24, 1988, Captain Castonguay was the only Air Ontario pilot who was qualified on the F-28. There is no doubt that Captain Castonguay was hired by Air Ontario to fulfil its particular requirement for a company check pilot.

Transport Canada reviewed this application and granted Air Ontario a temporary amendment to its operating certificate in May 1988 and a permanent amendment in July 1988. Included as part of the granting of an amendment to the operating certificate, Transport Canada granted approval for Captain Castonguay to act as a carrier check pilot. On March 28, 1988, Transport Canada, Ontario Region, forwarded to Air Ontario written notice of Captain Castonguay's appointment.

The Role of Captain Castonguay

Captain Claude Castonguay was in the employ of Air Ontario only from January 24, 1988, until February 29, 1988, when he tendered his resignation. Immediately after being hired, Captain Castonguay proceeded to Charlotte, North Carolina, and completed a brief recurrent ground training course with Piedmont Airlines. Thereafter, he went to Florida to commence aircraft reconversion training on the F-28 flight simulator. Captain Castonguay was given four hours of training and received a pilot proficiency check ride from Transport Canada inspector William McIntyre on February 10, 1988. Captain Castonguay's check report stated "the simulator was well flown. Thorough application and procedures only minor points for debrief" (Exhibit 841). Captain Castonguay spent the next two weeks in Tampa, Florida, learning to operate the flight simulator and observing Captains Deluce, Murray, Hansen, and Morwood conduct their flight simulator training. After observing the simulator training of these pilots, Captain Castonguay was recalled to Toronto by Captain Nyman, Air Ontario's director of flight operations. Captain Castonguay met with Captain Nyman on February 29, 1988, at which time Captain Castonguay resigned from his employment. Captain Castonguay's letter of resignation reads:

> So much as I would like to keep working to establish your FK-28 program, I have concluded that I cannot function in my duties as a check pilot when I do not get the support I need.
>
> I wish everyone good luck in the new venture.
>
> Yours truly,
> Claude Castonguay
>
> (Exhibit 805)

On March 13, 1988, Captain Nyman forwarded a CCP nomination form to Transport Canada nominating Captain Robert Murray as the new CCP. The nomination form disclosed that as of March 11, 1988, although Captain Murray had approximately 15,000 hours of large propeller-driven aircraft flight time, he had acquired only 85 hours on the Fokker F-28 aircraft and 1.2 hours on the Boeing 737 aircraft. The nomination form did not disclose that Air Ontario intended to replace Captain Castonguay with Captain Murray as the F-28 specialist. It should be noted that only a few months earlier, Air Ontario had represented to Transport Canada that it would use a seasoned large turbojet aircraft captain to assist with the implementation of the F-28 program. Captain Nyman testified that he did not advise Transport Canada of Captain Castonguay's departure. He explained as follows:

> A. I did not personally. They would have certainly – we could not introduce the aircraft without a check pilot. We would have had to have a company check pilot of some sort to introduce the aircraft, part again of the regulatory process.
>
> I can't recall exactly how it went. It was very shortly thereafter that the strike occurred. The program, the F-28 program was put, to my knowledge, on hold. It ... wasn't an item of immediate concern.
>
> Whether Transport Canada were advised that day or not, I don't know. I certainly knew that they would have to be advised before the program was implemented.
>
> (Transcript, vol. 107, p. 234)

There is no evidence to indicate that anyone from Air Ontario in fact advised Transport Canada of Captain Castonguay's departure or the reasons for his resignation.

Given the widely recognized necessity of having an experienced large turbojet aircraft specialist to assist with the implementation of the F-28 program, I find it strange that Air Ontario did not replace Captain Castonguay with another individual with similar turbojet aircraft flying experience. Instead, Air Ontario relied on Captain Murray, who had very limited turbojet experience.

At the request of Captain Joseph Deluce, Captain Castonguay rejoined Air Ontario for approximately two weeks in July and August 1988 to assist with line indoctrination and route checks on the F-28. He provided line indoctrination training and route checks for Captain Hansen, Captain Nyman, and First Officer Allan during five separate flights over the course of the two weeks, but had no further involvement with Air Ontario.

Captain Castonguay testified before this Commission about his involvement with Air Ontario, and provided his perceptions and observations relating to flight simulator training conducted by the first four pilots he observed. He also provided his views on the air carrier's flight operating procedures generally. He was a thoughtful and credible witness whose observations regarding the operation of large turbojet-type aircraft in an air carrier environment were most instructive.

Deficiencies Identified by Captain Castonguay

During the course of monitoring the flight simulator training of Captains Deluce, Murray, Hansen, and Morwood, and from conducting line indoctrination flights on Air Ontario pilots in July 1988, Captain Castonguay identified certain deficiencies in Air Ontario's cockpit procedures and flight operations philosophies. These deficiencies were not related to these pilots' flying capabilities, but rather reflected operational procedures which, in his view, are not recommended in jet aircraft operations.

Captain Castonguay was initially requested to assist Air Ontario in preparing manuals and weight and balance forms for the F-28. However, Air Ontario did not use Captain Castonguay's expertise in preparing its own F-28 operating manual and weight and balance forms, and other documents for use in F-28 operations.

Captain Castonguay spent approximately one week observing Captain Joseph Deluce and Captain Murray conduct their initial F-28 flight training in Piedmont's flight simulator. He observed that when these captains occupied the co-pilot's seat and took the role of the pilot-not-flying, they did not assist the pilot flying the aircraft in a meaningful way. It was his perception that these pilots did not practise integrated cockpit procedures. For example, Captains Deluce and Murray used the Piedmont briefing forms, but did not follow the proper procedures for "take-off briefing and approach briefing." In Captain Castonguay's opinion, both of these pilots were using procedures which, although perhaps adequate in flying turboprop-powered aircraft, were not suited to large jet-powered transport-type aircraft. He described the lack of crew concept which he observed as "the old concept: One guy flies and the other one doesn't do anything" (Transcript, vol. 105, p. 95). Captain Castonguay stated that in modern air carrier flying, one pilot carries out flying duties while the other, non-flying pilot does other duties such as reading checklists, handling radios and communications with air traffic control, and assisting the pilot flying wherever possible. Captain Castonguay's observations of lack of crew coordination were, in his words, "too numerous" to comment upon. He testified that neither Captain Deluce nor Captain Murray was receptive to Captain Castonguay's observations, advising him instead that Air Ontario had its own "ways of doing things" (Transcript, vol. 105, p. 99).

While Captain Castonguay observed that Captain Morwood and Captain Hansen both exhibited excellent flying skills, he also observed that, during their simulator training, both men, when acting as pilot-not-flying, did not always assist the pilot flying the aircraft in areas such as cross checks and checklists.

It was Captain Castonguay's opinion that these four pilots, as senior captains with Air Ontario, were not receptive to his observations of lack of proper flight crew coordination. He said he did not have the support of critical members of the F-28 implementation plan, Captains Murray, Deluce, and Nyman, without which he did not feel he could act properly in his capacity as company check pilot. Captain Castonguay also stated that it became clear that Air Ontario did not intend to allow him to continue conducting line indoctrination training, as represented to Transport Canada, but rather relegated him to the role of conducting simulator training.

For approximately two weeks in the months of July and August 1988, Captain Castonguay carried out line indoctrination flights with Captain Hansen, Captain Nyman, and First Officer Allan. Captain Deluce asked him to assist in line indoctrination because Captain Deluce felt himself to be overworked. Captain Castonguay recounted that he advised Captain Nyman during a line indoctrination flight that, in his view, Air Ontario had to change its philosophy and procedures in operating the F-28 aircraft; in his words, "you cannot operate this [F-28] like a turboprop" (Transcript, vol. 105, p. 132). Captain Nyman advised Captain Castonguay that procedures and philosophies could not change, and that "it may take six months, a year before we do any changes" (Transcript, vol. 105, p. 132).

Captain Castonguay testified that Quebec Air used fully qualified dispatchers in their flight watch system and that he was not experienced with a pilot self-dispatch system. He observed that while he saw an Air Ontario flight release used by Air Ontario F-28 crews, he at no time saw an operational flight plan issued to the flight crews. In his opinion, based on his experience and his understanding of the provisions of ANO Series VII, No. 2, he did not consider that the flight release used by Air Ontario for the F-28 met the requirements of an operational flight plan.

Captain Castonguay observed that Air Ontario F-28 pilots did not use an aircraft flight log to record flight leg times and fuel burn, but simply made entries into the aircraft journey logbook at the end of the flight. In his view, it was insufficient simply to use a flight release and an aircraft journey logbook for jet operations. A flight crew should have in their possession an operational flight plan that meets regulatory requirements, and should have an aircraft flight log in which to record during a flight critical items such as flight times, distances, fuel burns, and aircraft weights.

Captain Castonguay recommended that Air Ontario not allow a circling approach procedure to be conducted in the F-28 aircraft for several months, at least until the pilots had more experience flying the aircraft. Neither Quebec Air nor Piedmont Airlines, he said, conducted this low-altitude manoeuvre with jet aircraft. It was Captain Castonguay's opinion that Air Ontario did not have the expertise or the experience with jet aircraft to allow immediate use by its pilots of a circling approach as an approved IFR manoeuvre (Transcript, vol. 105, pp. 176–77). This advice was not accepted by Air Ontario.

Captain Castonguay's Recommendations

Captain Castonguay, at the conclusion of his testimony, provided the following observation:

> Q. ... From your experience of the two stints that you did at Air Ontario ...
>
> Do you think that when Air Ontario put the F-28 into public service, into service as a public carrier, that Air Ontario was ready?
>
> A. They weren't ready.
>
> (Transcript, vol. 105, p. 258)

Because of his extensive aviation experience, Captain Castonguay was asked, when he appeared before this Commission, to offer for the record any recommendations he might have to improve air carrier operations in Canada. He made three recommendations.

First, he testified that individuals with experience on an aircraft type should be hired as necessary on a short-term basis to fly with an air carrier that does not have qualified people. He gave examples of Quebec Air hiring experienced Douglas DC-8 and Boeing 707 pilots to fly as co-pilots with Quebec Air pilots on its DC-8 and 707 aircraft until the Quebec Air captains had adequate experience on the aircraft type.

The testimony of Captain Gert Andersson, a veteran F-28 pilot of the Swedish airline Linjeflyg, supports this view. He testified that when Linjeflyg recently commenced flight operations with new Boeing 737 aircraft, its most experienced flight instructors, all of whom had significant F-28 experience, were sent to Boeing Aircraft for the first conversion course. Route training conducted by Linjeflyg with their Boeing 737s was done using Boeing Aircraft flight instructors as first officers. When it was determined that the Linjeflyg pilots had sufficient flight hours and experience on the new aircraft, they were released to conduct line flying. Captain Andersson testified that as the conversion program matured, there was a "slow rollover program" in order that the Linjeflyg flight instructors could eventually take over the training of Linjeflyg's own pilots (Transcript, vol. 83, p. 179).

Second, with respect to flight crew pairing, Captain Castonguay recommended that one of the flight crew members, either the captain or the first officer, should, when a transition is being made to a new or different aircraft type, have substantial experience on that aircraft type.

Captain Andersson's testimony also supports this recommendation. He stated that it was a "bad combination" to have captains and first officers paired as flight crew on a new aircraft type when they had approximately 100 hours flight time each on that type and where the training pilot responsible for line indoctrination and check rides was almost as inexperienced, with perhaps 200 hours on the aircraft type. Captain Andersson testified that pairing two pilots who are equally inexperienced on an aircraft type could not happen in Linjeflyg. Through the use of computer programming, Linjeflyg ensures that neither an inexperienced captain nor a first officer who has recently completed aircraft type training and route flying will be paired with other inexperienced pilots (Transcript, vol. 83, pp. 158–60).

Third, Captain Castonguay recommended that all air carriers embrace cockpit resource management (CRM) programs. He expressed the view that the benefits of providing CRM courses and training to pilots would, in the long run, pay dividends by promoting harmonious work habits among flight crew members.

Cockpit and Crew Resource Management Training

Experience in the United States and other countries has demonstrated the importance of CRM training in improving the effectiveness of flight crew performance. America West Airlines has extended CRM training in a program called Aircrew Team Dynamics (ATD) to include both flight crew and cabin attendants in total crew coordination concepts. In this section, while I touch briefly on the total crew resource management training concept, I focus primarily on cockpit resource management, which deals with training of the aircraft flight crews.

CRM training originally focused on flight crews, as a result of recommendations made by the United States National Transportation Safety Board (NTSB) following the United Airlines accident in Portland, Oregan, in 1978 where a captain did not listen to "rather mild protestations by a crew member" that the aircraft was running out of fuel (Transcript, vol. 157, p. 158). The aircraft subsequently ran out of fuel and crashed. The recommendations from the NTSB were that interpersonal communication training should be carried out to improve flight crew coordination. Shortly thereafter, organizations such as the United States National Aeronautics and Space Administration (NASA) began research, and major United States air carriers, such as United Airlines, started training flight crews in CRM (Transcript, vol. 157, pp. 158–59).

The United States Federal Aviation Administration (FAA) has encouraged CRM training within the United States air carrier industry and, in December 1989, published an advisory circular, AC 120-51, entitled Cockpit Resource Management Training, to provide guidelines for developing, implementing, and evaluating air carrier CRM training programs. The guidelines for CRM training programs designed by the FAA were intended for use by all air carriers in training their flight crew. Efforts are now under way in the United States to make CRM training mandatory for all air carriers operating under Parts 121 and 135 of the Federal Aviation Regulations. I have attached United States FAA Advisory Circular AC 120-51, Cockpit Resource Management Training, as appendix J to this Report.

The premise of Advisory Circular 120-51, supported by empirical research such as that conducted by Dr Robert Helmreich, who testified before this Commission, is that a single CRM training course in CRM concepts is insufficient to provide long-term changes in crew coordination, attitudes, and operating methods, and that such training must be accompanied by opportunities to practise and reinforce the concepts. The circular suggests that check pilots and pilot instructors are a critical element in the reinforcement of CRM concepts, and should be given special training in the evaluation and reinforcement of resource management issues. This is an extension of their traditional role of teaching and examining individual flight crew member's technical skills and systems knowledge. CRM evaluation and reinforcement should, according to the FAA and experts such as Dr Helmreich, occur during ground school courses, flight simulator training, and line checks.

To its credit, Air Ontario assessed CRM training and, in late 1987, had its chief pilot and chief Dash-8 training pilot attend a CRM course conducted by a major United States air carrier. Captain Nyman, the director of flight operations, testified that in his view CRM is a new concept "certainly to Canada and Canadian carriers" (Transcript, vol. 109, p. 60). After assessing the CRM course attended by two of its supervisory pilots, Air Ontario decided that this type of course "did not fit" Air Ontario's operation, and that it was of limited value and was expensive. Air Ontario pilots also attended and reviewed other CRM courses, including those conducted by Air Canada and a "pilot decision-making course" recommended by Transport Canada. Captain Nyman testified that Air Ontario has adopted and is using the pilot decision-making course and that some Air Ontario pilots have attended the CRM course conducted by Air Canada.

The view expressed by Air Ontario's pilots that some CRM training courses were of limited value to certain air carrier operations is not uncommon. Captain Castonguay testified that the United Airlines course was more suited to three-person than two-person flight crews. Dr

Helmreich agreed in testimony that some CRM training courses might not have been applicable to Air Ontario's flight operations environment. When asked to comment on the position of Captain Nyman and his pilots regarding their experience with CRM training, Dr Helmreich testified as follows:

> A. ... I think it shows a very keen evaluation of the situation by Mr Nyman and his pilots, because what we saw developing in the last few years was airlines moving to recoup some of the substantial expense involved in putting in CRM by selling their courseware to other airlines.
>
> And the first attempts of that were usually off the shelf; in other words, there was kind of an assumption that one size will fit all, buy our course and we will do it. And some of the attempts were fairly depressing. Attempts to take an U.S. course and fit it into Korean culture did not come across very well.
>
> And I think these gentlemen attended at one of the major airline courses which was offered as a turnkey operation and said, gee, this doesn't quite fit the culture we have and it was expensive. I'm familiar with the course. So I think that was a very valid perception.
>
> Q. So you view this as a positive move by Air Ontario?
>
> A. I think looking into it was an extremely positive move and one ... of course, has to feel sorry for them that there wasn't the resources available to customize a course or develop their own or used their parent's course to fit their own culture.
>
> (Transcript, vol. 157, pp. 195–96)

In Dr Helmreich's opinion, CRM or equivalent training cannot alleviate operational problems associated with lack of management stability and consistent direction.[5] CRM training will also only be effective so long as the flight crew have adequate education and have the knowledge available to them to make a reasoned assessment of operational problems.

According to Dr Helmreich, statistical and research data still suggest that certain accidents and incidents involved the failure of flight crews to operate effectively as teams. Many airlines have responded to these findings by increasing the emphasis in flight crew training and checking on the overall flight crew performance, rather than on the individual flight crew member's aircraft handling skills.

In addition to encouraging CRM training through Advisory Circular 120-51, the FAA has made CRM training a requirement for air carriers who elect to operate under the new Special Federal Aviation Regulation

---

[5] Exhibit 1270, "Human Factors Aspects of the Air Ontario's Crash at Dryden," p. 10

(SFAR) 58, the Advanced Qualification Program (AQP). This new program has been developed in the United States by the FAA as an alternative means of qualifying, certifying, and training flight crew members and other flight operations air carrier personnel. A voluntary program, the AQP is intended to enhance flight crew qualifications by the development and use of innovative training and qualification techniques for flight crew and check pilots. Instead of defining specific manoeuvres that must be accomplished by individual flight crew members, the AQP contemplates, in certain instances, training and evaluating a flight crew as a unit, rather than the traditional method of emphasizing individual performance focusing on flying and technical skills. The AQP shifts the emphasis to crew coordination and to management of crew resources, communication, coordination, and decision-making skills.

One of the training approaches to be used for United States air carriers operating under the AQP is Line Oriented Flight Training (LOFT). LOFT involves all of the flight crew operating in a simulator under realistic operating conditions, using flight releases, conducting air traffic communications, and facing a variety of operational problems, including inflight emergencies. In LOFT, flight crews are allowed to experiment with a variety of behaviours and approaches without intervention by the flight instructor and without placing their licences at risk.

The Air Transport Association in the United States, in endorsing the FAA's Advisory Circular 120-51, has suggested that CRM training be extended beyond the aircraft cockpit to include flight attendants, maintenance personnel, and dispatchers. The experience of airlines such as America West Airlines has shown that efforts are being made to extend CRM training to cabin attendant crews. None of the crew on board C-FONF on March 10, 1989, had received cockpit or crew resource management training courses. According to Dr Helmreich, had both the flight attendants and the flight crew completed cockpit and crew resource management training and accepted its concepts, there might have been an exchange of information that would have precluded the last takeoff of C-FONF.

As discussed in chapter 39, Crew Coordination and Passengers' Safety Concerns, the evidence of flight attendants Sonia Hartwick and Labelle-Hellmann suggests, in the view of Dr Helmreich, an environment in Air Ontario that discouraged them from questioning a flight crew or bringing operational issues to their attention. Air Ontario flight attendant training stressed the competence of pilots and fostered a position of total reliance on the flight crew with regard to operational decisions. An example of this discouragement of crew communication was the failure of the flight crew of an Air Ontario HS-748 aircraft to respond to Mrs Labelle-Hellmann's concerns regarding contamination on the aircraft's wings prior to takeoff from Pearson International Airport. There was also a failure of the flight attendants to relay passenger concerns to the flight crew regarding contamination on the wings of C-FONF prior to its last takeoff. Dr Helmreich explained that the concepts taught in crew resource management training courses stress the importance of unfettered information exchange between the flight crew and the cabin attendant crew (Exhibit 1270, p. 14). However, cockpit and crew resource management training can be effective only when it is based on accurate technical information and knowledge.

In light of the possible benefits of CRM training, it is my opinion that concepts described in the United States FAA Advisory Circular 120-51, which have already been incorporated into training programs by many United States air carriers and by some Canadian air carriers, should be promoted by Transport Canada and adopted by all Canadian air carriers.

New programs such as the Advanced Qualification Program should be monitored and evaluated by Transport Canada and, if found suitable, should be adopted as an alternate method of training and evaluating pilots of air carriers operating large aircraft pursuant to ANO Series VII, No. 2. Specific crew resource management training courses expanded to include both flight crew and flight attendants should also be considered. Because Transport Canada air carrier inspectors and delegated company check pilots are critical in evaluating and reinforcing CRM concepts, they should receive special instruction in resource management training issues.

Cabin Attendant Training

ANO Series VII, No. 1, subsection 45(1)(b), requires an air carrier to provide for each crew member individual instruction in the location and operation of all emergency equipment carried on board an aircraft. Parts of section 45 that require the participation of cabin (flight) attendants during emergency procedures read as follows:

> 45. (1) Emergency procedure training provided by an air carrier in respect of an aeroplane shall include, for each crew member, individual instruction in the location of and operation of all emergency equipment carried and instruction, including co-ordination among crew members, in the emergency procedures for
>
> ...
>
> (b) handling of
> (i) emergency decompression,
> (ii) fire in the air or on the ground,
> (iii) ditching, and
> (iv) evacuation; and ...

Having regard to the evidence, it is indisputable that the primary role of a flight attendant is to ensure cabin and passenger safety. This concept, which was rigorously advanced by flight attendant Sonia Hartwick and the representatives of the flight attendants' union, was endorsed by senior Transport Canada management-witnesses and was fully supported by counsel on behalf of the Canadian Air Line Pilots Association (CALPA), who stated: "I would first like to say that CALPA fully supports the concept that Mrs Hartwick has expressed that a flight attendant's primary role is safety" (Transcript, vol. 12, p. 99).

Air Ontario's Flight Attendant Manual sets out in section 2 the requirements for the initial training of flight attendants. Subsection 2.2(c) states as follows:

> During training, ALL participants will be required to have practical use of:
> a. Oxygen bottles & systems as carried in the fleet
> b. Fire Extinguishers as carried in the fleet
> c. Exit operations – each aircraft type
> d. Evacuation drills
> e. Shouted commands
> f. Observation/operation of an evacuation slide & participate in evacuation drill down a slide on the F28 or the CV580
> g. Operation of an evacuation slide & participate in at least one evacuation drill on the HS-748 aircraft
> h. Pilot incapacitation drill
>
> Following completion of successful training, each candidate will then be assigned to line indoctrination flights.

Initial Training: Flight Attendant Hartwick

Flight attendant Sonia Hartwick testified that her initial flight attendant training with Air Ontario Limited spanned a six- or seven-day period. Following an employment screening interview, conducted on September 14, 1986, in Sudbury, Ontario, she reported to London, Ontario, on the next day for training. Ten days later she took her indoctrination flight on the Convair 580 as a flight attendant and completed approximately seven more flights on the Convair 580 as one of the working flight attendants..

The evidence indicates that the theoretical portion of Mrs Hartwick's initial flight attendant ground school training was thorough, and examinations written by her on safety procedures, dangerous goods, and flight attendant responsibilities, as well as the aircraft pre-flight examination, show that these matters were well covered. However, when asked what stood out in her mind about her initial training, Mrs Hartwick testified that "there was indeed some emergency procedures" training conducted during the course, but, in her opinion, "it was lacking."

Recurrent Training: Flight Attendant Hartwick

Examination records of Mrs Hartwick for 1987 and 1988 also indicate that the theoretical and written portion of the recurrent flight attendant ground school training was thorough. However, in sharp contrast to her initial flight attendant training, Mrs Hartwick was laudatory of the recurrent training she received from Air Ontario in October 1988 under the direction of Mr Roger Whittle with respect to the Convair 580 and the Dash-8 aircraft. This recurrent training involved hands-on training in simulated emergency situations. Mrs Hartwick stated that this recurrent training was very different from her initial training in 1986 and she described it as "exceptional training." She stated that having gone through the recurrent training in October 1988, she "felt like she was qualified" (Transcript, vol. 10, pp. 53–55).

Practical Training: Flight Attendant Hartwick

The term "practical use" as it appears in subsection 2.2(c) of the Air Ontario Flight Attendant Manual appears to be interchangeable with the term "hands-on." Air Ontario's flight attendant recurrent training program in October 1988, however, did not include any hands-on training on the F-28 aircraft, which had been in service since June 1988.

In February 1988 Mrs Hartwick took ground school training on equipment and procedures on the HS-748 and received hands-on training on the aircraft in March 1988 in Toronto. In June 1988 she expressed to Mr Bryan Pettman, who was at the time in charge of the in-flight service department at Air Ontario, her concern that she did not feel she was qualified and competent to work on the HS-748. It was her view that the actual hands-on training, which she took with a group of four or five other flight attendants, was not thorough, lasting only several minutes. In her memorandum of June 19, 1988, to Mr Pettman, Mrs Hartwick indicated that she was not alone in her concerns: "recently there have been several occasions where fellow YXU [London, Ontario] F/As [flight attendants] have flown the Hawker [HS-748], and who also feel as unqualified as I do."[6]

Mr Pettman, in a memorandum dated July 8, 1988, addressed the flight attendants' concerns outlined by Mrs Hartwick. He expressed the opinion that "they had received sufficient training to fully qualify them" on both the Convair 580 and the Dash-8 and that it should "not be

---

[6] Exhibit 121, Memorandum from Sonia Hartwick to Bryan Pettman, dated June 29, 1988

difficult to grasp a third aircraft after a few days' training." He indicated that the manuals contained all the resources needed to refresh them on equipment and that he was available to answer questions. He offered to fly with them until they felt comfortable on the equipment.

When questioned during hearings about specific problems she had regarding the practical hands-on training provided by her employer, Mrs Hartwick testified that, among other things, her major concern was the lack of hands-on training in assembling the emergency slide:

> A. With the practical hands-on training, I felt ... that not enough things were done ... we were only able to watch a girl take a light off – an emergency light because they didn't want to have to replace too many seals.
>
> I did open the cargo door in the washroom area and the main entry door a couple of times, but I was not able to actually assemble the emergency slide which is located in the rear of the aircraft ...
>
> I think ... that is more or less your most important thing on the aircraft would be an emergency slide and how to actually assemble it and this was not done with myself and, therefore, I did not feel that I was properly qualified unless I actually did this a couple of times and got the feel for actually assembling the slide, an emergency slide that is.
>
> (Transcript, vol. 10, pp. 86–87)

Flight attendant training should recognize the need for practical hands-on training in the operation of aircraft doors, emergency exits, evacuation chutes, and other emergency equipment in the course of a simulation of the various adverse conditions that might be encountered in an actual emergency. Such training should also include practical examinations in which flight attendant candidates, after initial training, and qualified flight attendants, after recurrent training, are required to demonstrate their capability of consistently carrying out their emergency-related tasks properly and within the time allotted for the evacuation of an aircraft.

While the evidence reveals that the theoretical training and examinations given by Air Ontario to the flight attendants were thorough, and while the flight attendant training did include some hands-on training, it was Mrs Hartwick's view that during her initial training on the Convair 580 and her conversion training on the HS-748, such hands-on training was not sufficiently extensive and, in her mind, was therefore not acceptable.

Mrs Hartwick testified that the only hands-on training she received from Air Ontario on the F-28 aircraft was in the opening of the main entry door. This was obviously a function that would have to be learned apart from cabin safety. She received no hands-on training with respect to the operation of the over-wing emergency exit windows and the galley service exit door on the F-28, nor on the location of the over-wing emergency window exit rope.

Flight attendant Hartwick described her training on the F-28 aircraft as simply a line indoctrination on a return flight, Toronto–Sault Ste Marie–Toronto, in October 1988, with passengers on board. When questioned as to the particulars of her Air Ontario training for the purpose of qualifying on the F-28, she stated:

> A. I did a line indoctrination sometime in October of '88, and my line indoctrination flights consisted of two flights, Toronto–Sault Ste Marie and return to Toronto.
>
> And, at that time, the purser who was in charge, I was just boarding passengers, I opened up the door, I closed the main entry door, and I just continued to serve passengers as I normally would on any other revenue flight.
>
> (Transcript, vol. 11, p. 178)

On her own initiative, Mrs Hartwick posed a "quiz question" to several Air Ontario F-28 flight attendants regarding their hands-on training on the F-28 and their knowledge of the location of the evacuation rope for the over-wing exit windows:

> A. ... So, it is good to actually try these things. Because I spoke to flight attendants and said to them, you know, did you have hands-on on the F-28 and many of them have said, No. And then I just gave them a quiz question on my own. Do you know where the rope is by the windows on the F-28? And a few of them went to say, yeah, it is in the frame.
>
> And I said, No, it is not. It is actually in the overhead rack or the overhead where your lights are and things ...
>
> So practical use and hands-on, in my opinion, is very important.
>
> (Transcript, vol. 11, pp. 131–32)

During her testimony, Mrs Hartwick commented on her perception as to why she did not receive hands-on training:

> A. Again, the only observation I could think of is that the F-28 was too busy with revenue flights and, therefore, there was no actual ground school time for it to actually be on the ground for us to have practical training on it.
>
> (Transcript, vol. 11, p. 132)

When questioned about the term "practical use" as found in subsection 2.2 of the Air Ontario Flight Attendant Manual, Mrs Hartwick stated:

> A. Well, practical use, again, in my view, is hands-on training on the aircraft itself, and, again, I [did] not have hands-on training on the F-28.
>
> (Transcript, vol. 11, p. 145)

I agree with Mrs Hartwick's view that adequate hands-on training on specific aircraft types is an essential element of cabin crew training.

Flight Attendant Licensing: CUPE Proposal

In its formal submission to this Inquiry, the Airline Division of the Canadian Union of Public Employees (CUPE), representing flight attendants, proposed that this Commission recommend that flight attendants be licensed by Transport Canada. Although I was presented with a written brief and oral argument by counsel on behalf of the flight attendants' union in support of the union's position, its representatives declined the opportunity offered to them to call witnesses before the Inquiry. Since I have not heard any witness testimony regarding this proposal, I am not in a position to make a recommendation with respect to this issue.

Ground-Handling Personnel Training

It is essential that ground handlers and fuellers be properly trained to carry out their duties and responsibilities in support of the flight crew.

Regulatory Requirements and Guidelines

There are no Canadian regulatory requirements pertaining to training of personnel involved in the ground-handling, fuelling, or de-icing of aircraft. With respect to fuelling operations, however, Transport Canada has policy documents, which the Dryden Flight Centre was required to follow. As well, ESSO issues guidelines for the handling of its equipment and products (see chapter 9, Crash, Fire-fighting, and Rescue Services).

While there are no Transport Canada policies respecting training of ground handlers, it is, nevertheless, an area subject to inspection. Transport Canada's Air Carrier Inspector (large and small aeroplanes) manuals include under the heading "Aircraft Servicing and Ramp Safety" the following procedure to be followed by inspectors as part of in-flight inspection:

> Observe refuelling procedures and the method of determining fuel quantities. Check loading methods and security, the use of ground handling equipment and safety precautions exercised in its use,

> aircraft parking and the control of passenger traffic on the ramp. Evaluate the fire precautions and the use of the aircraft electrical and heating systems during refuelling, use of cabin "no smoking" signs, if there is a cabin attendant on board and if there are ramps at the doors of the aircraft.
>
> (Exhibits 960 and 961)

In his testimony before the Commission, Mr Martin Brayman, superintendent of air carrier inspection (large aeroplanes), Ontario Region, reiterated that inspectors were to monitor ground handlers as part of their in-flight inspections, while the airworthiness group were responsible for monitoring fuelling operations.

With respect to the Dryden Flight Centre, however, it appears that neither ground-handling nor fuelling operations of Air Ontario's F-28 aircraft were monitored by Transport Canada. Mr Randy Pitcher testified that in his capacity as lead inspector of Air Ontario's F-28 operation, he was in Dryden only on one brief occasion and did not inspect the facilities in place for servicing the F-28. Contrary to Mr Brayman's understanding, airworthiness inspector Ole Nielsen indicated that he knew nothing whatsoever about an airworthiness responsibility to monitor fuellers.

As discussed in chapter 15, F-28 Program: Planning, Air Ontario was required to amend its operating certificate prior to commencement of its F-28 operation. While there is no precondition to amendment of the operating certificate that ground handlers or fuellers meet a particular standard, Air Ontario included the following representation respecting refuelling facilities in its application to Transport Canada to amend its operating certificate:

> N) The company has determined that existing terminal facilities, buildings, lighting, ground support, power units, refuelling facilities, communications and navigation aids, dispatch, weather service and ATC are adequate for the proposed operations. However, the company may require certain improvements as F-28 operations develop.
>
> (Exhibit 855)

Dryden Flight Centre Training

Mr Lawrence Beeler was the president of Dryden Flight Centre, and Mr Vaughan Cochrane was responsible for day-to-day management. Both Mr Beeler and Mr Cochrane, along with Dryden Flight Centre employee Mr Jerry Fillier, were involved in fuel and baggage handling.

In the December 7, 1987, agreement between Dryden Flight Centre and Air Ontario, Air Ontario assumed the responsibility of training Dryden Flight Centre's ramp and ticket agents. The agreement contained the following clause with respect to training: "Air Ontario will provide instructors and all material for the initial ramp and ticket agent training. The parties will agree to the manner of any subsequent or recurrent training" (Exhibit 177, para. 5).

In November 1987, in preparation for Air Ontario's Dash-8 service through Dryden and in expectation of concluding the December 1987 agreement, Air Ontario provided Mr Beeler and Mr Cochrane with a day-and-a-half of hands-on training on the Dash-8 series 100 aircraft at Sault Ste Marie. Despite intentions to the contrary, Dryden Flight Centre personnel never received ground-handling or fuelling training on the F-28 aircraft. In a letter dated March 8, 1988, to Mr Cochrane regarding arrangements for Air Ontario's new F-28 service, Mr Scott Tapson, Air Ontario's manager of airport services, stated that "Ground handling training for the F-28 will be arranged in the near future. Rod Coates will be contacting you with these arrangements" (Exhibit 392). On March 16, 1988, Mr Tapson again wrote to Mr Cochrane and, in addition to providing copies of the Fokker F-28 Ground Handling and Service Data Manual and the ESSO Aviation Fuelling Guide, he stated: "Formal training on the aircraft will be planned in the future. Bruce Maxim, at our London head office, will be coordinating this training" (Exhibit 398).

The evidence of Mr Cochrane and from Air Ontario's Mr Rodney Coates is in conflict as to why this planned training session never came to pass. Mr Cochrane testified that he could not recall being contacted by a representative of Air Ontario to schedule the training sessions referred to in the correspondence of March 8 and March 16, 1988. Mr Rodney Coates, in contrast, testified that he did arrange training for ground handlers from all stations through which the F-28 was to operate, including Dryden. He stated that he spoke to Mr Cochrane about the training:

> A. I explained to him when the course was, where the course was and which stations would be attending, and he declined to send any people to the course.
> Q. Did he give a reason why he was not going to send someone to the course?
> A. Yes, that being that, for a number of years, another airline had been operating an F-28 into and out of Dryden and that he felt he had sufficient experience and didn't need to attend the course.
> Q. So was it your understanding that Mr Cochrane had been handling the F-28 over an extended period of time?
> A. Well, I wouldn't say that. I would say that I felt that he had the experience. I don't know if in fact he was handling the F-28, but ... I felt that, from the conversation, that he had enough experience, and that satisfied me.
>
> (Transcript, vol. 57, pp. 19–20)

Dryden Flight Centre was the only ground-handling agent not represented at Air Ontario's F-28 training session, and Messrs Cochrane, Beeler, and Fillier received no formal training on the F-28.

There can be little doubt that the training course would have been worthwhile. Mr Cochrane agreed in his testimony before the Commission that, although the Dryden Flight Centre had received from Air Ontario copies of the Fokker ground-handling training manual and the ESSO refuelling publications, they were technical documents that would be understood best in the context of a training session. Furthermore, the testimony of Dryden Flight Centre personnel revealed gaps in their knowledge of certain refuelling safety procedures. Mr Cochrane testified as follows:

> Q. ... I questioned Mr Fillier about his knowledge concerning the proper technique and what instructions he had been given, and, under oath, he told me, for instance, that no one had suggested to him that, before doing a fuelling, the tank vent openings should be unobstructed, nobody pointed the tank vents out to him and so on.
>
> Does that testimony accord with your own recollection of his training?
>
> A. I would probably agree with that, yes.
>
> Q. ... And, also, he didn't know where the landing gear static ground wires were, so he couldn't check them for proper contact; is that the kind of thing that you even knew?
>
> A. No, I didn't – that's one I didn't know either.
>
> Q. Did you know, for instance, that the Fokker manual, at least, recommends that, before fueling is begun, one of the things that should be done is to check that the main gear inboard doors are closed; did you know –
>
> A. Yes, I knew about that one.
>
> Q. Now, Mr Fillier, however, testified that no one had instructed him in that regard. Does that testimony accord with your own recollection?
>
> A. That would be –
>
> Q. ... So these are all instances of – or these are all examples of how a proper training session on fueling that plane would have been of assistance to you and your employees; is that right?
>
> A. Agreed.
>
> (Transcript, vol. 54, p. 8)

It is unfortunate that Air Ontario did not insist that the Dryden Flight Centre personnel attend the training session. Although Mr Coates had no operational background in aviation, he accepted Mr Cochrane's position that, on the basis of the Dryden Flight Centre's track record and Mr Cochrane's own F-28 experience, training was not required. In fact, contrary to Mr Coates's understanding, Mr Cochrane's F-28 experience was extremely limited. Mr Cochrane's own testimony revealed that he had observed only one short turnaround of an F-28 in 1987.

Mr Coates testified that, as Air Ontario's regional manager for customer service, his concern was with on-time performance and passenger service. He was not responsible for ground-handler training or the operational and safety aspects of ground handling, such as marshalling, fuelling, de-icing, and cleaning of aircraft, and he was not certain who, within his company, was responsible. In fact, according to Mr Coates, in the absence of an internal inspection system, the only means by which Air Ontario could ensure the competence of its ground handlers would be reports from flight crews to system operations Control. As the following testimony of Air Ontario pilot, Captain Keith Fox, reveals, flight crews are themselves not trained to understand or monitor all aspects of a ground handler's or fueller's duties:

> Q. ... Given the fact that you used Jet B and that Jet B has a flash point something below zero, I believe, were you familiar with all of the grounding and bonding techniques that Fokker recommended for refueling the F-28 or is that something that you relied upon the ground crew to be familiar with?
>
> A. I was not familiar with it. I would rely upon the ground crew.
>
> (Transcript, vol. 51, p. 259)

When an air carrier contracts for ground-handling and fuelling services, it should satisfy itself that the contractor is competent. This can be achieved only by thorough training and purposeful monitoring by individuals with relevant operational knowledge and experience. As I have outlined in chapters 21 and 9 on hot refuelling and crash, fire-fighting, and rescue, many ground-handling activities, particularly aircraft refuelling, are potentially dangerous. The travelling public requires the assurance that ramp activities are conducted by well-trained, competent individuals operating properly maintained equipment.

I also find it difficult to comprehend why Mr Cochrane declined the training course. Mr Paul Lefebvre, an Air Canada station attendant who appeared before me in the de-icing phase of the hearings of this Commission, testified that Air Canada's station attendants receive a five-week training course, including separate instruction on the different aircraft types, followed by a six-month period of supervision and probation. Dryden Flight Centre was an agent for Air Ontario, whose training expenses would have been covered by Air Ontario. I can therefore see no acceptable reason why Dryden Flight Centre personnel did not take the ground-handling training course for Air Ontario's F-28 aircraft.

Aircraft Fuelling: Training

Pursuant to an ESSO aviation dealer agreement dated August 1, 1985, which the Dryden Flight Centre entered into with Imperial Oil, the Dryden Flight Centre undertook to "properly train all personnel involved in loading, handling and delivery of aviation petroleum products" (Exhibit 170, para. 11).

Mr Beeler testified that although he had no training or prior experience fuelling an F-28, he reviewed the Fokker F-28 Fuelling Procedures Manual, and fuelled the F-28 aircraft with his employee, Mr Fillier, on a couple of occasions, until he was satisfied that Mr Fillier understood the fuelling system. Also, as previously noted, Mr Cochrane's only previous experience on F-28 fuelling procedures occurred when he observed the fuelling of an F-28 in 1987.

The two manuals supplied by Air Ontario do not refer to the issue of hot refuelling. The Fokker F-28 Fuelling Procedures Manual and the Fokker F-28 Ground Handling and Service Data Manual, which for the most part are identical, state that pressure fuelling while an engine or APU is running is acceptable if certain precautions are followed. There is no mention of passenger protection in the list of precautions (Exhibits 180 and 181, section 4.1.9). The ESSO Aviation Operations Standards Manual provides detailed instruction on fuelling with one engine running.

I heard no evidence that Air Ontario was involved in any way in training fuelling personnel at Dryden Municipal Airport, nor did the Dryden Flight Centre request any such assistance. As discussed in chapter 21, F-28 Program: Hot Refuelling and Ground De-icing, there is also no evidence that Air Ontario trained its flight crews in fuelling procedures to assist them in monitoring off-line fuelling effectively.

Similarly, notwithstanding the cited excerpt from Transport Canada's Air Carrier Inspector (large and small aeroplanes) manuals, Mr Beeler testified that the Dryden Flight Centre's refuelling operation had never been subject to a Transport Canada inspection. It is my strongly held view that Transport Canada must take seriously the guidelines set out in its own publication and routinely inspect the training and activities of aircraft fuellers and ground handlers.

Findings

- The Piedmont Airlines and USAir ground school course and instruction provided to Air Ontario F-28 pilot trainees were generally thorough and comprehensive in form and content.

- Training and instruction given and received on an aircraft flight simulator is more comprehensive and thorough than training and instruction given and received on an aircraft, because an aircraft flight simulator is capable of simulating abnormal situations and dangerous flight manoeuvres that are not possible to perform in an aircraft without exposing the aircraft and occupants to unacceptably high risk.

- Captain Morwood received his F-28 aircraft flight training primarily on an F-28 flight simulator, accumulating 20 hours prior to taking a pilot proficiency check ride.

- First Officer Mills received all of his aircraft flight training on an F-28 aircraft, accumulating approximately 8.5 hours prior to receiving his pilot proficiency check ride.

- Captain Morwood received 27.5 hours of line indoctrination before commencing his duties as a line captain.

- First Officer Mills received approximately 20 hours of line indoctrination before he began flying as a line first officer on the F-28.

- As a result of receiving his F-28 training in an aircraft flight simulator, Captain Morwood probably received better and more thorough training and instruction than First Officer Mills.

- Captain Morwood commenced line flying as a captain on the F-28 aircraft with 29 hours in the F-28 aircraft and 30 hours simulator time.

- First Officer Mills commenced line flying as a first officer on the F-28 aircraft with approximately 30 hours of flight time, 9.5 hours of which were acquired during aircraft flight training.

- Both Captain Morwood and First Officer Mills completed the pilot ground training, pilot flight training, and line indoctrination training requirements for the F-28 aircraft in accordance with Canadian regulations and Air Navigation Orders.

- Although both Captain Morwood and First Officer Mills were qualified to operate and carry out flight crew duties in the F-28 aircraft in accordance with Canadian regulations and Air Navigation Orders, Air Ontario did not have a policy in place to prevent the pairing of both a low time-on-type captain and first officer.

- Air Ontario's F-28 Project Plan approved by the executive committee of Air Ontario and by Air Canada contemplated that Air Ontario would have an F-28 specialist hired on a contract basis to assist and advise Air Ontario on the operations of the F-28.

- The F-28 specialist was to be available for aircraft acceptance and for airborne training and line indoctrination during initial startup of the project.

- Captain Claude Castonguay was hired by Air Ontario's director of operations to fill the F-28 specialist function and to conduct F-28 simulator and line indoctrination of Air Ontario pilots.

- Captain Castonguay has over 27,000 flight hours, 11,000 of which are on large turbojet-type aircraft. He is experienced in operating large turbojet-type aircraft in an air carrier operational environment, and was fully qualified to act as Air Ontario's company check pilot.

- Captain Castonguay was also hired by Air Ontario to fulfil its requirement to have, during the initial implementation of the F-28 aircraft into Air Ontario service, a qualified company check pilot for the F-28 aircraft acceptable to Transport Canada.

- Based on the submissions made to it by Air Ontario and on the flying experience and qualifications of Captain Castonguay, Transport Canada granted approval for Captain Castonguay to act as Air Ontario's company check pilot for the F-28 aircraft.

- Captain Castonguay was employed by Air Ontario for approximately one month, from January 24, 1988, until February 29, 1988, at which time he tendered his resignation. He was later rehired by Air Ontario for a two-week period, in July 1988, to conduct F-28 line indoctrination.

- Air Ontario failed to advise Transport Canada of the resignation of Captain Castonguay and its resultant lack of a qualified F-28 company check pilot during a critical phase of its F-28 implementation program.

- Air Ontario should have replaced Captain Castonguay as its F-28 company check pilot with an experienced and qualified F-28 pilot during a critical phase of its F-28 implementation program.

- Transport Canada, because of its failure to monitor Air Ontario's F-28 implementation program, was unaware of the fact that, after Captain

Castonguay's resignation, Air Ontario did not have an experienced and qualified F-28 company check pilot between February 24, 1988, and March 13, 1988.

- During the time that Captain Castonguay was employed by Air Ontario as a company check pilot, certain deficiencies existed in F-28 flight crew cockpit and flight operations procedures, including:
  - there was no proper crew coordination concept;
  - no operational flight plan was issued to or used by the flight crews on the F-28 aircraft;
  - no aircraft flight log was used by F-28 flight crews to keep track of flight times, distances, fuel burns, and aircraft weights;
  - Air Ontario allowed circling-approach procedures to be conducted in the operation of the F-28 aircraft before the pilots had sufficient flight experience on the aircraft.

- The operation of F-28 aircraft with contaminated wings was dealt with thoroughly in the ground school instruction and training provided by Piedmont Airlines and USAir. The instructors cautioned the pilot-trainees against operating an F-28 aircraft with contaminated lifting surfaces in all flight modes including takeoff.

- All Air Ontario pilots who took the Piedmont/USAir ground school training course, including Captain George Morwood, received thorough instruction, warning, and caution that it was of utmost importance that the F-28 be operated at all times with a clean, uncontaminated wing.

- Most of the Air Ontario pilots who testified had a general understanding of some form of the cold-soaking phenomenon, but appear to have learned about its effect largely through operational experience.

- At the time of the crash, the A.I.P. Canada: Aeronautical Information Publication, which is circulated to all Canadian licensed pilots, contained a caution regarding taking off with contamination on the lifting surfaces, but failed to deal with the phenomenon of cold-soaked wings, cold-soaked fuel, and its potential to cause contamination to adhere to wings.

- While both Captain Morwood and First Officer Mills may have had some knowledge and experience regarding wing cold soaking, they may not have been sufficiently aware of or knowledgeable about the insidious nature of the cold-soaking phenomenon and, in particular, the effect of cold fuel in the wing tanks in contributing to or causing moisture to adhere to wing surfaces adjacent to wing tanks.

- A systematic and comprehensive discussion of the cold-soaking phenomenon does not exist in the manuals reviewed by this Commission, such as manufacturers' aircraft flight manuals, air carriers' aircraft operating manuals, and air carriers' flight operations manuals, which are normally referred to and used by flight crews on a day-to-day basis.

- Air Ontario pilots who took the Piedmont/USAir F-28 ground school training course, including Captain Morwood and First Officer Mills, received instruction in the use of the slush-correction chart for takeoff in runway contamination contained in the Piedmont and USAir F-28 operations manuals.

- Some Air Ontario pilots also received some instruction in the use of the runway slush-correction graph and chart contained in the Fokker F-28 Flight Handbook.

- Although Piedmont ground school instructors may have demonstrated to Air Ontario student pilots how to use the Fokker F-28 Flight Handbook slush-correction charts, neither Piedmont Airlines nor USAir used the Fokker chart for operational use.

- Although there was no advice or instruction by Air Ontario management to its F-28 pilots that they should use only the slush-correction chart contained in the Piedmont and USAir operations manuals, there was a general consensus among Air Ontario F-28 pilots that, because they were to use the Piedmont Airlines F-28 Operations Manual for purposes of operating the aircraft, they must also comply with the slush-correction charts contained therein.

- Both Captain Morwood and First Officer Mills should have been aware of the restrictive weight limitations imposed on the aircraft by the slush-correction chart contained in the Piedmont and USAir operations manuals.

- There are no Canadian regulatory requirements pertaining to the training of personnel involved in the ground handling, fuelling, or de-icing of aircraft, and Transport Canada has no stated policy with respect to the training of ground handlers and de-icing personnel.

- Although Air Ontario and Dryden Flight Centre contemplated the provision of instructors and materials to train ground-handling personnel, no such training was provided by Air Ontario to Dryden Flight Centre regarding such ground-handling training.

- Transport Canada air carrier inspectors, as part of an inflight inspection, are required to inspect aircraft servicing and ramp safety, including fuelling procedures, baggage and passenger loading methods, and safety and fire precautions.

- Transport Canada policy documents state that aviation regulation inspectors are to inspect and monitor ground handlers, and that airworthiness inspectors are responsible for monitoring fuelling operations.

- With respect to the Dryden Flight Centre, neither its ground-handling procedures nor fuelling operations with respect to Air Ontario's F-28 aircraft were monitored by Transport Canada at the Dryden Municipal Airport.

- The initial training provided to flight attendant Sonia Hartwick by Air Ontario in 1986, while reasonably thorough, did not include adequate practical (hands-on) emergency procedures training.

- The recurrent flight attendant training provided by Air Ontario to Mrs Hartwick in October 1988 did involve hands-on training in simulated emergency situations and was far superior to the initial training previously provided. This recurrent training, however, did not involve the F-28 aircraft.

- Air Ontario failed to provide practical (hands-on) emergency procedure training to flight attendant Sonia Hartwick, and probably to other F-28 flight attendants, with respect to the F-28 aircraft.

RECOMMENDATIONS

It is recommended:

MCR 67 That Transport Canada ensure that a systematic and comprehensive discussion of cold soaking be inserted in air carriers' flight operations manuals and/or aircraft operating manuals and in Transport Canada publications such as the Aeronautical Information Publication, to make all pilots and aviation operational personnel aware of the insidious nature of the cold-soaking phenomenon and the various factors that may cause contamination to adhere to aircraft lifting surfaces.

MCR 68 That Transport Canada ensure that all air carrier pilot flight training be conducted in aircraft flight simulators to the maximum extent possible.

MCR 69 That Transport Canada ensure that an air carrier, if it does not have pilots with the requisite and necessary flight experience on the aircraft when it introduces a new aircraft type, provide sufficient non-revenue flying time for its pilots to enable them to gain the requisite experience.

MCR 70 That Transport Canada encourage air carriers lacking pilots with sufficient experience on a new aircraft type to provide highly experienced pilots from outside the air carrier to assist in training the air carrier's pilots and to fly with them until they have gained an adequate level of flight experience on the new aircraft type.

MCR 71 That Transport Canada proffer for enactment legislation with respect to flight crew pairing, requiring that one of the flight crew members, either the pilot-in-command or the first officer, have substantial flight experience on the aircraft type.

MCR 72 That Transport Canada routinely inspect the activities of aircraft fuellers and ground-handling personnel, to ensure that they are properly performing their duties and to ensure that these personnel have received adequate training.

MCR 73 That Transport Canada ensure that all ground-handling personnel, whether employed by the air carrier or by a contract agent, receive ground-handling training on all aircraft types that they will be required to handle. If personnel are required to refuel aircraft, they should also have knowledge of proper fuelling procedures.

MCR 74 That Transport Canada proffer for enactment regulations setting the training and competency requirements for cabin attendants.

MCR 75 That Transport Canada monitor and periodically audit the cabin attendant training program of all air carriers to ensure that such training meets the standards set.

21 THE F-28 PROGRAM: OPERATIONAL PRACTICES – HOT REFUELLING AND AIRCRAFT GROUND DE-ICING

Hot Refuelling

Aircraft refuelling is always potentially dangerous, and it is essential that there be coordination of the activities of all personnel involved – the flight crew, the flight (cabin) attendants, and ground-handling personnel.

In the early phases of this Inquiry, I heard evidence regarding the refuelling of the F-28 aircraft C-FONF in Dryden, on March 10, 1989, with its right main engine running while passengers were on board.

In my *Interim Report* of November 30, 1989, I examined this issue and recommended that:

> The Department of Transport prohibit the refuelling of an aircraft with an engine operating when passengers are on board, boarding, or deplaning.[1] (p. 23)

In response to this recommendation, the minister of transport took immediate action and took steps to give effect to the recommendation by way of regulation. On August 28, 1990, section 540 of the Air Regulations was amended to read:

> 540.1 No operator of an aircraft shall permit the fuelling of an aircraft while an engine used for the propulsion of the aircraft is operating if passengers are on board or are entering or leaving the aircraft.[2]

---

[1] The recommendations from my *Interim Report*, 1989, and my *Second Interim Report*, 1990, are reprinted in Part Nine of this Report, Consolidated Recommendations. This recommendation is numbered MCR 1.

[2] It is to be noted that the minister of transport gave immediate notice to air carriers of the intended regulatory change and requested that carriers voluntarily comply with the intent of the recommendation until the regulation was ultimately amended.

Subsequent to my first *Interim Report,* I heard additional evidence regarding the hot refuelling of aircraft C-FONF on March 10, 1989, and I think it appropriate to address further this issue in the context of the Commission's system investigation of the crash of C-FONF on March 10, 1989.

Air Ontario Policy

Transport Canada had no policy on hot refuelling as of March 10, 1989. Similarly, Air Ontario did not have a policy set out in its Flight Operations Manual (FOM) that would have precluded a hot refuelling with passengers on board; nor was there an established flight operations policy regarding procedures or guidelines to be followed in the event of a hot refuelling.[3]

The Air Ontario FOM, carried by all pilots of the carrier, contained a section entitled "Aircraft Fuelling Procedures." That section, however, makes no mention of refuelling with an aircraft engine running, while clearly endorsing refuelling with no engines running and with passengers on board.

7.19 <u>AIRCRAFT FUELLING PROCEDURES</u>

(a) <u>On-Line Fuelling</u> – It is the responsibility of Air Ontario to be satisfied that refueling contractors are properly qualified and trained in refueling procedures and kept advised of any changes thereto. The Captain will not accept any aircraft which has not been fueled to the required minimum for flight dispatch. Actual departure fuel quantity will be shown in the weight and balance form displayed in the chapter "Flight Dispatch."

(b) <u>Off-Line Fueling</u> – All procedures remain the same as at on-line stations with the exception that the flight crew must supervise the re-fueling and ensure all procedures are complied with.

(c) <u>Re-fueling with Passengers on Board</u> – The Purser [in-charge flight attendant] must be notified that fueling is in progress. The Purser will ensure that there is absolutely no smoking; the main entrance door is open; the

---

[3] It should be noted that, on March 10, 1989, C-FONF was refuelled at Dryden with Jet B fuel, which, at +1°C, the ambient temperature at Dryden at that time, is within the flammability range of the fuel. That is, at that temperature Jet B fuel gives off fumes in sufficient concentration to burn if ignited. In contrast, the more common Jet A fuel would not have been within its flammability range at that temperature.

evacuation slide armed; flight attendants are in position for a rapid evacuation in case of a fire.

(d) Fuel Spill – If a fuel spill occurs the Captain will notify A.T.C. immediately and request the Airport Fire Department to immediately proceed with flushing procedures to minimize the risk of fire.

(Exhibit 146, pp. 7-15–7-16)

In contrast to the scant mention of the subject in the Air Ontario FOM, the Air Ontario Flight Attendant Manual (FAM) contained a section entitled "Refuelling Restrictions," which sets out, in greater detail, the procedures to be followed during aircraft fuelling. Although the FAM provisions specifically permitted the fuelling of an aircraft with passengers on board, with no engines running, subject to certain conditions set out therein, it clearly required the off-loading of passengers during the refuelling with one engine running:

2.31 Refuelling Restrictions

Fueling with passengers onboard or embarking/disembarking is permitted in accordance with the airport local regulations and provided the additional safety precautions as listed below are strictly complied with. The Captain or designated flight deck crew member will coordinate the requirements with the Purser and Ramp Control.

1. A flight deck crew member is on the flight deck.

2. Interphone contact between the flight deck/cabin and ground is available.

3. The flight Attendants have been advised that fueling will take place.

4. The NO SMOKING sign is on. The no smoking rule will be enforced. No striking of matches or use of flame producing devices is permitted.

5. Flash bulb photography is not permitted.

6. No oxygen is to be administered.

7. The exit doors are unobstructed at all times.

8. The Flight Deck and Cabin must be informed of any situation endangering the safety of the aircraft and its occupants.

9. The main entry door remains open with stairs in position, and on the CV580 [aircraft] the aft service door will be armed and minimum Cabin Crew limitations are met, with crew being stationed close to their assigned floor level exit(s).

10. Promptly notifying refuelling personnel if fuel vapours or any other hazard are detected in the cabin. If such conditions occur, the fueling will be discontinued.

11. When additional fuel is required after passenger boarding has been completed, the requirement for the main door to be opened with the stair in place may be disregarded under the following conditions:

    a) all loading and catering equipment is removed from the aircraft allowing room for slide deployment
    b) CV-580 aft door is armed and crew is on standby for immediate evacuation via slide
    c) interphone contact between ground and flight deck is established

12. *When refuelling is required with one engine running, all passengers are to be off-loaded and cleared from the area during the refuelling period. Flight Attendants should also leave the aircraft.*

(Exhibit 137, section 2.31; emphasis added)

In the case of a refuelling with no aircraft engines running, both the Air Ontario FOM and FAM direct that the purser be informed by the flight crew when refuelling is to take place with passengers on board the aircraft. The presumption is that once the purser is informed of the intended procedure by the pilots, he or she will ensure that the precautions listed in the FAM are carried out. The FAM provisions contemplate close cooperation among the pilots, the flight attendants, and the refuelling personnel, directing that there must be interphone capability between the flight deck/cabin and the ground. It is rather odd that these directives are included in the FAM and not the FOM, since the arrangements relating to fuelling could be made only by the pilots.

It is quite incomprehensible as to why the Air Ontario FAM addressed the required refuelling safety precautions in greater detail than the Air Ontario FOM. I am also concerned that there appears to have been no cross-referencing between the FOM and the FAM, even though, as of March 10, 1989, Air Ontario flight attendants and pilots were all part of the flight operations department, with the manager of in-flight services and the director of flight operations both reporting to the Air Ontario vice-president of flight operations.

Further to my earlier comments in chapter 19 of this Report, F-28 Program: Flight Operations Manuals, it would appear that the persons responsible for the production and amendment of the FOM and the FAM did so without reference to the other manual. This is particularly problematic in areas like refuelling, where close cooperation was required between pilots and flight attendants.

Personnel of the Dryden Flight Centre who conducted the hot refuelling of aircraft C-FONF on March 10, 1989, were given guidance on fuelling procedures from a number of sources. As discussed earlier (chapter 5, Events and Circumstances Preceding Takeoff, and chapter 9, Crash, Fire-fighting, and Rescue Services), at least four manuals related to fuelling were supplied to Dryden Flight Centre. Two were supplied by Air Ontario (Air Ontario Inc. Fokker F-28 Fuelling Procedures Manual, and Fokker F-28 Ground Handling and Service Data Manual), and two were ESSO manuals (ESSO Aviation Fuelling Guide, and ESSO Aviation Operations Standards Manual). The two manuals supplied by Air Ontario did not refer to hot refuelling.

The Air Ontario Inc. Fokker F-28 Fuelling Procedures Manual and the Fokker F-28 Ground Handling and Service Data Manual, which were substantially the same, stated that pressure fuelling while an engine or auxiliary power unit (APU) was running was acceptable if certain precautions were followed. These precautions were general in nature and were to be used when refuelling with an engine or an APU running. No mention was made of deplaning passengers or positioning the aircraft away from the terminal.

The ESSO Aviation Operations Standards Manual provided detailed instruction on fuelling with one engine running, including the following prohibition:

> Fueling must not be started until all passengers:
> - have vacated the aircraft
> - are kept at a distance of at least 46 metres (150 feet)
>
> (Exhibit 173, section AOSM 020-007, p. 2)

The evidence suggested that Air Ontario policy and procedures regarding the fuelling of its aircraft were characterized by a lack of coordination. Pilots, flight attendants, and ground-handling personnel, all of whom should have had well-defined responsibilities regarding the fuelling of Air Ontario aircraft, were instead guided by a number of uncoordinated operational manuals that were, in some respects, inconsistent.

With regard to the specific practice of hot refuelling, the evidence suggested that there was no policy communicated and understood by key operational personnel. In the absence of clear company policy, it would appear that some personnel derived their own hot-refuelling procedures based on practical experience. By way of example, I refer to the evidence of Air Ontario Dash-8 captain, David Berezuk. Captain Berezuk was asked about his experience regarding refuelling with one engine running. He stated that such a practice was often used by pilots in the north as a means of expediting station stops. He also indicated that the pilots followed what Captain Berezuk considered to be safe procedures. He testified as follows:

> Q. ... So basically what you do is to expedite a through-trip, you stop, one engine is shut down; you leave another engine running and you refuel with one engine running, is that correct?
> A. That is correct.
> Q. And the times that you have done this type of refuelling with an engine running, have there been passengers on board?
> A. Yes.
> ...
> Q. Now, in what areas have you done this; where have you done this?
> A. Most of our operation up north in the arctic and in northern remote areas.
> Q. And when you did these refuellings with an engine on, what precautions did you take?
> A. The precautions I stated before were the main cabin door with stairs extended were left in the open position, the door was not locked as far as passenger egression or deplaning, the ... quickest means, in case there [were] any problems.
> There was a credited flight crew member in the cockpit in order to secure the engine to shut down the aircraft and assist in evacuation in the event of some problem.
> (Transcript, vol. 14, pp. 170–71)

It appears that in the absence of a company policy which placed restrictions on hot refuelling, Air Ontario pilots relied on their own experience and continued to refuel with passengers on board.

There is evidence that Air Ontario management made an attempt to provide guidance on policy and procedures regarding the hot refuelling of its F-28 aircraft. This evidence is in the form of a June 2, 1988, memorandum authored by Mr Bruce Maxim of Air Ontario and given to Captains Robert Murray, Robert Nyman, and Walter Wolfe. Air Ontario director of flight operations Robert Nyman gave evidence on the subject of the memorandum:

> Q. ... the title of this is F28 Station Operation with an Engine Running. Under the heading Important, it reads: "This is a special procedure and must only be used at those stations where ground support equipment is not provided or where the neces-

sary equipment is unserviceable." Would that apply to the Dryden Airport?

A. Yes, it would.

Q. And if you can turn the page over to Additional Procedures for Refuelling, and just reading quickly the terms:

> 9 The fuelling vehicle must be located at the front of the wing tip.
> 10 Fuelling hoses and their (connectors) must be leak-free.
> 11 The fuelling hose should be routed below the wing so that in case of a hose burst, the emergency fuel-spray cannot enter the engine or APU intake.
> 12 Fuelling operations must be monitored continuously.
> 13 During pressure refuelling, either (left-hand) or (right-hand) engine may be running at idle RPM.
> 14 During gravity refuelling, the running engine must be opposite to the overwing fuelling point.
>
> The above assumes that these procedures occur without passengers on board. In the event that fuelling takes place with passengers on board, it is mandatory that the station fire trucks are standing by the aircraft. Otherwise, passengers must be deplaned.

Do you recall discussing so-called hot-refuelling procedures as detailed in this particular memo?

A. Do I recall discussing them? No.

Q. Did you recall reviewing the procedure as set out in the memo at the time?

A. No.

Q. Again, you were the Director of Flight Operations at that time, I believe; is that right?

A. Yes, I was.

Q. Did you adopt the recommended practices set out in this memo with respect to hot refuelling?

A. We did not.

Q. And why did you not?

A. Well, I shouldn't say we didn't adopt it. We did not advise anybody of the procedures.

(Transcript, vol. 108, pp. 56–58)

It should be noted that this proposed policy does not preclude hot refuelling with passengers on board; but if passengers are on board, then the station fire trucks must be standing by the aircraft.

I think it is instructive to review the hot-refuelling policy of Air Ontario's parent company, Air Canada.

Air Canada Policy

Air Canada's policy is that aircraft fuelling with a main engine running is not to be carried out as a planned procedure in normal operations.[4] This policy ensures that, except in rare circumstances, refuelling with an engine running is not required in normal operations. However, recognizing the possibility of being forced by peculiar circumstances to hot refuel, Air Canada has specific instructions set out in the aircraft operating manual for each aircraft type to address that contingency. Although these instructions are specific to each aircraft type, some parts of the instructions, such as the requirement to deplane all passengers and flight attendants prior to commencing the refuelling, are common to all types of aircraft. Captain Charles Simpson, Air Canada's senior vice-president of flight operations, gave the following testimony regarding his company's refuelling procedures for the Boeing 767:

> A. ... I brought an excerpt from the 767 operating manual again, the procedure that has to be used if you refuel with an engine running.
>
> And I guess the key to it is that you will take certain precautions because it's abnormal. We give the crew specific instructions of how it's to be done, even to the extent to ensure that the aircraft is positioned away from the terminal or other facility, and of course, all passengers are deplaned during the process.
>
> Q. And that was reiterated on the second page [of exhibit 911] where it says passengers and cabin crew may not be boarded until refuelling is completed?
>
> A. That's correct.
>
> (Transcript, vol. 118, p. 128)

For present purposes, three noteworthy aspects of Air Canada's policy regarding hot refuelling are:

1 It is not a normal operation, and hot fuellings are not to be planned.
2 The aircraft is to be moved some distance from the airport terminal building.
3 Passengers are to be deplaned.

On March 10, 1989, Air Ontario system operations control planned the hot refuelling that occurred at Dryden during the flight 1363 station stop; the aircraft was not positioned a safe distance from the airport terminal; and the passengers remained on board.

---

[4] This policy is compatible with Air Canada's policy, discussed in chapter 16, F-28 Program: APU, MEL, and Dilemma Facing the Crew, of not dispatching an aircraft with an unserviceable APU to a station without ground-support equipment.

Findings

- Hot refuelling is not a normal procedure.

- Air Ontario, as of March 10, 1989, did not have a consistent company policy that would have precluded the hot refuelling of an aircraft with passengers on board and a main engine running (hot refuelling). The Air Ontario Flight Attendant Manual (FAM) specifically prohibited such a practice, while the Flight Operations Manual (FOM) was silent on the subject.

- The Air Ontario policy and procedures regarding the fuelling of its aircraft were contained in a number of uncoordinated operational manuals.

- Both the Air Ontario FOM and FAM permitted the refuelling of an aircraft with passengers on board with no engines running. The FAM contained more specific restrictions and much more detail on the procedures to be followed in such a situation than did the FOM.

- There were no consistent and comprehensive procedures provided by Air Ontario to its pilots and operational personnel regarding the fuelling of F-28 aircraft with a main engine running.

- The Air Ontario FOM, its FAM, and the manuals used by ground-handling personnel at Dryden were significantly inconsistent in their treatment of the hot-refuelling procedure.

- Air Ontario lacked a clear policy with respect to hot refuelling of aircraft, and such policy as existed was not properly communicated to and understood by pilots and by operational personnel.

- There was no information available in manuals or documents normally available to and used by Air Ontario F-28 pilots regarding the hot refuelling of an aircraft either with or without passengers on board.

- Because of the lack of a clear company policy and specific procedures for hot refuelling of an aircraft, Air Ontario pilots resorted to improvising individual hot-refuelling procedures based on their own practical experience, when the occasion required.

- Given that there was no F-28 ground-start facility at Dryden, one of Air Ontario's scheduled F-28 station stops, there was a reasonable likelihood that, at some time in normal commercial operations, it might be necessary to fuel an F-28 aircraft at that station with a main engine running.

- Air Ontario senior operations management should have established, but did not establish, a procedure to accommodate such a contingency. By failing to do so, Air Ontario allowed a potentially unsafe situation to manifest itself on March 10, 1989.

- On March 10, 1989, Air Ontario F-28 C-FONF was refuelled at Dryden, Ontario, while one main engine was running.

- Although this hot refuelling was planned by Air Ontario system operations control (SOC), no instructions were given by Air Ontario SOC for the deplaning of passengers at Dryden while flight 1363 was being hot refuelled at that station.

- The surviving flight attendant was not notified of the hot-refuelling procedure and was unaware of it.

- The passengers on board the aircraft were not deplaned prior to the hot refuelling of the aircraft, contrary to the provisions of the Air Ontario FAM.

- The hot refuelling of C-FONF involved the more volatile Jet B fuel, and a small fuel spill occurred.

- The aircraft was not parked a safe distance from the Dryden terminal during the hot-refuelling procedure, contrary to the provisions of the Air Ontario FAM.

- The ground-handling personnel conducting the hot refuelling were not familiar with proper hot-fuelling procedures, including the use of the deadman switch and proper bonding and grounding.

- The hot refuelling of flight 1363 at Dryden on March 10, 1989, was carried out in a manner that exposed to unnecessary risk not only those persons on board the aircraft but also the nearby terminal and its occupants.

Aircraft Ground De-icing

The Clean Aircraft Concept: Interim Recommendation No. 2

In the first *Interim Report* of this Commission, I concluded:

> On the basis of the evidence I have heard, I am satisfied beyond any doubt whatsoever, and I find, that the critical upper-wing surfaces of the aircraft were, at all material times, severely contaminated with heavy wet snow and that such contamination was at least a contributing factor to the crash that occurred.
>
> (*Interim Report*, p. 25)

At the time of the Dryden accident, the Canadian regulation pertaining to commencement of a flight by a large aircraft with wing contamination was found in Air Navigation Order (ANO) Series VII, No. 2, section 25(3), which stated:

> No person shall commence a flight when the amount of frost, snow or ice adhering to the wings, control surfaces or propeller of the aeroplane may adversely affect the safety of the flight.

Implicit within this section of the ANO is the permissibility to commence a flight with frost, snow, or ice adhering to the aircraft's lifting surface, provided that, in the pilot's discretion, this contamination will not adversely affect the safety of flight.

Given the known hazards posed by contamination of aircraft lifting surfaces; the difficulties in accurately predicting performance decrements due to any given amount of wing contamination; and the permissive nature of the ANOs respecting takeoff with wing contamination, I recommended that:

> The Department of Transport immediately develop and promulgate an Air Navigation Order applicable to all aircraft that would prohibit takeoffs when any frost, snow, or ice is adhering to the lifting surfaces of the aircraft, and the Department of Transport provide guidelines to assist aviation personnel in conforming to the amended orders.[5]
>
> (Interim Recommendation No. 2, p. 28)

[5] MCR 2 in Part Nine, Consolidated Recommendations

I am pleased to note that this interim recommendation met with a favourable response from Transport Canada. Immediate steps were taken in the form of a letter from the minister of transport advising all Canadian carriers of Transport Canada's acceptance of my interim recommendation, along with a request for compliance with the intent of the recommendation during the period that the air regulations were being amended.[6] On November 1, 1990, section 540.1 of the *Aeronautics Act* was amended to give effect to Interim Recommendation No. 2 of this Commission.

Air Ontario's Policy on Flights in Icing Conditions

This section should be read in conjunction with chapter 12 of this Report, Aircraft Performance and Flight Dynamics, where, in the context of the performance and flight dynamics of the F-28, I discuss information and procedures available for safe operation in cold-weather operations. Specific attention is drawn to the provisions in the Fokker F-28 Flight Handbook, the Piedmont F-28 Operations Manual, and the USAir F-28 Pilot's Handbook addressing cold-weather operations. In the following pages, I address the company-specific cold-weather operations policy adopted by Air Ontario, as set out in its Flight Operations Manual (FOM).

Air Ontario's FOM states that "Take-off shall not be attempted when frost or freezing precipitation is adhering to the surfaces of the aircraft" (Exhibit 146, p. 7-3).[7] Rather than prominently displaying this critical prohibition in its FOM, Air Ontario included it in the broader operational directive dealing with in-flight operating procedures in icing conditions. Moreover, the directive is applicable to all aircraft types, including the F-28, and is not accompanied by a caution similar to those found in the Fokker F-28 Flight Handbook and the Piedmont and USAir F-28 operations manuals.

Unlike section 25(3) of ANO Series VII, No. 2, which included discretionary words permitting pilots to take off with frost, snow, or ice adhering to the aircraft, provided it does not "adversely affect the safety of the flight," Air Ontario's FOM prohibits pilots from attempting to

---

[6] Under letter dated March 15, 1990, from then Minister of Transport Doug Lewis to Commissioner Moshansky, Transport Canada provided the following response to Interim Recommendation No. 2: "The Department of Transport will take action to amend the Air Regulations to state that no person shall commence a flight if frost, ice or snow is adhering to the lifting surfaces or propellers of the aircraft and will provide guidelines for the interpretation of these regulations."

[7] The Air Ontario Flight Operations Manual, Part 10.1.1, provides the following meaning of the words "may," "should" and "shall": may – permissive; should – informative; shall – imperative, compliance is mandatory.

take off with frost or freezing precipitation adhering to aircraft surfaces, but is silent in relation to snow adhering to aircraft surfaces. In this sense, Air Ontario's FOM is more restrictive than the ANO Series VII, No. 2, section 25(3), and more closely resembles the "clean wing concept" that I recommended in my first *Interim Report*.

In that the FOM represents Air Ontario's company policy, it follows that Air Ontario flight crews, including Captain Morwood and First Officer Mills, would have been bound not to attempt a takeoff when frost or freezing precipitation adhered to the surfaces of their aircraft. Because Air Ontario's FOM is more restrictive than the ANO in this regard, it would be possible for an Air Ontario pilot to contravene company policy while still being within the bounds of the Air Navigation Order. Theoretically, this situation could occur where an Air Ontario pilot attempted a takeoff with frost or freezing precipitation adhering to the surface of the aircraft, but where, in the pilot's discretion, it would not adversely affect the safety of the flight. Compliance with a company manual should guarantee compliance with the Air Regulations since the company manual can be no less restrictive than the Air Regulations.

Although the FOM is more restrictive than the air regulation in the context described above, in another respect it may be less restrictive. Where the ANO speaks of "frost, snow or ice adhering to the wings," the directive to Air Ontario pilots in the FOM mentions only "frost or freezing precipitation." The omission of any reference in the FOM to snow adhering to the wings creates the potential for uncertainty as to the intention of the directive that the company provided to its pilots. The fact that snow is not mentioned could leave the impression that takeoff may be attempted with snow on the aircraft, and even adhering to it. It is unclear whether the company is deliberately, and unscientifically, distinguishing the adhering properties of frost and freezing precipitation from those of snow on the basis that snow may be more likely to blow off on takeoff. If this is a deliberate distinction on the part of Air Ontario, it fails to take into account the phenomenon of cold soaking, which is discussed in chapter 12 of this Report, Aircraft Performance and Flight Dynamics.[8] Further, if company policy countenances the dangerous practice of attempting takeoff with snow on the wings, there is no guidance given to pilots as to how to make a judgement on whether or not snow would blow off on takeoff.

During the course of the hearings of this Commission, I heard evidence from Air Ontario pilots and flight attendants that some Air

---

[8] In chapter 12 of this Report, Aircraft Performance and Flight Dynamics, I found that the cold-soaking phenomenon contributed to the freezing of falling snow to the surface of the wings of aircraft C-FONF in Dryden on March 10, 1989.

Ontario pilots had, in specific circumstances, attempted takeoffs with snow on aircraft wings. There is also evidence to suggest that some Air Ontario pilots may have carried out takeoffs even when they were not certain that the snow would blow off during the takeoff run. In the context of a discussion about the Piedmont F-28 ground school training, and the absolute necessity of a clean wing on the F-28 jet aircraft, Captain Erik Hansen testified that, by way of contrast, some amount of contamination was considered acceptable prior to takeoff in propeller-driven Convair 580 aircraft. He testified as follows:

> A. ... But the four of us [captains Morwood, Reichenbacher, Maybury, and Hansen] coming out of Convairs and the Convair will take, you know, some ice and some contaminants prior to departure before, you know, you're really starting to get upset about it.
>
> (Transcript, vol. 94, p. 72)

This reference to Convair aircraft taking "some ice and some contaminants" suggests that some Air Ontario pilots were accustomed to making successful takeoffs in the Convair 580 aircraft with some degree of wing contamination, even though they knew that it would not likely blow off. This group of pilots probably included Captain Morwood, since he was one of the "four" referred to by Captain Hansen in his evidence.

During hearings of the Commission that occurred subsequent to the release of my first *Interim Report*, evidence was heard indicating that takeoffs with contaminated wings were not confined to Air Ontario pilots of Convair 580 aircraft. The evidence shows that some Air Ontario pilots of HS-748 turboprop aircraft performed takeoffs in that aircraft with contaminants adhering to aircraft surfaces. Two such incidents are reviewed in chapter 24 of this Report, Flight Safety.

In examination of the circumstances involved in a December 15, 1987, HS-748 Austin Airways incident (see chapter 24), it was discovered that Captain Joseph Deluce and First Officer Scott Jensen had used an unapproved procedure on takeoff referred to as "the 80-knot check." This unofficial procedure involved a check of the wings by the pilots upon achieving a speed of 80 knots on the takeoff roll to ensure that snow or slush, previously observed on the wings, was blowing off the wings and not continuing to adhere. The evidence with regard to the "80-knot check" further indicates that some Air Ontario (or predecessor company) pilots had attempted takeoffs under the hazardous condition of wet snow or slush contaminating the surface of their aircraft. Because other Air Ontario pilots testified that they had heard of the "80-knot check," it would appear that this was more than just a procedure adopted by Captain Deluce on December 15, 1987.

The majority of the evidence referred to in this section pertaining to Air Ontario's policy for commencing flights in conditions conducive to wing contamination was not heard until after publication of Interim Recommendation No. 2 in my first *Interim Report*. Everything I have heard has reinforced the importance of a speedy transition in policy and attitude to the "clean wing concept." I am fully aware that the "clean wing" order in the United States has not alone precluded contamination-related accidents and incidents in that country. It is therefore of utmost importance that persons at all levels of flight operations be made fully aware of the potentially disastrous consequences of wing contamination on aircraft performance. This was the tenor of my Interim Recommendation No. 3 published in the first *Interim Report*, which I repeat below for emphasis, that:

> The Department of Transport forthwith develop and implement a mandatory and comprehensive education program for all aircrew engaged in commercial operations, including an integrated program for cockpit crew members and cabin crew members, on the adverse effects of wing contamination on aircraft performance, with provision for knowledge verification; and
>
> The Department of Transport similarly develop and implement a mandatory safety-awareness program for all other personnel involved in flight operations, including managers, dispatchers, and support personnel, on the adverse effects of wing contamination on aircraft performance.[9]
>
> (Interim Recommendation No. 3, p. 29)

Winter Operations Advisories

It is vitally important that an airline maintain an efficient system for the distribution of operational information to its pilot group and other operational personnel. Given the number of changes that were going on at Air Ontario in 1987 and 1988, including the introduction of the F-28 jet aircraft into the fleet, and a pilot group new on that aircraft type, the ability to produce and disseminate information was particularly important. Evidence presented before this Inquiry revealed, however,

---

[9] MCR 3 in Part Nine, Consolidated Recommendations. Under letter dated March 15, 1990, from then Minister of Transport Doug Lewis, Transport Canada responded favourably to Interim Recommendation No. 3 by agreeing to amend ANO Series VII, Nos. 2, 3, and 6, to require air carriers to establish and maintain a Transport Canada-approved training program concerning the adverse effect of wing contamination on aircraft performance and to provide this training to all crew members and to other air carrier personnel involved in flight operations. On November 1, 1990, the ANOs were amended appropriately (SOR/90-758; SOR/90-759).

that Air Ontario's response to the need to distribute operational information to its pilot group, particularly a winter operations advisory package for operation of the F-28, was deficient.

Mr Teoman Ozdener, a professional engineer employed by Air Ontario as its F-28 maintenance manager from February 1988 to February 1989, had a great deal of experience with F-28 aircraft. He testified that he was aware that an operator had to be "very careful" with the F-28 in icing conditions (Transcript, vol. 101, pp. 220–21), and that he was therefore anxious to implement special procedures for Air Ontario's F-28 winter operations.

On his own initiative, and with the initial support of Air Ontario management, Mr Ozdener had made arrangements to visit the Swedish carrier, Linjeflyg, which operated a large fleet of F-28 aircraft in a winter climate similar to that in which Air Ontario operated. By observing the experienced operator, Linjeflyg, Mr Ozdener had intended to familiarize himself with the practical aspects of F-28 winter operations and then to develop a winter operations information package for Air Ontario. This visit was to have been carried out in April 1988. However, the trip was delayed, and in late summer 1988 Mr Ozdener was told by Mr Kenneth Bittle, vice-president of maintenance, that the trip would not be authorized.

As a result of the cancellation of Mr Ozdener's trip to Sweden, Air Ontario pilots were deprived of what probably would have been a valuable and practical winter operations resource.[10]

Air Ontario Memorandum on F-28 De-ice/Anti-ice Instructions

Mr Robert Mauracher, director of maintenance at Air Ontario, prepared a memorandum, dated September 28, 1988, for the company's reliability committee, on the subject of "F-28 De-ice Anti-ice Instructions." Mr Mauracher's memorandum was based on an operation and maintenance publication produced by Fokker Aircraft, entitled, "Cold Weather Operation," which had been obtained by Mr Ozdener (Exhibit 318, "Operation and Maintenance of Fokker Aircraft, No. 3, Cold Weather Operation," February 1984). The general content of Mr Mauracher's six-page memo is apparent from the following introductory paragraph:

[10] It should be noted that in January 1988, Captain Joseph Deluce and Captain Robert Murray attended at Norcanair/TimeAir to observe its F-28 operation. However, these visits were not specifically related to winter operations, nor were winter operations procedures disseminated to the pilot group as a result of the visits. Also to be noted is that both Captain Joseph Deluce and Captain Robert Murray flew for TimeAir in February–March 1988.

> This memorandum details precautions necessary to protect the aircraft during cold weather ground conditions. Details are also given of the recommended methods for snow and slush removal, de-icing and anti-icing protection.
>
> (Exhibit 317, p. 1)

Mr Mauracher's memorandum contained very useful information for personnel connected with all aspects of the F-28 operation and maintenance, including the F-28 pilots. In fact, as indicated in the following excerpts, it appears that some passages of the memorandum are directly aimed at the flight crew:

> NEVER: Spray while main aircraft engine's are running!!!
>
> ...
>
> The following are Flight Crew or Maintenance Functions:
>
> Check all drains and vent holes are free from obstructions. At this point, remove all protective covers. Check that all control surfaces, including lift dumpers and speed brakes move freely over their complete operating range.
>
> NOTE: Airframe anti-icing system is not intended for de-icing the aircraft on the ground.
>
> WARNING: Even a slight ice roughness (or frost on the wing leading edge) may seriously [impair] the wing lift characteristics. Extreme care must be taken to clean the wing of any ice roughness.
>
> NOTE: If severe weather makes it necessary to de-ice while the APU is running, the APU bleed load control valve and air conditioning main valves must be closed to prevent glycol being blown into the cabin.
>
> (Exhibit 317, pp. 3, 4–5)

Clearly, Mr Mauracher's memorandum contained critical information that should have been required reading for everyone associated with the F-28 operation. It appears from the evidence, however, that distribution of the memorandum was extremely limited.

Mr Ozdener testified that although he was not involved with the reliability committee, he assumed that the various Air Ontario departments that were represented on it would pass the information on to their respective departments. Vice-president of maintenance, Mr Kenneth Bittle, testified that although it was the sort of memorandum that would usually be circulated to all Air Ontario stations, he did not know if in fact the stations had received it.

It was the evidence of certain Air Ontario system operations control (SOC) personnel that they were familiar with Mr Mauracher's memorandum, and that a copy of it was kept for their reference in SOC. Messrs Wayne Copeland, Danilo Koncan, Warren Brown, and Daniel Lavery all testified that they were familiar with the memorandum. In fact, because of the operational restriction contained in the Mauracher memorandum, Air Ontario duty operations manager (formerly dispatcher) Mr Koncan testified that he would have advised the pilots to overfly Dryden had he been dispatching flight 1363 on March 10, 1989:

> Q. Could you tell the Commissioner what your understanding on the 10th of March of last year was with regard to de-icing the F-28 with engines running.
> A. Engines are to be shut down, as well as APUs are to be shut down while de-icing.
> Q. Was there any further instruction given to you about the dispatch of aircraft, F-28s, unserviceable APUs, into line stations where there was no air starts and the possibility of de-icing?
> A. No, there was not.
> Q. What would you have done in the situation where there was forecast weather and the potential for the necessity of de-icing and an unserviceable APU on an F-28?
> A. If the aircraft was en route, one would be to overfly, to either, down-line station, whether it be the alternate. Or, if the aircraft was already on the ground and engines shut down with an unserviceable APU, and the aircraft is parked until such time as a ... portable air start ... can be provided or actually flying a Convair or other aircraft into that station and giving him a buddy start, which consists of hoses for the start capabilities.
> (Transcript, vol. 47, pp. 38–39)

The evidence revealed that the F-28 pilot group did not have the same familiarity with the Mauracher memorandum as did the SOC personnel. Several F-28 pilots testified that they had not received a copy of Mr Mauracher's memorandum or, what would have been more appropriate, a pilot bulletin with similar content. While F-28 pilot Christian Maybury testified that he had received the Fokker cold-weather operations publication – the document from which Mr Mauracher derived his memorandum – and understood that it had been provided to all F-28 pilots on the line at that time, F-28 pilots Deborah Stoger, William Wilcox, and Erik Hansen all testified that they had not seen the Fokker publication. Based on the evidence of pilots Stoger, Wilcox, and Hansen, which I accept, I find that the Mauracher memorandum was not distributed to all Air Ontario F-28 pilots.

This issue is further clouded by the evidence of the director of flight operations, Captain Robert Nyman. With respect to Mr Mauracher's memorandum, Captain Nyman recalled having seen it at a meeting of the reliability committee, but he did not believe it was ever distributed to the pilots. However, with respect to the Fokker publication, Captain Nyman testified that, through Air Ontario's internal mailing system, he had personally sent it to all F-28 pilots in August or September 1988, and that he could not explain why Captain Hansen had not received it. Moreover, Captain Nyman believed that he would have sent Captain George Morwood a copy of the Fokker cold-weather operation publication. Captain Nyman confirmed the importance of distributing this material to the pilot group:

> Q. Do you have any knowledge as to whether the memo was disseminated to the pilot group?
> A. I never saw it in the form of a pilot bulletin. I certainly never distributed it to the pilot group.
> Q. Now, the information contained within this particular document, would it be the sort of information that ought to be included either in a standard operating procedure for an aircraft type or the flight operations manual?
> A. Yes, indeed. It should probably be included in either the flight – well, not the flight operations manual. Probably more particular ... an SOP [manual].
> Q. So you are saying that this particular type-specific information ought to be included –
> A. It's the kind of information that you are interested in getting, yes.
>
> (Transcript, vol. 108, p. 124)

The body of evidence on this point does not support a conclusive finding, one way or the other, as to whether Captain Morwood and/or First Officer Mills received the Fokker cold-weather operation publication or the Mauracher memorandum, which contained, among other important information, the crucial proviso, "NEVER: Spray while main aircraft engine's are running!!!" (Exhibit 317, p. 3). What is clear is that a specific pilot bulletin was never disseminated on this point, and there is strong doubt, based on the above-mentioned evidence of Air Ontario pilots, as to whether pilots Morwood and Mills had received the Fokker cold-weather operation publication.

Air Ontario pilots Hansen, Wilcox, Stoger, and Monty Allan testified that they were not aware of specific restrictions against spraying the F-28 for the purpose of de-icing while one engine was running. Only Captain Maybury, who had received the Fokker publication, was aware of such restrictions. In the absence of specific instruction or a company policy on this point, Air Ontario pilots who were questioned in this regard (in particular, pilots Hansen, Wilcox, and Allan) testified that they considered the practice of de-icing with a main engine running unsafe, because of the risk of ingesting glycol into the engine and the danger of having a person in a de-icing bucket in close proximity to a running engine. However, the evidence of experts in the fields of aircraft ground de-icing, aircraft engines, and cold-weather operations indicated that aircraft ground de-icing is routinely performed in Europe and the United States with engines running. Clearly, an operational matter of such importance requires a standard company policy that is made explicitly known to all pilots and operational personnel. What is to be avoided are situations where crew members, faced with the stresses of their operating environment, are without the support of a company policy to assist in their decision making. This most likely was the situation facing Captain Morwood and First Officer Mills on March 10, 1989.

De-icing of Aircraft Nearer to Runway End: Interim Recommendations – Second Interim Report

I recommended in my *Second Interim Report* (Recommendation No. 1)[11] that Transport Canada design and construct permanent de-icing/anti-icing facilities near to runway ends, at Lester B. Pearson International Airport (LBPIA) in Toronto, to satisfy both safety and environmental concerns. I wish to deal briefly with events that have subsequently occurred.

By a letter dated June 6, 1991, the minister of transport, Jean Corbeil, wrote to me in response to the 13 recommendations made in my *Second Interim Report* (see appendix K at the end of this Report). Referring to Recommendation No. 1 of my *Second Interim Report*, he confirmed that Transport Canada accepts the need for dedicated facilities for de-icing of aircraft, and that there was general agreement between Transport Canada and the air carriers that dedicated de-icing facilities are required at LBPIA. I have subsequently been informed that Transport Canada, on August 13, 1991, published an Invitation to Tender for construction at LBPIA of a dedicated touch-up de-icing facility and has announced plans for the construction at LBPIA of a major permanent de-icing centre, with provisions for recovery of fluids, located near the takeoff ends of the runways that are primarily used in bad weather. Transport Canada and the air carriers are to be commended for this initiative.

---

[11] MCR 5 in Part Nine, Consolidated Recommendations

National Resource Specialist – Aircraft Ground De-icing/Anti-icing

In my *Second Interim Report,* I noted at page 1 that Mr Richard Adams, an aeronautical engineer and aviation consultant, was, until recently, the national resource specialist for aircraft icing with the Federal Aviation Administration in the United States. Mr Adams testified that this position was established as a result of a recommendation by a United States commission, similar to this Commission, based on a finding of a lack of technical expertise in certain areas. Mr Adams described the function of the national resource specialist as follows:

> A. .... Now, very briefly, the National Resource Specialist is intended to be a specialist who is a national resource or whose talents and capabilities can be tapped by anyone; in other words, they put us there, ask us to stay abreast of technology, and then they took turns using us, basically.
>
> (Transcript, vol. 80, p. 12)

In my view, the concept of a highly qualified national resource specialist within Transport Canada, dedicated to matters pertaining to aircraft surface contamination and de-icing/anti-icing of aircraft in its broadest sense, including methods, procedures, fluids, and advances in relevant technology, to name the most obvious, based upon the United States model, would be worthy of consideration by Transport Canada.

Findings

- The F-28 aircraft, because of its critical wing, required an operator of such aircraft to be very careful in conditions conducive to wing contamination to ensure that the aircraft's wings were clean for takeoff. (See discussion in chapter 20 of this Report, F-28 Program: Flight Operations Training.)

- The Air Ontario Flight Operations Manual (FOM) prohibited takeoff with frost or freezing precipitation adhering to the surfaces of an aircraft. Thus, the Air Ontario FOM was more restrictive than section 25(3) of Air Navigation Order Series VII, No. 2, which included the discretionary words "does not adversely affect the safety of flight."

- The Air Ontario FOM, however, did not prohibit takeoff with snow adhering to the aircraft wing, as was the case at Dryden on March 10, 1989.

- The omission by Air Ontario of any reference in its FOM to takeoff with snow adhering to the wings could have given Air Ontario pilots the mistaken impression that it was acceptable to take off with snow adhering to the wings of an aircraft.

- The Air Ontario FOM did not adequately address the phenomenon of cold soaking. (See the discussion of cold soaking in chapter 12, Aircraft Performance and Flight Dynamics.)

- Air Ontario did not issue a specific pilot bulletin to its F-28 pilots containing F-28 cold-weather operations information or de-icing and anti-icing information for the F-28 aircraft.

- A memorandum dated September 28, 1988, based on a Fokker Aircraft publication entitled "Cold Weather Operation," on the subject of "F-28 De-ice Anti-ice Instructions," was issued by Air Ontario's director of maintenance, Mr Robert Mauracher, for the company's reliability committee. This memorandum received limited distribution among Air Ontario system operations control (SOC) personnel.

- Although the Mauracher memorandum contained specific F-28 cold-weather operational restrictions and information of interest to F-28 pilots, it was distributed to few, if any, Air Ontario F-28 pilots.

- Had the operational restrictions contained in Mr Mauracher's memorandum been followed by the Air Ontario SOC dispatcher on March 10, 1989, the pilots of flight 1363 would have been advised to overfly Dryden on that date because of the potential necessity of de-icing with engines shut down and the unserviceable auxiliary power unit (APU) and lack of ground-start facilities at Dryden.

- Some of the Air Ontario F-28 pilots, probably including Captain Morwood, had in the past made takeoffs in propeller-driven Convair 580 aircraft and/or HS-748 aircraft with some wing-surface contamination. (See the discussion in chapter 12, Aircraft Performance and Flight Dynamics.)

- Prior to March 10, 1989, some Air Ontario pilots flying the HS-748 propeller-driven aircraft used a dangerous and unapproved procedure during the takeoff roll, referred to as the "80-knot check." The procedure involved a check of the wings upon achieving a speed of 80 knots, to determine whether snow or slush observed on the aircraft wings prior to commencement of the takeoff roll was blowing off the wings.

- Air Ontario's ground-handling agent at Dryden, Dryden Flight Centre, did not have its personnel attend a ground-handling training course for the F-28 aircraft, sponsored by Air Ontario, although invited to do so.

- It is of utmost importance that all pilots and all operational personnel be made fully aware of the potentially disastrous consequences of wing contamination on aircraft takeoff performance.

- Aircraft ground de-icing with a main engine running is routinely performed in the United States and Europe.

- Aircraft ground de-icing with a main engine running is an important operational matter requiring a standard company policy that is made explicitly known to all pilots and operational personnel.

- An Air Ontario internal memorandum was circulated throughout the Air Ontario SOC facility, prohibiting the de-icing of the F-28 aircraft with main engines running.

- The information contained in the memorandum, including the prohibition against de-icing with a main engine running, was taken from a Fokker publication that had limited circulation among pilots.

- Air Ontario dispatchers were familiar with the company prohibition, against de-icing with main engines running, while some Air Ontario F-28 pilots were not familiar with it.

- Air Ontario failed to have in place an effective system for distributing information regarding the de-icing of F-28 aircraft to all pilots and operational personnel, including information regarding de-icing procedures with a main engine running.

- There should have been an operational policy in place at Air Ontario, and understood by all pilots and operational personnel, regarding the de-icing of the F-28 aircraft and, in particular, the de-icing of the F-28 aircraft with a main engine running.

- Captain Morwood may have been aware of the Air Ontario prohibition against de-icing the F-28 aircraft with its main engines running.

- The Air Ontario prohibition against de-icing its F-28 aircraft with main engines running may have been an influencing factor in Captain Morwood's decision on March 10, 1989, not to de-ice the aircraft in

Dryden because of the circumstances that confronted him, including the non-functioning APU and the lack of ground-start facilities.

RECOMMENDATIONS

It is recommended:

Hot Refuelling

MCR 76 That Transport Canada ensure that the flight operations manuals of all air carriers specify that hot refuelling is an abnormal and potentially dangerous procedure and that they outline in detail the appropriate procedures to be followed in order to conduct hot refuelling safely.

MCR 77 That Transport Canada, during the process of approval of air carrier manuals, ensure that the provisions of the proposed manuals are consistent and, specifically, that they coordinate the duties of the cabin crew with those of the flight crew concerning hot-refuelling procedures, with appropriate cross-referencing between the manuals.

MCR 78 That Transport Canada ensure that all aircraft fuellers are adequately trained to standards set by Transport Canada.

MCR 79 That Transport Canada ensure the adequate monitoring of aircraft fuelling procedures at Canadian airports.

Aircraft Ground De-icing

MCR 80 That Transport Canada encourage air carriers to adjust their operational procedures and policies, where technically feasible, to permit the de-icing of an aircraft with a main engine running.

MCR 81 That Transport Canada ensure that the intention of the "clean-wing" concept, as embodied in Interim Recommendations 2 and 3 of this Commission (Consolidated Recommendations MCR 2 and 3) and in recent amendments to the Air Regulations (SOR/90-757) and the Air Navigation Orders (SOR/90-758, and SOR/90-759), be incorporated into and given effect in the appropriate operational manuals of Canadian air carriers.

MCR 82 That Transport Canada ensure, during its normal certification and inspection of Canadian air carriers, that the air carriers have well-organized and effective systems in place for the coordinated distribution to all pilots and operational personnel of comprehensive operational information – including, but not limited to, information regarding aircraft ground de-icing procedures.

MCR 83 That Transport Canada give serious consideration to appointing an appropriately qualified person as a national resource specialist dedicated to all matters pertaining to aircraft surface contamination and the ground de-icing and anti-icing of aircraft in Canada, in the broadest sense, based upon a similar position in the Federal Aviation Administration of the United States and with similar objectives and responsibilities.

22 THE F-28 PROGRAM: FLIGHT ATTENDANT SHOULDER HARNESS

Throughout the course of the hearings there were a number of occasions when evidence arising directly out of the Dryden crash prompted inquiries into larger questions of flight safety. Evidence regarding the forward flight attendant station of C-FONF prompted one such inquiry.

Mrs Katherine Say, an Air Ontario employee for 10 years and the senior flight attendant assigned to flight 1363, did not survive the crash of C-FONF. During the takeoff from Dryden she was seated in the forward flight attendant station.

Post-mortem and accident reconstruction evidence revealed that Mrs Say's chances of surviving the crash may have been enhanced if the flight attendant seats on C-FONF had been upgraded to standards existing in the United States. I heard, with considerable consternation, testimony that Canadian regulations permit the operation of the F-28 Mk1000 with flight attendant seats that are below United States safety standards for the same aircraft.

The rationale behind increasing the crash survivability of flight attendant seats is straightforward and obvious. The surviving flight attendant, Mrs Sonia Hartwick, gave testimony on the subject. Her words need no embellishment:

> Q. And why is it important for a flight attendant to be secure?
> A. So that, in the event of an emergency ... we are able to assist our passengers once the impact has occurred and able to assist our passengers with a quick evacuation as we are, again, a piece of an emergency equipment on that airplane and we are trained in order to assist in a rapid evacuation through our exits.
>
> (Transcript, vol. 12, p. 127)

The forward flight attendant seat on C-FONF (and also on C-FONG) consisted of a forward-facing pedestal to the right of the aircraft's centre line, in the galley and adjacent to the starboard service/emergency exit.[1]

---

[1] The other flight attendant seat, of similar construction, was at the back of the passenger cabin and was unoccupied on March 10, 1989. Flight attendant Sonia Hartwick was seated in seat 8D, which was adjacent to the overwing emergency exit.

The seat was equipped with a lap belt but not with armrests, side restraints, rigid back, or shoulder harness.

Canadian regulations have never required the installation of a flight attendant's shoulder harness on aircraft of C-FONF's certification vintage. Such requirements have existed in the United States since 1980. The relevant United States regulations regarding flight attendant seats are as follows:

> 14 Code of Federal Regulations (CFR) 25.785:
>
> **Seats, berths, safety belts, and harnesses**
>
> (h) Each seat located in the passenger compartment and designated for use during takeoff and landing by a flight attendant required by the operating rules of this chapter must be:
>
> ...
>
> (5) Either forward or rearward facing with an energy absorbing rest that is designed to support the arms, shoulders, head, and spine.
>
> (6) Equipped with a restraint system consisting of a combined safety belt and shoulder harness unit with a single point release. There must be a means to secure each restraint system when not in use to prevent interference with rapid egress in an emergency.
>
> 14 CFR 121.311:
>
> **Seats, safety belts, and shoulder harnesses**
>
> (f) Each flight attendant must have a seat for takeoff and landing in the passenger compartment that meets the requirements of 25.785 of this chapter, effective March 6, 1980.
>
> [Note: The section goes on to list exceptions not relevant to the present case.]

Despite the lack of a Canadian regulatory requirement, the absence of a shoulder harness was specifically referred to in the notes of Mr Ole Nielsen of Transport Canada, who inspected C-FONF in France in March 1988. In his notes, Mr Nielsen wrote: "Flight attendant seats require approved shoulder harness" (Exhibit 1000, p. 4). Similar comments were made by Mr Nielsen in May 1988, immediately prior to the aircraft's importation and its addition to the Air Ontario operating certificate. This and other evidence, described below, indicate that both Transport Canada and Air Ontario were well aware of the cabin safety implications of inferior flight attendant seats installed in C-FONF.

At times, the regulator's primary role of protecting the travelling public is thwarted by what may be described only as bureaucratic lassitude and pliancy. The evidence before this Inquiry offers no other reasonable explanation as to how this inferior level of cabin safety was allowed by Transport Canada to persist in Canada.

Accordingly, I feel bound to review the evidence on this issue in some detail to illustrate how such failures in the regulatory and operational sectors of the air transportation system can occur.

The Forward Flight Attendant Station of C-FONF

The "Cause of Death" section in the report of the post-mortem examination of Katherine Say reads simply: "Generalized body burns" (Exhibit 23, "Compilation of Post-Mortem Records of Air Crash Victims"; tab 22). In the same report, however, the following significant notation was included under the heading "Summary of Abnormal Findings":

> The only impact injury found was the metal foreign body which had embedded itself in the frontal bone. The presence of soot in the respiratory passages indicated some respiratory activity during the fire.
>
> (Exhibit 23, tab 22, p. 5)

There were two metal objects that caused the head injury to Katherine Say. These were examined and photographed in the early stages of the investigation; however, at some point during or after the post-mortem examination, they were misplaced.[2] The Commission's human factors and crash survivability investigative group used its best efforts to determine the origin of the metal pieces, comparing the photographs with the galley configuration on the sister aircraft, C-FONG. Unfortunately, the source of the pieces of metal could not be identified.

The evidence disclosed that Mrs Say's body was found in the wreckage some distance from her seat.[3] This evidence and toxicological evidence reported by the Ontario Region aviation medical officer of

---

[2] Mr David Adams, chairman of the Commission's human factors and survivability investigative group, testified that he was quite annoyed when he learned that the metal objects were misplaced. For present purposes, it is sufficient to note that I share Mr Adams's chagrin at the careless handling of this significant forensic evidence.

[3] Flight attendant Hartwick confirmed that in fact Mrs Say was in the forward flight attendant's seat at commencement of the takeoff. See figure 22-1, Pre- and Post-Accident Locations of Individuals Seated in Forward Positions on Flight 1363.

Transport Canada led to the following finding by the human factors and survivability group:

> *Survival time* was likely **less than a minute** but this value could vary and post impact voluntary movement cannot be ruled out! It appears that some evidence suggests minimal respiratory activity after impact and that death was probably less than a minute, however body location may suggest some form of post impact, voluntary movement. The head injury, Katherine Say received, may not have resulted in a loss of consciousness. The latter would be supported by the fact that this head injury did not cause any internal cerebral damage. In summary, Katherine Say may have died shortly after impact and never regained consciousness or she may have been conscious enough to make a vain attempt at egressing the aircraft before losing consciousness.
>
> (Exhibit 1258, Human and Survival Factors Group Chairman Report; tab 2, p. 24)

Because of the extensive post-crash burns to her body, it was impossible to determine whether Katherine Say suffered other impact injuries.

There was evidence as to the location in the aircraft of the "male" portion of a buckle from Mrs Say's seat belt. Because the investigators were unable to locate the buckle's "female" portion or any other part of the seat belt, it could not be determined conclusively whether the flight attendant's seat-belt buckle opened on impact or was undone before or after the crash.[4]

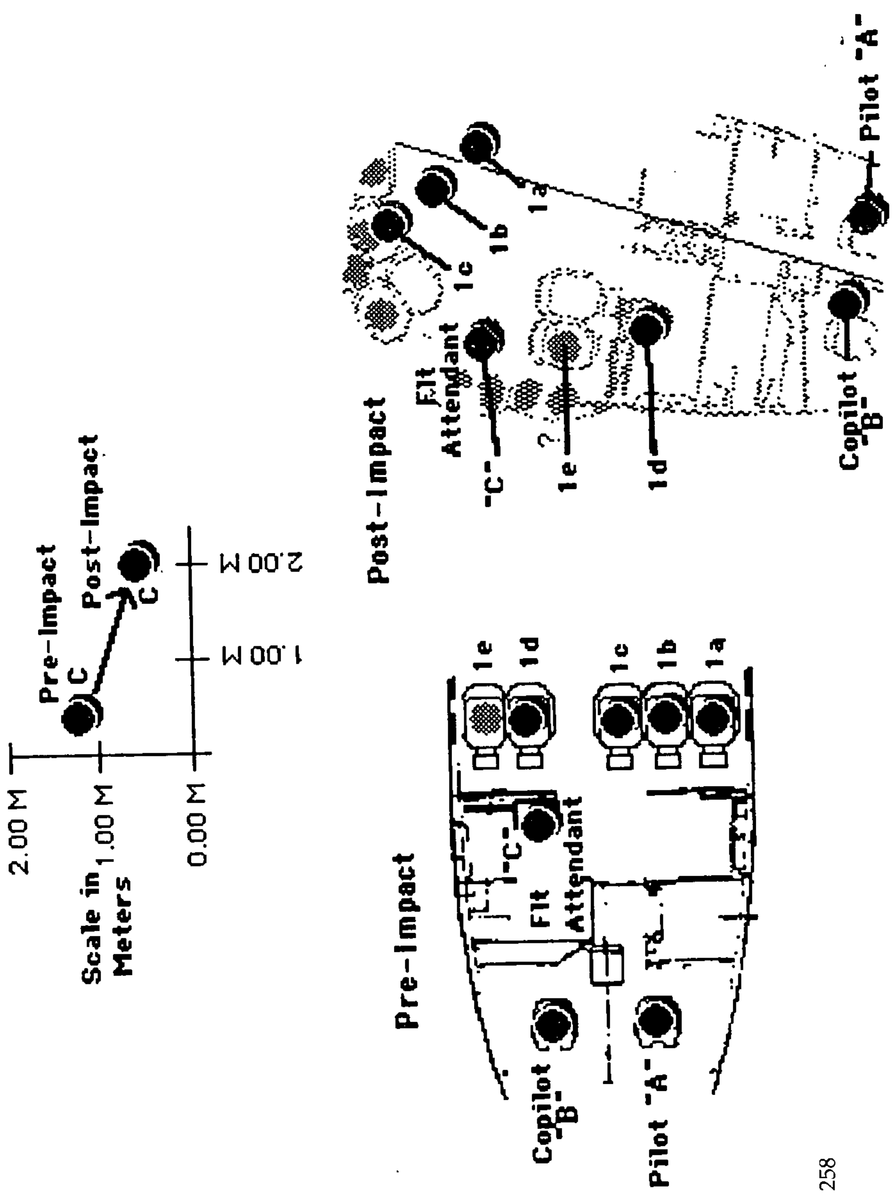
Attempts to draw inferences from the physical evidence remaining after a crash and fire of this magnitude are naturally fraught with uncertainty. There are a number of possible explanations for the location of Katherine Say's body after the crash.

The only impact injury revealed at autopsy was the penetration injury to her forehead, from which area the two metal objects were extracted. If one assumes that Katherine Say was seated in her flight attendant seat at the time of impact, then the natural forces at work on impact would have thrown her upper body forward. There is therefore a high probability, based on all of the evidence, that the head injury suffered by Mrs Say resulted from the forward impact of her head against a metal object located immediately adjacent to her cabin attendant seat.

---

[4] Mr Adams was able to determine with a high degree of probability that the "male" portion of the buckle located was in fact Mrs Say's. It was the testimony of Mr Adams that flight attendant seat-belt buckles are different from those on regular passenger seat belts. The "insert" and "latch" portion of the buckle has two holes in the flight attendant buckle and only one hole in the passenger buckle. The buckle attributed to Mrs Say's seat belt was the only two-hole buckle found in the forward section of the cabin (Transcript, vol. 156, pp. 149–51).

Figure 22-1 Pre- and Post-Accident Locations of Individuals Seated in Forward Positions on Flight 1363



Source: Exhibit 1258

Although other factors may have intervened to cause her head injury during the breakup sequence, it is beyond dispute that, had she been secured by a shoulder harness, her upper body would have been markedly better restrained and protected from injury caused by forward motion on impact. This, after all, is the function of a shoulder harness.

Whether Mrs Say would have been able to aid passengers or eventually to make her way out of the wreckage had she not sustained the head injury cannot be stated. What can be said is that her chances for survival may have been enhanced if she had had the protection of a shoulder harness.

If C-FONF had been a United States–registered aircraft, there would have been, pursuant to United States law, a shoulder harness in place for Katherine Say. Instead, this Canadian-registered aircraft, because of the lack of Canadian regulatory requirements, was legally flying without this critical piece of flight safety equipment.

I now turn to the relevant Canadian and United States legislation: design and manufacturing criteria; operational standards and regulations. A review of the history of the flight attendant shoulder harness issue will then follow.

Governing Legislation

To enhance the safe carriage of passengers in transport category aircraft such as the F-28 Mk1000, regulatory authorities stipulate criteria under which aircraft are to be designed, manufactured, and operated. Design and manufacturing criteria are generically referred to as "certification standards" or "airworthiness standards." Only if these certification standards are met will a type certificate and a certificate of airworthiness be issued and the aircraft type be allowed by law to fly in commercial service. Operational standards are defined by the regulations and orders governing air carriers.

Design and Manufacturing Criteria

Aircraft meeting the airworthiness standards of design and manufacture of a particular jurisdiction will typically be permitted to operate by way of some form of certification process. Various jurisdictions have, over time, developed a system of bilateral and multilateral acceptance of one another's certification criteria. The most common certification criteria to which transport category aircraft are designed and manufactured are those of the United States. Because the United States has historically been the largest manufacturer of transport category aircraft, there is wide acceptance of its certification criteria.

Canadian regulators accept, for the most part, United States design and manufacturing criteria when granting "type approval" to an aircraft for operation within this country.

The United States certification criteria for transport category aircraft are set forth in Part 25 of the Federal Aviation Regulations (FAR 25).[5] These criteria must be met before the Federal Aviation Administration (FAA) will grant a United States type certificate to a model of aircraft. FAR 25 is a vast compendium of certification requirements addressing everything from engines and electrical systems to passenger and crew member seats.

Prior to the enactment in the United States of FAR 25 in 1964, the United States criteria for the certification of transport category aircraft were contained in a certification regime designated as Civil Aviation Regulation (CAR) 4(b). According to the testimony of Mr Ole Nielsen, the Transport Canada inspector who supervised the importation of C-FONF into Canada, it was under CAR 4(b) that the F-28 Mk1000 aircraft received its United States type certification. CAR 4(b) did not require the installation of either flight attendant seat shoulder harnesses or energy-absorbing seats. In fact, until 1980, FAR 25 did not require such installation.[6]

In 1972 the Canadian Department of Transport granted the F-28 aircraft type approval, thereby authorizing its operation by Canadian air carriers. By granting the F-28 type approval, the Canadian authorities accepted the United States certification of the aircraft. At the time of the granting of the type approval in 1972, neither Canada nor the United States required the installation of flight attendant shoulder harnesses on the F-28.[7]

By the late 1970s, however, the issue of cabin safety had undergone a comprehensive review in the United States, resulting in a number of significant improvements. In 1980, FAR 25 was amended to require the installation of flight attendant seats of a safer design. All transport category aircraft designed and manufactured after the effective date of the amendment to FAR 25 (March 6, 1980) had to meet the new criteria in order to receive a United States certificate of airworthiness. United States aircraft of older design were permitted to continue in commercial operation provided that they conformed with another Federal Aviation

[5] FAR Part 25 is cited as 14 CFR 25. These regulations are promulgated and administered by the Federal Aviation Administration of the U.S. Department of Transportation.

[6] FAR Amendment 25-51, "Airworthiness Review Program – Amendment No. 8: Cabin Safety and Flight Attendant Amendments"

[7] Exhibit 679, "Aircraft Type Approval, A-108, Fokker F-28 Mark 1000 and Mark 2000" (February 27, 1973)

Regulation specifically directed at the operational accommodation of the new technology in older aircraft. These "operational requirements" were set out in FAR Part 121.[8]

United States Operational Standards

Application of Standards to New Aircraft

The certification standards set out in FAR 25 delineate requirements for aircraft design and manufacture. The operation of aircraft is governed by operational regulation. In the United States the operational regulations are contained in FAR 121. In Canada they are dealt with in the Air Navigation Orders.

One significant purpose of the certification standards outlined above is to inform aircraft builders of the criteria that their products will have to satisfy before such products will be permitted to be operated in private or commercial service. In short, the certification standards represent conditions precedent to the entry into the marketplace of new aircraft.

The certification criteria in FAR 25 are amended from time to time to incorporate new technology in aircraft design and materials. Aircraft designed and manufactured after an amendment to a certification criterion will thereafter be built to the new standard.

Application of New Standards to Existing Aircraft

FAR 25 does not accommodate the problem of incorporating new technology into existing aircraft. The application of new technology to old aircraft is typically addressed through operational regulation, which, if appropriately drafted, will complement the certification regime.

---

[8] 14 CFR 25.785:

Seats, berths, safety belts, and harnesses

(h) Each seat located in the passenger compartment and designated for use during takeoff and landing by a flight attendant required by the operating rules of this chapter must be:

... (5) Either forward or rearward facing with an energy absorbing rest that is designed to support the arms, shoulders, head, and spine;

(6) Equipped with a restraint system consisting of a combined safety belt and shoulder harness unit with a single point release. There must be means to secure each restraint system when not in use to prevent interference with rapid egress in an emergency ...

[Note: The "operating rules" in section 25.785(h) refer to FAR Part 121; specifically, FAR 121.311 (cited as 14 CFR 121).]

New Seat, Safety Belt, and Shoulder Harness Requirements (1980) In 1980, the FAA incorporated various developments in cabin safety technology into both the FAR 25 certification criteria as well as the FAR 121 operational criteria. New requirements for flight attendant seat construction in existing aircraft were set out in FAR 121.311, which states:

> **121.311 Seats, safety belts and shoulder harnesses**
>
> ...
>
> (f) Each flight attendant must have a seat for takeoff and landing in the passenger compartment that meets the requirements of FAR 25.785 of this chapter, effective March 6, 1980, except that –
>
> (1) Combined safety belt and shoulder harnesses that were approved and installed before March 6, 1980, may continue to be used; and
>
> (2) Safety belt and shoulder harness restraint systems may be designed to the inertia load factors established under the certification basis of the airplane.

The result of this operational requirement was, in essence, that the requirements set out in FAR 25.785, including the provision of flight attendant shoulder harnesses, were made mandatory for all transport category aircraft, regardless of their date of manufacture.

Canada has never adopted the United States operational requirements of FAR 121. The applicable Canadian operational standard that was in place on the date of the accident was Air Navigation Order (ANO) Series II, No. 2, the Aircraft Seats, Safety Belts and Safety Harnesses Order. This order had been in force since May 1966.

ANO Series II, No. 2, contains no provision specifically dealing with flight attendant seating, seat belts, or shoulder harnesses.

The Canadian Approach to the Shoulder Harness Issue

In July 1987, some seven years after the promulgation in the United States of FAR 121.311, the Canadian authorities published a proposed amendment to the Aircraft Seats, Safety Belts and Safety Harnesses

Order.[9] The proposed amendment addressed, among other things, the issue of flight attendant seats. The relevant amendment to the existing requirement was the following:[10]

> s. 4 (4) After January 1, 1988, no person shall operate an aircraft on a commercial air service unless it is equipped with an approved safety belt, consisting of a lap strap combined with a shoulder harness, for each flight attendant seat.

An additional concern in the proposed amendment was that regarding "Use of Safety Belts." The relevant section stated:

> s. 8 (1) Except as provided in subsection (2)[11] or (3), every person carried on board an aircraft, other than an infant or a passenger or parachutist referred to in Section 6 or 7, shall keep a safety belt, including the shoulder harness, if any, properly fastened about him while the aircraft is taxiing, taking off or landing, and at any other time when so directed by a crew member or by a safety belt sign displayed in the aircraft.
>
> ...
>
> (3) A crew member is not required to comply with subsection (1) when the aircraft is being operated otherwise than on take-off or landing and the crew member is performing assigned safety related duties.

The proposed implementation date of January 1, 1988, came and went with no approval of the amendment to ANO Series II, No. 2, and, therefore, there was no compliance required by Canadian operators.

The delay in the implementation of the proposed ANO is attributable, in part, to protracted discussions between Transport Canada and the Air Transport Association of Canada (ATAC). ATAC is the national service organization for the Canadian commercial air transport industry. Its membership, comprised of individuals and companies involved in the

---

9 *Canada Gazette*, Part 1, July 18, 1987, pp. 2311–15. *Canada Gazette* is the publication through which the Government of Canada provides notification of proposed regulatory change. After the government has considered comments arising out of the notice of proposed regulation, the public is notified of the promulgation of the regulation by its publication in *Canada Gazette*, Part 2.

10 In addition to addressing flight attendant seats, the proposed amendment considered passenger seats and seat belts; pilot seats and seat belts; seats and seat-belt requirements for "special purpose operations" (e.g., aerial spraying); seats and seat belts for parachutists; approved child restraint systems; crew member activities while the aircraft is operating and the seat-belt sign is displayed; and the use of seat belts by pilots.

11 Subsection 2 refers to the use of child restraints.

Canadian airline industry, includes airlines accounting for approximately 95 per cent of Canadian commercial air transport revenue. Among its many other roles, ATAC reviews developments in legislation that could potentially affect the aviation industry. There is regular contact between ATAC and the Government of Canada regarding aviation-related legislation, and, for this reason, ATAC has been variously described as an industry interest group and an industry lobby group.

Amending the Aircraft Seats, Safety Belts, and Safety Harnesses Order

The Role of ATAC

When faced with the operational changes that would be necessitated by the amendment to ANO Series II, No. 2, ATAC appears to have marshalled its forces, effectively forestalling its implementation. The concern of the industry was not with the necessity of installing safer flight attendant seats; rather, the industry was concerned primarily with the proposed restrictions on flight attendant activities when the safety belt sign is displayed in the cabin. The debate over the wording of the proposed amendment appears to have commenced more than a year following its July 1987 publication.

On October 11, 1989, Mr Donald E. Lamont, ATAC vice-president of flight operations, met with the ATAC cabin operations subcommittee with regard to the proposed amendment. Certain concerns were expressed regarding the proposed restriction on the ability of flight attendants to provide passenger services while the safety belt sign is illuminated. On October 20, 1989, Mr Lamont met with Mr Weldon Newton, the director-general of aviation regulations, and Mr William Slaughter, the director of flight standards, Transport Canada, to discuss the ATAC concerns. Mr Lamont reported to the ATAC cabin operations subcommittee on his meeting with Transport Canada:

> The concern was expressed that if the Order as written became a regulation, attendants would be compelled to be seated and strapped into a seat while the safety belt sign was illuminated except while performing assigned safety related duties.
>
> Transport Canada has agreed to revise these paragraphs to permit the performance of other related duties (meals, service, etc) while the seat belt light is turned on. The qualification will be that the Captain has approved of such service(s) taking place while the seat belt sign is displayed.
>
> Transport Canada will consult with ATAC on the revisions and I will keep you advised of developments as they occur.
>
> (Exhibit 1168, tab 3)

There was, apparently, no discussion between ATAC and Transport Canada regarding the proposal that flight attendant seats be equipped with shoulder harnesses. The industry was concerned primarily with in-flight service.

On October 24, 1989, Mr Slaughter wrote a memorandum to Mr Arthur LaFlamme, also of Transport Canada, stating that, following his meeting with Mr Lamont and Mr Newton, there was agreement that the wording of subsection 8(3) of the amendment to ANO Series II, No. 2, was too restrictive. Mr Slaughter suggested the following alternative amendment to the order:

> A crew member is not required to comply with subsection (1) where the aircraft is being operated otherwise than on take off or landing and the crew members performing assigned duties related to the safety of passengers, or other duties as approved by the Captain.
>
> (Exhibit 1168, tab 5)

Mr Slaughter stated further that this amendment would enable the "in-charge" flight attendant to make decisions as to whether to continue or discontinue passenger service during periods when the "fasten seat belt" light is illuminated.

On December 11, 1989, Mr LaFlamme, exercising, in my view, good judgement, replied to Mr Slaughter that making changes relevant to flight attendants' in-flight activities would delay the requirement for safer flight attendant seats. Mr LaFlamme wrote:

> Any changes to the order at this time can delay publication in Canada Gazette, Part II and may require the document to be republished again in Part I for consultation. The order also contains the requirement for shoulder harnesses on flight attendant seats, permits use of infant/child restrain[t] devices, securing of stretchers, etc., all highly sensitive regulatory safety issues which will not be resolved until the proposed rule change is published as a final rule.
>
> For all the foregoing reasons, it is requested that the revised wording of subsection 8(3) as contained in your memorandum be reconsidered in favour of the paragraph contained in the present amendment.
>
> (Exhibit 1168, tab 6)

I heard evidence that, following Mr LaFlamme's advice to Mr Slaughter, there were many communications between Canadian air carriers and Transport Canada regarding the proposed amendment to the Air Navigation Order. These communications, which persisted until as late as April 1990, all addressed the subject of permissible flight attendant activities. None appeared to canvass the subject of safer flight attendant seats.[12]

Mr Slaughter, in his evidence before me, seemed to have grasped the essential point, albeit belatedly. His testimony was as follows with regard to the issue of the proposed amendment to ANO Series II, No. 2:

> A. ... there's three major and independent regulations in being, and for the sake of discussions over one line in one area of it, we have held up the whole Air Navigation Order.
>
> And perhaps that should be separated in some way so that we can examine one in isolation without impeding the progress of the other two.
>
> (Transcript, vol. 145, p. 55)

The issue of mandatory flight attendant shoulder harnesses is still unresolved, some four years after the initial proposed amendment to ANO Series II, No. 2, and twelve years after the issue had been carefully considered and resolved by the United States regulator and industry.

This is the bureaucratic lassitude and pliancy referred to earlier. In light of the evidence, I offer no apologies for my choice of language.

One final note on the subject that is worthy of mention came to light during the evidence of the director of flight standards for Transport Canada, Mr Slaughter. The Air Transport Association of Canada is often called upon by the carriers, whom it represents, to lobby Transport Canada in support of positions being advanced or favoured by air carriers regarding the content of existing or proposed legislation. In certain instances, such as with the shoulder harness issue, such legislation may have financial implications for the carriers as well as having aviation safety implications. Transport Canada officials responsible for the development and implementation of such rule changes therefore must be vigilant to ensure that the safety component of the legislation is not effectively diluted or neutralized as a result of industry pressure.

It was therefore surprising to discover during Mr Slaughter's evidence that the selection board, which was put in place by Transport Canada in early 1989 to hire Transport Canada's new chief of air carrier standards, included the vice-president of operations of the industry lobby group, the Air Transport Association of Canada, Mr Donald Lamont. The successful candidate was Mr Arthur LaFlamme.

---

[12] Exhibit 1168, tabs 8-17: A series of memoranda and notes regarding permissible flight attendant activities while the seat belt sign is illuminated, and the proposed amendment to ANO Series II, No. 2

I do not in any way question the integrity of either Mr Lamont or Mr LaFlamme. Certainly, Mr LaFlamme's actions regarding the shoulder harness issue and ANO Series II, No. 2, following his selection as chief of air carrier standards, were in my view not only entirely appropriate but indeed commendable. However, the Transport Canada practice of appointing, or acquiescing in the appointment of, individuals to its hiring-selection board who may subsequently be required, by the very nature of their own aviation industry positions, to bring pressure to bear on the future decisions of the successful candidates is, in my opinion, an unacceptable practice that should be discontinued. Mr Slaughter was questioned on the appearance of a conflict of interest arising under these circumstances, and he agreed that such was to be avoided:

> Q. All right. Well, if you can, you should avoid even the appearance of conflict so as not to call the integrity of Transport Canada into disrepute; isn't that right?
> A. I agree. When you put it in this light, I certainly agree.
> (Transcript, vol. 145, p. 248)

The Role of Air Ontario

I would not like to leave the impression from the foregoing that Air Ontario is itself without a measure of responsibility for allowing substandard flight attendant protection in its aircraft.

Both Air Ontario's own employee Mr Teoman Ozdener, and its outside consultant Mr Derek Hicks, noted the flight attendant shoulder harness deficiency during the survey of sister aircraft C-FONG and reported the deficiency to Air Ontario management.[13] Mr Hicks, in his survey report to the company, made the following comments:

> Front Stew seat considered unsatisfactory as is and is not to be used on take off or landing. Rear seat is satisfactory if and when a shoulder harness is fitted. Seat not to be used for take off and landing until shoulder harness is fitted.
> (Exhibit 832, Derek Hicks, M.L.B. Associates, to Douglas Christian, Air Ontario, March 28, 1988)

The approach suggested by Mr Hicks would seem to be a sensible compromise. Until the shoulder harness/flight attendant retrofit could have been completed, both flight attendants would have been required

[13] Although Mr Ozdener and Mr Hicks initially inspected aircraft 10070 (C-FONG), it was acknowledged by witnesses Mr Ozdener and Mr Bittle that the inspection comments regarding the absence of a flight attendant shoulder harness on C-FONG were equally applicable to aircraft C-FONF.

to take seats in the passenger compartment on takeoff and landing. Although the passenger seats did not offer an equivalent protection to a proper flight attendant seat with a shoulder harness, they were superior to the flight attendant seats that were in place on C-FONF. The passenger seats provided back and lateral support while the flight attendant seats did not. Having stated this, I would add that ANO Series VII, No. 2, requires all cabin attendants to be seated at their approved stations with safety belts fastened on takeoff and landing (sections 19(2), 19(3)).

Transport Canada and Air Ontario therefore created a predicament for the senior flight attendant on the F-28. A greater level of safety could have been achieved by sitting in a passenger seat; however, for the senior flight attendant, in the absence of any authorization from Transport Canada, it was illegal to be seated in any but the approved flight attendant station.[14] Ironically, in the case of the F-28 C-FONF, the approved flight attendant station was the substandard forward jump-seat. Transport Canada could have readily designated an appropriate passenger seat as the approved flight attendant station, had Air Ontario so requested.

In March 1988 Mr Ozdener reported to Mr Kenneth Bittle, the Air Ontario vice-president of maintenance, on the progress of the F-28 importation. With regard to the present issue, Mr Ozdener noted: "Shoulder harnesses for flt. attendants are on order by TAT" (Exhibit 811, p. 5).

Mr Bittle testified that he initially thought that the installation of the shoulder harnesses was a regulatory requirement and that TAT would be assuming the cost of installation. He testified further that, when TAT informed Air Ontario that it was not going to install the harnesses, he made inquiries regarding the cost of the installation. When Mr Bittle became aware that there was no regulatory requirement for the shoulder harnesses, he recommended to the Air Ontario flight operations department that they not be installed. Mr Bittle's recommendation was based largely on economic considerations. He testified that the shoulder harness modification on the F-28s would have cost approximately U.S.$90,000, and, because Air Ontario was leasing the aircraft, he was of the opinion that it would have been a poor business decision to incur the cost. Mr Bittle's evidence clearly indicated that Air Ontario took advantage of the laxity in the regulation in order to avoid the expense

[14] The Air Ontario Flight Attendant Manual required the junior flight attendant in the F-28, when there were fewer than 65 passengers, to be seated in seat 8D, adjacent to the mid-aircraft emergency exit. When the aircraft had 65 passengers, the junior flight attendant was required to be seated in the rear flight attendant jump-seat. The senior flight attendant, in all instances, was to be seated in the forward jump-seat.

of replacing the substandard flight attendant seats and the installation of the shoulder harnesses in the F-28:

> Q. It was not necessary to have the front harness, in your opinion?
> A. That's right, in my opinion. And I stand to be corrected, but I still don't think it has been put through.
> I think it was published in the Canada Gazette and has ceased any activity since then, but I could be proved wrong on that.
> But at that time, certainly my understanding that was not a requirement, and we were pretty familiar with what was a requirement, due to us having to research all this stuff, floor track lighting, seat flammability, GPWS. You name it, it was all covered by ANOs. This was not.
> So at that time, we elected to wait on ordering. We were also trying to see if there was another way to do it. Maybe we would redesign the whole front of the airplane ourselves.
> But you have to keep in mind that this airplane was not the long-term airplane for Air Ontario. It was a one-year lease, and when we received our permanent airplanes, then you would be much more interested in investing some heavy money into modifications that would stick with you.
> Because this would go back – this airplane ... will go back to TAT at some point, and anything we had done to it, it would be money wasted.
>
> (Transcript, vol. 103, pp. 172–73)

Mr James Morrison assumed the position of vice-president of flight operations in July 1988, shortly after the commencement of the F-28 operation. He was informed by Mr Bittle of the flight attendant seat deficiency, and he accepted Mr Bittle's assessment of the situation (Transcript, vol. 116, pp. 36–37).

From the period of the importation of the aircraft in May 1988 to the addition of the F-28 on Air Ontario's operating certificate in June 1988, the issue was considered by both Air Ontario and Transport Canada. Mr Ozdener, who was supervising the importation for Air Ontario, informed Mr Nielsen of Transport Canada of the status of certification requirements for the two F-28 aircraft. Mr Ozdener noted the following in one communication to Mr Nielsen:

> Shoulder Harnesses F/A seats S.B. ordered. Seats not to be occupied until shoulder harness installed[:] N/A: not mandatory until 89/06.
>
> (Exhibit 1001, p. 1)

Mr Nielsen noted on his own "aircraft importation check sheet" for C-FONF that the seat belts for the aircraft were acceptable "except F/A seat belts" (Exhibit 1002, "Aircraft Importation Check Sheet," May 1988). Mr Nielsen explained that he discussed the matter with Mr Ozdener and Mr Hicks and was under the impression that the flight attendant shoulder harnesses were required. Subsequently, Mr Nielsen consulted the Engineering Branch of Transport Canada and was advised that there was no requirement for flight attendant shoulder harnesses on the F-28 Mk1000. Air Ontario took the position that it would not install the shoulder harnesses until it was a regulatory requirement (Transcript, vol. 130, pp. 198–99).

Mr Nielsen was asked whether, as the inspector in charge of the certification of the F-28 C-FONF, he had any discretion to insist upon the installation of the shoulder harnesses, regardless of the state of the amendment to ANO Series II, No. 2. Mr Nielsen acknowledged that the shoulder harnesses would enhance the safety of the aircraft, but, absent any legislative authority, he would not insist upon their installation. Mr Nielsen testified:

> A. ... The shoulder harness had been a FAR 25 requirement for many years before this airplane ever came into the country, so it was obviously deemed to be a safety factor prior to this airplane ever arriving.
>
> But as far as advising the carrier to install it, we are not going to do that unless we've got some legislative background to do it on.
>
> (Transcript, vol. 129, p. 139)

As late as December 1988, Mr Ozdener wrote to Mr Bittle about the installation of the shoulder harnesses on the F-28 (Exhibit 812). This was the last documentary reference to the shoulder harnesses at Air Ontario until the crash of C-FONF. Mr Ozdener left the employ of Air Ontario in January 1989.

In May 1989 Air Ontario flight safety officer Captain Ronald Stewart noted the absence of flight attendant seat shoulder harnesses during an inspection of C-FONG. He addressed the issue to Mr Bittle in a memorandum dated May 19, 1989, recommending installation of the harnesses.

On May 29, 1989, two and one-half months after the accident, chief inspector Douglas Christian of Air Ontario wrote to Fokker Aircraft (United States) requesting information regarding the cost of the installation of shoulder harnesses on the remaining F-28, C-FONG. Shortly thereafter, Air Ontario discontinued its F-28 program.

From the evidence it was clear that both Transport Canada and Air Ontario were fully aware of the flight safety implications of introducing C-FONF into commercial service without the flight attendant shoulder harnesses. Air Ontario made a commercial decision not to enhance the standard of safety of the flight attendant seats above the minimum standard required by Transport Canada.

The aircraft was "legal" according to the witnesses; however, if the regulatory component of the air transportation system had not failed, a law requiring flight attendant shoulder harnesses would have been enacted in a timely fashion.

I must emphasize that it is the job of the regulator to look after the safety interests of the travelling public, not the commercial convenience of the carrier. Only with this appreciation of the regulator's role will the air transportation system function properly. Having stated this and regardless of the standards set by the regulator, I am of the view that the carriers should do what they are reasonably able to by way of securing the safe air carriage of their passengers and employees. It was acknowledged by a number of witnesses, including Mr Bittle, that the short, one-year lease of the aircraft inhibited the substantial expenditure for the shoulder harness installation. The chief executive officer, Mr William Deluce, testified that he became aware of the shoulder harness issue when an accommodation for the installation of shoulder harnesses appeared in Air Ontario's 1989 revised capital budget. Apparently, in December 1988 Air Ontario had budgeted for the eventual installation of the shoulder harnesses.

I am of the view that, had Air Ontario properly prepared for the introduction of the F-28, surveying the aircraft well in advance of accepting its delivery, then the flight attendant seat retrofit and shoulder harness installation could easily have been achieved prior to the start of commercial service. Air Ontario committed itself to the terms of the aircraft lease on November 19, 1987. The lease contained specific provisions for the mutual inspection of the aircraft in advance of aircraft acceptance, and Air Ontario commenced its comprehensive survey of the aircraft in early March 1988, with the expectation that the lease period would commence on March 15, 1988. The pilot strike intervened, and the Air Ontario importation team was ordered back to Canada. Upon Mr Ozdener's return to Canada, Air Ontario management was informed of the flight attendant shoulder harness deficiency. Air Ontario management equivocated on the necessity of the shoulder harnesses. The Air Ontario vice-president of maintenance and engineering, Mr Bittle, recommended initially that, in the absence of a regulatory requirement, Air Ontario not effect the installation.

Had Air Ontario properly planned the implementation of the F-28 program, it should have anticipated the cost of rectifying the deficiency of the flight attendants' stations. Even in the absence of such foresight, at the very least Air Ontario should have made application to Transport Canada for the designation of appropriate passenger seats for flight attendant stations. This action, as an interim measure, albeit not desirable, would have resulted in a higher degree of safety for the flight attendants, pending completion of the flight attendants' shoulder harness retrofitting.

It should be noted that much later, after the introduction of the jet into commercial service, the carrier budgeted for the installation of the harnesses by May 1989.

Air Ontario had at least a six-month window of opportunity, from November 1987 to the commencement of commercial service in June 1988, to resolve the shoulder harness issue. The failure to do so reflects very poorly upon the planning and implementation of the Air Ontario F-28 program. This observation has been made repeatedly in assessments of other operational deficiencies arising directly out of the investigation of the crash of C-FONF.

This air carrier safety deficiency is not mitigated by the fact that the amendment to the Aircraft Seats, Safety Belts and Safety Harnesses order had stalled in Transport Canada. Air Ontario managers testified that they believed that approval of the shoulder harness order was in fact imminent and, more importantly, that the installation of the shoulder harnesses was a significant safety benefit to its cabin crews and passengers. In my view, it was inappropriate for Air Ontario to rely on an argument that C-FONF was "legal" and therefore "safe." A corporate commitment to flight safety requires more than a simple dependence on the regulator to set standards.

Findings

- Flight attendant Katherine Say was seated in the forward flight attendant station at the time of the crash. This forward-facing seat was not equipped with a shoulder harness, armrests, side restraints, or a rigid back.

- During the crash sequence, Mrs Say suffered an impact injury to her forehead: two small pieces of metal became embedded in her forehead.

- There is uncertainty about whether Mrs Say died shortly thereafter, having never regained consciousness, or whether she made an attempt to egress the aircraft before succumbing.

- Mrs Say's chances for survival may have been enhanced if she had been afforded the protection of a shoulder harness.

- Had C-FONF been a United States–registered aircraft on the date of the crash, United States law would have required the flight attendants' seats to be equipped with shoulder harnesses.

- United States law requiring a retrofit of shoulder harnesses and other safety-enhancing features for flight attendant seats in older aircraft such as the F-28 has existed in relation to United States–registered aircraft since 1980.

- Canadian efforts to legally require a retrofit of shoulder harnesses and other safety-enhancing features for flight attendant seats in older aircraft such as the F-28 were not formally proposed until 1987, some seven years after similar United States law had been enacted.

- The proposed Canadian law, which, if passed, would require a retrofit of shoulder harnesses and other safety-enhancing features for flight attendant seats, has been stalled for more than four years and remains unresolved twelve years after this same issue was carefully considered and resolved by the United States regulator and industry.

- Transport Canada airworthiness personnel were aware of the safety deficiencies of the flight attendant seats on C-FONF but felt powerless to require that such safety deficiencies be remedied in the absence of legislative authority.

- The delay in implementation of proposed amendments to Canadian law regarding flight attendant seats is due in part to bureaucratic pliancy and lassitude on the part of certain sections of Transport Canada.

- Air Ontario management was aware of the safety deficiencies on C-FONF prior to the importation of that aircraft into Canada.

- For economic reasons, Air Ontario decided not to incur the cost of retrofitting the flight attendant seats with shoulder harnesses and other safety-enhancing features until such time as it was a regulatory requirement.

- A consultant hired by Air Ontario suggested that, until a shoulder harness retrofit could be accomplished, flight attendants be required to be seated in the passenger compartment during takeoff and landing.

- The retrofit of flight attendant station shoulder harnesses could easily have been achieved prior to the start of commercial service if Air Ontario had properly prepared, in a timely way, the introduction of the F-28 program.

- Although passenger seats were not equipped with shoulder harnesses, they were superior to the flight attendant seats. Passenger seats provided back and lateral support. Flight attendant seats did not provide such support.

- Canadian law requires that flight attendants be seated at their "approved" stations during takeoff and landing. In the case of C-FONF, the approved flight attendant station was the substandard forward jump-seat.

- No request was ever put forward to Transport Canada by Air Ontario to have any passenger seats approved for seating flight attendants during takeoff and landing.

- As an interim measure, Air Ontario should have made application to Transport Canada for the designation of appropriate passenger seats as approved flight attendant stations.

- Transport Canada could readily have designated an appropriate passenger seat as an approved flight attendant station, had Air Ontario so requested.

- The Air Transport Association of Canada (ATAC), among its many other roles, acts as an industry interest group on behalf of air carriers in its dealings with Transport Canada.

- The delay in the implementation of legislation that would enhance the safety requirements for flight attendant seats is attributable in part to protracted discussions between ATAC and Transport Canada.

- In 1989 a promotional competition for the Transport Canada position of chief of air carrier standards was presided over by a three-person selection committee that included the ATAC vice-president of operations as one of the committee members.

RECOMMENDATIONS

It is recommended:

MCR 84 That Transport Canada immediately press ahead with appropriate amendments to Air Navigation Order Series II, No. 2, that would require the retrofit of shoulder harnesses and other safety-enhancing features for flight attendant seats on older aircraft types such as the F-28 aircraft.

MCR 85 That Transport Canada assess and amend, as necessary, the procedures required to enact aviation safety–related legislation so as to avoid the bureaucratic process that has delayed the enactment of flight attendant shoulder harness and other important aviation safety–related legislation for the 12-year period since similar legislation was enacted in the United States.

MCR 86 That Transport Canada ensure that individuals from aviation industry positions are not placed on Transport Canada hiring or selection committees where there is any appearance of those individuals having a conflict of interest between their industry positions and their positions on the selection committee.

23 OPERATIONAL CONTROL

The Purpose of Operational Control

In the introduction to this Report, I described the interrelationship of the various components that comprise the air transportation system. Central to the safety of this transportation system, and indeed to the safe operation of an airline, is the function of operational control. Operational control is defined in Air Navigation Order (ANO) Series VII, No. 2, as "the exercise of authority over, or the initiation, continuation, diversion or termination of, a flight." Implicit within it are the crucial functions of flight dispatch and flight following.

In a broad sense, operational control is intended to provide support to the flight crew by ensuring that they have available to them full-time communications systems providing access to up-to-date information which permits them to make the safest possible operational decisions. The circumstances of the Dryden accident illustrate the key role of operational control within the transportation system, as well as the tragic results of a breakdown in that system.

During the course of the hearings of this Inquiry, I heard extensive evidence which traced the events of Air Ontario flight 1362/1363 on March 10, 1989, and which, in my view, indicated a breakdown in Air Ontario's operational control. Flight crews rely on company dispatchers to plan flights and monitor their progress (flight following).[1] Decisions on flight planning necessarily require dispatchers to consider a range of factors including unserviceabilities on the aircraft, en route weather, fuel, en route station facilities, and passenger loads.[2] Operational control is intended to prevent circumstances of the sort that occurred at Dryden, that is, the operation of an F-28 with an unserviceable auxiliary power unit (APU) into a station with no ground-support facilities, under conditions of forecasted freezing rain.

---

1 The degree of the flight crew's reliance on the dispatcher is dependent on whether the dispatch system is a pilot self-dispatch system, as employed by Air Ontario, or a full co-authority dispatch system, as used by Air Canada. These systems will be expanded on below.

2 The terms dispatcher, flight dispatcher, and flight operations officer are synonymous and are used interchangeably in this Report.

I also heard evidence about, and from, Air Ontario's dispatchers which revealed that the dispatcher of flight 1362/1363 was very inexperienced and inadequately trained for his job. Further, I heard evidence that the dispatcher responsible for the flight following of flight 1363 was also inadequately trained. The evidence suggested several breakdowns in Air Ontario's execution of its obligation to the travelling public which impacted directly upon flight 1363 on March 10, 1989. This section explores how this could have happened within the present regulatory framework, why the carrier did not live up to its obligation, and why the regulator allowed this to happen. In this discussion, I will examine the system of operational control that Air Ontario had in place at the time of the accident, and, based on the evidence of Mr Adrian Sandziuk, an experienced flight dispatcher from Air Canada, I will compare it with the system used by Air Canada. The importance of operational control, and the necessity to tighten its role in support of the flight crew, could not be clearer. Had a decision been taken by Air Ontario SOC for flight 1363 to overfly Dryden on March 10, 1989, the accident would not have occurred.

Because civil air transportation is regulated for the protection of the travelling public, and because the regulator obviously cannot monitor the safe planning and execution of every flight, the regulator requires a commercial carrier to exercise operational control over its flights. Transport Canada, being the regulator, is responsible for promulgating and enforcing aviation regulations and standards in Canada. During the course of the Commission hearings, the efficacy of existing Canadian standards relating to operational control, as well as dispatcher training requirements, was brought into question and both are therefore addressed in this section.

Operational Control and Operations Control

Considerable confusion surrounds the meaning of "operational control" and "operations control." The terms are not interchangeable, and the distinction between them is significant.

Operational control is defined by ANO Series VII, No. 2, section 2, as "the exercise of authority over, or the initiation, continuation, diversion or termination of, a flight." Operational control involves the control of the movement of a specific flight and is the responsibility of the pilots and the flight dispatchers.

Operations control is a broader term involving the organization of the carrier's equipment, personnel, and flights to ensure the efficient operation of the airline on a day-to-day basis and in the long run. The many aspects of operations control not directly connected with operational control would ordinarily include matters like crew scheduling, long-term aircraft and personnel utilization planning, and reliability studies of system on-time performance. Operations control is often called system operations control (SOC), where it applies to an air carrier's total flight operations, or station operations control (STOC), where it applies to a single station in the system.

Operational control is the sole responsibility of pilots and dispatchers, while operations control is the responsibility of a diverse group, the composition of which depends upon airline size and organizational structure.

Mr Adrian Sandziuk, a senior flight dispatcher with Air Canada testifying before the Inquiry on behalf of the Canadian Airline Dispatchers Association (CALDA), described the confusion that exists surrounding the two terms. Mr Sandziuk testified that, ever since the creation of system operations control (SOC) centres in the early 1970s, neither Transport Canada nor the Federal Aviation Administration (FAA) in the United States has ever definitively described where system operations control terminates and operational control begins, thereby causing considerable confusion. In his evidence, Mr Sandziuk described incidents where unqualified individuals in SOC centres have interfered with operational control of aircraft with the potential for devastating results. He cited, by way of example, an incident in which a SOC centre, without consulting or advising the flight dispatcher, diverted a flight to Halifax, where the weather was below operating limits.

During the course of his testimony, Mr Sandziuk offered the following recommendation to the Commission:

> A. ... I think that one of the things that should be done through this Commission is a definitive line be drawn of what and where operational control starts and where ... Operations control ends.
> (Transcript, vol. 155, p. 19)

I strongly endorse Mr Sandziuk's recommendation. In my view this is clearly an area which requires specific delineation of authority by the regulatory body.

Throughout this chapter, the lack of clear delineation between operations control and operational control at Air Ontario is apparent, and its significance is discussed.

Operational Control: Governing Legislation

The Canadian regulations governing flight dispatch, which are to be found in ANO Series VII, No. 2, Part III, beginning at section 13, require

Canadian carriers to exercise operational control over their flights and set forth the methods by which this is to be accomplished. The object of this exercise of operational control is, or should be, to impose upon licensed carriers the obligation to ensure that flights are conducted in accordance with the Air Regulations and within the operating parameters of the aircraft type being flown. ANO Series VII, No. 2, Part III, sets out the minimum infrastructure and personnel requirements for flight operations which the carrier must satisfy prior to regulatory approval of its operation.

Approved Flight Watch System

Section 14 of ANO Series VII, No. 2, states that an air carrier "shall have an approved flight watch system, adequate for the nature of the operations to be conducted." A flight watch system is to ensure "proper monitoring of the progress of each flight," and be able to convey any information necessary for the safe conduct of the flight to the pilot-in-command.[3]

Operational Flight Plan

"Operational flight plan" is defined in ANO Series VII, No. 2, as "the operator's plan for the safe conduct of a flight based on consideration of aeroplane performance, other operating limitations and relevant expected conditions on the route and at the aerodromes concerned."

Section 15(1) of ANO Series VII, No. 2, provides that a flight cannot be commenced without an operational flight plan approved and signed – in the case of a pilot self-dispatch system – by the pilot-in-command, and – in the case of a full co-authority dispatch system[4] – by both the pilot-in-command and the flight operations officer authorized by the company to exercise operational control over that flight.[5] The co-authority nature of the full co-authority dispatch system is revealed in the requirement for pre-flight and other approval of the operational flight

---

[3] The term "flight following," as found in FAR 121, the equivalent United States operational control legislation, was used interchangeably with "flight watch" by some witnesses at the Commission hearings.

[4] Throughout the hearings the terms "co-authority" dispatch system and "dispatcher-dispatch" system were used interchangeably. In this Report, I will use the term "co-authority" as appropriate.

[5] Pursuant to ANO Series VII, No. 2, the director of flight operations is the approved position responsible for the exercise of operational control; this responsibility can be delegated to a flight operations officer providing that person meets minimum qualifications as set out in ANO Series VII, No. 2, Part III.

plan by both the pilot-in-command and the responsible flight operations officer. Such a full co-authority dispatch system was not required by Transport Canada for use at Air Ontario.

Qualifications for Persons Exercising Operational Control

The qualifications required under Canadian law for an individual, acting within an approved flight watch system, to serve as a flight operations officer and to exercise operational control over a flight have been the subject of contention for many years. The circumstances of the Dryden crash and the evidence presented before this Commission call for a serious reassessment of the current regime.

Section 15(6) of ANO Series VII, No. 2, sets out in detail the minimum requirements for a flight operations officer (or dispatcher) operating in a full co-authority dispatch organization. There is no requirement that flight operations officers be licensed; there are no training standards; nor is there a requirement that Transport Canada approve the training syllabus for dispatchers. The responsibility to ensure the training and competency of flight operations officers is vested in the carrier and not the regulator. Section 15(6) states:

> (6) Where, under an approved flight watch system, operational control over a flight is to be exercised by a flight operations officer and not the Director of Flight Operations, that officer shall not be assigned to duty as a flight operations officer unless
> (a) he has satisfactorily demonstrated to the air carrier his knowledge of
> (i) the provisions of the *Air Regulations* necessary for the proper performance of his duties,
> (ii) the contents of the air carrier's *Operations Manual* and the operations specifications necessary for the proper performance of his duties, and
> (iii) the radio facilities in the aeroplane used;
> (b) he has satisfied the air carrier as to his knowledge of the following details concerning the operations for which he will be responsible:
> (i) the seasonal meteorological conditions and sources of meteorological information,
> (ii) the effects of meteorological conditions on radio reception in the aeroplane used,
> (iii) the peculiarities and limitations of each radio navigation facility that is used by the air carrier,
> (iv) the aeroplane loading instructions including preparation of aeroplane weight and balance forms, and
> (v) the aeroplane performance operating limitations; and

(c) he has satisfactorily demonstrated to the air carrier his ability to
   (i) assist the pilot-in-command in preparing the operational flight plan and flight plan,
   (ii) provide the pilot-in-command with all information required both before and during flight that is relevant to the flight,
   (iii) initiate such emergency procedures as are outlined in the air carrier's *Operations Manual*, and
   (iv) co-ordinate operational control so as not to conflict with established Air Traffic Control, Meteorological or Communication Services procedures.

These provisions provide minimum requirements for flight operations officers operating within a full co-authority dispatch system, but do not address a self-dispatch system, or the type of "hybrid" system employed by Air Ontario. Air Ontario's hybrid system will be discussed further below. While Air Ontario's Transport Canada–approved Flight Operations Manual (FOM) does outline that carrier's flight dispatcher qualifications and training requirements, they are less comprehensive in scope than the dispatcher requirements set out in section 15(6) of ANO Series VII, No. 2. In particular, Air Ontario's FOM does not contain the prerequisites relating to knowledge of meteorological conditions, sources of meteorological information, and the effects of meteorological conditions on radio reception that are found in ANO Series VII, No. 2, section 15(6)(b)(i) and (ii). Because the flight watch provisions of the air carrier's FOM are approved by Transport Canada, both Air Ontario and Transport Canada must share responsibility for this unsatisfactory state of affairs.

Although Air Ontario described its operation as "pilot self-dispatch," I find, on the basis of extensive evidence presented before this Inquiry, that its dispatchers were *de facto* exercising some measure of operational control. That it was not a requirement for Air Ontario's system of operational control to comply with the dispatcher training standards in ANO Series VII, No. 2, section 15(6) is a serious omission. However, it is necessary not to overlook the larger issue, namely the inadequacy of the regulatory provisions that wholly vest the training of dispatchers with the carriers, and the corresponding absence of Transport Canada from the process.

The Operating Certificate

Prior to granting an operating certificate to a carrier, Transport Canada is supposed, according to the sections of ANO Series VII, No. 2, noted above, to satisfy itself that the carrier is able to exercise "adequate" and "proper" operational control over its flights. The carrier accomplishes this operational control through, among other things, adequate communications with its aircraft, a system of flight authorization, an operational flight plan that conveys sufficient information to the crew for the safe conduct of flights, and flight operations officers who are properly trained with regard to both the routes to be flown and the operating specifications of the aircraft under their control. Finally, there should be an operations manual, approved by the regulator, which clearly outlines what the carrier intends to do to fulfil these requirements, and against which the carrier should be audited.[6]

As I discussed in greater detail in chapter 15, F-28 Program: Planning, the operating certificate is the regulatory document that licenses Canadian air carriers' operations. When Air Ontario sought to introduce the leased F-28 aircraft to its operation, it was necessary for Air Ontario to apply to Transport Canada for an amendment to its operating certificate.

Air Ontario's application to amend the operating certificate, dated January 24, 1988, included a number of representations about the current status of its dispatch operation, as well as a proposed F-28 training program for its flight operations officers. Although these representations may simply have been too ambitious, in retrospect they were clearly inaccurate. For example, the portion of the application entitled "Personnel" includes a certification, signed on behalf of Air Ontario by the director of flight operations, Robert Nyman, that 11 flight operations officers (along with 9 captains, 9 first officers, and 25 cabin attendants) have been trained and qualified to "meet the requirements and/or the applicable ANO for operating the proposed service" (Exhibit 855, p. 23). In addition, further on in the same application, it states that:

> operations officers will receive training by Air Ontario supervisory pilots who are qualified on the F-28 to familiarize them with the aircraft and its systems with a special emphasis on flight planning, performance and MEL procedures.
>
> (Exhibit 855, p. 32)

Despite Air Ontario's certification to Transport Canada that 11 flight operations officers had received or would receive the critical F-28 training, the fact is that only duty operations managers, who performed

[6] ANO Series VII, No. 2, sections 31–37, provide that an operations manual shall be provided for the use and guidance of operations personnel in the execution of their duties.

a supervisory function with respect to Air Ontario dispatchers, received any effective training on the aircraft.

From the evidence described below it became clear that neither the carrier nor the regulator took the operational control requirements seriously. I heard evidence that:

- the regulations regarding operational control are imprecise, incomplete, and not adhered to by either Air Ontario or Transport Canada;
- Air Ontario made undertakings to Transport Canada regarding its operational control facility and personnel that were not fulfilled; and
- Transport Canada had no meaningful audit or surveillance of Air Ontario that could have ensured sufficiency of operational control of the air carrier.

I found this latter point regarding the lack of surveillance particularly disturbing. In the case of regulated industries where statutory obligations are imposed, it is only prudent for the regulator to anticipate that individual companies may backslide on those obligations. This does not necessarily result from improper intentions; it can occur through simple misunderstanding of the regulations or disorganization.

Pilot Self-Dispatch System versus Full Co-authority Dispatch System

Air Ontario's approved flight watch system at the time of the Dryden accident, and that which was deemed by Transport Canada to be "adequate to the nature of the operations," was a pilot self-dispatch system. A pilot self-dispatch system is one of two recognized types of flight watch systems, the other being a full co-authority dispatch system, as employed by Air Canada.

In a self-dispatch system the pilot is charged with the responsibility of flight planning and maintains sole authority to make operational decisions regarding the flight. A co-authority dispatch system, in contrast, is characterized by co-authority between the dispatcher and the pilot. The dispatcher responsible for operational control of a particular flight prepares, approves, and signs the operational flight plan before submitting it to the pilot-in-command. The co-authority rests on the fact that the pilot-in-command must also approve and sign the operational flight plan; in the event the dispatcher and the pilot-in-command disagree over the dispatch of a flight, the most conservative operational opinion must prevail. Indeed, safety is enhanced in this co-authority dispatch system by building in the requirement of a conservative resolution of any operational disagreement between the pilot and the dispatcher.

Mr Sandziuk, while comparing pilot self-dispatch to a full co-authority dispatch system, spoke of the pressures put upon a pilot in a marginal weather situation under a self-dispatch system. The pilot must decide whether to cancel a flight while facing a room full of passengers waiting to get to other destinations, and must then explain his or her decision to do so to management. Under a full co-authority dispatch system, the decision to cancel a flight can be made by, or at least shared with, the dispatcher, thus reducing the pressure on the pilot.

Air Ontario's Hybrid Dispatch System

Air Ontario's system of operational control was described in its approved Flight Operations Manual (FOM) as pilot self-dispatch.[7] On the basis of the evidence presented before this Commission, it can be said that Air Ontario's system was not in fact a pure pilot self-dispatch, but a mixture or "hybrid" of pilot self-dispatch and co-authority dispatch systems. This was confirmed by Air Ontario's director of flight operations, Robert Nyman. Air Ontario's system involved having a dispatcher in SOC prepare flight releases in much the same manner as in the full co-authority dispatch system, but with final acceptance of the flight release being the sole responsibility of the pilot.

Legally, and in the eyes of Transport Canada, Air Ontario operated a pilot self-dispatch system. In practice, however, it employed a hybrid system which, in normal day-to-day scheduled operations, more closely resembled a full co-authority system than a pilot self-dispatch system.

Air Ontario's FOM provides that no pilot shall commence any flight, other than local circuits, unless a flight dispatch clearance form/flight release, or operational flight plan, has been completed prior to flight. It is the evidence that operational flight plans, or flight releases, were generated at Air Ontario exclusively by its system operations control (SOC) centre. It can therefore be stated, as per the definition of operational control in ANO Series VII, No. 2, section 2, that Air Ontario dispatchers were exercising authority over the initiation of a flight. It follows by regulatory definition that dispatchers at Air Ontario were exercising a degree of operational control over flights. Clearly, therefore, the requirements of section 15(6) of ANO Series VII, No. 2, should have applied to Air Ontario at all material times regardless of the fact that Air Ontario labelled its operation a pilot self-dispatch system, and the fact that Transport Canada approved such a characterization.

---

[7] Only two components of a company operating manual require Transport Canada approval: flight watch and crew member training.

Mr Sandziuk agreed with this proposition in his evidence:

> A. ... I would say to you that in my opinion that if this wording exists in the manual, then I have to agree with you, I believe that they do have a flight watch system in accordance with the Air Navigation Order.
> Q. ... If you tell a pilot, look you can't take off unless you have got a flight release from dispatch, then you have got a situation where dispatch is exercising operational control, correct?
> A. That is correct.
> Q. And, therefore, the requirements of section 15 (6) apply whether you employ the rules of calling it a pilot self-dispatch system or not?
> A. I would have to agree with that.
>
> (Transcript, vol. 155, pp. 114–15)

The Air Ontario system described as pilot self-dispatch not only reduced somewhat the legal obligations on Air Ontario, particularly in the critical area of dispatcher qualifications, but also created a potentially hazardous uncertainty as to the true role of the dispatch operation within the company. In the final analysis, even though final authority rested with the pilot-in-command in Air Ontario's pilot self-dispatch system, the dispatch department maintained a measure of operational control over any flight. It follows that Air Ontario should have had on duty a flight operations officer who met the criteria set out in section 15(6). In the case of Mr Daniel Lavery, the flight operations officer or dispatcher who dispatched flight 1362/1363 on March 10, 1989, Air Ontario did not comply with the requirements of the Air Regulations.

Co-authority Dispatch System: Classification Proposal

It is generally acknowledged that a full co-authority dispatch system of operational control should not be required for every level of air carrier operation. Mr Ian Umbach, Transport Canada superintendent of air carrier operations, had proposed a four-tier categorization of operational control delineated on the basis of the relative sophistication of air carrier operations (Exhibit 1114). At one end of the scale, Mr Umbach advocated what he termed a "Type A" system for large scheduled domestic passenger carriers operating turboprop or turbojet aircraft and for all carriers operating turbojet aircraft internationally. The "Type A" system would require that dispatch be exercised jointly by a flight operations officer and the pilot-in-command of the flight in a full co-authority dispatch system. Further, it would involve advanced communications between the aircraft and the dispatcher, and a staff of trained and qualified dispatchers. At the other end of the scale is what Mr Umbach termed a "Type D," a pilot self-dispatch system. Types "B" and "C" define plausible alternatives for levels of service that are somewhere between the major national and international carriers and small bush operations. Mr Umbach's proposal sets out in some detail levels of training expected of flight operations officers at the various tiers.

Mr Sandziuk testified that he agreed in principle with Mr Umbach's proposal. While he was uncertain as to how air carriers ought to be properly classified for the purposes of required dispatch organizations, he was certain that CALDA would strongly support required co-authority dispatch systems for Canadian air carrier operations as complex as those of Air Ontario, AirBC, and the like.

I support the recommendation of CALDA that all passenger-carrying IFR commercial air operations to the level of Air Ontario and like operations be required to put in place a co-authority dispatch system. It would obviously be unreasonable to impose such requirements on small-scale or northern bush operations below that level.

Dispatcher Training

In 1980 the Dubin Commission of Inquiry on Aviation Safety considered an application from CALDA requesting that Canadian dispatchers be licensed. Based on the evidence then before him, Mr Justice Dubin stopped short of recommending such licensing. He recognized the need for proper training of dispatchers, however, and the need for dispatchers to be inspected by the regulator.

Since 1980 there has in fact been no change in the regulatory requirements for the training of flight dispatchers. The Air Navigation Order vests the authority to train and approve the flight operations officers solely with the carriers. Furthermore, there has been no apparent monitoring by Transport Canada of the level of training provided by the carriers or of the proficiency of the individual dispatchers.

The need for adequate training of flight dispatchers has been highlighted by the Dryden accident and the evidence presented before this Commission. As a result, CALDA sought the opportunity to appear before me and revive its application to require that Canadian dispatchers be licensed. I discuss CALDA's application later in this chapter.

Dispatcher Training at Air Ontario

According to Air Ontario's F-28 Revised Project Plan (Exhibit 802), training of SOC personnel with respect to the F-28 aircraft was to have been completed by April 11, 1988. This goal was not attained. The dispatchers who appeared before me testified that they received no effective training on the F-28 and acknowledged a lack of familiarity with F-28 systems. The dispatcher responsible for the preparation of the flight release for the ill-fated flight 1363 and the flight following of the aircraft until its turnaround in Thunder Bay was Mr Lavery. Mr Lavery admitted that he was not adequately trained and not qualified for this highly responsible position.

Mr Lavery, a young Air Ontario ramp attendant, was promoted from his outside ramp work in May 1988 and given only one week of a projected two-week dispatcher training course by an Air Ontario dispatch supervisor.[8] He then sat with an experienced dispatcher in the SOC control room at London for about one week, before being designated as a dispatcher and set to work with minimal supervision. He was not given any tests or examinations following the one-week course. Mr Lavery, who had no aviation background, described his meagre training and qualifications as a flight dispatcher as follows:

> Q. ... Now, when you went and took your brief course to train to be a dispatcher, had you had any previous aviation experience or exposure to aviation that prepared you in any way to be a dispatcher ...
> A. No, I came directly from the ramp, so.
> Q. ... so this would be your first exposure to reading weather reports and to legal requirements for landing minima, alternate minima, all that?
> A. Yes.
> Q. ... Now, at the end of the one-week course, could you in fact read the weather sequences, the terminal forecasts and area forecasts and so on?
> A. Enough to get by.
> Q. ... Were you familiar with the Flight Operations Manual at the end of a week? Let me ask you, had you read it from cover to cover?
> A. No.
> Q. ... you had looked at it but you really hadn't even read it, correct?
> A. Yes.
> Q. And when you were turned out to run or to operate on your own on a shift, had you even by that time read the flight operations manual?
> A. I don't believe so.
>
> (Transcript, vol. 48, pp. 179–80)

[8] Mr Martin Kothbauer, Air Ontario duty operations manager, taught the training course taken by Mr Lavery.

Mr Lavery further testified that when he began working as a dispatcher he was not familiar with the F-28's operating specifications or performance limitations, nor had he been trained on the F-28 manual prior to dispatching F-28 aircraft.

When asked about the legal implications of an operational flight plan, Mr Lavery replied as follows:

> Q. ... Do you know whether or not the pilot is required by law to have an operational flight plan before he departs?
> A. I don't know the answer to that one.
>
> (Transcript, vol. 48, pp. 255–56)

A dispatcher requires a knowledge of the air regulations. The job involves complex mathematical calculations, and a dispatcher requires specific knowledge and expertise, as well as familiarity with such things as aircraft performance, fuel burns at various altitudes, load limitations for various atmospheric and runway conditions, and many other matters. Mr Lavery, after the most cursory and rudimentary introductory training, was left to dispatch Air Ontario aircraft, including the F-28 jet aircraft, on his own. Not only had he not received training on the Piedmont F-28 manual, but his testimony reveals that Mr Lavery had not even familiarized himself with that manual. Mr Kothbauer described Mr Lavery as a "weak dispatcher"; he said he was doubtful of Mr Lavery's competence to generate the flight release given the weather conditions on March 10, 1989, and that Mr Lavery was not given adequate training for the tasks that were required of him as dispatcher (Transcript, vol. 49, pp. 44–45).

The evidence before this Inquiry establishes conclusively that Mr Lavery as a flight operations officer was not qualified to exercise operational control over flight 1362/1363, on March 10, 1989.

On that day, Mr Lavery went off shift at Air Ontario SOC at 10:30 a.m.; replacing him was Mr Wayne Copeland. When Mr Copeland arrived at work at 9:45 a.m. for his shift, which commenced at 10:00 a.m., he briefed himself on the area weather and received a "handoff briefing" from Mr Lavery. While Mr Lavery was principally responsible for the dispatch of flight 1362/1363 and the flight following of flight 1362, Mr Copeland, from 10:30 a.m. on, was principally responsible for the flight following of flight 1363. The transition from Mr Lavery to Mr Copeland occurred at the same time that the F-28 aircraft was flying into Thunder Bay as flight 1362 and being turned around in Thunder Bay as flight 1363.[9]

[9] On March 10, 1989, flight 1362 arrived at Thunder Bay at 10:35 a.m. and departed as flight 1363 for Dryden at 11:55 a.m.

Mr Copeland's testimony regarding his training from Air Ontario echoed that of Mr Lavery. While Mr Copeland had the benefit of some aviation experience prior to joining Air Ontario, he did not in any way receive adequate training on Air Ontario dispatch procedures and, in particular, he did not receive any training on F-28 systems.

Mr Copeland completed a two-year air carrier and airport management course offered by Confederation College of Thunder Bay, Ontario. He testified that the course was very general in nature, touching upon most aspects of small air carrier and airport operations. Mr Copeland described the training that he received when he joined Air Ontario as a dispatcher in May 1988:

> Q. – did you take any courses within the organization before the commencement of your duties as a dispatcher?
> A. Any courses with Air Ontario?
> Q. Yes.
> A. No, I did not.
> Q. Were there courses available within Air Ontario?
> A. Just prior to my employment, there was, I believe, a one-week course for dispatchers, but I was hired on after its completion.
> Q. And so you did not receive a formal course training?
> A. Correct.
> Q. What sort of training did you have?
> A. My training included working side by side with another dispatcher. I can't remember the exact duration, but it was one to two weeks, just working with him, and then he would give me instruction on all parts of the operation at that time.
>
> ...
>
> Q. What then occurred? Did someone just come in and say, okay, Wayne, you're on your own?
> A. I assume the dispatcher I was working with communicated with the manager of SOC at that time and they discussed it and I was then allowed to work the desk by myself.
>
> (Transcript, vol. 45, pp. 4–5)

Mr Copeland went on to testify that he would have liked to have had more training prior to his commencing his duties as a dispatcher. He stated that he had a low level of confidence:

> Q. Well, did you feel that you had enough training after two weeks to operate as a dispatcher and tell the captain everything he needed to know about fuel needed to get to the alternate, tell him everything he needed to know about what kind of weather he might expect to encounter, tell him everything he needed to know about whether he would break out the bottom of an ILS in the clear or in the clag, tell him about whether or not he

could expect to get stopped on that runway under those conditions, that kind of thing?

...

A. At the end of two weeks, there could have been things that I could have passed on to him that I wasn't passing on to him because of my low level of confidence.

(Transcript, vol. 45, pp. 143–44)

Mr Copeland was questioned at length on the dispatcher qualifications and familiarization training described in the Air Ontario Flight Operations Manual (FOM). Mr Copeland conceded that much of what was represented in the company's approved FOM was, in fact, not achieved in his case:

Q. And nor were you familiar with company rules and regulations at the end of the two-week apprenticeship, correct?

A. I guess I was partially, but not as much as I would have liked to have been.

...

Q. And so, really, the apparent requirements of the Flight Operations Manual with respect to the training that you should require before you're turned loose apparently weren't met; isn't that right?

...

A. I would have liked to have been trained more, yes.

(Transcript, vol. 45, p. 147)

The evidence before me establishes beyond any doubt that Mr Copeland was not properly trained or qualified to exercise operational control over flight 1363 on March 10, 1989.

Air Canada's Dispatcher Training

A comparison of Air Ontario's training of Mr Lavery or Mr Copeland with Air Canada's training of Mr Sandziuk provides a striking disparity. Mr Sandziuk first accepted a position in flight dispatch with Air Canada in 1966. At that time his initial training included one week in a classroom followed by seven years working as an assistant dispatcher under the supervision of a qualified flight dispatcher. Although he stated that two to three years as an assistant dispatcher should be adequate qualification to work as a dispatcher, Mr Sandziuk indicated that promotion was a function of industry demand and that seven years had not been an unusually long apprenticeship prior to his elevation to full dispatcher.

Air Canada's current training regime for its dispatchers is far superior to that which Air Ontario provided. Upon hiring, an Air Canada dispatcher spends four to six weeks in classroom training during which time most of the functions in dispatch are introduced. In addition, Air Canada dispatcher trainees are required to take an eight- or ten-part home study course in meteorology. Thereafter, the new dispatcher works with an experienced dispatcher for approximately one year, and must pass an examination (Air Canada requires a passing grade of 80 per cent) before being given authority to sign off flight releases. Even then, the company imposes certain limitations on the dispatcher, such as a requirement for an additional qualification on transatlantic flights.

When asked in cross-examination to characterize the Air Ontario dispatch system, based on Mr Lavery's evidence, Mr Sandziuk was unequivocal in his condemnation of it. He described it as "unbelievable" and was emphatic that it was impossible for anyone to become a qualified dispatcher after one or two weeks' training.

> Q. ... Now, just having looked at those bits of his evidence, give me your characterization of a dispatch system which would allow this calibre of dispatch to support the pilots of passenger-carrying turbo-jet aircraft.
>
> A. Well, firstly, I must say that it's unbelievable that we could expect that type of a system to fit into the criteria that the Air Navigation Order sets out. I don't think under any view whatsoever could you consider that a flight watch system. Perhaps the system is acceptable, but I think the system fell apart in the training procedures.
>
> I do not think it is – in fact, I know it is impossible for any one person in a one- or two-week course to have been trained in the extensive knowledge required of all the subjects involved, and then be able to operate a functional airline as he has described his tasks.
>
> I'm not surprised he wasn't – that he felt incapable of doing them. I'm sure that people with much more training than he received would not be capable to cope with it. And I certainly wouldn't be surprised of the fact that it didn't cross his mind about the de-icing problem.[10]
>
> (Transcript, vol. 155, pp. 129–30)

Mr Sandziuk expressed the belief that a competent dispatcher would have adverted to the possibility of the need to de-ice the aircraft at Dryden without a serviceable APU and would have in all probability opted to overfly Dryden:

[10] See pp. 719–20 infra.

Q. Would an experienced ... dispatcher, a competent dispatcher have adverted to this problem, the possibility of the need to de-ice without an APU?
A. I believe he would have. I would suggest in our office, this type of thing occurs every day and decisions are automatically made.
Q. All right. And the decision would be to overfly?
A. In all probability, yes.

(Transcript, vol. 155, p. 130)

It was Mr Sandziuk's opinion that the Air Ontario dispatch system, employing as it did dispatchers lacking proper training, was unsafe. In his view a pilot would be better off with no dispatcher than one lacking proper training:

Q. Is it, in your opinion, safe to have turbojet passenger-carrying aircraft dispatched by a system which allows individuals with this lack of training to dispatch aircraft?
A. I could not accept that it is reasonable to operate an airplane under those conditions. I believe you would be better off not to have a dispatcher, because at least the pilot would do his own calculations, and he'd know where he is. But, I would contend, that you would be far better off by having a flight watch system that is functional.

(Transcript, vol. 155, pp. 130–31)

It was Mr Sandziuk's evidence that an experienced Air Canada dispatcher would in all probability have caused flight 1363 to overfly Dryden on March 10, 1989.

Operational Flight Plan: Flight Release

An operational flight plan is the fundamental document used by an air carrier to fulfil its obligation to exercise operational control over its aircraft. Pursuant to section 2 of ANO Series VII, No. 2,

> "operational flight plan" means the operator's plan for the safe conduct of a flight, based on consideration of aeroplane performance, other operating limitations and relevant expected conditions on the route and at the aerodromes concerned;

While this ANO definition provides a conceptual overview of the importance of an operational flight plan, nowhere else in the ANO does Transport Canada provide a guide to operators in devising their own systems. Moreover, because Transport Canada has not prescribed a form for carriers to follow, operational flight plans in use by carriers may be disparate in both form and substance. This disparity was vividly highlighted by evidence before this Commission that contrasted the operational flight plans in use by Air Ontario and Air Canada.

Typically, an operational flight plan contains significant operational information, including planned alternates, aircraft weights, fuel consumption, passenger loads, and other operational information necessary for the crew to plan and conduct its flights in a safe and orderly manner. It is the practice of Air Canada to issue a flight release, the company document that authorizes dispatch of the flight, only after an operational flight plan has been signed off by both the flight crew and the dispatcher.

In contrast, Air Ontario used just a flight release to serve the dual role of operational flight plan and flight release. Hence, there was much discussion during the hearings of this Commission as to whether Air Ontario's F-28 flight release in fact satisfied the ANO Series VII, No. 2, requirement for an operational flight plan. Legal or otherwise, the flight release format (Exhibit 345) utilized by Air Ontario for its F-28 operation was roundly criticized in testimony before this Commission by experienced dispatchers, pilots, and air carrier inspectors.[11] Both Mr Randy Pitcher, Transport Canada Ontario Region's lead inspector on the F-28 and himself a former dispatcher, and Mr Sandziuk were pointed in their criticism of the Air Ontario F-28 flight release format. They both identified the lack of detail to assist the pilots in ascertaining the basis of the dispatcher's calculations as a fundamental and glaring flaw in Air Ontario's flight release.

In the following excerpt from his testimony, Mr Pitcher described as "minimal" the information provided to Air Ontario's flight crews in the flight release and used the words "scraping the bottom of the barrel minimal" in saying that the flight release barely fit within the ANO Series VII, No. 2, definition of operational flight plan:

> Q. And can you explain generally to the Commissioner, first of all, what sort of information this flight release provides you with as a captain of an airplane?
>
> A. This particular flight release provides very little. In fact, I believe it provides minimal knowledge to the captain.
>
> He needs to know, for example, in situation here, he is given a time but he is not given any idea of how the time was calculated. There's no true air speed ... there's no mach number, there's no ground speed, there's no wind component, there are no fuel flows.

---

[11] Air Ontario's Flight Operations Manual provides a Convair 580 operational flight plan that includes far more information for the flight crew than could be found on the F-28 flight release. This operational flight plan is set out in chapter 19 of this Report, Flight Operations Manuals.

> I see that the fuel on board in the first column, 326, of this Exhibit 345 says "fuel on board of 16,000 pounds," I imagine that is.
>
> But ... this meets, I think, the minimum standard that the ANO speaks of ... when it defines operational flight plan. And when I say "minimal," I mean scraping the bottom of the barrel minimal.
>
> As a pilot, I would want to know a breakdown, at the very least, of my fuel. What's my burn-off, for example?
>
> But in all fairness, this form, with the type of operation that Air Ontario has and had at the time of the accident, is a pilot self-dispatch system. The pilot-in-command is absolutely responsible for ensuring that he is knowledgeable in terms of the stuff presented here.
>
> I just think that this form could be far more forthcoming in terms of making the pilot's job easier, because what he has to do in order to confirm this figure, he has to go back and work the whole thing up, whereas if they had ... broken it down in terms of burn-off, contingency factors, alternate and reserve fuels, he would have a much easier job of getting the whole picture.
>
> (Transcript, vol. 127, pp. 116–18)

Mr Sandziuk was equally critical of Air Ontario's F-28 flight release. When shown Exhibit 345 and asked to comment whether, based on his experience, it met with the definition of "operational flight plan" in ANO Series VII, No. 2, Mr Sandziuk responded:

> A. Well, I would have to say that the information presented is absolutely minimal. There are no guidelines as to what considerations were given to the calculations, how they arrived at them, what factors were considered with reference to any portion of it. Basically, all we have here is ... the minimal fuel, the alternate, via alternate. We have come up with a weight and fuel and the number of passengers.
>
> But short of that, I would suggest to you that a clearance like that is tantamount to giving a pilot a dart board and saying, you know, try and find how I got there. I say that without derision, and I'm serious that, if you look at the AFPAC [Automatic Flight Planning, Air Canada] that's presented by Air Canada, each of these items is very clearly explained so that the pilot knows how I arrived at that point.
>
> (Transcript, vol. 155, p. 68)

To the extent that Air Ontario operated a hybrid system of dispatch, such that the flight release prepared by dispatch was subject to approval by the captain, it would have been especially important to have a form that permitted an easy review of the dispatcher's calculations. However, as Mr Sandziuk added, easy review of the Air Ontario flight was not possible; further, he did not believe that the flight release satisfied the ANO Series VII, No. 2, requirements for an operational flight plan:

> A. ... how in the world could the pilot ever arrive at these statistics to match the figures they've got here [in the flight release]? I believe it's terribly incomplete. There's certainly not sufficient evidence to justly expect a pilot to come up with the same answers and be able to explain how the dispatcher did it.
> Q. And, do you believe in this format [the F-28 flight release] ... meets with the requirement of the ANO, that it should provide a plan for the safe conduct of a flight?
> A. I don't believe it does because it doesn't enable the ... pilot to consider all the factors. If they are, it's guesswork.
> (Transcript, vol. 155, p. 69)

Another deficiency in the operational flight plan used by Air Ontario dispatchers in the operational control of F-28 aircraft concerned the calculation of minimum fuel. The Air Regulations, sections 551 and 552, require that no IFR flight[12] can be commenced unless the aircraft carries sufficient fuel to get to its destination and thence to an alternate airport, still with a specified reserve of fuel remaining. By regulation, the amount of fuel must take into account wind and other anticipated meteorological conditions as well as any anticipated air traffic delays. The evidence revealed that Air Ontario dispatchers did not include in their minimum fuel calculations any additional fuel for abnormal meteorological conditions or anticipated traffic delays. Instead, the need for such additional fuel was factored into the fuel on board (FOB) figure on the F-28 flight release.[13]

Mr Martin Kothbauer, formerly an Air Ontario dispatcher and duty operations manager, and himself a commercial pilot, testified that the minimum fuel figure on the Air Ontario F-28 flight release was occasionally less than the minimum fuel required by law. This information came out in the context of Mr Kothbauer being questioned on fuel calculation practices at Air Ontario.

He testified that the standard operating procedure at Air Ontario was to add contingency fuel to the fuel on board for the purpose, for example, of deviating around thunderstorms. This resulted in the minimum fuel not reflecting the fuel that might be required for deviation around weather shown on weather reports, or fuel that might be required for an air traffic control (ATC) hold. Mr Kothbauer stated that

---

[12] Most if not all scheduled Canadian commercial flights under normal operating circumstances are conducted pursuant to instrument flight rules (IFR).

[13] FOB refers to the total amount of fuel on board an aircraft.

this standard operating procedure at Air Ontario was different from what was legally required and what he had known as a commercial pilot. He testified that he was surprised to discover this situation at Air Ontario:

> Q. Do you know why the standard operating procedure at Air Ontario concerning minimum fuel as reflected in the flight release did not follow the notion of minimum fuel as the law requires and that would be in the minds of commercial pilots?
> A. No, sir, I don't know.
> Q. That was never explained to you?
> A. Not that I can remember, no.
> ...
> Q. I take it it was a surprise to you when you first discovered that?
> A. Yeah, it was.
>
> (Transcript, vol. 49, pp. 99–100)

I find Mr Kothbauer's surprise to be understandable given the training all commercial pilots receive concerning legal minimum fuel requirements.

Air Ontario pilots were questioned on their understanding of the minimum fuel figures on the F-28 flight release. Monty Allan, who was a first officer on the F-28, testified as follows:

> Q. ... Now, is it your understanding that ... minimum fuel that is required by law is also the min fuel in the flight release?
> A. No, it's beyond that, I believe. The company, albeit they use the Transport's minimum requirements, I believe that the way it's been resolved is the company min has added a little bit more. I think we have provided ourselves – it's outlined in the company route manual specifically, but I believe we have allowed ourselves an approach at destination and an approach at alternate which I don't think Transport requires, but it's contained in the route manual.
>
> (Transcript, vol. 91, p. 225)

Captain Robert Nyman, Air Ontario director of flight operations, who had "ultimate responsibility" for operational control according to the Air Ontario FOM and who was an F-28 check pilot, was questioned on the evidence of Mr Lavery with regard to his minimum fuel calculations. He conceded that there were some fundamental problems with the training of F-28 dispatchers at Air Ontario:

> Q. And further, we see from page 210 and 211 of the transcript that when Lavery was calculating the min fuel, he would not account for known deviations due to weather or known holds due to ATC. He wouldn't include that in min fuel, but he would add

that to granny fuel and it would be added – it would be part of fuel on board but would not be reflected in min fuel. Do you follow me?

A. Absolutely.

Q. ... Now, first of all, shouldn't the dispatchers have been trained on – to a certain extent, at least, on the performance of the F-28?

A. Yes, a certain amount, yes.

Q. ... So they should know what altitudes the plane is likely to use, what the fuel burn is likely to be, how much fuel it's going to burn in climb and so on and so forth?

A. Absolutely.

Q. ... Definitely, the dispatcher should know how to calculate maximum payload available, correct?

A. Yes.

Q. And as a pilot, you would expect the dispatcher to include in minimum fuel any fuel required to get around known meteorological problems or to accommodate expected ATC delays?

A. That would have to be part of minimum fuel, yes.

Q. Sure, all right. So then, having reviewed that evidence in a cursory way, is it now evident to you that there were some problems, some fundamental problems with the training of dispatchers for the F-28 at Air Ontario?

A. If they didn't understand that, and it appears that this particular one did not, then I would have to say yes.

(Transcript, vol. 109, pp. 191–93)

The basic cause of this rather intolerable situation at Air Ontario was the fact that dispatchers who prepared the F-28 flight releases, and the pilots who relied upon the flight releases had different understandings of the meaning of the critical minimum fuel (MIN) figure. The difficulty caused by the lack of a common understanding of the meaning of MIN could be manifest in a situation like that encountered by flight 1362/1363 in Thunder Bay on March 10, 1989. A pilot like Captain Morwood, faced with a last-minute increase in passenger load, would look to a difference between FOB and MIN to see whether the increased passenger load could be accommodated by decreasing fuel load. If the MIN figure was relied upon by a pilot to ensure minimum legal fuel, it is conceivable that fuel could be off-loaded to the MIN level and below the legal requirement. For this reason, the minimum fuel indicated on a flight release should never be less than the minimum fuel required by regulations. It must be noted, however, that there is no evidence that the minimum fuel figure caused such a problem on March 10, 1989.

A further deficiency in the operational flight plan used by Air Ontario dispatchers in their operational control of the F-28 aircraft concerned the absence of a minimum reserve fuel figure. Minimum diversion fuel at a given location, usually the destination airport, is the minimum amount of fuel required to fly from that location to the alternate destination, arriving with the fuel reserves required by law. Mr Randy Pitcher, when asked about minimum diversion fuel and whether that figure should be included in an operational flight plan, testified as follows:

> Q. On March 10, the day the plane crashed, the pilots were stretched to the limit for fuel because of general bad weather and full loads.
> A. They were stretched likely because the nearest alternate required them to carry this fuel.
> Q. That's right. So the alternate that they were carrying for Winnipeg was Sault Ste Marie?
> A. Yes.
> Q. ... Now, in cases in like that, you should have a good idea what your minimum diversion fuel is in case you have to hold in Winnipeg, don't you think?
> A. I'm sure they did.
> Q. ... A pilot should know that?
> A. Yes.
> Q. All right. Well, if a pilot should know that for safe flight, shouldn't it be part of the operational flight plan?
> A. It would be a good idea to be on the operational flight plan.
> Q. ... I'm not asking you whether it's a good idea or not. I'm asking you whether if the minimum diversion fuel in a situation like that is a number that's required for safe flight.
> A. In a situation as you described, yes.
>
> (Transcript, vol. 128, pp. 148–49)

It should be noted that the flight release form used by Air Ontario dispatchers in their operational control of F-28 aircraft (Exhibit 345) did not provide flight crews with an estimate of minimum diversion fuel. I agree with Mr Pitcher that this information should have been provided to pilots.

It was the opinion of Mr Pitcher, and one with which I emphatically concur, that ANO Series VII, No. 2, should be amended to define explicitly the minimum acceptable requirements for an operational flight plan. Mr Pitcher stated:

> A. Under the ANO definition of operational flight plan, because it is so vague, it does permit the type of document that Air Ontario was utilizing as their dispatch form to be accepted by Transport.
>
> Maybe a schedule of some sort to set out exactly what should constitute an operational flight plan with at least the basic knowledge or information that a pilot requires would, I believe,

> be very advantageous and would certainly prevent situations such as we have seen with the operation of the F-28.
>
> (Transcript, vol. 128, pp. 4–5)

As earlier alluded to by Mr Sandziuk, and in obvious contrast to the inadequate operational flight planning employed for Air Ontario's F-28, Air Canada's AFPAC provides extensive and useful information.[14] Not only are calculations clearly explained, but the system permits the flight crew to run checks that allow them to monitor their progress on an ongoing basis. Mr Sandziuk's preference for the AFPAC system is readily apparent from his evidence:

> A. It's very comprehensive. All the information is there: What I based the planning on, what the pilot's based the planning on is there. And not only that, but he has the opportunity to check it to make sure it is going ... according to plan. And for that reason, I think it's a very comprehensive and efficient way to do it.
>
> To go to the Air Ontario plan, it has, I guess, the minimum requirements ... of fuel burn, minimum and takeoff weights, but I would not say that it's a very ... efficient flight plan. I really would not be very happy with it. I think it's incomplete because I don't think it meets the requirements as indicated here in the ANO.
>
> (Transcript, vol. 155, pp. 71–72)

Ability of Air Canada To Provide Flight Dispatch Expertise to Air Ontario

As discussed elsewhere in this Report, Air Canada, despite its extensive experience and expertise in commercial jet transport operations, did not provide any significant operational consultation for its subsidiary, Air Ontario, during the implementation of its F-28 program. This was particularly true in the case of operational control. During Mr Sandziuk's testimony, he left little doubt as to Air Canada's ability to provide such expertise in setting up a proper flight dispatch system. Moreover, he clearly thought that such consultation was needed.

The Flight Release Requirement

Each Air Ontario revenue flight must, in accordance with Air Regulations and the company's flight operations manual, be specifically

[14] AFPAC (automatic flight plan Air Canada) refers to Air Canada's computer-generated flight plan.

authorized before departure. Normally Air Ontario SOC, London, does this by issuing a flight release. The flight release is sent by telex to the point of departure, where it is picked up by the captain of the planned flight, and to all en route stations.

In light of the fact that Air Ontario ostensibly operated a pilot self-dispatch operation, the question was raised in the Commission hearings as to whether a pilot-in-command could initiate a flight on his own accord, without a flight release. Mr Danilo (Dean) Koncan, Air Ontario's duty manager of operations, indicated in his evidence that the pilot-in-command of an Air Ontario revenue flight would not take off without either a printed or verbal flight release (for example, in the event of a computer failure) from SOC. In fact, it is clear from Mr Koncan's testimony that Air Ontario pilots relied on SOC to dispatch them even in the absence of a printed or verbal flight release:

> A. ... under the pilot self-dispatch system, if I were to lose the computers because of power failure or what not, we can still verbally, through the flight watch system, issue him an aircraft, advise him of which crew he is working with, advise him the last reported alternates that we were carrying for him to double check through flight service if his computers are down as well, and what basic information we have; i.e., what flight numbers he is doing at which times which he will have a copy of.
>
> ...
>
> Q. ... If Captain Morwood or any other captain on a revenue flight did in fact not even receive a flight release of any kind, either verbal or printed, would he phone SOC?
>
> A. Yes, he would.
>
> Q. I take it from your evidence that he can't go unless he either gets a verbal or printed flight release approval, is that correct?
>
> A. That is my understanding, yes.
>
> (Transcript, vol. 47, pp. 94–95)

The procedure described by Mr Koncan reinforces the fact that, notwithstanding its description as a self-dispatch system, Air Ontario's dispatchers were exercising a degree of operational control over revenue flights.

Reliance of Air Ontario Pilots on Flight Releases

The evidence shows that because company dispatchers were exercising a degree of operational control in what has been termed a hybrid between the pilot self-dispatch and the full co-authority systems, there was a degree of uncertainty in Air Ontario's operational control of its aircraft.

Even though Air Ontario dispatchers would make all necessary calculations in the course of preparing flight releases, the degree to which Air Ontario flight crews relied on these calculations was not clear. It was the evidence of Air Ontario pilots and dispatchers that F-28 flight releases often contained errors in calculations. However, in that pilots were responsible for checking the accuracy of the flight release, both pilots and dispatchers tended to downplay the significance of such errors. Air Ontario pilots would routinely contact dispatchers in SOC to rectify any errors in flight releases.

A senior Air Ontario captain, William Wilcox, testified that in his view the flight releases were less reliable when the weather was bad. He added that he believed this view was shared by the Air Ontario pilot group. Another Air Ontario captain, Erik Hansen, testified that, although he did not always find Air Ontario flight releases to be accurate, this never caused him any problems.

Captain Christian Maybury, when asked whether he ever had occasion to question the accuracy of flight releases he received from Air Ontario SOC, gave the following evidence:

> A. ... after a while, you get to know that they are human too and they make mistakes.
>
> You just learn to skim the – you know, have a look at your flight release, and after a while, you get used to seeing a certain set of numbers that match. And sometimes ... that one isn't right. And usually call them up and they will change it and reissue the release, a correct one.
>
> Q. Would it be fair to assume, sir, that you then wouldn't accept blindly a release that you received from SOC?
>
> A. I always look at mine.
>
> Q. Look at them for what purpose?
>
> A. Well, make sure the numbers jibe as far as operational weights. Also check them especially weather-wise, looking at alternate airports and whether the alternate airports that they have given in the release jibe with the weather forecasts.
>
> (Transcript, vol. 92, pp. 63–64)

The fact that Air Ontario pilots, as a rule, knew they could not rely on calculations in flight releases issued to them and routinely redid the calculations themselves was corroborated in the evidence of Mr Kothbauer and Air Ontario dispatcher Warren Brown. Mr Kothbauer testified as follows:

> Q. Did you ever receive any comments back from flight crews as to whether or not they considered the system of the issuance of the flight releases as adequate?
>
> A. Yes, sir, I did.

Q. And could you enlighten us on that.
A. They were not considered accurate.

(Transcript, vol. 49, p. 50)

Mr Brown, when questioned at to what reliance the Air Ontario pilots put on the flight release, stated:

A. ... they look at it and they – I'm sure they take some of it for – ... I would hope they take it all as valid information.
Q. And they would use it for planning their day, would they?
A. Yes, they would.

(Transcript, vol. 48, p. 88)

He stated that it would be the pilot's responsibility, if they were going to rely on the details in the release, to ensure that they were accurate, and that he knew this when he prepared the release:

Q. You know that the pilots are not going to rely on this release as the last word?
A. That's correct.

(Transcript, vol. 48, p. 88)

When asked for his perception as to what Captain Morwood's attitude towards SOC and flight releases had been, Captain Hansen was resolute in stating that Captain Morwood would not have hesitated to assert his authority in dealings with SOC:

Q. And you heard George Morwood a few times have a few tiffs with SOC?
A. Absolutely.
Q. And what kind of a posture would he be adopting when he had these?
A. There would be no doubt in the other individual's mind what George wanted, and he wasn't going to go along with whatever plan of attack they might have picked for the day, and he would tell them.
Q. It was George's plan or no plan?
A. That's right.

(Transcript, vol. 94, p. 137)

The Flight Release for Flight 1362/1363, March 10, 1989

Because of the deficiencies in the Air Ontario operational control system, the F-28 aircraft C-FONF was dispatched with a non-functioning auxiliary power unit (APU) into Dryden airport, an airport that had no

F-28 ground-start equipment, with forecasted freezing rain conditions. The flight release that was prepared for Captain Morwood on March 10, 1989, contained serious errors.

The flight release for flight 1362/1363 on March 10, 1989, is reproduced below (figure 23-1). A discussion of some of its specific errors, as well as its likely impact on the events of March 10, 1989, follows.

Figure 23-1 Flight Release: Flight 1362/63, March 10, 1989

OU YWGOOAC YHDTRGX YQTOOAC YQTTRAC YXUOWGX
.YXUOWGX 03101257
< T608F > FLIGHT RELEASE
CAPT: MORWOOD ACFT: 281/ONF DATE/TIME:10/0753L
F/O: MILLS PURSER: SAY F/A: HARTWICK

FLT	DEP	ARR	VIA	ALT	MIN	FOB	WT.	LOAD	PAX	STD	REMARKS
362	YWG	YHD	YQT	YAM	126	160	610	121	11	0725L	
362	YHD	YQT	==>	YAM	92	116	614	155	30	0830L	
363	YQT	YHD	YQT	YAM	130	158	617	121	55	1055L	
363	YHD	YWG	YQT	YAM	146	150	606	103	52	1100L	
364	YWG	YQT	==>	YAM	BALANCE OF RELEASE TO FOLLOW						
365	YQT	YWG	==>	YHD	89	120	638	—	65	1515L	

CARGO ALLOTMENT 1000 LBS UNLESS OTHERWISE NOTED
S.O.C.: — CAPTAIN:

;101257 0222

Source: From Exhibit 345

The flight release (Exhibit 345) must be read together with the daily system operations control log (Exhibit 348). The SOC log is prepared by SOC personnel in anticipation of the flights scheduled for a particular day. The flight release is generated by SOC personnel on the basis of the SOC log and the latest available weather and passenger load information.

Both Messrs Kothbauer and Koncan, who were duty operations officers at SOC, testified that the figures generated by Mr Lavery on the flight release for flight 1362/1363 on March 10, 1989, did not match with the figures on the computer-generated daily SOC log. In fact, after reviewing Mr Lavery's figures, both Mr Koncan and Mr Kothbauer identified numerous errors in the actual calculations and testified that the flight release made no sense. When asked to explain why the figures did not make sense to him, Mr Kothbauer responded that, while the numbers on the flight release should mirror what is on the SOC log, it was "clearly evident" to him that they did not (Transcript, vol. 49, p. 49).

On the morning of March 10, when he was to prepare the flight release for Captain Morwood's flight segments that day, the dispatcher, Mr Lavery, was faced with making several changes to the standard entries on the SOC log. The standard routing for the first segment of flight 1362 (Winnipeg to Dryden) had Thunder Bay as an alternate, a minimum dispatch fuel of 10,000 pounds, required fuel on board of 15,000 pounds, and a maximum takeoff weight of 62,000 pounds, yielding a maximum payload of 12,100 pounds. Because of the weather, Mr Lavery had to change the alternate to Sault Ste Marie, thereby requiring a change in minimum dispatch fuel (MIN), to his mind, of 12,600 pounds and a maximum takeoff weight (WT.) of 62,400 pounds; figures that he pencilled in on the SOC log. On the flight release, however, the takeoff weight for this segment was recorded as 61,000 pounds.

When Mr Koncan was asked to examine these two documents the first discrepancy he noted was that, contrary to standard company policy, the flight release had not been signed. Second, the takeoff weight on the first segment of flight 1362 on the flight release was 61,000 pounds. On the SOC log, however, Mr Lavery had crossed out the computer-generated 62,000 pounds and pencilled in 62,400 pounds. Mr Lavery was not able to provide an explanation for this inconsistency.

Mr Koncan was also unable to explain the maximum takeoff weight of 62,400 pounds. In fact, Mr Koncan explained that because the structural landing weight of aircraft C-FONF was 59,000 pounds, the maximum takeoff weight of 62,400 pounds would have required an unusually high fuel burn of 3400 pounds between Winnipeg and Dryden to meet the 59,000-pound landing limit.

Another problem detected in the flight release was the entry of 12,100 pounds under the payload column (LOAD). The payload is calculated by subtracting the basic empty operating weight of the aircraft – in the case of C-FONF 37,723 pounds – from the takeoff weight of 61,000 pounds, which yields 23,277 pounds.[15] The difference between the

[15] The takeoff weight must also take into consideration that, after the appropriate fuel burn to the destination, the maximum landing weight of 59,000 pounds will not be exceeded.

23,277 pounds and the fuel on board (FOB) is the allowable payload. Mr Koncan explained that the payload figure represents a recommended maximum figure not to be exceeded when calculating the combined weight of the passengers, cargo, baggage, and everything that is to be carried on the aircraft other than fuel. Obviously, the ability to refer to the appropriate weight calculation formula and to generate the correct allowable payload is fundamental to competent operational control.

The minimum dispatch fuel on the first leg of flight 1362, recorded on the first line of the flight release, was 12,600 pounds.[16] The fuel on board, or the actual amount of fuel carried, that Mr Lavery noted for the first leg of flight 1362 on March 10 was 16,000 pounds. However, according to Mr Koncan's calculations, subtracting the 16,000 pounds fuel on board from the 23,277 pounds (the difference between the empty weight of the aircraft and the maximum takeoff weight), results in a figure of 7277 pounds, instead of the payload figure of 12,100 pounds as on the flight release. Although, during his testimony, Mr Koncan carefully reviewed Mr Lavery's calculations, he was unable to explain the incongruities, which prompted him to comment: "How he came up with 12,100 is beyond me" (Transcript, vol. 47, p. 77).

Mr Koncan identified yet another error in the flight release, this time pertaining to the second leg of flight 1362, from Dryden to Thunder Bay (second row). Again, there was a discrepancy between the maximum takeoff weight of 62,400 pounds from the SOC log and the 61,400 pounds entered on the flight release. Mr Koncan could not rationalize Mr Lavery's entry of 15,500 pounds as a maximum payload available for the leg, prompting him to comment: "The basic fundamentals of adding and subtracting were totally in error in coming up with this figure" (Transcript, vol. 47, p. 80).

Errors were also identified in the flight release on the Thunder Bay to Dryden leg of flight 1363. As per the flight release, Captain Morwood ordered an uplift of 15,800 pounds of fuel upon arrival at Thunder Bay and awaited what he thought would be 55 passengers to be boarded. With the 61,700 pound takeoff weight and 15,800 pounds of fuel, using the same calculations as above, the available payload would have been 8177 pounds. With 55 passengers and 1000 pounds of cargo the payload would be 12,000 pounds; some 2800 pounds beyond that permitted to make allowable takeoff weight of 61,700 pounds.

Further evidence disclosed that Mr Lavery's errors in calculating maximum payload were attributable to his consistent application of an

---

[16] In the Air Ontario system, in accordance with the requirements of ANO Series VII, No. 2, minimum dispatch fuel consists of fuel required for start and taxi, takeoff, climb to altitude, an IFR approach at destination and a missed approach, a diversion to the alternate, plus, on the F-28, a 30-minute reserve.

erroneous formula. Mr Lavery substituted "minimum allowable fuel" for "fuel on board" in applying this formula. Hence, the allowable payload weight, by his calculations, was always too high because it erroneously included the weight of any fuel carried in excess of the minimum allowable fuel.

The question remains, why did the crew of flight 1362/1363 order the uplift of 15,800 pounds of fuel called for by the flight release when, as stated by many witnesses, Captain Morwood would have noticed such an obvious error?

During his testimony, Mr Lavery admitted his confusion in compiling the flight release, particularly with regard to the maximum payload figures:

> Q. ... Now, it appears, then, that in the very early morning hours of the 10th of March, 1989, there was some confusion in your mind about what the correct formula was for coming up with the maximum payload; is that right?
> A. It appears that way.
> Q. And that confusion apparently accounts for the erroneous maximum payload figures; is that right?
> A. Yes.
> Q. And all of those erroneous maximum payload figures find their way onto the flight release which you issued a little later that morning; is that right?
> A. I believe so.
> Q. Yes, 12.1, 15.5, 12.1 and 10.3? [payload figures from flight release]
> A. Okay.
> Q. Now, are you able to explain why some of the other figures on the SOC log did not get transposed verbatim or why they're not reflected in the SOC log? How did those disparities happen?
> A. I don't know.
>
> (Transcript, vol. 48, p. 184)

Deteriorating Dryden Weather and Air Ontario SOC

In my view, there were two critical weather forecasts which should have been accommodated by Air Ontario SOC in the operational control of flight 1363. These were the amended Dryden terminal weather forecast issued at 1502Z (10:02 a.m. EST) and valid at 1523Z (10:23 a.m. EST) and the terminal weather forecast for Dryden issued at 1630Z (11:30 a.m. EST) and valid at 1703Z (12:03 p.m. EST). Both forecasts called for light freezing rain at Dryden, and both were available to the Air Ontario SOC personnel and the crew of flight 1363 via Reservac computer terminals located in London SOC and the Thunder Bay airport crew room, respectively.

Aircraft C-FONF arrived at Thunder Bay at 10:35 a.m. EST and departed for Dryden at 11:55 a.m. EST. As stated earlier, on March 10, 1989, Mr Lavery went off shift at Air Ontario SOC at 10:30 a.m., and was replaced by Mr Wayne Copeland. When Mr Copeland arrived at work at 9:45 a.m. for his shift, which commenced at 10:00 a.m., he briefed himself on the area weather and received a "handoff briefing" from Mr Lavery (Transcript, vol. 45, p. 75).

It was the responsibility of Mr Lavery and Mr Copeland, as dispatchers, to monitor the weather that would be encountered by the flights they were following. In particular, with respect to the weather that would likely be encountered by flight 1362/1363, Mr Lavery should have been aware of the 1502Z (10:02 a.m. EST) amended terminal forecast for Dryden, and Mr Copeland should have been aware of both the 1502Z (10:02 a.m. EST) and the 1630Z (11:30 a.m. EST) forecasts.

Mr Lavery testified that, in the normal course of his duties, he should have been aware of the 1502Z amended terminal forecast calling for freezing rain at Dryden. Although he stated that he had no specific recollection of seeing that particular forecast, Mr Lavery testified that he was aware that freezing rain was a possibility for the entire area (Transcript, vol. 48, pp. 175–77). In this regard, Mr Lavery acknowledged that he had not had sufficient weather training and he conceded that, because of his lack of experience, he did not make the critical connection between the weather forecast for freezing rain at Dryden and the possibility that the aircraft might need de-icing there. Mr Lavery testified that in retrospect, if he had made such a connection, it "definitely" would have been better to overfly Dryden:

> Q. ... if you take a look at the weather for Dryden that day, which would have been available to you, if you had looked at that, you might have been clued in to the fact that the F-28 might have needed de-icing in Dryden; is that right?
> A. Yes.
> Q. And, if you had thought about that, is that something that you would have discussed with the duty dispatcher to see whether or not the F-28 should overfly Dryden?
> A. Yes.
> Q. But you did not have enough experience at that time to have your mind click on that issue; is that right?
> A. I don't think I did.
> Q. ... Today, if the same scenario came up, you would think about that possibility of de-icing, that it may be better to have the plane overfly since the plane doesn't have an APU, is that right?
> A. Definitely.
> Q. On March the 10th, did you know what the ramifications of not having an APU working were? I mean, did you know that the plane could not start without an APU?

A. Yes.
Q. ... and you knew that the plane would have to shut down in order to de-ice. At least that was your opinion, is that right?
A. Yes.
Q. And do you agree that it is part of dispatch's responsibility to follow the flight by looking at the new and updated weather as it comes out, and considering whether or not that might impact on the flight?
A. Yes.
Q. ... And if you had done that, you would have seen other indications that there might be freezing rain in Dryden, isn't that right?
A. Yes.

(Transcript, vol. 48, pp. 211–12)

Mr Copeland testified that he would have reviewed the weather when he commenced his shift, and he would have noticed any changes in the weather which had any operational significance. Having stated this, Mr Copeland claimed that he had no specific recollection of seeing either the 1502Z or the 1630Z terminal forecasts calling for freezing rain in Dryden. Mr Copeland acknowledged that, as the dispatcher on duty on March 10, 1989, it was his responsibility to monitor the weather which could affect flight 1363. He stated that had he been aware of the terminal forecasts calling for freezing rain in Dryden, he would have appreciated the possibility of having to de-ice the aircraft in Dryden and he would have brought the scenario to the attention of the duty manager, Mr Kothbauer. Mr Copeland was questioned on this issue:

Q. ... it was your responsibility to see this forecast in a timely way, isn't that right?
A. Yes.
Q. ... assuming that you saw this forecast, you would have known that there is a possibility that if the F-28 landed in Dryden, it would need to be de-iced, right?
A. Yes.
Q. But you knew that was a big problem because it couldn't de-ice with the engines running, right?
A. True.
Q. And it couldn't shut the engines off because if it did that, it couldn't get started again and you would have a bunch of people stuck in Dryden, right?
A. True.
Q. So once again, assuming that you saw the forecast, the logical thing for you to do would have been to relay this information to the captain so he could consider whether or not to overfly Dryden, is that right?

A. If it did happen the way you describe, I would have not at that time instructed the aircraft to overfly. I would have asked the duty manager, here is the way it is, what do you want to do.
Q. All right.
A. That decision would be his.
Q. So he would have had the option, then, of getting ahold of the aircraft and suggesting to the captain that he might want to consider overflying Dryden, right?
A. That's a possibility.
Q. I take it you don't tell these captains anything, you suggest things to them?
A. True.
Q. All right. Now, did you tell your duty manager that there is a possibility the F-28 might have to de-ice in Dryden and you might want to do something about it?
A. I don't remember doing that.

(Transcript, vol. 45, pp. 182–84)

Mr Kothbauer, the duty manager supervising the SOC facility at Air Ontario on March 10, 1989, testified that the two terminal forecasts calling for freezing rain in Dryden were not brought to his attention as they should have been. Mr Kothbauer explained how the weather forecasts were significant to the operational control of flight 1362/1363:

Q. ... Did you have occasion to look at either of those two sequences when you say you looked at the weather for Dryden after the departure of 363?
A. I don't remember seeing the amended terminal forecast.
Q. You don't remember seeing it. The 1502 amended FT for Dryden is, of course, 10:02 local London time, is that correct?
A. Yes, it is.
Q. And in the ordinary course, would that FT generated at 10:02 have been available on the RESERVAC system in London during the length of the turnaround at Thunder Bay being 10:35 ramp time to 11:55 departure time local Thunder Bay?
A. It should have been available, yes.
Q. ... could I direct your attention to the end of that sequence where it says two miles in light rain, light freezing rain and fog. Do you see that?
A. Yes, I do.
Q. But you [didn't] have occasion to have looked at that document?
A. No, sir, I didn't.
Q. ... If you would have had occasion to look at that document, would this amendment including ... light freezing rain ... have influenced your decision one way or the other with regard to the continuation of Flight 363 to Dryden with an unserviceable APU?

A. Yes, sir, it would have.
Q. And what ... conclusion would you have come to?
A. Normally, if it was just an occasional as it is in that terminal forecast, I would at least confer with the captain to see what his thoughts on it were, but I would plan a no-stop or to overfly the station.

(Transcript, vol. 49, pp. 74–75)

It is clear that there was a breakdown in Air Ontario SOC regarding the two terminal forecasts. Mr Lavery would have been in a position to see the 1502Z amended forecast calling for freezing rain in Dryden, and Mr Copeland would have been able to see both the 1502Z and the 1630Z terminal forecasts calling for freezing rain in Dryden. There is evidence that, at least in Mr Copeland's case, had he seen the forecasts, he would have appreciated their operational significance to aircraft C-FONF with an unserviceable APU flying into Dryden where there was no ground-start capability. In any event, neither Mr Lavery nor Mr Copeland notified his duty manager, Mr Kothbauer, or the crew of C-FONF regarding the forecast freezing rain for Dryden. Both forecasts were issued prior to the 11:55 a.m. EST aircraft departure from Thunder Bay.

Overfly Options

The evidence of the three individuals in Air Ontario SOC responsible for the dispatch and flight following of flight 1362/1363 led me to consider the possibility of Captain Morwood's deciding to fly directly to Winnipeg and overflying Dryden. None of the three individuals involved suggested this possibility to Captain Morwood and it is not known whether Captain Morwood considered this alternative.

The fuel required to fly from Thunder Bay to Winnipeg with Sault Ste Marie as an alternate would have been 13,000 pounds with no reserve fuel, using the formula of 5000 pounds for the first hour and 4000 pounds for each additional hour of flying. This is the formula that the testimony indicates the dispatchers would have used. Since the flight departed Thunder Bay with 13,000 pounds of fuel, the option of overflying Dryden and proceeding to Winnipeg after departure from Thunder Bay was not possible since the 30-minute holding fuel as required by ANO Series VII, No. 2, would not have been on board. In order to overfly Dryden, Captain Morwood would have had to take on additional fuel at Thunder Bay to meet legal requirements.

In practical terms, if, while airborne from Thunder Bay to Dryden, Captain Morwood had decided not to land at Dryden for whatever reason, he would have had to find a suitable alternate for Winnipeg that was within the range of his fuel on board, or he would have had to abandon Winnipeg as his destination early enough to allow the flight to fly back to Thunder Bay or to Sault Ste Marie with required fuel reserves.

The time for Captain Morwood and Air Ontario SOC to have considered these options would have been during the one hour and 20 minute station stop at Thunder Bay.

Captain Morwood and the Flight Release

Several witnesses were asked, based on their knowledge of Captain Morwood, what they believed his reaction would have been upon receipt of the flight release on March 10, 1989. Early on March 10, prior to the dispatch of flight 1362 from Winnipeg, Mr Kothbauer had left word for Captain Morwood to call SOC so that Captain Morwood could be updated about what he would encounter that day, including the fact that ground starts had been set up at all en route stations except Dryden. However, as Mr Kothbauer testified, Captain Morwood did not return this message from Winnipeg. Mr Kothbauer testified further that, given his knowledge of Captain Morwood, he found it unusual that Captain Morwood did not return his message.

The evidence indicates that Captain Morwood received the flight release in Winnipeg the morning of March 10, 1989. However, notwithstanding the evidence cited above that Air Ontario pilots, including George Morwood, did not rely on the accuracy of SOC's flight releases and routinely reviewed the calculations themselves, Captain Morwood did not telephone SOC to advise of calculation errors in the flight release.

Both Mr Koncan and Mr Kothbauer testified that they would have expected Captain Morwood to call had he not received a flight release or had he received a flight release so error-laden as the one supplied to him. On the basis of his prior experience in dispatching Captain Morwood's flights, Mr Kothbauer was questioned about his expectations of Captain Morwood in the circumstances:

> Q. ... Mr. Kothbauer, if a pilot – and let's use the example of Captain Morwood on the 10th of March last year early in the morning in Winnipeg – if he did not receive a flight release, what would you expect him to do?
> A. Standard procedure was for the crew to call London SOC.
> ...
> Q. And you had, I take it, flight-followed or dispatched his flights before?
> A. Yes, sir.
> Q. From your recollection of Captain Morwood, would it be your opinion that, upon his viewing of this Flight Release, if indeed

he received it, he would consider it in the same light that you have considered it?
A. Yes, sir.
Q. I take it he would have known that it was erroneous?
A. I believe so, yes.
Q. Now, you've stated that you would have expected Captain Morwood to call you if he did not receive a flight release.
Would you have expected Captain Morwood, from your recollection of the man, to have called you if he received a flight release that, as you put it, he would have known was erroneous?
A. Yes, sir, I would expect the call.

(Transcript, vol. 49, pp. 51–52)

Similarly, the other duty operations manager, Mr Koncan, also expressed his opinion that in the circumstances he would have expected Captain Morwood either not to accept the flight release or to call SOC to discuss the errors:

Q. ... If Captain Morwood, or any other captain, for that matter, received a flight release such as the one we have in Exhibit 345, and it was as patently incorrect as you have described in terms of its payload, what would you expect the captain to do?
A. Knowing Captain Morwood –
Q. And did you know Captain Morwood?
A. I have known Captain Morwood since the day I started with Air Ontario. I have known him quite well. And in personally releasing flight releases as acting dispatcher on previous occasions with Captain Morwood, there have been instances whereby the flight release is issued at the same time as Captain Morwood is checking in, and within the time span of the issuance of the flight release, Captain Morwood getting the copy in hand, turning to his computer and reviewing the weather, Transport Canada amends the terminal forecast, your alternate has just gone down, and he will call you and ask you for a revision to the flight release.
... Captain Morwood, if indeed he got ... this particular flight release, I can only say that (a), he would not accept it, (b), he would definitely call dispatch as to why these numbers are so far out and incorrect.

(Transcript, vol. 47, pp. 92–93)

The evidence supports the conclusion that the errors in the March 10, 1989, flight release were not detected by pilots Morwood and Mills, and that they probably relied on the erroneous flight release.

The Thunder Bay Station Stop: Passengers versus Fuel

The cancellation of a Canadian Partner flight in Thunder Bay on the morning of March 10, 1989, and the accommodation of its passengers on Air Ontario flight 1363 presented operational problems for the flight crew and SOC personnel. The circumstances surrounding the fuel-versus-passengers question were clearly described by Mr Kothbauer in the following excerpt from a handwritten memorandum he prepared on March 11, 1989, regarding his involvement with flight 1362/1363, which he read in testimony:

A. "At approximately 1100 o'clock Eastern Standard Time Air Canada in Thunder Bay notifies SOC that 363 is overloaded and will require offloading of ten passengers and their bags. Air Canada advised us that it was now a full load, 65 passengers. The projected load had been 55. Apparently Canadian Partner had cancelled their Thunder Bay-Dryden-Winnipeg sched and their passengers were protected on our flight.

"Due to the heavy workload in SOC, the last check of projected passenger loads" would have been ... "prior to the issuance of the flight release.

"Air Canada had not notified SOC of the increased passenger load and no load restriction had initially been placed on the flight by SOC.

"I told Air Canada that I would check to see if we could defuel the aircraft while they checked further into the overload condition.

"Initially SOC, [meaning myself] placed a 35 minute delay on the flight as we sorted it out. I did not want to bump 10 passengers if we could avoid it, and hot refuelling was required in Dryden anyway.

"I called Thunder Bay ESSO and set up the defuelling. Since Air Canada couldn't give me exact figures, I told them to check with the captain on how much to remove.

"At approximately 1130 Eastern Standard Time Air Canada called and advised that 2,000 pounds of fuel was being off-loaded as well as [and I can't remember exactly but I believe they said] 4 or 5 passengers. At this time, SOC forecast a departure out of Thunder Bay ... for 1145 Eastern Standard Time.

"And the flight actually departed Thunder Bay 1 hour behind schedule at 11:55 Eastern Standard Time.

"I spoke again with ESSO in Thunder Bay regarding billing procedures for the defuelling and, at this time, I again checked Dryden weather, and it was still VFR.

"This is the last thing that I did related to this flight before the accident."

(Transcript, vol. 49, pp. 88–90)

As stated earlier, after the aircraft arrived at Thunder Bay at 10:35 a.m. EST, the passengers from flight 1362 were deplaned and the aircraft was fuelled up to 15,800 pounds FOB, as specified in the flight release, by Mr Jack McInnis of ESSO Thunder Bay. The fuelling of the F-28 took approximately 15 to 20 minutes.

After the passengers of flight 1363 were boarded, approximately 15 minutes after the aircraft arrived, it was discovered that there were 65 passengers on board rather than the 55 passengers indicated on the flight release. The extra passengers had been moved to flight 1363 by Air Canada STOC in Thunder Bay after the cancellation of a Canadian Partner flight. Because of the extra 10 passengers, flight 1363 was overweight. There was some deliberation on the flight deck of C-FONF as to how to resolve the weight problem. They could off-load passengers, fuel, baggage, or any combination of these to get down to the proper weight.

Approximately 15 minutes after the aircraft arrived, Mr Morgan Brown, an Air Canada station attendant, boarded the aircraft to advise Captain Morwood of the baggage count for flight 1363. Mr Brown testified as to his discussion with the flight crew of C-FONF:

Q. ... Now, did the captain say something to you about passengers coming on and about taking off some fuel? Did he make a comment to you about that?
A. Yeah, he asked where all the passengers came from, and he said he was overweight, he would either have to defuel or take passengers and baggage off.
Q. ... And did the co-pilot say anything in relation to the defuelling of the aircraft?
A. He said it was available at Thunder Bay, they did defuel in Thunder Bay, and that's when I told him that, You make up your mind what you're doing, and when you've got – passengers or fuel, whatever you're taking off, because I had a Dash 8 to work. I left.
Q. Oh, you had another aircraft –
A. I had another aircraft to work.
Q. So you said, Make up your mind what you want to do and then I'll be back?
A. That's exactly what I said.

(Transcript, vol. 56, pp. 99–100)

Flight attendant Hartwick testified that she advised Captain Morwood that there were five non-revenue or contingent passengers on board.[17] Captain Morwood then tried to contact the Air Canada STOC to request that they take off the contingent passengers and their baggage.

Because there was no direct radio link between Air Ontario aircraft and the Air Canada STOC in Thunder Bay (or Air Ontario SOC in London), Captain Morwood relayed his message through an Air Canada radio operator, Mr Peter Shewchuk. Mr Shewchuk testified that he received the request from C-FONF approximately 15 minutes after its arrival and then tried unsuccessfully to contact Air Canada STOC. Because he received no answer from STOC, Mr Shewchuk contacted the Air Canada baggage room and spoke with an Air Canada passenger agent. Mr Shewchuk testified that he advised the passenger agent that the Air Ontario aircraft needed a passenger agent on board to deplane 10 passengers and their baggage because of an overweight problem. Mr Shewchuk testified that, approximately 15 minutes later (at approximately 11:00 a.m. EST), one of the crew of C-FONF called back advising that no passenger agent had come on board and requesting that Mr Shewchuk contact Air Canada STOC again. Mr Shewchuk then called the Air Canada customer service manager, who sent a ticket agent out to the aircraft.

Flight attendant Hartwick testified that the flight crew was trying to radio Air Canada STOC and the ESSO fuelling agent from on board the aircraft. At one point, Captain Morwood asked her to try to get the attention of some baggage handlers who were loading the aircraft. Mrs Hartwick provided the following testimony as to how these deliberations in Thunder Bay were affecting the crew:

> Q. ... In speaking to the pilots, Mrs Hartwick, did you ... get a feel of what their mood was starting to be?
> A. They were ... becoming very frustrated. They felt like we were all being ignored. No one was coming to our rescue. We sat there and we were actually delayed one hour in Thunder Bay.
> Q. As a matter of fact, did the captain to the best of your recollection make a bit of a comment that you recall?
> A. Well, he was very upset. He may have swore and said God damn it like this but ...
> Q. He felt ignored, didn't he?
> A. We all felt ignored. Passengers had connections to make in Winnipeg and we were delayed a total of an hour in Thunder Bay. So, we were worried about them as well.
>
> (Transcript, vol. 10, p. 191)

[17] Contingent passengers or "cons" are those passengers flying on a special pass. They would usually be company employees.

Apparently the ticket agent sent out to deplane passengers was stopped before reaching the aircraft and advised by one of the ground handlers that they were going to defuel rather than take passengers off.

Some time after his last conversation with the flight crew of the aircraft, Mr Shewchuk was again contacted by them. One of the flight crew explained to him that they were going to defuel rather than off-load passengers, and asked him to contact the ESSO fuelling people at Thunder Bay. Mr Shewchuk telephoned ESSO but received a busy signal. He the called Air Ontario SOC in London to apprise them of the situation, but was advised by them that they had already made the arrangements and the ESSO fuelling agent was already taking steps to off-load the necessary fuel. This was Mr Shewchuk's last involvement with the defuelling/passenger situation. Mr Shewchuk testified that during his discussions with the flight crew, they expressed concern regarding the delay and the connections that passengers had to make in Winnipeg.

At approximately 11:10 a.m., Mr Kothbauer contacted Mr Gary Linger of Thunder Bay ESSO and arranged for the defuelling. Fifteen minutes later, at about 11:35 a.m., Mr Linger and Mr McInnis of ESSO commenced the defuelling of the F-28 aircraft. Mr Linger spoke with Captain Morwood, who was standing outside C-FONF, and he instructed them that the aircraft was to be defuelled down to 13,000 pounds FOB. Mr Linger testified that Captain Morwood was very calm and professional but somewhat apologetic about the defuelling. The defuelling was completed approximately 20 minutes later. The aircraft then departed, approximately one hour late.

In my view, the additional delay and accompanying frustration experienced by the passengers and crew of flight 1363 in Thunder Bay was a result of poor communications among Air Canada STOC, Air Ontario SOC, and the crew of C-FONF. Air Canada STOC apparently determined that 10 additional passengers were to be loaded on Air Ontario flight 1363, yet it was tardy in entering this information in the Reservac computer. As a result, Air Ontario SOC was not notified of the change until approximately 11:00 a.m. EST, after the fuelling of the aircraft had been completed and the overweight situation was manifest. Had the increased passenger load been made known to Air Ontario SOC in a more timely manner, prior to the arrival of flight 1362 in Thunder Bay at 10:32 a.m. EST, they could have made arrangements for a change in the scheduled fuel uplift. With more timely and better organized communications, the passengers-versus-fuel difficulty could have been avoided altogether, and the crew of C-FONF would have been spared the frustration of having to communicate indirectly with Air Ontario SOC, Air Canada STOC, and the fuelling agent via the Air Canada radio operator and avoided the unnecessary delay at Thunder Bay.

The Performance of Air Ontario SOC: Conclusions

I am of the view that there were two significant shortcomings with respect to the operational control of flight 1362/1363: first, the preparation of the erroneous flight release; and second, the failure to accommodate for the forecast freezing rain for the Dryden area.

The question remains as to how Air Ontario's operational control of flight 1362/1363 could break down in the manner that it did. As in much of this investigation, several factors can be identified as at least contributing to the critical system failure, although a single cause is often difficult to identify.

Certainly, as he acknowledged himself, Mr Lavery erred in his preparation of the flight release. That there was such an error was not entirely unpredictable. It was stated by all of the operational control personnel who testified that the training and qualification of the Air Ontario dispatchers was inadequate. Mr Kothbauer, Mr Lavery's immediate supervisor on March 10, 1989, testified that Mr Lavery was a "weak dispatcher" who tended to have difficulty when the pressure was on, but the evidence suggested that Mr Lavery might not have been alone in this regard. For example, Captain William Wilcox testified that, when the weather was bad, the reliability of flight releases tended to diminish. This evidence suggests to me that the preparation and review of such flight releases by Air Ontario operational control could have been more hurried and less careful during poor weather operations, the exact opposite of what should have been required in such circumstances.

With regard to the accommodation of the forecasted freezing rain for Dryden, clearly Air Ontario SOC personnel should have been aware of the changing weather and made appropriate arrangements. Mr Kothbauer acknowledged this in questioning:

> Q. ... It is your evidence that had the flight watch system worked properly, had the weather been monitored with ... a properly trained and experienced dispatcher, what would have happened is the F-28 would have ended up overflying Dryden, is that right?
> A. Possibly, yes.
> Q. Possibly or probably?
> A. Probably.
> Q. ... thank you. It would have ultimately, I suppose, been up to the captain, but your advice to him would have been overfly?
> A. Correct.
>
> (Transcript, vol. 49, p. 187)

It is clear that the time for arranging an overflight of Dryden would have been during the one hour and 20 minute station stop at Thunder

Bay. One would have expected the dispatchers immediately responsible for the following of flight 1362/1363 to have detected the amended terminal forecast of 1502Z and the terminal forecast of 1630Z and passed along the information regarding freezing precipitation to the flight crew and/or the duty manager, Mr Kothbauer. From the evidence of Messrs Lavery and Copeland, it is not certain whether they saw the two critical terminal forecasts. From all of the evidence, I am certain that the information regarding freezing rain was not communicated by them to Mr Kothbauer or the crew of flight 1362/1363.

On March 10, 1989, Mr Kothbauer was the duty manager supervising the entire operational control function at Air Ontario. To the extent that Mr Lavery erred with respect to the flight release, it was Mr Kothbauer's responsibility to detect and prevent the error from taking on operational significance. At the same time, the F-28 C-FONF was not the only aircraft that Mr Kothbauer and Air Ontario SOC had to worry about – they were responsible for the operational control of all Air Ontario flights over their entire system. Mr Kothbauer was questioned at length on the failure of Air Ontario SOC on March 10, 1989. The following interchange provides, I believe, interesting insight into the problems encountered at Air Ontario SOC on that day:

Q. ... if you had not been so busy and if you hadn't been attending to other duties that were imposed on you, do you agree that there was weather information available to you as much as three hours before the crash which would have confirmed your concern from the area forecast about the need for de-icing?
A. Yes, sir, I agree.
Q. You agree with me that it is the duty of the dispatcher to follow the weather for the assistance of the pilots?
A. Yes, sir, I do.
Q. And, if you had a properly trained dispatcher who was doing his job, that is, following the weather, he would have seen that terminal forecast three hours before the crash which spoke of light freezing rain in Dryden, specifically, right?
A. Yes, sir, that terminal would have come out about the time that the dispatchers were shift changing.

...

Q. ... List all the things you think that may have combined to cause that proper system outlined in the Flight Operations Manual to break down.
A. I think the major factor that morning would have been the workload that not only the dispatchers but myself as well were under.
Q. What else?
A. I'm not sure that the dispatchers were aware that the auxiliary power unit was unserviceable. Or, at least, the dispatcher that

came on duty at about 10 o'clock, I'm not sure if he was briefed that it was.

...

Q. So what other reasons would there be for this system not working? You have mentioned workload.
A. Yeah, a lack of knowledge of what is required. The way – you would end up discarding things that you didn't have to do. You'd prioritize while you were on the shift, and if you didn't prioritize correctly, then that possibly wouldn't even be on your list of things to do.

...

Q. Now, the lack of knowledge, that goes back to poor training and lack of experience; is that right?
A. Yes, sir.
Q. You mentioned a shift change. Were there any other factors which you think might have contributed to the system not working, flight watch not working properly?
A. Going along with workload would be distractions, the telephone ringing, background noise off the radios, other people in the office. Crew Scheduling shared the same office that we did, and there was a lot of background noise during irregular ops in that office.

...

Q. You agree with me that the flight watch system broke down, it did not work the way it should have worked –
A. Correct.

(Transcript, vol. 49, pp. 173–78)

Mr Copeland, the dispatcher with the last chance, in my view, to have alerted Mr Kothbauer and/or the flight crew of the forecast freezing rain for Dryden, echoed Mr Kothbauer's evidence regarding the workload in SOC. On March 10, 1989, Mr Copeland would have been responsible for the flight following of six to ten aircraft over a large geographical area that included Winnipeg, Montreal, Toronto, and London, Ontario. Mr Copeland stated that he and everyone in SOC were quite busy that day as the weather was poor throughout the entire system:

Q. And if you're going to fulfil your duty as set out in the Flight Operations Manual, and that is, you're going to monitor every stage of each plane's progress across this broad geographical area, I take it that, at times, you were a very busy man?
A. Correct.
Q. Were you working in that scenario on March the 10th; that is, were you monitoring numerous airplanes simultaneously in a situation where you had generally bad weather and you had airplanes all over the place?

A. Are you asking me if I was busy?
Q. I guess. That's a pretty succinct way to put it ...
A. Yes, it was a busy day.
...
Q. ... All right, it was ... busy for the reasons that I mentioned: You had a number of aircraft, it was generally bad weather, and the aircraft that you were monitoring were spread over a large area; is that right?
A. That's not what I would call the reasons for being busy.
Q. Why were you busy?
A. Everyone in the room was busy. There was weather problems throughout the system. That keeps us busier. And there's a lot of other factors that can keep us busy that I can't really quote for sure, such as crew problems, rerouting aircraft, rerouting air crews, maintenance delays within the system, maintenance problems within the system.
I can't really account for why it was busy that day, but those are some possible factors.

(Transcript, vol. 49, pp. 161–62)

The explanations for the poor performance of Air Ontario SOC offered by Messrs Kothbauer and Copeland seem to boil down to the following:

- March 10, 1989, was a busy day which was getting busier as the weather deteriorated; and
- distractions, including noise and activity in the SOC centre, a shift change among dispatchers, and the activity generally associated with what could be called a bad day.

These factors all contributed to a situation where the personnel involved in the operational control of C-FONF performed in a less-than-optimal fashion.

I am not persuaded by these explanations. As was suggested by the questioning of Mr Kothbauer, when there is bad weather, aircraft unserviceabilities, or other irregular operational circumstances, SOC is especially relied upon by pilots. These sorts of demanding operational conditions are by no means unexpected. They call for prompt and professional attention by operational control personnel, and for this reason regulatory authorities require a high standard of training and qualification from operations control officers. A review of the evidence relating to these matters has convinced me that the most significant factors contributing to the breakdown in the operational control of flight 1362/1363 was poor planning and organization within SOC, a lack of training and qualification of Air Ontario SOC personnel, and the failure of SOC personnel to appreciate the importance of their function.

Licensing and Training of Dispatchers

The Canadian Airline Dispatchers Association (CALDA) is a trade union with a membership of approximately 120 dispatchers employed by Air Canada, Canadian Airlines International, and AirBC. CALDA submitted a brief to this Commission of Inquiry (virtually the same brief as the one it prepared for the Dubin Commission of Inquiry on Aviation Safety in 1980) expressing in the strongest terms the need for proper training and licensing of flight dispatchers. The following passage from its introduction clearly indicates the impetus for CALDA's revival of its licensing application at this time:

> CALDA firmly believes that if a dispatcher dispatched system equivalent or better to the system at Air Canada or Canadian Airlines International (both of which systems are, in CALDA's submission, not perfect) this tragic accident would not have occurred. CALDA believes that if all air carriers in Canada were required to employ only federally licensed dispatchers, accidents of the nature of the accident at Dryden would be permanently prevented.
>
> (Exhibit 1232)

In 1971 the Department of Transport (DOT) announced its intention to establish licensing requirements for flight operations officers. This proposal was strongly opposed at that time by the Air Transport Association of Canada (ATAC), whose position was that "[t]here is no evidence that the standard of flight dispatch has ever had an adverse effect on safety, therefore, there is no reason to believe that licensing dispatchers will in any way contribute to a higher degree of safety" (Exhibit 1233). Although, in correspondence through to 1973, the DOT director-general, civil aeronautics, vacillated on the subject, he did finally initiate a study in 1974 which found that licensing of dispatchers appeared to be unnecessary. In 1976 the director, aeronautical licensing, supported CALDA's position on the need for detailed information and guidelines for an acceptable operational control system.

Following the Dryden crash, regulatory interest was revived, and in 1990 CALDA presented a proposed flight dispatcher training syllabus to Transport Canada and has continued to press for implementation of a standardized training system for flight dispatchers and for their licensing.

Report of the Dubin Commission of Inquiry on Aviation Safety

Based on the evidence then before him, Mr Justice Dubin stopped short of recommending the licensing of flight dispatchers in 1982. He did, however, recognize in the following recommendations the need for proper training of dispatchers and the need for dispatchers to be inspected by the regulator:

> Recommendation 240: A flight dispatcher's training manual should be prepared by the airline carriers and approved by Transport Canada.
>
> Recommendation 241: Transport Canada's inspectors should inquire into whether the airlines carriers are complying with the proposed Flight Dispatcher's Training Manual, once introduced ...

Despite Mr Justice Dubin's recommendations, there has been little change in the training requirements of flight dispatchers since his Commission of Inquiry was established in 1980. Training is still left up to the carriers. There is no approved training manual, and, as the evidence before this Commission revealed so clearly, Transport Canada has not, in any meaningful sense, monitored the training provided by the carriers or the proficiency of the individual dispatchers.

CALDA's Application for Licensing of Dispatchers

It is high time to increase the level of regulatory involvement in dispatcher training. This is not in issue. There is some controversy, however, over the two principal options. In general terms, these two options are:

1 A system along the lines recommended by Mr Justice Dubin in 1980, whereby training remains in the hands of the carriers but follows a Transport Canada–approved training manual, and Transport Canada carries out regular and effective compliance checks.

2 A system in which flight dispatchers would be licensed by Transport Canada.

The deficiencies observed in Air Ontario's dispatch operation would be alleviated, and the CALDA concerns satisfied, through implementation of an approved standard to which dispatchers must be trained, coupled with Transport Canada enforcement of those standards. However, Mr Sandziuk pointed out that little, if anything, was implemented from the 1980 recommendations of Mr Justice Dubin and that in the intervening period the Dryden accident occurred, at the expense of 24 lives. Referring to the Dubin recommendations, Mr Sandziuk provided the following compelling testimony:

> A. ... [I]n general, perhaps his conclusions were correct. The only thing that was wrong with it is that very little, if anything, has ever been implemented. I think the concept that Justice Dubin perceived, if I understand it correctly, was to attain all the goals the flight dispatchers were looking for.
>
> Unfortunately ... there is no obligation upon the companies to meet his suggested program. Transport Canada, to my knowledge, does not do the inspections of the company to see that these things are fulfilled.
>
> And despite all the good things that are said in the report, my contention comes right back to what I initially said, and that is, that I view it, as long as Transport Canada vests the responsibility for flight operations solely within the company and the duties of the flight dispatcher in the company, rather than giving the flight dispatcher that authority, nothing really is going to change.
>
> Because, although they are very well-intentioned, they have every reason to follow the program, the ... hard cold facts are that monetary restraints cause companies to cut corners. And the first place they cut corners is a small group like flight dispatch ... [L]ook at Air Canada's example, they give us two days recurrent training; last year because we got the Airbus, we got two days on the Airbus – which we are very grateful and I think it is great – but as a result, we didn't get any recurrent training, and that is what we consider a really good airline.
>
> The question I have to ask is: What is happening in what we consider the not really good airlines? Are they getting any training? So, the concept that Justice Dubin had suggested is a very good concept, but I am saying it is unworkable, it will never be workable as long as Transport Canada vests that responsibility in the company and not in the flight dispatcher then nothing is going to change.
>
> ...
>
> A. ... And I'm saying to you that I have to believe, right or wrong, that part of the reason is that there was no inspection of the flight dispatchers by Transport Canada. I am saying to you, if one of those or I, as a dispatcher, have a licence, it is my responsibility to make sure that it's current because I know that at the end of the year if I don't meet ... their criteria, I don't

> have a job. But as long as you vest that responsibility in the company, there really are no rules that way.
>
> (Transcript, vol. 155, pp. 102–105)

ICAO and Licensing of Dispatchers

Canada is a contracting state to the 1944 Chicago Convention at which the International Civil Aviation Organization (ICAO), was created, and is a member of ICAO.

The Annexes to the Chicago Convention, also known as International Standards and Recommended Practices, set out minimum standards in areas that are recognized as necessary or desirable for the safety, regularity, and efficiency of international air navigation. Annex provisions are not binding on contracting states. Rather, when a contracting state is unable to comply with an international standard, it is required to file with ICAO a notification of difference.

ICAO has non-mandatory provisions for licensing flight operations officers (FOO); when a contracting state chooses to require licensing, it can use ICAO provisions setting out minimum prerequisites to be followed by the licensing body in issuing licences to its FOOs.

Where, however, a contracting state does not chose to license its flight operations officers, it is still required that operators establish and maintain an approved method of supervision of flight operations. In this scenario, as is the case in Canada, the responsibility for ensuring that dispatchers are properly instructed in their duties and responsibilities is vested in the operator.

In 1986, the Air Navigation Commission of ICAO rejected an internal committee's recommendation to abolish dispatcher licensing and stated in its decision that:

> Notwithstanding the recommendation of the panel to delete from Annex 1 the provisions for the flight operations officer licence, and the fact that the majority of replies support that recommendation, the Secretariat is impressed by the cogent arguments advanced for retaining the licence. It also feels that, because of the non-mandatory nature of the FOO licence, many States who agreed with the panel's proposal may, in fact, be content if a decision was made to retain the licence.
>
> (Exhibit 1236)

Canadian Position

The Canadian position on this question was to support deletion of the licensing requirements for the flight operations officer. The reasons for the Canadian position, as described by Mr Sandziuk, portray a Transport

Canada that was unresponsive to the interests of CALDA and the safety of the travelling public:

> A. ... I would like to say though at this point, that as a representative of CALDA at the time, I had approached Transport Canada hoping to convince them that they should support retention of licensing. Unfortunately the decision was already made.
>
> The Government of Canada and Transport Canada ... in particular, did not ever consult the flight dispatch groups in Canada for an opinion on retaining licences. And this is all despite the fact that I previously had a letter from the then Transport Minister Jean Luc Pepin that they would consult the addressed parties in the future, and that did not happen.
>
> (Transcript, vol. 155, p. 92)

Licensing and Labour Relations

A major issue to parties against licensing of dispatchers is the concern that licensing will be used as a labour relations tool in the hands of the dispatchers. Theoretically, if a company operates a full co-authority dispatch system of operational control, and if the law requires that dispatchers be licensed, a strike by dispatchers would possibly affect a carrier's ability to operate efficiently. I do not believe that logic supports this argument. Instead, I concur with the remarks of Mr Sandziuk on this point:

> A. Well, that has always confused me as to the contention of the licence for a flight dispatcher being used as an industrial weapon, because nothing could be more further from the truth.
>
> Today, I am not a licensed flight dispatcher and, yet, under the certification that Air Canada has, if the CALDA group at Air Canada decided to take strike action against Air Canada, we would literally close down the airline. It's unequivocal. It cannot be denied. They would close down.
>
> If we had a licence, the same thing would happen. If this were to happen – and I have to point out to you that throughout the history of CALDA there has never been an industrial strike. We have never had a strike in the flight dispatch groups in Canada that I know of. We have a very good rapport with the companies. We feel we do a very professional job and our people are very proud of the work we do.
>
> ... We don't have licences but under the certificate Air Canada, Canadian Airlines International have, if the dispatchers walked out of the office, the airline would shut down.
>
> Now, I could look at the recourse. What is the recourse? The recourse would be, if the dispatchers walked out of the office, it

> is not legal to just parachute pilots or anybody else into the function of flight dispatcher. They don't meet the criteria of their Navigation Order. Therefore, the option in my view that the airline company would have would be to go to Transport Canada, ask for a recertification as a pilot self-dispatched airline.
>
> But what is different whether I have a licence or no licence? There is zero difference. There is no difference. So, I don't understand the concept of anybody thinking that we would use it as an industrial weapon.
>
> (Transcript, vol. 155, pp. 107–108)

CALPA Position

On behalf of Canadian Air Line Pilots Association (CALPA), the following statement was offered with respect to the CALDA proposal that flight dispatchers be licensed:

> CALPA's position at present is that providing that the consequences (enforcement) of licensing are understood and that the ICAO and ANO standards are met, and that Transport Canada audits are performed, and that certain additional training topics are considered, CALPA's position is that it will not oppose licensing of dispatchers.
>
> The second portion of the statement is that CALPA would like to participate in the training programs to assist in presenting the flight deck point of view for the benefit of the dispatchers.
>
> (Transcript, vol. 155, p. 146)

United States Licensed Dispatchers and FAR Provisions

In the United States, the FAA licenses flight operations officers. Applicants must not only have two to three years of appropriate aviation experience, but they must also undergo formal training pursuant to an FAA-approved training course and pass a written "knowledge requirements" examination, as well as a practical "skill requirements" test before being licensed.[18] No such regime exists at present in Canada. The Air Ontario experience is in my view proof that such an initiative is overdue.

Moreover, Part 121 of the Federal Aviation Regulations, entitled "Certification and Operations: Domestic, Flag, and Supplemental Air Carriers and Commercial Operators of Large Aircraft," contains provisions on dispatch of far greater scope and detail than the corresponding provisions of Canada's Air Navigation Orders. For example,

[18] "Knowledge Requirements," as set out in 14 CFR 65.55, include Federal Aviation Regulations, Meteorology, principles of aircraft navigation, and air traffic control procedures.

FAR 121 contains individual sections addressing the following relevant areas:

- Flight following system: requirements (14 CFR 121.127)
- Crew member and dispatcher training requirements (14 CFR 121.415). This section includes minimum instruction time allotments; requirement for "differences training" to ensure competence in dispatching different aircraft of the same type.
- Aircraft dispatchers: initial and transition ground training (14 CFR 121.422)
- Recurrent training (14 CFR 121.427)
- Aircraft dispatcher qualifications (14 CFR 121.463)
- Duty time limitations (14 CFR 121.465)
- Responsibility for operational control (14 CFR 121.533)

While the scope of this section does not warrant a more detailed scrutiny of the United States FARs, their superiority to Canadian ANOs in this regard is readily apparent. Canada's provisions are vague, ambiguous, and open to a variety of interpretation by both operators and regulator. In contrast, the FARs provide a clear and comprehensive code setting out the duties and obligations of all parties involved in the operational control of aircraft.

Findings

- There exists within the aviation industry confusion as to where system operations control begins and terminates and where operational control begins and terminates, and there is a need for Transport Canada to delineate the two concepts clearly and definitively.

- Air Ontario made undertakings to Transport Canada regarding its operational control facility and the training of its operational control personnel, undertakings which were not fulfilled.

- The Transport Canada regulations regarding operational control are imprecise and incomplete and were not adhered to by either Transport Canada or Air Ontario.

- The most significant factors contributing to the breakdown in the operational control of flight 1362/1363 were poor planning and organization within Air Ontario SOC, a lack of training and qualification of Air Ontario SOC personnel, and the failure of SOC personnel to appreciate the importance of their function.

- Air Ontario flight dispatchers exercised a degree of operational control over aircraft flights, within the meaning of ANO Series VII, No. 2.

- Because Air Ontario flight dispatchers were exercising a degree of operational control over flights, they were operating as flight operations officers within the meaning of ANO Series VII, No. 2. (The terms flight dispatcher and flight operations officer are interchangeable.)

- Air Ontario's application to amend its operating certificate to include the F-28 aircraft, dated January 24, 1988, included a number of representations about the status of its dispatch operation that were clearly inaccurate.

- Air Ontario held itself out as having a pilot self-dispatch system, whereas its dispatchers were in fact exercising a degree of operational control over flights. This resulted in a hybrid dispatch system which introduced an element of uncertainty among flight operations personnel, in particular pilots and dispatchers, regarding their respective duties and responsibilities.

- Transport Canada approved a pilot self-dispatch system as adequate for Air Ontario.

- The hybrid dispatch system in place at Air Ontario on March 10, 1989, was not an adequate flight-watch system given the nature of the F-28 operation.

- A full co-authority dispatch system, which requires the concurrence of both the dispatcher and the captain in operational decisions, would have been a safer and more appropriate dispatch system for Air Ontario than the hybrid system that was in place on March 10, 1989.

- Transport Canada failed to monitor and inspect Air Ontario's system of operations control adequately.

- There is no Canadian regulatory requirement that flight dispatchers be licensed. Responsibility for the training and competency of flight dispatchers is left to the air carrier.

- The Air Ontario FOM that was approved by Transport Canada outlined qualification requirements for Air Ontario flight dispatchers that were less comprehensive in scope than the minimum training requirements required by law in a full dispatch system.

- Air Ontario provided inadequate training to its flight dispatchers.

- The flight dispatchers who exercised operational control over C-FONF on March 10, 1989, did not meet the qualification requirements for flight operations officers (dispatchers) as set out in ANO Series VII, No. 2.

- The operational flight plan (flight release) issued to the flight crew of C-FONF at Thunder Bay on the morning of March 10, 1989, contained serious errors and inaccuracies.

- The operational flight plan used by Air Ontario dispatchers did not contain sufficient detail to assist flight crews to understand and validate the dispatchers' calculations.

- The operational flight plan used by Air Ontario for the F-28 did not include an estimate of minimum diversion fuel.

- A procedure followed by Air Ontario F-28 dispatchers occasionally resulted in an operational flight plan which showed as minimum fuel an amount of fuel that was less than the minimum fuel required by Air Regulations.

- Inaccuracies in Air Ontario F-28 flight releases were not an unusual occurrence.

- Air Ontario F-28 pilots were accustomed to finding inaccuracies in their flight releases and customarily reviewed them to check their accuracy.

- It was the usual practice for Air Ontario captains, including Captain Morwood, to telephone SOC when they noted a problem with their flight release.

- Because Captain Morwood and First Officer Mills did not communicate to Air Ontario SOC on March 10, 1989, that they noted any problem with the flight release which was subsequently shown by the evidence to contain errors, it is probable that they relied on the erroneous information contained therein.

- Air Ontario SOC personnel should have been aware of the 1502Z and 1630Z terminal forecasts calling for freezing rain for Dryden on March 10, 1989, and should have made appropriate arrangements to have flight 1363 fly direct to Winnipeg without stopping in Dryden.

RECOMMENDATIONS

It is recommended:

MCR 87 That Transport Canada re-examine its regulatory requirements pertaining to air carrier operational control and flight watch systems, and that it consider putting into place the four-tiered scheme for such systems discussed in chapter 23, Operational Control, of my Final Report.

MCR 88 That Transport Canada proffer for enactment legislation requiring the licensing of flight dispatchers as a prerequisite to their acting as flight dispatchers and training to standards set by Transport Canada, including the passing of appropriate Transport Canada licensing examinations. I commend for Transport Canada's consideration the Federal Aviation Administration licensing regime for flight operational officers (flight dispatchers) in the United States.

MCR 89 That pending implementation of Recommendation MCR 88 above, Transport Canada direct its air carrier inspectors to be diligent in ensuring that flight dispatchers who exercise any operational control over flights meet the minimum training requirements of Air Navigation Order Series VII, No. 2.

MCR 90 That Transport Canada proffer for enactment amendments to Air Navigation Order Series VII, No. 2, that spell out minimum acceptable requirements for an operational flight plan (flight release).

MCR 91 That Transport Canada direct air carrier inspectors to be diligent during in-flight and base inspections in monitoring the accuracy of operational flight releases.

MCR 92 That Transport Canada, when approving air carrier manuals, ensure that flight dispatcher training qualifications set out in a flight dispatcher training manual are no less comprehensive than those requirements set out in the Air Navigation Orders in all cases where such dispatchers may exercise any operational control over flights.

MCR 93 That Transport Canada initiate a continuing program for the monitoring, inspection, and audit of air carrier flight dispatchers and flight dispatch and flight watch systems, with provision for spot checks and no-notice audits.

MCR 94 That Transport Canada introduce appropriate amendments to the Air Navigation Order Series VII, No. 2, Part III, so as to describe clearly and definitively where system operations control begins and terminates and where operational control begins and terminates.

MCR 95 That Transport Canada require that air carriers provide a system, automated or otherwise, for alerting dispatchers to significant changes in the weather, actual or forecast, at stations significant to flights for which a flight watch is provided.

MCR 96 That Transport Canada require that flight-planning data and procedures used by air carriers for pre-flight planning be accurate and sufficient to provide fuel reserves as stated in Air Navigation Order Series VII, No. 2, and to ensure that aircraft will be operated within the certificated weight restrictions.

MCR 97 That Transport Canada ensure that any flight watch system required under Air Navigation Order Series VII, No. 2, and approved by Transport Canada, provide for direct pilot-to-dispatch communications from the flight deck, where the necessary communications links exist.

MCR 98 That, if a pilot self-dispatch system is to be approved, both Transport Canada and the air carrier ensure that the duties and responsibilities of pilots and dispatchers are clearly and comprehensively covered in the Flight Operations Manual (FOM). It should be made clear in the FOM that no operational decisions are to be made without the captain's agreement.

MCR 99 That Transport Canada require all air carriers to have in place a system that requires ground-handling agents to inform dispatch and/or the captain of any significant change to aircraft passenger or freight loads immediately upon such a change becoming known to the ground-handling agent.

24 FLIGHT SAFETY

Introduction

During the hearings of this Commission a great deal of evidence was presented on the importance of flight safety within air carrier organizations. In particular, I heard evidence from experts and other informed individuals in the aviation industry regarding the necessity of a corporate commitment to flight safety within air carriers, and programs designed to give effect to such a commitment.

Dr C.O. Miller, an aviation safety expert appearing before the Commission, explained that there are two principal schools of thought regarding the infusion of a corporate commitment to flight safety within an air carrier. Dr Miller pointed out that the classic management approach argues that the application of basic management principles to an air carrier will inherently provide optimized safety. In simple terms, safety is everyone's responsibility, and if everyone does his or her job, then safety will be optimized. It may be apparent to the reader that such principles would indeed apply to any organization, be it a government agency, a manufacturing plant, or an airline.[1]

Dr Miller described a second approach to airline safety, which does not really contradict the classic management approach since it builds upon it. In what he terms the safety program approach, he suggests that, "given the complex technical and sociological nature of aviation today," something more than sound, professional management is required to foster safety adequately in air carriers. Dr Miller states that "a safety program involves specialized accident prevention efforts in addition to safety being part of everyone's job."[2] In keeping with this second approach, one can pose the question as to whether dedicated flight safety organizations ought to be mandatory for large air carriers. In fact, according to Dr Miller, as many as 50 per cent of the airlines in the United States already have identifiable safety departments, although there is no regulatory requirement to have them.

---

[1] Exhibit 1251, C.O. Miller, "Investigating Management Factors in an Airline Accident," presented at the Brazilian Congress of Flight Safety, Rio de Janeiro, Brazil, 26 November 1990, p. 5.

[2] Exhibit 1251, pp. 5–6.

To explain what would be expected of a dedicated airline flight safety program, Dr Miller referred to an excerpt from the International Air Transport Association (IATA) Technical Policy Manual wherein four broad categories of flight safety function are identified. For clarity, the excerpt from the IATA publication is reproduced in full:

Flight Safety Functions
per IATA Technical Policy Manual
OPS Amendment No. 37, 1 July 1989

1. **Organization of Accident Prevention Programmes**

Independent internal investigations of incidents and accidents with provision of appropriate safety recommendations to Management.

An overview function comprising appropriate Safety Assurance and Quality Assurance programmes.

An Airfield Inspection programme.

Comprehensive safety training programmes focused on specific safety objectives.

A flight data recorder exceedance programme.

Developing management objectives to reverse undesirable safety trends.

2. **Collection/Analysis/Communication of Safety Information**

Maintaining a flight safety data base to record and preserve operational safety incident information.

Participation in industry safety activities.

Internal analysis of incident trends and periodic reviews with senior management, including the CEO.

Communication to crew members of appropriate safety information, including the publication of a Safety magazine, incident summaries, safety bulletins, technical letters and safety articles.

Operation of a confidential crew member incident reporting system.

3. **Technical and Training Safety Coordination**

Establishment of effective liaison between administration, operations and maintenance and training departments on safety issues.

The overview of all emergency training and emergency procedures for both flight and cabin crews.

Supervision of the evacuation/ditching demonstrations required by the appropriate authorities.

Monitoring the contents of cabin safety information cards and video tapes.

Ensuring aircraft safety equipment meets user requirements.

4. **Corporate Emergency Response Procedures**

Development and maintenance of a corporate emergency response procedures manual.

Testing and validation of all corporate emergency response procedures.

Participation in airfield emergency exercises.

Liaison with accident investigation authorities.

(Exhibit 1251, pp. III-1–III-2)

The safety program model contemplated by Dr Miller and IATA involves a dedicated program of clearly defined flight safety functions within an air carrier organization. It might be argued that some individuals within air carriers may tend to regard the presence of a well-defined safety organization as providing them with absolution from their own flight safety obligations. It is clear from Dr Miller's comments that this is not what he was describing. Flight safety programs are designed to enhance the accepted premise that safety is everyone's responsibility, rather than to relieve individuals of such responsibility. An effective flight safety program should be regarded as a catalyst for flight safety activity throughout an airline.

It is apparent from the testimony that much of what is described in the IATA model program is already in place at and working well in Air Canada, and has been attempted to some extent by Air Ontario. In this chapter I examine the safety program adopted by Air Ontario to determine whether it was effective in addressing accident prevention in the context of the accident that is the subject of this Inquiry.

An air carrier's professed commitment to flight safety, as reflected in company policy documents and procedures manuals, its actual commitment to flight safety, as reflected in the example set by its senior management, its safety program, and the acts of its employees all make up what I have termed an air carrier's flight safety ethic. What I have found, having considered the evidence before me, is that the single most significant determinant of an air carrier's flight safety ethic is the actual commitment of the air carrier to flight safety as reflected in the example set by senior management. What might be a sound and apparently well-thought-out safety program can be scuttled if senior management support is lacking.

In this chapter I briefly review the legislative requirements regarding flight safety and examine Air Ontario's flight safety organization. Air Ontario's professed corporate commitment to flight safety is reflected in corporate documents and the evidence of senior managers. The development of the Air Ontario flight safety organization is recounted by its one and only flight safety officer. The effectiveness of the Air Ontario flight safety organization is also considered, using as examples the handling of three relevant flight safety incidents and a flight safety survey that was conducted because of the crash of C-FONF. I have also briefly reviewed the flight safety organization of the parent company, Air Canada, with particular emphasis on its involvement – or lack thereof – with the flight safety organization of its subsidiary, Air Ontario.

Legislative Requirements

The traditional and accepted method of regulating aviation safety is through operational and airworthiness legislation. In Canada, this legislation is contained in the *Aeronautics Act*, the Air Regulations, and the Air Navigation Orders. All operational regulations by their nature have a flight safety implication. Regulatory standards regarding pilot proficiency, licensing, maintenance facilities, operational control, and instrument flight rules, for example, are all designed to ensure an acceptable degree of operational integrity within the air transportation system and an acceptable level of safety. Nevertheless, it is the individual air carrier's prerogative to determine how it will meet the operational requirements specified in legislation.

A review of the United States Federal Aviation Regulation (FAR) 121 and Canada's Air Regulations and Air Navigation Order (ANO) Series VII, No. 2, reveals that there are no legislative requirements in Canada or the United States that are specifically directed at flight safety programs or that require an air carrier to designate an individual to carry out a dedicated flight safety function.

As discussed in earlier chapters, there are required air carrier management personnel identified in both the ANO Series VII, No. 2, and FAR 121.[3] In Canada, ANO Series VII, No. 2, specifies that air carriers must have individuals employed on a full-time basis in the following or equivalent positions:

(a) Managing Director;
(b) Director of Flight Operations (or Operations Manager);
(c) Director of Maintenance and Engineering (or Maintenance Manager);
(d) Chief Pilot; and
(e) Chief Inspector.

(ANO Series VII, No. 2, section 5)

However, only the qualifications required of a chief pilot and a chief inspector are outlined in the Canadian legislation. In the case of Air Ontario and most Canadian air carriers, both the flight operations and maintenance manuals also provide a detailed description of the duties and responsibilities of the chief pilot and inspector as well as the other key operational managerial personnel.

The functions of each of the positions set forth in ANO Series VII, No. 2, and the equivalent United States FAR subsection 121.59 are seen by the regulators as being essential to the running of a safe air carrier operation. On the maintenance side of the air carrier's organization, there should be someone responsible for directing the actual maintenance work (director of maintenance) and another ensuring adequate quality control and monitoring of maintenance activities (chief inspector). Similarly, on the flight operations side of the organization, there should be a director of flight operations in charge of the control of operational flights (flight authorization, dispatch) and a chief pilot to ensure that flight training and operating standards for each type of aircraft in the carrier's fleet are properly maintained.

Contrary to the approach taken with maintenance and flight operations personnel, current legislation does not address the need for either a dedicated flight safety program or a flight safety managerial position as essential for the safe operation of Canadian air carriers.

The Canadian Aviation Safety Board (CASB), now the Transportation Safety Board of Canada (TSB), is charged with investigating aviation occurrences and making recommendations to enhance aviation safety.

---

[3] The United States FAR 121.59 has air carrier management personnel requirements that are virtually identical to the requirements of ANO Series VII, No. 2.

Transport Canada's Directorate of Aviation Safety Programs also enhances aviation safety by tracking aviation occurrences, educating the industry, and promoting flight safety. Canadian legislation requires that certain types of aviation occurrences be reported to the TSB. Transport Canada publications, such as A.I.P. Canada: Aeronautical Information Publication, list these types of aviation occurrences.

Although not required by legislation, Air Ontario's approved Flight Operations Manual (FOM) contained a description of the carrier's dedicated flight safety officer (FSO),[4] referred to in the FOM as the company aviation safety officer (CASO) position, and included a list of CASO duties and responsibilities.[5] In addition, in the Emergency Procedures section of the Air Ontario FOM there is a description of, among other things, an aviation incident and occurrence reporting system.[6]

Air Ontario's Flight Safety Organization

Background

The Air Ontario business plans for 1987 and 1988 and surrounding board minutes were tendered into evidence. Mission statements contained within the plans included flight safety as part of Air Ontario's corporate objectives. Mr William Rowe, one of Air Canada's representatives on the board of directors of Air Ontario, gave evidence regarding the attitude of Air Ontario management to their professed objective of flight safety and what practical steps were taken to implement this objective.

During testimony, Mr Rowe was asked to address the proposed Air Ontario Inc. corporate mission statement for 1987. He was referred to a minute of the June 23, 1987, meeting of the board of directors where this issue was discussed.[7] Mr Rowe's testimony begins with his reading the minute:

---

[4] For the purposes of this chapter, I use the term flight safety officer (FSO) to refer to the position occupied by Air Ontario's CASO and to the position occupied generically by air carriers' aviation safety officers.

[5] Exhibit 146, section 3.19

[6] Exhibit 146, section 8

[7] This was actually a meeting of the joint boards of directors of Air Ontario Limited and Austin Airways Limited. This was the last such meeting because, on August 12, 1987, the first meeting of the board of Air Ontario Inc. was held.

A. " ... The Statement of Mission of the Company contained in Section 5 of the Business Plan should be amended to include the twin objectives of dependability and safety."

Q. ... Do you recall the discussion that centred around the inclusion of dependability and safety in the mission statement?

A. Well, that's a manifestation, Counsel, of our influence on the company and the wording of the business plan itself. That appears in all of our mission statements ... that is, Air Canada's mission statements, and in ... its corporate plans as well, and we wished to ensure that it was highlighted in each of our subsidiaries' plans, and that's where the addition was asked of management.

(Transcript, vol. 121, pp. 103–104)

Mr Rowe testified further as to how these objectives were to be attained:

A. ... It was a statement that the document itself was a guide to management, and the objectives were taken seriously, and that's why they were incorporated in the document itself, and why we wanted specific mention of them.

...

A. ... [I]t is a direction to management that you will, in your normal corporate activities, contemplate those actions and keep that as one of the things uppermost in your mind.

...

A. ... the reputation for safety and concern for safety is paramount in the operation of an airline. There is no permissiveness in that regard. It must be and has to be the prime – one of the prime [guides] of all of management's personnel, management's performance.

(Transcript, vol. 121, pp. 105–109)

A new mission statement, incorporating Air Canada's philosophy, was submitted by the Air Ontario executive committee to the Air Ontario board for approval. The statement, approved by the board on June 17, 1988, reads as follows:

> The creation of a safe and reliable diversified air transportation system serving central Canada and northern United States, whose primary goal is the maximization of profitability and return on its shareholders' investment while optimizing feed traffic to and from the Air Canada network.
>
> (Exhibit 940)

The rationale of the "safe and reliable diversified air transportation system" was further elaborated in the explanatory notes presented by the executive committee to the board:

> Recognition of safety as being the paramount criteria with respect to both current operations and future planning. Recognition of reliability as being the most significant element of product quality. Recognition of Air Ontario's diverse revenue base and of the inherent competitive advantage of maintaining diversity.
>
> (Exhibit 940)

As well as addressing product quality and its diverse revenue base, Air Ontario recognized safety as an important element in the equation. In its mission statement approved by Air Ontario's board of directors, it places safety as "the paramount criteria" for the carrier's operations and planning.

Mr Rowe was reminded that during most of his tenure as Air Canada representative on the board of directors at Air Ontario, including the period when the mission statement was written, there in fact was no company aviation safety officer in place. The position of safety officer at Air Ontario was occupied by Captain Ronald Stewart from late in 1985 until the fall of 1987, but was then vacant until February 1989, when Captain Stewart was again appointed as FSO. When Mr Rowe was asked for his opinion, as the majority shareholder's representative, about this vacancy, he stated that it was understood that Air Ontario's flight safety program "was a much less formal arrangement" than that of Air Canada, but that this did not concern him (Transcript, vol. 121, p. 92). Mr Rowe viewed the issue of on-time performance as an indication of the operational integrity and safety of an air carrier. As there was nothing remarkable about Air Ontario's on-time performance, he stated that he felt that he did not have cause for concern.

Even though there may have been satisfactory on-time performance within Air Ontario, the lack of concern by Air Canada's representative on the Air Ontario board of directors that there was no FSO in Air Ontario is still somewhat incongruous, given the principle of primacy of flight safety espoused by Air Ontario's mission statement for 1988, and in view of the fact that Air Canada itself had a dedicated flight safety organization.

Mr Rowe testified that, on behalf of Air Canada, he retained Mr John McMurtry to look into Air Ontario's facilities at London.[8] When asked what was involved in Mr McMurtry's task, he replied:

---

[8] Mr McMurtry was himself an Air Canada nominee on the Air Ontario board. Mr McMurtry was a long-time Air Canada employee who retired in 1985, after 39 years with the company, as its vice-president, central region. The expertise that he gained over the years was primarily in the areas of planning (including maintenance planning), administration, customer service, and operations control. Mr McMurtry was not qualified as a pilot, AME, or professional engineer.

A. Well ... he wouldn't go through, as Transport Canada might in their audits, all the records on an aircraft, for example, all the way back, maintenance records and log books and things of that nature.

But he looked at the delineation of responsibilities, the condition of the facility itself, were there the proper people in place or responsibilities delineated to individuals, because unlike our corporation which might have one individual per responsibility, in a company the size of Air Ontario, one individual might carry three or four responsibilities, and just by virtue of size.

(Transcript, vol. 121, pp. 94–95)

Mr Rowe stated that, to the best of his recollection, Mr McMurtry did not report to him the fact that there was no FSO at Air Ontario, but he did report that "he was satisfied the operation was a safe one" (Transcript, vol. 121, p. 96).

Mr Thomas Syme, as the person in charge of the everyday management of Air Ontario, was asked for his thoughts on the importance, the role, and the reporting relationship of an FSO:

A. His reporting relationship was defined as to myself. Functionally, he was interfacing much more closely with senior flight ops management, and also, he did interface and have direct access to the president of the company.

Q. ... [A]s the then group vice-president of operations, what was your understanding of the role of the flight safety officer?

A. Flight safety officer is performing an audit function and compliance function with respect to the flight safety aspects of the flight operations function.

The reporting stream recognizes the need for independence of action and his ability to access individuals not directly involved in the function that he is auditing.

Q. Now, is the flight safety officer position an important position, as far as you are concerned?

A. Yes.

Q. Was it somehow less important in December of 1987 and following when Mr [Stewart] was not in situ as a flight safety officer.

A. No, it was not.

(Transcript, vol. 97, pp. 163–64)

Mr Syme explained further that it was important for the FSO to report directly to him as the head of operations, "for the purpose of objectivity, that he has access to someone outside of the flight operations group" (Transcript, vol. 97, p. 145).

Mr Syme was questioned about the importance of having an FSO in place during Air Ontario's introduction of its F-28 program. In particular, he was asked about the possible contribution of an FSO with regard to specific flight safety concerns, for example, the installation of a flight attendant seat shoulder harness, during the F-28 implementation. He conceded in his testimony that it would have been desirable to have an FSO "in place all along":

> A. I accept the fact that it would have been desirable to have ... him [the FSO] in place all along. I don't know if that would have – what difference that would have made, but it would have been desirable.
> Q. We'll never know, but it would have been desirable –
> A. Yes.
>
> (Transcript, vol. 99, pp. 74–75)

The Development of Air Ontario's Flight Safety Organization

Captain Ronald Stewart, in his testimony, outlined his experience in the field of flight safety. He served as a Canadian Armed Forces pilot from 1967 to 1974, after which he joined Transport Canada as an accident investigator. He also spent a few years as a regional air safety officer in Edmonton. He joined Great Lakes Airlines in 1979 and soon became the Canadian Air Line Pilots Association's technical chairman for that airline's pilot group. From 1979 to 1985 Captain Stewart was a line pilot with Great Lakes, and, late in 1985, was appointed flight safety officer at Air Ontario Limited.

In a March 1985 memorandum to Captain Robert Murray, director of flight operations at Air Ontario Limited, Captain Stewart, at the request of Captain Murray, outlined his views on how a flight safety organization should fit within the company's flight operation. He emphasized the importance of the FSO reporting directly to the chief executive officer of the company, bypassing intermediary management. He testified as follows:

> A. ... this is a normal reporting relationship in most safety organizations, that the safety officer always has a direct line to the chief executive officer of the company.
>
> I think that the rationale behind it is, should the safety officer have problems say dealing with a vice-president or a problem that he can't resolve, that he can go freely one step beyond that and go to the president with that information.
>
> And I think it makes the flight safety process all that more effective, in that the vice-presidents and other managers in the company realize that the flight safety officer does have that

direct reporting relationship to the president. It keeps them honest, I think.
Q. And does it deal, then, with safety, really, in a bit of an elevated manner, putting it –
A. That's right.
Q. – as a matter of priority?
A. It certainly does, yes.

(Transcript, vol. 95, p. 11)

Captain Stewart testified that he reported not to the president of Air Ontario Limited but to Captain Murray as head of flight operations, because, in the view of Captain Stewart, the president, Mr Plaxton, was apparently uncomfortable with having the FSO reporting to him directly. This was not the ideal situation that Captain Stewart envisaged, but, as he stated, Captain Murray was very safety conscious and the situation proved to be satisfactory. Captain Stewart testified that he did not receive extra compensation, secretarial help, or a budget for his FSO duties at Air Ontario Limited.

Captain Stewart described the activity within the flight safety organization of Air Ontario Limited (and the successor companies) from the beginning of his tenure in 1985 to his resignation in 1987 as consisting of a few ad hoc meetings. Captain Stewart resigned as FSO late in 1987 because of the lack of management support, the lack of direct access to the CEO, and to avoid having to fly as a management pilot during an impending pilot strike (Transcript, vol. 74, p. 90). He was not replaced, and the position remained unfilled until February 1989.

Captain Robert Nyman was the director of flight operations at Air Ontario when Captain Stewart resigned late in the fall of 1987, and Captain Nyman remained in that position until the late summer of 1988, when he was replaced by Captain Clifford Sykes. The director of flight operations at Air Ontario reported to the vice-president of flight operations, a position occupied in December 1987 by Mr Peter Hill, and in June 1988 by Mr James Morrison.

Captain Nyman, who was formerly employed with Austin Airways, described the flight safety organization at Austin. He pointed out that the references to a company aviation safety officer (CASO) in the Air Ontario Inc. Flight Operations Manual were in fact taken from the Austin Airways Manual:

3.19 *Company Aviation Safety Officer (CASO) – Duties, and Responsibilities*

General Responsibilities
Responsible for monitoring and advising on all Company aviation safety and aircraft accident prevention activities.

Reporting Relationship
Reports directly to the area manager as well as to the Vice President of Operations on aviation safety matters

Safety Duties
A. Secretary of Company Aviation safety committee meetings responsible for scheduling, agendas, taking of and distribution of minutes.
B. Coordinates a flow and exchange of aviation safety matters within Company.
C. Maintain liaison with Transport Canada's Aviation Safety Programs Branch.
D. Follows up on any aviation safety occurrences in the interest of accident prevention.
E. Conducts periodic aviation safety surveys of all operational departments.
F. Identifies aviation safety deficiencies and makes collaborative suggestions for corrective action.
G. Solicits and processes aviation safety improvement suggestions.
H. Develops and maintains an aviation safety awareness program.
I. Monitors the F.O.D. Program.
J. Monitors program for the transportation and handling of dangerous goods.

(Exhibit 146, pp. 3-39, 3-40)

Captain Nyman, when questioned about efforts to replace the FSO position vacated by Captain Stewart, revealed that he himself had limited knowledge regarding the duties of a flight safety officer within an air carrier's operation (Transcript, vol. 108, pp. 159–64). He testified that he was unfamiliar with the flight safety structure within Austin, because when he left the company in 1984 it did not have an FSO. Captain Nyman indicated that while he was director of flight operations at Air Ontario, he did not have available any flight safety materials after Captain Stewart resigned from the FSO position, nor was he familiar with Captain Stewart's FSO program.

After Captain Stewart's departure, Captain Nyman advertised for an FSO within the company, attracting a response from Captain James Byers, an Air Ontario line pilot. He provided to Captain Nyman a comprehensive list of FSO duties as he saw them, and such were discussed at a meeting on December 21, 1987. Having received no response to his proposal, Captain Byers in May 1988 withdrew his application for the FSO position. In his letter to Captain Nyman he stated:

> I am unable to accept the position of company Safety Officer until there is a clear written description of the job and associated working

> conditions. Receiving this description will allow me, to make an informed decision about the position.
>
> (Exhibit 863)

During the period from late 1987 until February 1989, Air Ontario had no designated safety officer. Captain Nyman gave two reasons for this situation: his own "ignorance of the value of a good flight safety program" with available computerized information, and the fact that "there were other items that we [flight operations] had to deal with on a daily basis." He conceded that the replacement of Captain Stewart was not his highest priority (Transcript, vol. 108, pp. 169–70).

In November 1988 a fatal accident occurred at Pikangikum, Ontario, involving an Air Ontario DC-3. Captain Stewart agreed to a request by Captain Clifford Sykes, then director of flight operations, to investigate the Pikangikum accident on behalf of Air Ontario. He also conducted a safety survey of the company's northern operations. Captain Stewart carried out the investigation because, in his view, there was a company crisis and he felt duty-bound to help. In the fall of 1988 Mr James Morrison, newly appointed vice-president of flight operations for Air Ontario, expressed his concerns over the lack of an FSO to Mr Hill and to Captain Byers. Mr Morrison, who had come directly from Air Creebec where he had served in an executive capacity, approached Captain Stewart seeking to rehire him for the FSO position. Mr Morrison considered a flight safety department to be a necessity and he wanted Air Ontario to have a "good reliable flight safety officer" (Transcript, vol. 115, p. 137).

Captain Stewart advised Mr Morrison that he was not prepared to accept the position of FSO. Based on his previous experience, Captain Stewart anticipated that the support he would get from the company was "not the type of support that should have been given to a FSO" (Transcript, vol. 95, p. 50). In his testimony, Mr Morrison corroborated Captain Stewart's evidence:

> A. ... Quite frankly, he told me that he left his last position as FSO because he did not have direct access to the president, nor did he have good access to the previous operations manager. He had a number of reasons.
>
> He was not content at all, and he didn't feel that, given the size of Air Ontario at that time, that he would be able to have access to the president or ... have the ability to perform his duties the way he would want to do them.
>
> (Transcript, vol. 115, p. 137)

It is evident that the sources of Captain Stewart's discontent with the FSO position were essentially a lack of support by Air Ontario management and a lack of direct access not only to the president but also to the operations manager. Mr Morrison explained:

> A. He did not have access directly to the president, and, that time, it was Jim Plaxton. He didn't have, as he said, direct access to the operations manager. I think it was Captain Murray. He didn't have the vehicle with which to do his job. He was using his own personal computer at home to develop the program that he wanted to have. He didn't have an office ...
>
> (Transcript, vol. 115, p. 140)

Following discussions with Mr Morrison, and after completing his investigation into the company's northern operations, Captain Stewart agreed to accept once again the FSO position at Air Ontario effective February 1, 1989. Captain Stewart drew up a proposal and a job description for the position of CASO that was acceptable to Air Ontario management. A letter of understanding was prepared covering Captain Stewart's primary concerns, namely, the provision of secretarial help, a computer terminal, direct access to all employees, and, most importantly, a direct reporting relationship to the president, Mr William Deluce. Compensation in terms of flight credits was also to be built into his employment contract. In return, Captain Stewart was to carry out the duties as set forth in the "major responsibilities" section of his job description. These included developing an incident reporting system, monitoring worldwide safety data, analysing in-house safety data, developing safety lectures, and monitoring the dangerous goods regulations. While some of these matters reflected what was already in the Air Ontario Flight Operations Manual, others did not. However, the Flight Operations Manual was not updated to reflect this new thrust, even to the time of the hearings.[9]

When specifically asked why the FSO should report directly to the company president, Mr Morrison gave the following reasons:

> A. I think that, quite simply stated, that if a flight safety officer were to report to anybody else in the flight ops group, that there's always a danger that the flight ops personnel he might be reporting to may not take any of his concerns seriously, that if there is any implication that is with financial or economic ramifications, they may try not to access the information.
>
> By going directly to the president, the flight safety officer would have the ability to have the freedom to make the

[9] The issue of the failure by Air Ontario to have in place a flight operations manual that reflected the actual structure of the flight operations of the company is discussed in chapter 19, F-28 Program: Flight Operations Manuals.

recommendations. Whether they could be met or not is up to, at that point, the flight safety officer and the president, but it certainly is a good means of doing this job.

Q. So, in a sense, it gives the flight safety officer an independence from the rest of the company structure with direct access to the president?

A. That's correct, and the least amount of influence as well.

(Transcript, vol. 115, p. 149)

At the time of the March 10, 1989, accident, the flight safety organization within Air Ontario had been reactivated for approximately six weeks. Its effectiveness was canvassed during the hearings of this Inquiry, with particular emphasis on its impact on the management of the F-28 program.

Three Case Studies in the Effectiveness of Air Ontario's Flight Safety Organization

The evidence shows that an air carrier flight safety organization must be able to investigate any incident or accident adequately and to follow up that investigation to ensure that occurrences are not repeated.

One of the most valuable tools for an aviation accident prevention program is an effective system of collecting, investigating, evaluating, and circulating occurrence information. This Commission examined how Air Ontario collected and handled occurrence reports in an attempt to evaluate the degree to which the Air Ontario flight safety program, or the lack of it, had an effect on the F-28 operation.

Three incidents involving Austin Airways and Air Ontario Inc. aircraft, two of which occurred prior to the Dryden crash, were examined in some detail during hearings of this Commission in an effort to evaluate the accident prevention program at Air Ontario and to identify any possible links to the F-28 accident. Two of these incidents had common elements with the Dryden crash; both involved adverse winter weather conditions and snow contamination of aircraft surfaces, and all three involved Captain Joseph Deluce. At the time of the Dryden accident Captain Deluce held multiple Air Ontario management positions as the F-28 chief pilot, chief instructor, and check pilot, and as the manager of the Air Ontario F-28 program.

Incident No. 1: November 20, 1986 – HS-748 – Kingston, Ontario
The first incident occurred on November 20, 1986, at Kingston, Ontario. An Austin Airways HS-748 aircraft was parked overnight on the ramp at the Kingston airport. It had snowed during the night and, prior to departure, snow was swept from the wings and the horizontal stabilizer.

The pilots on this flight were Captain Joseph Deluce and his brother, First Officer James Deluce. Captain Deluce testified that, although he could not specifically remember, he assumed a walkaround inspection of the aircraft would have been done because snow had been swept from the aircraft.

Captain Deluce was in the left seat and carried out the takeoff. After liftoff, aircraft vibration was felt that increased as the aircraft's speed increased. The flight was in visual weather conditions and the crew immediately returned to Kingston. After landing, the pilots inspected the aircraft and found ice adhering to the vertical stabilizer.

Captain Joseph Deluce called Captain Larry Raymond, at the time Austin Airways director of flight operations, and explained what had occurred. Captain Deluce testified that he did not recall whether an incident report was filed. He believed there was a company FSO at the time, but he definitely did not talk to him regarding this incident.

Captain Raymond investigated the incident and reported to Mr Robert Deluce, general manager of Austin Airways, in a memorandum that began by indicating some difficulty in obtaining an incident report from James Deluce. Captain Raymond further indicated in the memorandum that he had filed an aviation occurrence report at the time and had concluded that the vibration was caused by wet snow adhering to the vertical stabilizer.

Captain Raymond attached to this report a copy of a bulletin he had drafted, both of which were to be displayed on all Austin Airways pilot bulletin boards. Portions of this bulletin are noteworthy since they apply to future events. Captain Raymond stated in this bulletin:

> There is a vast difference between wet snow on any airframe, any snow on a warm airframe or dry snow on a cold airframe. The first two will probably adhere with potentially catastrophic results, in the last case the snow will probably blow off.
>
> (Exhibit 685, Part 2, tab 9)

In the bulletin, Captain Raymond also directed the pilots to review the applicable ANOs. He concluded by stating that the key word in the ANO is "adhering."

Given Captain Raymond's position at Austin Airways, I take this bulletin to reflect the thinking of the Austin Airways flight operations management on ice and snow contamination in late 1986. The information Captain Raymond provided on aircraft surface contamination is very general and seems to be based on experience rather than definitive testing. He did not mention de-icing methods, and it appears that his investigation did not establish why the de-icing methods used on November 20, 1986, were not effective in ensuring that the aircraft was clean or why the contamination was not detected by the pilots on a walkaround.

In his bulletin, Captain Raymond expressed the opinion that the personnel involved would not forget the incident. In fact, Captain Joseph Deluce stated in testimony that he did learn from the incident that contamination on the vertical stabilizer posed a serious problem. He testified that at the time of this incident he was aware of the potential problems of contamination on the wings.

Incident No. 2: December 15, 1987 – HS-748 – Toronto, Ontario

The second incident involving an Air Ontario aircraft that was examined during the hearings of the Commission occurred on December 15, 1987, at Toronto's Lester B. Pearson International Airport. The captain involved was Joseph Deluce, the first officer was Scott Jensen, and the in-charge flight attendant Alana Labelle-Hellmann. The aircraft was an HS-748, the same aircraft type as was involved in the Kingston incident.

The flight departed the ramp at approximately 8:30 a.m. for a scheduled flight to Timmins, Ontario. It had been snowing for some time prior to departure, and the aircraft was de-iced at the ramp by Air Canada personnel. Neither Captain Deluce nor First Officer Jensen did an external walkaround following the de-icing.

It continued to snow heavily as the aircraft taxied towards the departure runway. The departure, however, was delayed for approximately 40 minutes, primarily because of the weather conditions. The reported weather at the time was a precipitation ceiling between 100 and 300 feet above ground, the visibility between one-eighth and three-eighths of a mile, in heavy snow, temperature 0°C, and the wind from 090 to 100 degrees at a speed of 28 knots with gusts up to 39 knots. It should be noted that snow which reduces visibility below one-half mile is defined as heavy snow.

In her testimony, Ms Labelle-Hellmann recalled that, about 15 minutes after the aircraft had departed the gate, a number of passengers raised concerns about snow accumulating on the wings as the aircraft waited for takeoff clearance. She stated that during this time several of the passengers expressed the opinion that the aircraft should go back and de-ice again. Ms Labelle-Hellmann attempted to reassure the passengers by expressing confidence in the pilots and by telling such passengers that "it will be fine, don't worry" and that "if it was necessary to go back and de-ice, we would, not to worry."

It is significant that the flight attendants aboard flight 1363 at Dryden on March 10, 1989, made similar expressions of confidence in the pilots of the F-28 in response to passengers' concerns about wing contamination just prior to the ill-fated takeoff. The subject of flight attendants' expressions of confidence in pilots, in the face of passengers' concerns over observed wing contamination, is discussed in chapter 39 of this Report, Crew Coordination and Passengers' Safety Concerns.

Ms Labelle-Hellmann, who was generally aware of the dangers of ice contamination on aircraft wings, after listening to the passengers' concerns on December 15, 1987, went to the cockpit to inform the flight crew that passengers were asking whether the aircraft should go back and be de-iced. She stated that she spoke to Captain Deluce and described the scene in the cockpit:

> A. I went up there and I said, Joe, a couple of passengers have mentioned that there's snow on the wings and they feel that maybe we should go back and de-ice, what do you think.
> Q. All right, and what was his response to you?
> A. ... I believe he looked out and he said no, we de-iced at the gate and we should be fine.
>
> ...
>
> A. He also said that we should be departing shortly and that I should go back and take my seat.
>
> (Transcript, vol. 106, pp. 18–19)

Ms Labelle-Hellmann stated that it was about five minutes between the time she returned to the cabin and took her seat and the beginning of the takeoff roll. During the takeoff roll, she did not specifically recall looking out the window at the wings.

Both Captain Deluce and First Officer Jensen testified that they could not recall Ms Labelle-Hellmann coming into the cockpit with these concerns; however, both stated that under the circumstances it would be normal for the flight attendant to enter the cockpit to inquire about the delay. All three crew members agreed that the total time between de-icing and takeoff was approximately 40 minutes, in conditions of heavy snowfall.

Both Captain Deluce and First Officer Jensen testified that at the time they were unsure as to how long de-icing would provide protection against snow buildup on the wings. First Officer Jensen testified that about halfway through the taxi he had observed some snow on the wing turning to slush. He said that both he and Captain Deluce considered alternatives and decided that the de-icing should provide protection for 30 minutes and they felt the aircraft would be airborne by then.

First Officer Jensen stated that he had looked at the wings just prior to the takeoff roll, and he described what he saw:

> A. You can see the actual wings outside the engines. And there was snow, and there was slush – the snow was falling onto the wings and producing a slush on top of the wings less than a quarter of an inch in depth.
>
> ...

... it was not frozen, it was not freezing, it was liquid. It was slush, pinkish slush.
Q. It was pinkish slush, and what does the colour pink indicate to you?
A. De-icing fluid. The glycol mixed with the snow.
Q. Did you see any white?
A. No, apart from the white falling from the clouds, from the snow.
(Transcript, vol. 106, pp. 139–43)

First Officer Jensen also described the runway at the time as being snow- and slush-covered to a depth of one-half inch. He stated that Captain Deluce checked the runway braking action prior to takeoff and assessed it as fair to poor.

First Officer Jensen testified that the visibility on takeoff was one-quarter mile, the lowest allowable visibility at the time of takeoff provided that a takeoff alternate was available and filed. Both pilots assumed that a takeoff alternate had been filed but neither could recall whether this had been done.[10] In this case, it was fortunate that the weather improved enough after takeoff to allow an immediate landing at the departure airport.

During his testimony First Officer Jensen was asked to compute the crosswind component on the date in question, using the reported wind and the Canada Flight Supplement crosswind component chart. The evidence is that the wind was gusting from 28 to 39 knots, giving a crosswind component by his calculation of between 20 and 27 knots.[11]

Given the directions in the FOM and the described conditions of the runway, First Officer Jensen was asked on the witness stand to apply the "runway surface condition and JBI equivalent."[12] Using these charts, First Officer Jensen, who during testimony calculated the maximum

---

[10] A takeoff alternate was required because the ceiling and visibility at takeoff were lower than the captain's weather limits required for landing at the departure airport. However, generally speaking, the takeoff alternate requirement is designed to allow for mechanical malfunctions where the aircraft's redundancy would allow it to be flown to the takeoff alternate, but not for emergencies requiring an immediate landing.

[11] The Air Ontario Flight Operations Manual (FOM) advised pilots not to attempt a takeoff when crosswind components are greater than those demonstrated for the aircraft. In the case of the HS-748, this demonstrated maximum crosswind was 30 knots. The FOM also advises pilots that in a crosswind condition the decision to take off should "take into account associated conditions which might adversely affect the take-off or landing such as turbulence or icy runways, reduced visibility, limited runway length, etc., and will allow what they judge to be an appropriate tolerance above the limitations shown in the Flight Manual"(p. 7-6).

[12] Historically, it has been found that certain runway surface conditions (RSC) will produce a specific JBI (James Brake Index) or coefficient of friction on a runway surface. A chart is provided to convert RSCs to a JBI equivalent. A second chart shows the maximum recommended crosswind at any given JBI reading.

recommended crosswind for the takeoff on that day, found the maximum crosswind limit to be 14 knots. First Officer Jensen acknowledged that the crosswind limit had been exceeded, given the runway surface conditions (Transcript, vol. 106, p. 168).

Notwithstanding their decision to take off, the evidence indicates that Captain Deluce and First Officer Jensen were still concerned about the snow and slush that had accumulated on the wings. Captain Deluce decided they would conduct a visual check of the wings at 80 knots on the takeoff roll, whereby each of them would check the wing on his respective side of the aircraft to verify whether the slush had blown off. This unusual and potentially dangerous procedure was apparently not entirely new to former Austin Airways pilots and had been used on occasion by pilots in northern operations when cold, powdery snow accumulated on the wings. First Officer Jensen testified regarding this so-called "80-knot check" as follows:

> Q. Did either you or Captain Deluce – or did the fact of this substance on the upper surface of your wings give some pause to you or Captain Deluce? Did you take it into consideration for your takeoff?
> A. Yes, we did.
> Q. Okay, could you describe for the Commissioner what considerations you took?
> A. We discussed it amongst ourselves, and we had – actually, Joe decided that through the 80-knot check, we should check the wings to make sure that the snow ... or the slush was running off the wings, much as you would see water pouring off the wings, and at 80 knots, we would make the decision whether to continue the takeoff, and if it wasn't rolling off or running off the wings, then we would abort the takeoff at that point, at 80 knots, before we got to critical speed.
>
> (Transcript, vol. 106, p. 144)

The critical speed referred to by First Officer Jensen is the decision speed (V_1) below which the takeoff could be discontinued should anything go wrong. He could not remember exactly, but thought that the decision speed would have been around 88 knots. When asked about his previous knowledge of this "80-knot check," he testified that he had seen it "once or twice before in the north" and in "very cold" weather, involving conditions of a non-adhering "very light dusting of snow on the surface of the wings" (Transcript, vol. 106, pp. 145–46).

First Officer Jensen described the takeoff and the 80-knot check as follows:

> A. Okay, when I called 80 knots, I checked out the right wing to make sure the wing was clear, and I called the wing was clear,

and Joe checked out quickly and he checked the same time that his wing was clear.

Q. Okay, and what differences did you see? Did you see the pink disappear, for example?
A. It was all gone by then. At 80 knots, there was nothing on the wings.
Q. All right. And you have a distinct recollection of –
A. Oh, yeah.
Q. – the wings being clear?
A. The wings were absolutely clean.
Q. What did you think of this procedure, sitting there as first officer? Did you consider it a safe procedure?
A. I didn't consider it unsafe.

(Transcript, vol. 106, pp. 148–49)

Captain Deluce elected to take off, and, just after liftoff, the aircraft began to vibrate in a manner which was later described as severe. First Officer Jensen stated that after they were airborne he could read his aircraft instruments but with some difficulty. He testified that Captain Deluce explained to him what the problem was:

A. ... when I first felt the vibration just after departure, I was taken aback. I wouldn't consider myself frightened, but I was curious and I was wondering what the vibration was.

Joe told me a few minutes thereafter that he knew what it was, that it was snow buildup on the vertical fin or ice buildup on the vertical fin and that it had happened before and there was nothing ... to worry about. Now, whether or not this relaxed me at all, I don't know.

(Transcript, vol. 106, p. 175)

In-charge flight attendant Alana Labelle-Hellmann testified as to vibration after takeoff and the reaction of the passengers aboard the aircraft:

A. ... it just started vibrating all of a sudden, and it didn't start as tense or as bad as it got. And I heard a big crash ... in the back.
Q. And when did you hear this crash? Was that the first thing you heard?
A. No, we started to shake and then I heard a big crash in the back, and I didn't know what was going on.
Q. Okay. Could you describe the state of the passengers when this started to happen?
A. They were pretty scared ... as we were still climbing, we started to shake even more, and the passengers started to hold hands in

> the aisles, and the gentlemen sitting with me were saying, maybe we should have went back to de-ice.
>
> (Transcript, vol. 106, pp. 24–25)

An emergency was declared and the flight returned to the airport, where it landed safely on runway 06 left. A controller at Pearson International Airport made an entry in his log indicating that after takeoff the crew "declared an unspecified emergency" (Exhibit 852). First Officer Jensen testified that while inspecting the aircraft on the ground after landing he observed snow adhering to its vertical fin. He described the snow as "a vertical band a foot to a foot and a half wide, and it was for sure less than an eighth of an inch deep" (Transcript, vol. 106, p. 176). He stated that it was the sort of snow one would see on a car that was sitting with its side facing into the direction in which the wind was blowing. It was his opinion that the snow accumulated while waiting for takeoff.

Following the landing, the three crew members went to an Air Ontario office in Terminal Two, where they each completed incident reports in writing. According to her testimony, Ms Labelle-Hellmann in fact wrote two reports. In her first report she wrote that she had observed snow on the wings prior to the takeoff and that she had gone to the cockpit to relay passenger concerns regarding this snow on the wings. Her evidence was that she included this information in the first version of her incident report because she assumed that the snow on the wings had caused the vibration. She stated that, upon completing her first incident report, she handed it to Captain Deluce, who told her that the problem was not caused by snow on the wings. Ms Labelle-Hellmann testified as follows:

> A. He didn't say that it was snow on the tail, he said that there was a problem with the tail and I just remember that. That it was not caused by snow, is what Joe was telling me.
>
> Q. Okay. Now, was this the reason; that is to say, was Captain Deluce's explanation to you the reason you wrote the second report?
>
> A. Yes.
>
> (Transcript, vol. 106, p. 35)

Following her discussion with Captain Deluce, she wrote a second incident report, omitting any mention of snow on the wings prior to takeoff.

Captain Walter Wolfe, who was then the chief pilot of Air Ontario Inc., reported to Captain Nyman that Captain Joseph Deluce called him shortly after the incident to report the details. It is clear from the evidence that Captain Wolfe thereafter conducted only a cursory investigation of this serious incident, though it was his responsibility to conduct a thorough investigation. In this case, however, he summarized his post-incident actions as simply speaking to Captain Joseph Deluce, sending Captain Deluce's report of the incident to Transport Canada, and instructing maintenance personnel to investigate the condition of the aircraft. He also spoke to Captain Deluce and the Air Ontario maintenance people about the de-icing of the HS-748 aircraft. Captain Wolfe indicated that he was satisfied that the aircraft had been de-iced prior to taxiing and that, in view of the fact that an Air Ontario Dash-8 aircraft had successfully taken off ahead of Captain Deluce in the HS-748, he considered follow-up disciplinary action inappropriate in the circumstances.

The Flight Operations Manual (FOM) for Air Ontario Inc. identifies "reportable" incidents and outlines the follow-up actions that are to be taken. Section 8.3.1(c) of the Air Ontario FOM indicates that, whenever a flight crew has difficulty controlling an aircraft because of vibration, the incident must be reported. Either a member of the flight crew, air traffic control, or someone within the air carrier organization must inform the Canadian Aviation Safety Board (CASB, now the TSB) and provide the board with information describing the incident.

The provisions of section 8.3.5(c) of the Air Ontario FOM require the pilot-in-command of an aircraft involved in a reportable incident to report the incident to the carrier's system operations control (SOC) centre in London. SOC is responsible in turn for contacting one of a list of Air Ontario personnel, including the following:

- the director of flight operations
- the chief pilot
- the vice-president of operations
- the president of the company, or
- the company flight safety officer.

In the Pearson incident of December 15, 1987, Captain Wolfe did not take steps to have the flight data recorder and cockpit voice recorder data analysed. Nor did he investigate the prevailing weather and runway conditions at the time of this incident further, in order to determine if the flight crew had adhered to the "aircraft handling procedures" for crosswind and slush-covered runways contained in the FOM.

Curiously, CASB did not investigate this incident. The Ontario Region CASB occurrence record dated December 21, 1987, includes the following statements under "occurrence description":

> The aircraft was de-iced before leaving the ramp. But had a long taxi prior to takeoff. After takeoff a severe vibration was felt, the crew

> declared an emergency and returned to Toronto without incident. Inspection showed a large build up of ice on the tail plane.
> (Exhibit 852)

Under the heading of "investigation activity planned," the CASB record simply states: "case closed/nil." In my view, action should have been taken to determine the circumstances that allowed the ice buildup to occur. CASB should have conducted a thorough investigation, including interviews with the entire crew to verify the information received. CASB should have checked to ascertain if the flight characteristics of the aircraft described by the crew were consistent with a buildup of ice on the tail.

Transport Canada did not follow up to determine the nature of the declared emergency and to ascertain whether in fact any violation of the Air Regulations had occurred. I view this lack of response by Transport Canada and CASB to such a potentially serious incident to be inadequate.

Aviation safety is the express responsibility of both agencies. If the incident was caused by contamination, an opportunity was missed to highlight the hazard to all commercial operators in the early part of a winter season and to take steps to ensure that Austin Airways flight crews had a much greater awareness of the consequences of such conditions.

In summary, it seemed that Ms Labelle-Hellmann's observation that "nobody cared" contained more than a grain of truth (Transcript, vol. 106, p. 71). It is not difficult to understand Ms Labelle-Hellmann's reaction. This was obviously a dangerous and frightening incident. Clearly, positive action should have been taken by both CASB and Transport Canada to identify the source of the problem and to implement measures to prevent a recurrence. Virtually nothing was done by either organization other than to note the incident and close the books on it.

Following the December 15, 1987, incident at Toronto, the director of flight operations for Air Ontario, Captain Robert Nyman, quite appropriately, although belatedly, issued two advisory bulletins relating to these two incidents to Air Ontario pilots. The first advisory bulletin, dated December 23, 1987, signed by the director of flight operations, described the Toronto incident as involving an aircraft that was de-iced prior to taxi, that waited in line for 40 minutes for takeoff clearance, whose wings remained clear of snow and ice, but which, after takeoff, experienced severe vibration. The bulletin called for pilots to be vigilant regarding contamination on airframes prior to takeoff; if they had any doubts, they should de-ice again.

The second advisory bulletin was dated January 20, 1988, and contained advice for company pilots dealing with the effectiveness, or lack thereof, of de-icing fluid after the de-icing of an aircraft. This bulletin advised pilots to be aware that the heavier the precipitation the faster the dilution rate of the de-icing fluid. It also stated that, in light precipitation at temperatures near or just below the freezing point, a spray of glycol-water de-icing fluid may be effective for periods in excess of 15 minutes. The bulletin also stated that constant vigilance is required on the part of the captain to ensure that no precipitation accumulates on the wings prior to takeoff.

First Officer Jensen testified that, although at the time he considered the decision at Toronto to take off with slush on the wings to be safe, in retrospect he considered the practice unsafe. He testified as follows:

> A. At the time, did I consider it a safe takeoff?
> Q. Right.
> A. Yes, at the time, I –
> Q. Do you consider it a safe takeoff today?
> A. As I look back on it, no.
> Q. Then what should have been done differently?
> A. Simply taxiing back to re-de-ice the aircraft would have been the simplest thing.
>
> (Transcript, vol. 106, p. 202)

For his part, Captain Joseph Deluce conceded during his testimony that he had made an error in judgement in using an "80-knot check" during takeoff that day. He agreed during questioning that he had exposed the passengers to unnecessary risk in the event that he had had to reject the takeoff:

> Q. I mean, if Scott Jensen said, Captain, there is rough ice on the wing, the slush has blown off and there is rough ice there, you would have had to reject and that would have caused the passengers an unnecessary risk, correct?
> A. It would have – the reject would have caused an unnecessary risk, yes, sir.
>
> (Transcript, vol. 149, pp. 144–45)

I might add that if the first icing incident at Kingston, Ontario, involving Captain Deluce had been properly investigated and dealt with, it might have become a valuable source of information for dissemination to all Air Ontario pilots, including Captain Deluce. A proper investigation of the Kingston incident might well have precluded the second incident from occurring.

Incident No. 3: April 4, 1989 – F-28 – Toronto, Ontario

The third incident examined during the hearings of this Commission concerned an alleged unstabilized approach and landing of an F-28 aircraft at Toronto on April 4, 1989, less than a month after the Dryden crash. The captain on this flight was Joseph Deluce, who at the time was giving line indoctrination training to First Officer Steve Burton.

The Commission did not examine this incident to establish whether an unstabilized approach occurred, but rather to review how the investigation of the alleged incident was handled from a flight safety organization perspective. Captain Stewart, the Air Ontario FSO at the time, explained during his testimony how the incident came to his attention and the actions which were taken by him:

> A. Again, it was a rumour. Came to my attention via rumour.
>
> I was able to determine the source of the rumour and contacted the individual that had witnessed the event, and I asked him over the telephone if he would be willing to give me some information on the occurrence.
>
> I suggested to him that we could do it anonymously or confidentially and he agreed to that, whereby I took down the information from him.
>
> (Transcript, vol. 95, pp. 183–84)

Captain Stewart learned that the captain of the aircraft involved was Captain Joseph Deluce. During his testimony, Captain Stewart indicated that he viewed this matter as an "allegation of a fairly serious occurrence." However, he elected to carry out no further investigation personally. Instead he brought the incident to the attention of James Morrison, the Air Ontario vice-president of flight operations. Captain Stewart stated that he felt he had fulfilled his responsibility by bringing this situation to the attention of Air Ontario senior management and he denied that Captain Joseph Deluce's involvement influenced his decision:

> Q. ... The fact that Joe Deluce was involved, was that an influencing factor in not conducting a more thorough investigation?
>
> A. No, I don't think so. You remember what I said was we had this discussion in Jim Morrison's office between myself, Joe Deluce, the chief pilot, and Jim Morrison, the vice-president of flight operations.
>
> And I felt that the fact that Jim was there and was very aware of what was going on, and he being Joe Deluce's supervisor, and the fact also that I had brought to the attention of management, of senior management in fact that there had been an allegation of a fairly serious occurrence, that that was really all I had to do. My responsibility was done.
>
> I told them of the problem. It's not really up to me to tell them how they should fix up that problem.
>
> (Transcript, vol. 95, pp. 189–90)

Mr Morrison subsequently asked Captain Joseph Deluce to explain his perspective on the occurrence in writing. In a written statement, Captain Deluce denied that the approach and landing were in any way unsafe. First Officer Burton was then supplied by Mr Morrison with a copy of Captain Deluce's statement and asked for his comments. He agreed with the statement made by his chief pilot and instructor.

Captain Stewart was questioned on the witness stand regarding the conduct of this investigation:

> Q. Do you think, sir, that giving someone like the First Officer Burton a copy of the Deluce report for comment is a proper way to conduct an investigation?
> A. No, probably not.
> Q. Not probably. I suggest to you, sir, that it is highly improper. Would you agree with me?
> A. I would think that you would ask the first officer for an independent opinion.
>
> (Transcript, vol. 95, p. 192)

Since First Officer Burton was the pilot being trained during the alleged unstabilized approach, one might expect that he would also deny that the approach and landing were unsafe. However, in the interest of ensuring an unbiased and fair process in the investigation of this alleged incident, one would be hard pressed indeed to accept a simple concurrence as to the facts rather than an independent statement.

Captain Joseph Deluce in his testimony stated that, at the time, he felt that he was being "set up" by Captain Stewart:

> A. ... To me, I felt very much like I was being set up. And I was concerned because what can you do?
> Q. Being set up by whom, sir?
> A. ... at the time, I thought it was Ron Stewart. I was concerned, and I filled out a report, and I advised Steve that he better do the same thing.
>
> (Transcript, vol. 112, p. 81)

Captain Deluce's stated perception that Captain Stewart was "setting him up" implies that Captain Stewart was acting maliciously when he made his report to Mr Morrison. This was denied by Captain Stewart on the witness stand. Clearly the investigation of the alleged incident was mishandled. The most obvious inference from the evidence is that everyone involved in Captain Stewart's investigation was sensitive to the fact that the subject of the investigation was Captain Joseph Deluce, Air Ontario chief pilot, check pilot, and company shareholder. This situation illustrates the highly undesirable perception that can result from an individual, however well-motivated, wearing at the same time the many hats of a significant shareholder, the chief pilot, the training pilot, the company check pilot, and line pilot of an air carrier.

Having reviewed the evidence from these three incidents, I have no doubt that the Air Ontario flight safety organization was, for a substantial period of time prior to the Dryden crash, inactive as a result of there being no designated safety officer and owing to the low priority assigned to this position by Air Ontario management. When active, Captain Stewart's position as FSO was obviously at times made ineffective because of the inconsistent positions taken by management in dealing with certain incidents.

Captain Ronald Stewart's Post-Accident Survey of F-28 Pilots

As the Air Ontario Flight Safety Officer (FSO), Captain Stewart headed up Air Ontario's internal investigation into the F-28 accident at Dryden. As part of his investigation, he drafted an F-28 pilot questionnaire. During his testimony, he explained his rationale for so doing as follows:

> A. Well, a survey is done simply to find out attitudes, opinions, safety deficiencies, perhaps. A survey can be designed for many different reasons. But, basically, you ... suspect that there's a problem, you go out and you survey a group of people and you determine whether or not in fact there is a problem.
>
> (Transcript, vol. 74, p. 94)

Captain Stewart pointed out that other carriers carry out these types of surveys and gave as an example a fairly extensive Air Canada survey conducted in 1984–85 involving a large proportion of its pilot population. Air Canada had questioned its pilots regarding its training standards and training procedures, and looked "for recommendations on the ways that they could improve the training in Air Canada" (p. 94).

Specific to the pilot survey conducted following the Dryden accident, Captain Stewart in his testimony referred to "rumours ... surrounding the F-28 operation." He stated his reasoning for his decision to conduct a survey of the Air Ontario F-28 pilots as follows:

> A. ... After the accident, there was many rumours ... surrounding the F-28 operation and what was wrong with it, and I wanted to get to the bottom of it to see if there was any basis for fact.
>
> Also, I had some specific questions, some concerns that had been raised during the investigation, during the on-site investigation out in Dryden, with respect to ... de-icing on aircraft with an engine running and also with respect to, in quotation marks,

"hot refuelling," and I wanted to learn what the pilot viewpoints were on those two issues as well.

Q. Now, what use was going to be made of this survey by you once you had it completed?

A. Well, what I intended to use this for was simply to assess whether or not the rumours were true and, assuming the worst, make recommendations to the president with respect to the operation.

(Transcript, vol. 74, p. 98)

The evidence is that Captain Stewart began his pilot survey by telephoning F-28 pilots. He stated that it took him "approximately half an hour to an hour to complete each telephone survey." The actual questionnaires were not distributed but rather the questions were read over the telephone, and Captain Stewart recorded in handwritten notes his impression of the conversation with each pilot. He recalls it as a time of very deeply felt emotion and he made the point that the survey was conducted against such a background. Participation in the survey by the F-28 pilots was optional and confidentiality was extended to each of the pilots by Captain Stewart. He explained:

A. ... I told them that the survey was confidential, that what they said to me wouldn't go any further than me, and that they could be free and open ... with their responses to me. And I also told them that their participation was optional, if they didn't want to participate, that was fine.

Q. Now, what did you mean by confidential, sir, when you told them that the survey would be confidential?

A. Right, what I was saying is that, if they had any comments with respect to the operation or perhaps supervisors or management or whatever, that it wouldn't go any further than me, I wouldn't be going to tell the president that Joe Blow said this about you and that about the company, but what I wanted to find out was the pilots' feelings and thoughts on the safety of the F-28 operation.

Q. Now, sir, why did you promise them confidentiality?

A. Because, by promising them confidentiality, I felt that I would get more open and honest responses.

(Transcript, vol. 74, pp. 103–104)

Captain Stewart added that no Air Ontario pilot to his knowledge had ever been disciplined on the basis of information contained in a pilot report filed with the company.

After five pilots had been interviewed by telephone, Captain Stewart had a conversation with his superior, James Morrison, then vice-president of operations. The "quite an emotional discussion" centred around the survey, and certain negative views about the pilot surveys were expressed by Mr Morrison, whom Captain Stewart described as "very upset." Captain Stewart testified as follows:

> A. ... I remember now that it was quite an emotional discussion ... Jim was very upset that I would be doing something behind his back. I guess maybe he hadn't read my proposal thoroughly enough and didn't realize that perhaps there would be occasions when I would be doing surveys and that sort of a thing, but I guess he felt that I was stepping on his toes and what I was doing was going to cause him a lot of problems. He was very upset.
>
> (Transcript, vol. 74, p. 108)

Although he stated that Mr Morrison did not order him to stop doing the survey, Captain Stewart in fact terminated his pilot survey program after this meeting. He said:

> A. Well, as a result of the conversation, I, well, after I left his office, went to my office, sat down and thought about it again. I thought, you know, this darn survey isn't going all that well, it's got the problems that I previously described to you, I've learned what I want to know about the operation, so ... I stopped.
>
> (Transcript, vol. 74, p. 109)

Based upon the five completed pilot surveys, Captain Stewart formed certain opinions about practices within the Air Ontario F-28 program:

> A. ... They confirmed that there was some practices that were going on in the operation that – that were suspicious, at least. I wouldn't go out and say that they were unsafe, because – I don't know if everybody in this room would understand my viewpoint, but I don't view an operation as safe or unsafe, but at one end, you have a totally accident-risk-free operation. At the other end of the spectrum, there's no question that there's going to be an accident, it's just a matter of time. And where I would place the F-28 operation on that continuum would be very ... close to the top; however, there were some questions and they were legitimate, there were some concerns and they were legitimate concerns.
>
> (Transcript, vol. 74, p. 111)

After visiting the Dryden accident site, Captain Stewart recorded his personal observations about Air Ontario's servicing of the F-28 at Dryden specifically and about its F-28 program generally. He prepared a written memorandum dated April 3, 1989, and addressed to Mr William Deluce, the president of Air Ontario and the person to whom he was to report directly within the company flight safety system. Rather than sending the memorandum, he subsequently met with Mr William Deluce and discussed with him what he perceived to be the F-28 program difficulties.

During his testimony, Captain Stewart was questioned regarding notes he had prepared to brief Mr William Deluce. These handwritten notes are reproduced in their entirety below:

Arguments

JET PROGRAM

- I believe this was a preventable accident.
- There is lots of info available about ice contamination and how it affects hard wing a/c – some from Fokker
  – Air Canada

  yet there was one of our Capt's out there doing tests to see how much ice the F28 could handle
- When you set up the DHC-8 program an expert "Walter Wolfe" was hired to head up the program.
- In retrospect that was a very wise move
  Now the program is up and running on its own without Walter
- We should have followed the same procedure with F28 program even if we could contract a Piedmont or Air Canada person for a period of time 1.5–2 yrs at which time the position could revert to internal personnel.

Jet Program cont'd.

- initially our experience on Jet OPS & F28 OPS very low
- we could really use outside assistance while our experience is growing
- A tightly written & controlled SOP is required.
- Whatever way you decide to go I recommend closer ties w/ Air Canada to draw on their experience on Jet OPS (DC-9)

Operations

- Some F28 pilots (captains) did not know de-icing was avail at Dryden. We have no way presently of informing the flight crews of the availability of these services – This check list to go in Route Manual
- we often get these fuel load/pax load last minute changes and need a procedure/policy to advise flight crews and how to handle situation
- Experience level very low
- Start up new program.
- need to buy experience
- recommend hiring outside co for Chief Pilot – /VP in charge of flt ops/Chief Training Pilot
- Recommend closer liaison w AC to rely on their experience in Jet Ops
- if we decide to change types
  ie BAC 146 – F100

- Operational Control and Communications
- Load info vs fuel planning believed
- SOC – prepare a list of

  Primarily scheduled but consider expansion to charter.

  √ list of facilities/services/equip avail

(Exhibit 766)

Captain Stewart expanded upon his notes by stating that he had recommended to company president William Deluce that, unless good outside expertise was brought in to get the F-28 program running, the F-28 program should be discontinued:

> A. I felt that there was not enough background experience in the program, that the chief pilot needed some advice, some outside help.
>
> Somebody that was very experienced in swept wing jet operations, I felt, should be involved in the program on a day-to-day basis to assist and get the program running. And I felt that if they couldn't provide this sort of an individual or individuals, if they could not recruit these individuals into the program, that they should perhaps considering winding down the program.
>
> Q. All right. Not to muddy the verbal conversation you had with Bill Deluce, did you in fact make a recommendation to him that unless he secure good outside expertise, that the F-28 program should be discontinued?
>
> A. Yes, I did.
>
> (Transcript, vol. 95, pp. 109–10)

Captain Stewart made observations regarding the role that, in his opinion, Air Canada should have played in the F-28 program:

> A. Well, just another source of information. Air Canada operated the DC-9 which is also a swept wing jet, tail-mounted engines, no leading edge devices, fairly similar type to the F-28, I thought, and I knew that there must be some vast experience in that operation that we could maybe use.
>
> Q. Which was not solicited by Air Ontario?
>
> A. I don't believe that it was, no.
>
> (Transcript, vol. 95, p. 110)

In testimony, Captain Stewart elaborated on the importance of Captain Wolfe's role in the introduction of the Air Ontario Dash-8 program. Captain Stewart compared the F-28 and Dash-8 programs at Air Ontario and commented upon the serious error which, in his view, was made by Air Ontario in failing to bring in F-28 expertise for the introduction of the F-28 jet program:

A. [Captain Walter Wolfe] ... was one of the original Dash-8 pilots, I believe, working for possibly Air Dale up in Sault Ste Marie, but I'm not positive on that, and then he went from there to, I believe it was Air Atlantic, and flew the Dash-8 for a number of years.

When he came to Air Ontario, he was one of the most experienced Dash-8 pilots available anywhere. He became the chief pilot at Air Ontario and helped to set up the Dash-8 program complete with the training, and all the line indoctrination, training, the basic training, simulator training, the SOPs, and probably some involvement in the MEL, this type of thing.

(Transcript, vol. 95, p. 119)

Captain Stewart believed that Air Ontario's Dash-8 implementation program was excellent, partially attributable to the expertise brought into the company by Captain Walter Wolfe. He maintained that similar expertise should have been brought in in order to improve the F-28 program. He described the discussion with Mr William Deluce as follows:

A. He asked me several questions as we went along and we had good discussion of all the points. And at the end, he didn't commit himself one way or the other while I was there, but he gave me a fair hearing.

(Transcript, vol. 95, p. 131)

Finally, from his investigations Captain Stewart noted that information about the availability of ground equipment at on-line stations and at charter destinations had not been disseminated to flight crews:

Q. ... You recommend essentially that a checklist be prepared of all stations outlining things which are available at those stations, correct?
A. That's correct.
Q. And the example you cite is Dryden, where you have noted fuel, Jet A, DC ground power available, yes. AC ground power, no. De-icing, yes. Laboratory service, no, and commissary, no.

Now, did Air Ontario have an inventory of this type of information for the various places it flew to as at that point in time?
A. I believe that they did in SOC. What I was recommending here is that they disseminate this information to the operating crews.
Q. Why?
A. Otherwise, how would the crew know what services were available when they got into a particular station? We don't carry the government supplement ... the VFR – or the IFR supplement as a matter of course.

Q. The Canadian Supplement, you are talking about?
A. That's correct. And beyond that, we have destinations that are not in Canada, so that –
Q. You are talking of ones like charter?
A. Charter destinations, say Atlantic City where we go there often enough that we should know what's available there.
I felt that this should go in the route manual as a route bulletin listing all of the stations that we regularly visit and what services would be available at those stations so that the flight crews would have a handy reference.
(Transcript, vol. 95, pp. 110–12)

Air Canada's Flight Safety Organization, and Its Involvement with Air Ontario

Background

The evidence indicates that after 1985 there was some contact between the flight safety organizations of Air Ontario, including that of its predecessor airlines, and Air Canada. Captain Stewart testified that he had visited Air Canada's Montreal facility four or five times to consult with Air Canada flight safety personnel, Mr Jack Mitchell and Mr Jack Galliker, regarding matters such as what Captain Stewart was doing with the "computerized incident reporting system [and] other safety problems" (Transcript, vol. 95, pp. 32–33). Captain Stewart testified that their expertise would have been beneficial to Air Ontario. He further testified that the only other contact that he had with Air Canada was when it conducted a post-crash audit on Air Ontario.

Mr Mitchell, who has been director of flight safety for Air Canada since 1983 and who was called as a witness, described the flight safety organization at Air Canada and its relationship to that of Air Ontario. Captain Stewart's position was similar to the position occupied in Air Canada by the manager of flight operations safety, who reports directly to the senior vice-president, flight operations, and functionally to the corporate director of flight safety, Mr Mitchell.

The everyday duties of Air Canada's flight safety organization were summarized by Mr Mitchell as planning, investigation of incidents and accidents, and liaison with government agencies. Part of the planning function was the creation of the Air Canada Flight Safety Board. The board is chaired by the company president and meets quarterly. One of its main functions is to review the incidents and accidents investigated by the flight safety group. Such reviews allow for "trend analysis" and coordinated follow-up action flowing from the incident reports.

At Air Canada, in addition to these quarterly meetings that are attended by senior management personnel, members of the flight safety organization attend the regular morning meetings of the flight operations department. Mr Mitchell described the benefits of such daily sessions as follows:

> A. ... it's a particularly useful source of information from the flight safety point of view, first of all, to establish what incidents have been occurring, which we should have prior knowledge of by other communication means that we have, but sometimes there were items coming up which were of interest to us.
>
> And, particularly, it's useful to us to hear the report from the maintenance personnel when they come on the line to find out what sort of action they've been taking against an incident that may have occurred during the last 24 hours.
>
> (Transcript, vol. 119, pp. 19-20)

In addition to Air Canada's daily flight operations meetings, there are also daily meetings of flight safety personnel. These meetings are mainly to exchange flight safety information and to analyse information gleaned from various departments of the company. Members of the flight safety organization have access to all departments of the Air Canada organization.

Categorization of Aviation Occurrences at Air Canada

Within the Air Canada flight safety system, aviation occurrences are categorized from A to G depending on their severity or importance, category A being a catastrophic crash. This categorization allows for the appropriate allocation of resources for response to and follow-up of safety concerns.

Mr Mitchell, when questioned about what Air Canada's flight safety organization's response would have been to the Air Ontario HS-748 incidents described above, stated that he thought the initial response would have been to "categorize that as a Category C occurrence" (Transcript, vol. 119, p. 34).

He described a category C occurrence by referring to the Air Canada Flight Operations Manual, commonly referred to as the 550 manual:

> *Category C:*
> IN OPERATION ACCIDENTS OR INCIDENTS OF A POTENTIALLY HAZARDOUS NATURE: Accidents or incidents reported from the aircraft indicating any type of emergency condition,

> necessitating assistance or guidance, and that might result in a catastrophic or major accident.
>
> (Exhibit 920)

Mr Mitchell described the steps to be taken by the flight safety personnel in the case of a category C occurrence as follows:

> A. Well, we would obviously discuss it between some of the flight safety personnel and decide what action needs to be taken, and one of the first actions, most likely, would be to ensure that we get the flight data recorder and the information that it contains so that we can investigate the occurrence ... in more detail and with more precise accuracy than maybe a verbal description contained.
>
> (Transcript, vol. 119, p. 34)

He stated that the information from the aircraft flight data recorder is used to test the accuracy of the statements of the crew members, all of whom would be interviewed as a matter of course. Such interviews of crew members are always conducted on an individual basis. These procedures are quite unlike those followed by Air Ontario after the three incidents described earlier in this chapter.

In addition to analysing the flight data recorder and interviewing crew members, the Air Canada flight safety group is able to call upon the maintenance and flight operations departments for input during its investigation of an occurrence. Once the Air Canada flight safety group has completed the investigation, a report is submitted to the Air Canada Flight Safety Board. Appropriate follow-up is then decided upon, and the necessary corrective action taken.

The Air Canada flight safety department does not suggest or determine any disciplinary action to be taken by the company against any employee. Mr Mitchell explained the reasons for the flight safety department's non-involvement in disciplinary matters as follows:

> A. ... it's felt that the two would be of conflicting interest.
> It wouldn't be to our benefit, from the flight safety point of view or from the point of view of improving the safety, to get involved in any disciplinary action from the flight safety point of view.
>
> Q. And who takes care of discipline involving pilots?
>
> A. That would be taken care of by the branch concerned, either flight operations, technical operations or in-flight service, if they are involved.
>
> (Transcript, vol. 119, p. 43)

If the applicable policies and procedures of Air Canada's flight safety department had been in place at its majority-owned subsidiary, Air Ontario or its predecessor airline, when the three Air Ontario incidents discussed above occurred, they would probably have been investigated more appropriately.

Air Canada Internal Incident-Reporting Procedures

In the mid-1980s Air Canada introduced an anonymous incident-reporting system. Pilots can use one of two methods: they telephone and have their comments recorded on a dedicated recorder unit, or they can complete a form located on the back of a company monthly publication distributed to pilots and mail it to the Air Canada flight safety department. Mr Mitchell in his evidence described the purpose of the system, to whom it was available, and how it fit into the regulatory scheme. He stated that this system was introduced to "provide an extra source of information ... on potential problems which couldn't be identified in any other way" (Transcript, vol. 119, p. 45).

Interestingly, Mr Mitchell stated that the Air Canada flight safety group does not receive many anonymous reports, and he indicated an Air Canada pilot preference for the CTAISB (Canadian Transportation Accident Investigation and Safety Board, now called Transportation Safety Board or TSB) confidential reporting system:

> A. ... We thought when we first introduced the system, that we would have quite a heavy response to it, and we did get a few initially, but they sort of tapered off. We don't get that many these days.
>
> In fact ... I think it was about two years ago, we opened up the system to include our cabin crews as well in the anonymous reporting system. There again, it started off in a promising manner but has tapered off ... you have to remember that there are other anonymous reporting systems in operation.
>
> There's the one through the CTAISB which some pilots use. Rather than going through the company anonymous reporting system, it's ... always a little bit suspicious about that, so they report it direct to CTAISB and we do get some feedback from CTAISB where they are investigating an incident and trying to get some more information on an incident of that nature, but usually when it's anonymous, there's very little available on it right from the start.
>
> (Transcript, vol. 119, pp. 45–46)

Mr Mitchell went on to discuss some of the difficulties involved in following up anonymous reports. The primary problem is how to confirm the truth of the facts reported by an unknown complainant.

Nevertheless, the anonymous reporting system has merit in that it brings forward operational problems that might not otherwise be discovered and to which competent FSOs can direct their investigative skills. Although the FSO at Air Ontario deserves full credit for setting up a confidential pilot reporting system, his follow-up of the April 4, 1989, incident report was not completed, and most certainly the support he received from the vice-president of operations, Mr Morrison, regarding this incident left much to be desired.

Flight Safety: Relationship between Air Carrier and Regulator

Mr Mitchell, when asked whether flight safety organizations should be a regulatory requirement for air carriers in Canada, stated that "somewhere it should be laid down that there should be a safety officer in all airlines, whether he is a full-time safety officer or part-time, I think there should be someone" (Transcript, vol. 119, pp. 57–58).

Mr Mitchell stressed the fact that, in addition to the relationship with Transport Canada in the area of flight safety, there are flight safety–oriented organizations to which Air Canada FSOs belong and courses they attend. He mentioned specifically the safety courses given by the University of Southern California, the Safety Committee of the Air Transportation Association of Canada, the Flight Safety Foundation, the International Society of Air Safety Investigators, and others.

As well, he outlined the flight safety department's involvement when new aircraft types are introduced into the Air Canada fleet. He described the role as follows:

> A. ... with the introduction of new aircraft, there is an introduction committee that is formed. And these are representatives from various branches which have an interest in ensuring the smooth introduction of an aircraft into service.
>
> And flight safety always has a representative on all of those meetings. One reason is to gather the latest information on the aircraft, which may be of use to flight safety, and also to ensure that any actions which flight safety has to take with the introduction of a new aircraft are part of the program and are completed on schedule.
>
> Q. And so with the introduction of the A320, was there such an introductory committee?
>
> A. Yes, there was, and Mr Galliker was a member of that committee.
>
> (Transcript, vol. 119, pp. 74–75)

Given Air Canada's substantial experience with jet aircraft and the introduction of new aircraft into service, as well as its position as majority shareholder in Air Ontario, it is difficult to understand why it failed to share the benefits of this experience and to ensure that there was an FSO and an appropriate flight safety organization in place at Air Ontario during and following the introduction of the F-28 jet aircraft into its fleet.

Air Canada's Assistance to Air Ontario

Mr Mitchell testified that he first learned of Air Canada's acquisition of feeder airlines in 1987. He stated that, at that time, there was some discussion between himself and Captain Charles Simpson, vice-president of flight operations for Air Canada, about the possibility of offering flight safety assistance to the connectors. He expressed it this way:

> Q. And what ways did you mention that you could assist Air Ontario?
> A. Well, flight operations felt that perhaps they might be able to offer some type of training to Air Ontario, and flight safety was interested in letting Air Ontario know that we had various publications and information which might be of use to them, and also, of course, the seminar which they had already had previous to that date, but there was some interest in discussions which took place between Air Ontario and Air Canada on maybe holding another seminar.
>
> (Transcript, vol. 119, pp. 87–88)

The "previous" seminar mentioned by Mr Mitchell was an Air Canada accident management seminar that had been given to personnel of Air Ontario Limited in 1985. Captain Simpson and Mr Mitchell discussed the advisability of repeating this seminar.

They also considered conducting an "operational review" of Air Ontario at this time. Mr Mitchell stated that an audit of Air Ontario was not discussed. He described what was contemplated as follows:

> Q. ... When you were discussing this with Captain Simpson, did you ever discuss the possibility of doing an audit of Air Ontario or any of the connector carriers?
> A. No, not really an audit. We felt that there was a need for us to have some communication with Air Ontario to establish how they were organized and what they were doing and who did what and how well it was being done.
>
> (Transcript, vol. 119, p. 92)

These discussions culminated in a meeting of Air Canada and its several connector airlines on August 18, 1987. In attendance at this meeting for Air Canada were members of the flight safety, flight operations, and training departments. Mr Mitchell recalled the presence from Air Ontario of Mr Thomas Syme, vice-president of operations, and Captain Robert Nyman, director of flight operations. Mr Mitchell described the meeting as exploratory, its purpose being "to sit down with some of our allied carriers and discuss what sort of things Air Canada had available which may be of use to them, and primarily what we could do for them, and give them the opportunity to maybe tell us what they could do for us as well." Mr Mitchell stated that some kind of commercial arrangement between Air Canada and the connector carriers for certain services was considered at the time, "especially in relation to the more expensive packages. If flight operations were to provide some training, for instance, that would probably be a cost item." With respect to flight safety items, Mr Mitchell testified that "there was never any consideration given at that time to charging them for those services" (Transcript, vol. 119, p. 95). The nature of the flight safety assistance Air Canada thought it might provide to the connectors was described as technical information relating to flight safety, as well as playback facilities for flight data recorders.

Mr Mitchell stated that Air Canada ran an accident-response seminar for Air Ontario personnel at Air Ontario's request in May 1989, following the Dryden crash. Air Canada had previously run an accident-response seminar in 1985 for the predecessor corporation, Air Ontario Limited.

Mr Mitchell was questioned about the relationship between the Air Canada and Air Ontario flight safety departments during the period between the initial meeting of the two departments in August 1987 and the accident-response seminar held in May 1989. He testified that at the time of the 1987 meeting he was under the impression there was an FSO in place at Air Ontario, when in fact there was not. He assumed that appropriate computer recording and trend analysis, similar to that done at Air Canada, was being carried out at Air Ontario. It was not. The only flight safety integration between the companies appears to have been the establishment of an accident-response plan. An accident-response plan cannot be equated to a flight safety organization; one is designed to respond to accidents, the other to prevent accidents.

When asked about the degree of integration between the flight safety organizations of the parent, Air Canada, and its feeder, Air Ontario, Mr Mitchell conceded that there was none. In testimony, he explained that there was no formal reporting relationship between the Air Ontario FSO and himself:

> A. No, that was left up to the flight safety officer in Air Ontario for him to observe what was going on in that area, and they didn't sort of share any of that information with Air Canada. Neither was it requested by ourselves. Only in the event of a larger or major catastrophe that might require our assistance.
>
> (Transcript, vol. 119, p. 106)

Mr Mitchell's explanation for the lack of a more comprehensive and formalized flight safety reporting relationship between Air Canada and Air Ontario was that "it was in the formative stages, so it was a matter of developing the systems in the time that it was available. And these things were progressing." He stated that except in the event of a major accident, there was no exchange of flight safety information or occurrence reports between the two entities.

Mr Mitchell advanced the reason for Air Canada not pursuing the flight safety organization issue at Air Ontario as follows:

> A. ... there seemed to be a safety organization in place, and their handling of the data within their own organization where the action needs to be taking place in the event that there is something that requires some action ... seemed to be well under way, and it didn't require Air Canada to get involved in it at that stage.
>
> (Transcript, vol. 119, p. 107)

Mr Mitchell's view of the Air Ontario flight safety organization was erroneous, inasmuch as the evidence clearly indicates that Air Ontario had no effective flight safety organization in place during the critical period of the introduction of the F-28 jet aircraft into its fleet. The evidence also demonstrates that Air Canada had little involvement in the flight safety aspects of its subsidiary, Air Ontario, and that Air Ontario's management did not adequately support its existing flight safety organization. Furthermore, Air Canada did not impress upon Air Ontario its own more developed flight safety ethic.

Air Canada's Operational Review of Air Ontario (Autumn 1989)

An operational review of Air Ontario was conducted by its parent, Air Canada, in the fall of 1989, six months after the Dryden crash. This review was not specific to Air Ontario and was part of a similar review of all Air Canada feeder airlines.

As already stated, Captain Stewart returned to the position of Air Ontario FSO in February 1989, approximately one month before the accident. Air Canada's post-Dryden operational review of Air Ontario, which was conducted in the fall of 1989, included a review of the then existing flight safety organization. Mr Mitchell was asked about the findings of Air Canada; the Air Canada report, which was read into the record, stated:

> Air Ontario employs a Flight Safety Officer who reports direct to the President. This is an ICAO recommended reporting relationship and is the most favoured in the industry. A Pilots to Flight Safety Officer Incident/Accident Reporting System is in place. Judging by recently published statistics, this system is functional.
>
> Air Ontario maintains an Aircraft Accident Alarm Plan. The plan is of good standard with check lists for Management and the Control Centre (SOC).
>
> (Transcript, vol. 119, pp. 153–54)

Mr Mitchell testified that in September 1989 Air Canada found the flight safety organization of Air Ontario to be "quite commendable" (Transcript, vol. 119, p. 153).

General Conclusions

The evidence before me demonstrated that the lack of continuity in the position of a flight safety officer, the lack of adequate support of the FSO position by senior management, and the lack of a flight safety organization within Air Ontario over the material time span was a managerial omission. That the majority owner Air Canada did not know of this situation indicates, at worst, a lack of concern on the part of parent corporation, or, at best, a lack of proper supervision on its part.

It appears from the evidence that the establishment of a company flight safety organization has the potential to enhance flight safety. With the advent of inexpensive information management systems, it cannot be considered an extraordinary burden on a carrier to set up at least an occurrence-reporting and investigating system and an information dissemination system. Considering the safety implications, it cannot be considered overly burdensome for an air carrier to appoint a flight safety officer with appropriate compensation for the work performed to oversee whatever flight safety organization is put in place.

Many air carriers have flight safety departments within their organization with detailed job descriptions for the flight safety officers. Transport Canada has, at headquarters and in its regions, flight safety officers ready and anxious to provide any assistance a carrier may require to set up an air carrier flight safety department.

Certain fundamental aspects of a successful flight safety organization were brought to light during testimony, the principal one being the independence of the flight safety officer in carrying out his or her duties. This independence includes access to all departments within the corporation. Another fundamental aspect of a successful flight safety organization is direct and unfettered access to senior corporate management, including the president. This direct access means direct action at an effective management level with respect to the oversights and failings of managers and supervisors at all levels.

Findings

- The single most significant determinant of an air carrier's flight safety ethic is the actual commitment of the air carrier to flight safety as reflected in the example set by senior management of the air carrier.

- An effective flight safety organization with a dedicated flight safety program and dedicated flight safety personnel is vital to the safe operation of an air carrier.

- Captain Stewart, the flight safety officer (FSO) for Air Ontario prior to the fall of 1987, resigned at that time from the FSO position primarily because of the lack of direct access to and support from the company president.

- The management of Air Ontario assigned a low priority to the importance of filling the vacant position of flight safety officer.

- The management of Air Ontario failed to have in place a flight safety officer and a flight safety organization between the fall of 1987 and February 1, 1989, a period that included the critical phase of the introduction of the F-28 jet aircraft into its fleet, and its scheduled operations with the F-28 aircraft from June 1988 to February 1989.

- The total absence of a flight safety officer and flight safety organization within Air Ontario, from the date the F-28 jet program was introduced until shortly before the crash of C-FONF, must be regarded as a serious omission on the part of Air Ontario management.

- The merger of Austin Airways and Air Ontario Limited, which resulted in a long period of instability for the new entity, Air Ontario Inc., was, among other things, marked by frequent changes in senior management personnel, continuous management restructuring, problems associated with the integration of the seniority lists, displacement of personnel, and the integration of operations and training programs. This period of instability carried over into the introduction of the F-28 program and had an impact on flight safety.

- The two HS-748 takeoff incidents with contaminated aircraft, which occurred on November 29, 1986, and December 15, 1987, involving Captain Joseph Deluce and Captain James Deluce (flying as first officer) and First Officer Scott Jensen, respectively, were not properly investigated by the responsible Air Ontario officials who undertook such investigations.

- As the pilot-in-command of an Air Ontario HS-748 aircraft on December 15, 1987, at Pearson International Airport in Toronto, Ontario, Captain Joseph Deluce committed an error in judgement in commencing a takeoff in the circumstances.

- The Canadian Aviation Safety Board did not investigate the December 15, 1987, Air Ontario HS-748 incident, although it was reported to it. The lack of response by CASB was inappropriate in the circumstances.

- Transport Canada regulatory authorities did not take any action in the December 15, 1987, Air Ontario HS-748 incident and did not implement measures to prevent a recurrence. Such lack of response was inappropriate in the circumstances.

- It is probable that had the November 1986 incident at Kingston Airport involving Captain Joseph Deluce been properly investigated and had Captain Deluce been appropriately sanctioned and properly instructed with regard to the dangers of takeoff with contaminated aircraft surfaces, the December 15, 1987, incident at Pearson International Airport may not have occurred.

- Had both HS-748 incidents been properly investigated and information with respect to the dangers of takeoff with contaminated aircraft surfaces been disseminated to Air Ontario operational personnel, including its pilots, there would have been a heightened awareness among Air Ontario pilots of the very serious problems associated with aircraft surface contamination.

- The third alleged incident involving Captain Joseph Deluce, as pilot-in-command of an Air Ontario F-28 aircraft, was anonymously reported to have occurred at Pearson International Airport in Toronto on April 4, 1989, and was referred by Captain Stewart, the Air Ontario flight safety officer, to the vice-president of flight operations, Mr Morrison. I infer from the evidence that both Captain Stewart and

Mr Morrison were highly sensitive to the fact that the pilot-in-command involved in this alleged incident was Captain Joseph Deluce, and that this sensitivity militated against their conducting a thorough investigation.

- When a person has significant shareholdings in an air carrier and, at the same time, occupies managerial positions such as chief pilot, training pilot, company check pilot, as well as being a line pilot of the carrier, there is the potential for conflict of interest and the possibility of creating an atmosphere of intimidation among other personnel. In such circumstances, air carrier management must be especially vigilant to safeguard against the occurrence of such conflicts.

- Current Canadian legislation does not address the need for either a dedicated air carrier flight safety program or a flight safety managerial position as an essential element for the safe operation of Canadian air carriers.

RECOMMENDATIONS

It is recommended:

MCR 100 That Transport Canada proffer for enactment legislation to amend Air Navigation Order Series VII, No. 2, section 5, to include the position of flight safety officer as a required air carrier managerial position.

MCR 101 That Transport Canada proffer for enactment legislation to amend Air Navigation Order Series VII, No. 2, section 5, to require the appointment by an air carrier of a person to the position of flight safety officer for the carrier, the qualifications of such person and the description of the duties and responsibilities of such position to be determined by Transport Canada after consultation with the air carrier industry, and to provide that the flight safety officer shall have direct access on a continuing basis to the chief executive officer of the air carrier in flight safety–related matters.

MCR 102 That Transport Canada initiate a program of consultation with Canadian air carriers and the Transportation Safety Board of Canada with a view to having air carriers institute, staff, and operate, on a continuing basis, an effective flight safety program that is based upon the "Flight Safety Functions," identified in the International Air Transport Association Technical Policy Manual, OPS Amendment No. 37, July 1989, referred to in chapter 24 of my Final Report, Flight Safety.

MCR 103 That Transport Canada institute a program for the monitoring of the flight safety programs of Canadian air carriers, with a view to ensuring that each air carrier has in place an effective flight safety program that is appropriate for the size and scope of the carrier's operations.

25 MANAGEMENT PERFORMANCE

During this Inquiry, management effectiveness was reviewed in the context of Air Ontario's introduction of the F-28 aircraft into commercial service. By analysing Air Ontario's planning and implementation of the F-28 program, and the certification and inspection of the F-28 program by Transport Canada, deficiencies in the air transportation system became apparent.

Owners and managers of air carriers must operate within the bounds of the Air Regulations and the authority delegated to them as licence holders. The regulator and the air carrier functionally meet at three principal stages:

- at the approval or certification stage of the air carrier's proposed operation;
- during the inspection or monitoring of an air carrier operation; and
- when the regulator pursues an enforcement action against any air carrier or air carrier employee who has breached the *Aeronautics Act*, the Air Regulations, or the Air Navigation Orders (ANOs).

The evidence before me disclosed that there were weaknesses in each of these three functional stages – certification, inspection, and enforcement – as they applied to the Air Ontario F-28 program. Irregularities in the F-28 program, which could have led to enforcement action but were undetected during routine regulatory inspection, could have been avoided entirely if proper care had been taken by Air Ontario and Transport Canada in the planning, implementation, and certification stages of that program.

An example of this can be seen in the irregular maintenance deferral practices discussed previously. The practice by some Air Ontario F-28 maintenance personnel of deferring the maintenance of essential aircraft equipment without an approved MEL, and the practice by some Air Ontario F-28 pilots of noting maintenance defects on loose pieces of paper, instead of promptly recording them in the aircraft journey log, would both appear to violate ANOs and could have given rise to enforcement action. Neither of these practices was detected during routine Transport Canada inspections, yet the inspectors involved knew or ought to have known that, for a period of six months, Air Ontario F-28 C-FONF was operated without either an approved MEL or an adequate store of spare parts. Further, the inspectors knew or ought to have known that, under such circumstances, aircraft serviceability would have been a serious problem.

What is most significant is that Air Ontario was allowed by Transport Canada to operate the F-28 aircraft in commercial service without an approved F-28 MEL or adequate supporting spare parts. It is true that there is no regulatory requirement for an MEL in Canadian commercial air carriage, and I have already questioned the wisdom of this situation. Air Ontario had planned to have an F-28 MEL developed and approved by February 28, 1988 – weeks before F-28 commercial service was to have started – yet that goal was not achieved until December 1988, months after commercial service began. Adequate supporting spare parts are required by regulation, and Air Ontario had planned to have them prior to commencing commercial F-28 service; this goal was also not achieved.

Had Air Ontario taken steps to implement its F-28 Project Plan in accordance with the schedule presented to Transport Canada and had Transport Canada monitored the progress of the Project Plan properly, withholding the necessary regulatory approval until all operational prerequisites were in place, the problems that were later manifested – for example, the irregular maintenance deferrals – could have been avoided.

Other deficiencies in the Air Ontario F-28 program that were discussed at length above include:

- the failure to make operational accommodation for the lack of F-28 ground-start facilities at Dryden;
- the untimely production, lack of coordination, and insufficiency of key operational manuals;
- the failure to develop and methodically disseminate operational guidance on refuelling and de-icing with main engines running;
- the failure to install a flight attendant shoulder harness on the F-28 aircraft; and
- the inadequacy of training and procedures within SOC.

All should have been addressed by Transport Canada and corrected by Air Ontario prior to the regulatory approval of Air Ontario's commercial F-28 service.

For this reason, I will conclude my examination of Air Ontario and its F-28 program by concentrating on the actions of the air carrier and the regulator during the planning, implementation, and certification stages.

Certainly, it may be argued that the Air Ontario F-28 program was not the only matter of concern to either Air Ontario management or Transport Canada inspectors. Air Ontario had hundreds of employees, operating many aircraft and aircraft types, and serving many cities. The

F-28 program was a relatively small, though significant, part of Air Ontario's overall operation. Transport Canada inspectors were similarly responsible for many air carriers operating hundreds of aircraft. Nevertheless, these facts in no way mitigate the responsibility that Air Ontario and Transport Canada had to ensure that the Air Ontario F-28 program was properly carried out.

It must also be noted that the findings of this Commission regarding the inadequacies of the Canadian air transportation system are the chance product of the tragic crash of Air Ontario flight 1363 on March 10, 1989.

Certification

The regulatory scheme in Canada is designed to give Transport Canada the ultimate authority over the licensing of commercial air carriers. The criteria and procedures for licensing air carriers operating large aircraft are set out in ANO Series VII, No. 2, and in Transport Canada internal policy and procedures manuals. The approval process requires that the operational soundness of a prospective air carrier operation be assessed by both the Air Carrier and the Airworthiness branches of Transport Canada's Aviation Regulation Directorate. The process is described in the Air Carrier Certification Manual of Transport Canada – Aviation Regulation Directorate (both the 1987 and 1990 editions):

> The applicant's ability to conduct the proposed operation safely, involves a determination as to whether or not his Company facilities and organizational structure, including properly licensed and qualified personnel, meet the applicable statutory and DOT policy requirements. This determination necessitates that DOT inspectors, as the first step, make themselves thoroughly familiar with all aspects of the proposed operation; identify all applicable requirements and then, measure the applicant's facilities and organizational structure (including properly licensed and qualified personnel in sufficient numbers) against the requirements.
>
> ...
>
> The tests of adequacy and capability apply not only in the case of an applicant for an Operating Certificate but also to any incumbent holder of such certificate. The basic intent of all inspection relative to certification is an on-going process of determining whether or not the Company meets and continues to satisfy the requirements.
>
> (Exhibits 1026, pp. 6–7; 1031, pp. 7–8)

An air carrier begins the certification process by filing with Transport Canada a written application for an operating certificate or an amendment to an operating certificate. As I have described earlier, this written application would typically detail the specifications of the aircraft to be operated, the airports into which the aircraft is to be operated, the operations personnel involved with the program, and the maintenance facilities that will service the aircraft. Further, the proposed operation may also be described in narrative form. When Transport Canada receives the air carrier's application, regulatory personnel verify the contents of the application and assess the suitability of what is described. In this regard, the Air Carrier Certification Manual states:

> It is essential that inspectors ensure that the applicants' forms are properly completed and so verified by inspecting his aircraft facilities and by reviewing the applicants supervisory personnel.
>
> The importance of properly investigating the facilities to be provided and the operational feasibility of the proposed operation cannot be over emphasized.
>
> (Exhibits 1026, p. 7; 1031, p. 8)

Regulatory personnel are therefore charged with the responsibility of deciding whether the carrier has qualified management personnel and a training, operational, and maintenance infrastructure that will support adequately the safe conduct of the prospective operation. In short, the air carrier must be able to demonstrate to Transport Canada that it is able to operate the service safely, properly, and in accordance with the prescribed standards and procedures.

After what should be a very rigorous appraisal process, an operating certificate may be granted for the proposed air carrier operation. In addition, Transport Canada may impose special operating limitations upon a carrier; these are included on the face of the operating certificate or within the air carrier's approved operating specifications.

Once issued, the operating certificate can be rescinded or suspended for cause, as detailed in section 704 of the Air Regulations:

> 704. The Minister may cancel or suspend an operating certificate where
>
> (a) the holder of the operating certificate has failed to conduct the commercial air service in a safe and proper manner or to maintain adequately the equipment required in connection therewith;
>
> (b) the operation in respect of which the operating certificate was issued is discontinued; or
>
> (c) the Minister, on reasonable grounds, believes the holder of the operating certificate has contravened
>
> (i) any operations specifications,
>
> (ii) any provision of these Regulations, or
>
> (iii) any order or direction made pursuant to these Regulations.

This certification process should be considered as a very important regulatory function.[1] If the capability of a carrier to perform a given operation is assessed properly at the approval stage, many downstream safety problems can in all probability be avoided.

In pragmatic terms, an air carrier is much more amenable to the suggestions or requirements of the regulator while it is waiting for approval of its operating certificate than after that certificate is granted. Without the operating certificate, the air carrier cannot operate; therefore, there is a large incentive for the carrier to satisfy any and all regulatory requirements imposed upon it. The evidence revealed that the withdrawal or suspension of the operating certificate is considered to be a drastic enforcement tool which the regulator is loath to use. Therefore, while the regulator has the undivided attention of the carrier during the approval stage, the regulator should be extremely vigorous in reviewing the request for an operating certificate or amendment to an operating certificate, and insist that all operational prerequisites be in place before any such licence is granted.

Approval of the Air Ontario F-28 Program

Transport Canada was responsible for assessing Air Ontario's management and operational infrastructure prior to granting it a licence to operate the F-28 aircraft. Transport Canada failed to carry out this responsibility.

Air Ontario made a number of representations and undertakings about the operational infrastructure that was to support the proposed F-28 program in its January 24, 1988, application to amend its operating certificate. Certain facilities and personnel were represented to be in place prior to the commencement of F-28 commercial service. In particular, I note the following:

- There were to be 11 flight operations officers (dispatchers) who would be trained to be familiar with the F-28 aircraft and its systems, with special emphasis on flight planning, performance, and MEL procedures.
- By emphasizing that operations officers would be trained on MEL procedures, it is implied that there would be an MEL in place for use in the operation of the F-28 aircraft.

[1] The three regulatory functions being certification (approval), inspection (monitoring), and enforcement.

- Air Ontario nominated Captain Claude Castonguay as an air carrier check pilot and described him as the company check pilot to be involved in the first revenue flight of aircraft C-FONF, implying that Captain Castonguay would have an ongoing role in the F-28 program.
- An "adequate spares package" was to be provided as part of the aircraft lease agreement.

Had Transport Canada officials carefully inspected the facilities and personnel in place at Air Ontario prior to the licensing of the F-28 service, using Air Ontario's application as a checklist, they would have discovered that:

- There was no meaningful training of dispatchers in Air Ontario system operations control (SOC) regarding F-28 flight planning, performance, and MEL procedures.
- There was no approved F-28 MEL in place.
- Captain Castonguay had resigned from Air Ontario as of February 29, 1988, less than six weeks after commencing his employment as the F-28 company check pilot, citing that he was not given adequate company support.
- The spares package in place at Air Ontario could not have adequately supported the aircraft C-FONF, particularly given that there was no approved MEL in place.

These and other operational deficiencies should have been remedied prior to the licensing of Air Ontario's F-28 service.

The evidence revealed several flaws in the selection and monitoring, by both Air Ontario and Transport Canada, of the Air Ontario management personnel responsible for the F-28 program. Certainly, it is a fact that management personnel who are unqualified or otherwise unable to perform their delegated tasks will diminish the overall effectiveness of any corporation. The selection of qualified and competent management personnel is particularly important in the aviation industry, in part because of the potential severity of the consequences of mismanagement, and also because of the extensive delegation of flight safety responsibility by Transport Canada to individual air carriers.

For the air transportation system to work, initiatives like the Air Ontario F-28 program must be managed by individuals with sufficient training, experience, and ability. Further, there must be management checks or safeguards within the corporate organization to ensure that if there is a failing on the part of any one manager, other individuals – in particular, more senior managers – will intervene to correct any problems.

The remainder of this chapter will examine the performance of Air Ontario management personnel with direct responsibility over the F-28 program.

The Planning and Implementation of the F-28 Program

The primary responsibility for the day-to-day coordination and implementation of the F-28 Project Plan was that of the project manager, Captain Joseph Deluce. Although the role of the project manager was never formally defined, Captain Deluce was described by Mr Syme, as the prime coordinator of the plan. Mr Syme further stated:

> A. ... In flight operations matters relating to the plan, he would have reported to Bob Nyman. In his coordinating role and facilitating role with respect to the plan outside of flight operations, he interfaced directly with myself.
>
> (Transcript, vol. 98, p. 53)

Mr Syme went on to describe the project manager as a "cross-departmental" facilitator (p. 175), and further:

> A. ... Joe was responsible for communicating to me, from his perspective, when the plan was getting off the rails or when the implementation date – you know, the assessment of the likelihood of the implementation date of the aircraft.
>
> (Transcript, vol. 98, p. 176)

When Captain Deluce became the F-28 chief pilot, he was charged with the additional responsibilities set out as follows in the Air Ontario Flight Operations Manual:

> 3.4 <u>CHIEF PILOT – DUTIES, RESPONSIBILITIES AND AUTHORITY</u>
>
> 1. The Chief Pilot is responsible to the Director of Flight Operations for the safe and efficient operation of Company aircraft, the administration of matters concerning pilots, pilot training, examinations, competency tests, enroute operations and operating limitations of aircraft and crew members.
>
> 2. He will set up such controls and checks to assure that D.O.T. and Company regulations, policies and standards are adhered to and to administer such disciplinary or other action as may be required for any infractions of Company policy or regulations or for failure to meet Company standards.

More specifically he will:

3. Establish such courses of ground school (in cooperation with the Training Manager), aeroplane simulator and flight training as are required to maintain pilot competency, to promote pilots from First Officer to Captain's rank, to convert pilots from one aircraft type to another and to check pilots out on appropriate routes.

4. Establish examinations (in cooperation with the Training Manager, Check Pilots and Training Pilots) that are acceptable to the D.O.T. to serve as tests of knowledge of pilot personnel.

5. Ensure compliance with ANO VII No.'s 2 and 3 in regards to the requirements for pilot proficiency checks, instrument checks, initial and recurrent ground and flight training and examinations.

6. In cooperation with Training and Check Pilots, write and update Standard Operating Procedures Manuals for each aircraft type.

7. Ensure that licensed personnel hold valid licenses, ratings and certificates.

8. Ensure the maintenance of current records on Company pilots, including:
   - personal file
     - employment history with the Company
     - garment purchase summary
     - vacation/L.O.A./sick leave history
     - loan card
     - pay and promotion memo's
     - photocopies of pilot licence, LVC, PPC card, radio licence, immunization record, first aid training etc.
     - warning reports
     - etc.
   - training file
     - training sessions, ground and air
     - etc.
   - training sessions, ground and air
   - check flights
   - examination results
   - flight times
   - information updates (biannually)
   - etc.

9. Ensure that D.O.T. approved CCP authorizations are kept valid.

10. Perform normal line pilot duties; and line checks, PPC's and instrument rides if so authorized.

11. Train and check pilots to assure retention of proficiency for the duties assigned, including:

    - line pilots
    - training pilots
    - check pilots

12. Be responsible for the overall supervision of crew scheduling and routing to assure that work available is equitably assigned to pilots in a manner which will enhance safety, permit planning as far in advance as is possible and which will not exceed D.O.T. or Company limitations of pilot time.

13. Check and approve flight crew expense claims as required.

14. Formulate and distribute information memos as required pertaining to Flight Operations.

15. Be responsible for the supervision of all pilots regarding working conditions, granting of vacation requests, and personnel problems.

16. Conduct initial survey flights of new routes and to establish such enroute limitations, procedures and checks as may be required to conduct safe operations over such routes.

17. Conduct such initial flights on new equipment as to become competent to serve as check pilot on such equipment and to establish procedures and regulations as are required to operate such equipment in service and to train and check out other pilots as may be required to operate such equipment.

18. Maintain a library of appropriate manuals as required by Transport Canada and Company policy, ensuring that amendments are inserted:

    - Flight Operations Manual
    - Crew Member Training Manual
    - Standard Operating Procedures Manuals
    - Aeronautics Act and Air Regulations
    - ANO VII No. 2 and ANO VII No. 3
    - AIP
    - Designated Airspace Handbook
    - Canada Air Pilot
    - L.E. Charts

19. While some of these duties may be delegated to other company personnel, ie., (Chief Training Pilot) the Chief Pilot will maintain overall responsibility.

(Exhibit 146, s. 3.4)

From this lengthy list of duties and responsibilities I note in particular the chief pilot's responsibility for "the safe and efficient operation" of the aircraft, including the writing and updating of standard operating procedures manuals for the F-28 and the formulation and distribution of information pertaining to F-28 flight operations.

The specific shortcomings in the F-28 program that should have been but were not addressed and remedied by Captain Joseph Deluce – as the F-28 project manager and F-28 chief pilot – include:

- the operation of the F-28 aircraft without an approved minimum equipment list;
- the deferral of the maintenance of essential aircraft equipment absent an approved minimum equipment list;
- the operation of the F-28 aircraft without a single standardized aircraft operating manual, with an appropriate amendment service;
- the operation of the F-28 aircraft without standardized operational procedures, disseminated to all relevant operational personnel, regarding the de-icing of F-28 aircraft with a main engine running;
- the operation of the F-28 aircraft without standardized operational procedures, disseminated to all relevant operational personnel, regarding the refuelling of F-28 aircraft with a main engine running;
- the operation of the F-28 aircraft without standardized procedures, disseminated to all relevant operational personnel, to accommodate for the lack of ground-start facilities in Dryden and aircraft operations with an unserviceable auxiliary power unit;
- the operational control of F-28 aircraft by flight operations officers who were inadequately trained generally, and who were inadequately trained specifically with regard to F-28 operating procedures; and
- the operation of the F-28 aircraft without standardized operational procedures, disseminated to all relevant operational personnel, regarding takeoffs from slush-covered runways.

The fact that Captain Deluce did not fulfil certain aspects of his management duties and responsibilities represents a failure in the air transportation system. While a finding of pilot error should only be the starting point in the analysis of an aircraft accident, it is equally true that the identification of the management failings of one air carrier manager should only be the starting point in an examination of the management organization within which that individual worked. In analysing the failure of Air Ontario management, the following issues were explored in evidence:

- **The Performance of the F-28 Project Manager and F-28 Chief Pilot** What were the duties and responsibilities of this individual who was immediately responsible for the day-to-day operation of the F-28 program? How did he fail to fulfil these duties?

- **The Role of Supervisors** What management safeguards were in place to recognize the difficulty that the F-28 project manager and F-28 chief pilot was experiencing? Why did the supervisors not intervene?

- **The Management Selection Process** To the extent that the individual was not able or qualified to perform his required duties as F-28 project manager and F-28 chief pilot, how and why was he selected for the management position?

The Performance of Captain Joseph Deluce, F-28 Project Manager and Chief Pilot

Captain Joseph Deluce was given a great deal of responsibility in the period from October 1987 until June 1989. On the recommendation of his brother, CEO William Deluce, Captain Joseph Deluce, then a line pilot on the HS-748 aircraft, was selected as the F-28 project manager. He initially assisted chief operating officer Thomas Syme in formulating the first F-28 Project Plan and then, in consultation with managers from the maintenance, flight operations, and marketing departments, he produced the revised F-28 Project Plan of December 28, 1987. He was formally appointed F-28 project manager in early January 1988. As project manager it was his responsibility to coordinate and facilitate the completion of the various tasks on the Project Plan.

While Captain Deluce was coordinating the implementation of the F-28 program, he was also training on the aircraft. To increase his experience on the F-28, he flew 59.2 hours with TimeAir in western Canada. Because of the Air Ontario pilot strike in the spring of 1988, he interrupted his flying with TimeAir to fly Air Ontario HS-748 aircraft in Northern Ontario. Following the pilot strike he became involved in importing from France the first F-28, C-FONF. Many items on the F-28 implementation plan were still outstanding when Air Ontario commenced F-28 commercial service in June 1988. Instead of concentrating his managerial efforts on completing the tasks necessary for the safe and efficient operation of the F-28 – tasks that should have been completed before commercial service began – Captain Deluce was flying the line and training and checking the F-28 pilots. In fact, during the period from

June until September 1988, Captain Deluce logged over 220 hours on the F-28, a normal full-time flying schedule for most commercial pilots.

The most critical period in the F-28 program, in my view, occurred in late 1988. In November 1988, the second F-28, C-FONG, was imported from France. In December 1988 Mr James Morrison reorganized the flight operations department so that Captain Joseph Deluce formally became the F-28 chief pilot. At about the same time, Air Ontario lost its access to the Piedmont/USAir F-28 flight simulator, and Captain Deluce commenced the flight training of Air Ontario crews on the F-28 aircraft in Winnipeg at night. Captain Deluce at this time was wearing many hats, too many in my view. He was the F-28 chief pilot, an F-28 training pilot, an F-28 company check pilot, and the Convair 580 chief pilot. In addition, there were still critical items outstanding from the F-28 implementation plan, and as the F-28 project manager it was still his responsibility to see that they were completed.

The fact that Captain Joseph Deluce was overburdened did not go undetected by his fellow pilots. Captain Erik Hansen, one of Air Ontario's most senior pilots, testified that, in his opinion, Captain Deluce was wearing "too many hats" and that he was spreading himself too thin (Transcript, vol. 94, pp. 118–19). Further, Captain Hansen testified that he spoke with Captain Deluce about these concerns, advising him "you need help" (Transcript, vol. 94, p. 158). Captain Deluce, when asked about his workload during the critical period and about Captain Hansen's comments, admitted that he had "a lot on my plate." He testified as follows:

> A. I can't deny the fact that I was very busy. What can I say? I ... worked very hard. I tried to deal with ... the operation in the best way that I could, and –
> Q. Were you overworked, sir, at that time? Did you have too much on your plate?
> A. Well, that's a difficult question to answer. I guess, if I had to describe it, I would have to talk about the whole process, and –
> Q. In hindsight, do you think that you had too much on your plate, Captain Deluce?
> A. Maybe I should describe how I viewed being taken onto projects .... [I]n taking on any new project or new job, one anticipates having to do a lot of work.
> ...
> Myself, I usually, when I have taken on a new job, I kind of put in my mind a year's time frame where you're really going to have to put a lot of extra effort into things, and at about that time, you would feel like it would ... you know, you've gone through the learning curves and ... you would be getting on top of things and things would settle down. And that happened with the project itself, and ... at the end of that year, there were

> a few items outstanding before I took the chief pilot's job, but ... they were items that could have been addressed by a new chief pilot or a combination of check pilots.
>
> I took a considerable amount of time off at that point to, you know, re-energize myself ... and to start into the new year with renewed energy, and with the circumstances as they fell ... losing the simulator slot and having to reorganize an airborne training program and to do the training myself and that running through into the end of February and then the accident happening ... and then everything that happened after that, I had a lot on my plate. I admit that.
>
> (Transcript, vol. 114, pp. 30–31)

While the loss of access to the Piedmont/USAir simulator did represent a critical juncture in the Air Ontario F-28 program, the evidence revealed that there were operational problems with the program from the commencement of commercial service in June 1988.

The evidence clearly shows that, throughout the period from early 1988 up to and including March 10, 1989, Captain Joseph Deluce was overburdened by his multiple duties and responsibilities. I make no assessment of Captain Deluce's ability to perform adequately in any one of the multiple positions that he held if unencumbered by other duties. However, it was his clear responsibility to advise his superiors, at an early stage, that he was unable to carry out all of his tasks. This he did not do.

The Role of Senior Flight Operations Managers

Captain Joseph Deluce, as a relatively young, inexperienced manager, took on more responsibility than he could reasonably handle. It is surprising that senior operational managers at Air Ontario did not recognize that Captain Deluce was in some difficulty, that the F-28 program was suffering as a result, and that immediate steps had to be taken to remedy the situation.

I am of the view that a reason for the lax supervision of Captain Joseph Deluce was the fact that the company as a whole was undergoing great change. Managers who should have been scrutinizing the F-28 program were occupied by the management of the newly merged company. As described in the early chapters of this part of the Report, Air Ontario's managerial resources were greatly taxed during the functional merger of the two regional carriers. The divestment of northern operations, the depletion of up to one-third of its employee group, the consolidation of its operation in London, Ontario, the merger of two disparate pilot groups, a lengthy pilot strike, the cultivation of a new relationship with the new controlling shareholder, Air Canada, the rationalization of its aircraft fleet, and the introduction of a new aircraft type all represented significant challenges to Air Ontario management in the 18 months following the merger.

While management distraction is a partial explanation for the lack of scrutiny of the F-28 program, it appears from the evidence that Captain Deluce was as disinclined to be supervised and to take advice from any source as some of his superiors were disinclined to give advice to him. There were a number of examples of this state of affairs.

When Captain Nyman learned that there were two different aircraft operating manuals, the Piedmont manual and the USAir manual, being used by Air Ontario F-28 pilots, he immediately asked Captain Deluce to place a copy of the Piedmont manual in both F-28s (Transcript, vol. 109, pp. 67–68). This measure could have served as an interim solution – though an inadequate one – pending the completion of the Air Ontario F-28 aircraft operations manual. Neither Captain Nyman nor Captain Deluce did anything to follow up this request.

Captain Robert Perkins, a senior Air Ontario pilot, an F-28 captain, and a F-28 company check pilot,[2] testified that in December 1988 he advised Captain Joseph Deluce that they should either develop their own Air Ontario F-28 operations manual or subscribe to an amendment service for the Piedmont F-28 operations manual (Transcript, vol. 44, p. 94). In fact, Captain Perkins and another Air Ontario pilot, Steven Burton, were enlisted to assist in the production of the F-28 aircraft operating manual. However, no amendment service to the Piedmont manual was ever obtained by Air Ontario, and the Air Ontario F-28 operating procedures manual was not submitted to Transport Canada for approval until June 7, 1989, the same month that Air Ontario discontinued its F-28 service and three months after the crash of C-FONF.

Interestingly, when the Air Ontario director of flight operations, Captain Clifford Sykes, attempted to intervene in the F-28 operations, Captain Deluce responded with vigour. The following excerpt from a post-crash memorandum (dated March 31, 1989) from Captain Deluce to Captain Sykes, his superior, provides a revealing glimpse into their working relationship:

> The second comment I would like to make relates to your comments to other pilots on the operation of the FK28. As Chief Pilot it is very clear to me that I am responsible to the Director of Flight Operations for many things. A large list is contained in the Flight Operations Manual. I'm responsible for setting up standards and monitoring

[2] Captain Perkins was granted "B" authority CCP status on January 30, 1989 (see chapter 20, F-28 Program: Flight Operations Training).

> standard operating procedures with the assistance of the check pilots. These standards can only be maintained if changes warranted come out directly from me. Interference from you and direct communications with crews on SOP type items or systems will ensure a brake [sic] down of the system and lead to many different procedures. I am very interested in any comments you have about what you see on the line but I would appreciate these comments coming directly to me. I will research these items and correct any that need correction and advise you. You are not an experienced F-28 pilot, nor a check pilot, nor a training pilot on that aircraft. Don't be drawn into the trap if [sic] thinking you are and passing on incorrect information. Besides I'm responsible to you to do a job. Help me do it but don't do it for me.
>
> (Exhibit 897)

Captain Deluce properly identified in this memorandum the importance of flight standards and some his duties and responsibilities as chief pilot. However, he failed to mention that, at the date of his memorandum, March 31, 1989, although he was responsible for them, there were still no Air Ontario standard operating procedures in place for the F-28 aircraft. What I find most revealing is the tone Captain Deluce took with his superior. The working relationship reflected in this memorandum does not, in my view, reflect the usual subordinate/superior relationship that one would expect to find in any organization.

It would appear that Captain Joseph Deluce had more influence within Air Ontario than his position on the organization chart would indicate. His direct line supervisors, Captain Nyman, Captain Sykes, and Mr Morrison, seemed unwilling or unable to exert any influence over Captain Joseph Deluce. Indeed, when Captain Deluce was involved in a number of flight safety–related incidents as a line pilot, he appears to have been immune from criticism by his superiors.

Captain Nyman's handling of Captain Deluce's December 15, 1987, HS-748 icing incident is telling (see chapter 24, Flight Safety). After what was a very serious incident, one which could easily have resulted in a serious accident and which was similar to an equally serious icing incident involving Captain Deluce the previous year, Captain Nyman, as the director of flight operations, did nothing to criticize or discipline Captain Deluce.

Captain Nyman's treatment of an incident involving pilot Keith Mills presents an interesting contrast to his treatment of Captain Deluce's incidents. Following an HS-748 aircraft runway-overrun incident at Marathon, Ontario, on May 15, 1988, in which Keith Mills was the captain, Captain Nyman ordered Captain Mills to undergo 50 hours of line indoctrination. In meting out this discipline, Captain Nyman advised Captain Mills that, had it not been for his previously good record, the discipline would have been even more severe, including a period of suspension without pay. In his testimony Captain Nyman acknowledged that, as director of flight operations, his disciplinary response to an incident includes a consideration of the pilot's safety record. Given that testimony by Captain Nyman, it is indeed curious that Captain Deluce's two virtually identical icing incidents, involving potential loss of life, failed to attract any discipline at all.

Not only was Captain Deluce not disciplined for his second icing incident, but, when he was considered for and granted the position of F-28 chief pilot, his incident/accident record was not even taken into account. These incidents should have alerted the company's senior managers that Captain Deluce, at the very least, may not have been capable, as the F-28 chief pilot, of commanding the respect of F-28 flight crews on questions of flight safety.

Some months following his appointment as F-28 chief pilot, Captain Deluce was implicated in an anonymous incident report involving a destabilized approach of an F-28 aircraft. The alleged incident, which was reported to have occurred at Pearson International Airport on April 4, 1989, 25 days after the Dryden crash, was brought to the attention of the vice-president of flight operations, James Morrison. Mr Morrison, in examining the alleged incident, simply accepted Captain Deluce's denials thereof without further investigation. Given Captain Deluce's previous history, Mr Morrison should have investigated the matter thoroughly. When questioned on his own handling of this anonymous incident report, Mr Morrison criticized flight safety officer Ronald Stewart for performing an inadequate investigation. However, it is not the role of a flight safety officer to investigate incidents for the purposes of discipline. Such investigations are more appropriately conducted by flight operations management personnel, like the chief pilot or the director of flight operations. Mr Morrison was certainly able to direct an investigation into this matter, yet he chose not to.

In spite of frequent assertions by Captain Nyman and other members of Air Ontario senior management that Captain Joseph Deluce was treated like any other pilot, the preponderance of evidence suggests otherwise. I am of the view that, given Captain Deluce's flying record, had he not been a member of the family that owned and operated Air Ontario, it is unlikely that he would have been selected as the F-28 chief pilot and F-28 project manager – two critical management positions.

Air Ontario Management Selection: "Best Man for the Job"

It is the responsibility of any chief executive officer to determine the needs of his company and to take appropriate steps to meet these needs.

Senior management selection is one of the most important responsibilities of the CEO.

Although the Air Ontario president and CEO, Mr William Deluce, delegated more authority to others in the management of Air Ontario Inc. than he had in the earlier history of his company, he testified that he was still active in selecting his managers. When asked about the basis of his selection of his senior managers, Mr William Deluce testified that his sole criterion was to appoint "the best man for the job" (Transcript, vol. 151, p. 175). If this criterion was in fact followed, then Mr William Deluce was doing what chief executive officers are expected to do: exercise his judgement in the selection of his managers.

There was much testimony regarding the criteria for the selection of managers at Air Ontario. In particular, questioning centred on the selection of Deluce family members and former Austin Airways personnel to key management positions.

Mr William Deluce rarely went outside the sphere of his family companies in search of new management candidates, preferring instead to promote managers from within his company. In his selection of operational managers, I find from the evidence that there was, in the merged company, Air Ontario Inc., a definite preference for former Austin Airways personnel – individuals with whom Mr Deluce had a long familiarity – as opposed to former Air Ontario Limited personnel. In my view there is nothing inherently wrong with this approach to the selection of managers, as long as the selected individuals perform effectively as managers.

Mr Syme and Mr William Rowe both described their own concerns regarding the possibility of nepotism – "undue favour from holder of patronage to relatives" and "favouritism shown to relatives in conferring offices or privileges" (Concise Oxford Dictionary) – being the basis of some management selections. Mr Rowe, the Air Canada representative on the Air Ontario board of directors, stated that he did not want there to be a perception that Air Canada supported nepotism in management selection. Further, he expressed Air Canada's concern that the long-term senior management at Air Ontario be secured and not be merely dependent on the Deluce family. Mr Syme, though denying any nepotism in management selection, testified that he was aware of resentment among junior managers and employees who felt nepotism was a basis for management selection at Air Ontario.

Nepotism is often viewed as a pejorative term, and questioning of Air Ontario management witnesses in this regard may have implied that there was something inherently wrong in Mr William Deluce sponsoring the appointment of his brothers Bruce and Joseph to key management positions. Again, I am of the view that there is nothing inherently wrong in the selection of family members to significant management positions, as long as those selected are the best individuals available to fill the position and have not been shown undue favour. Certainly a chief executive officer must be given discretion to manage his company in the manner that he sees fit. A CEO is accountable to his shareholders by way of his board of directors. If a board of directors is unhappy with the performance of the CEO, it can, at least in theory, take appropriate action, including the CEO's removal. Such removal may in actual practice be difficult to accomplish where the CEO holds a substantial interest in or is in a position to exercise control of a company.

What is more important than the issue of nepotism is the effectiveness of Air Ontario management as it relates to the crash of flight 1363. After an extensive review of the evidence, I find that the deficiencies in the F-28 program were ultimately attributable to bad management. There can be no doubt that those managers responsible for the Air Ontario F-28 program were not discharging their duties and responsibilities effectively.

Captain Joseph Deluce was the manager principally responsible for the implementation of the F-28 program and the ongoing F-28 operation. The question to be answered, therefore, is whether Captain Deluce was the best man for the job of F-28 project manager and chief pilot. To answer the question, the circumstances surrounding his selection should be considered.

In the autumn of 1987, when the F-28 program was in its earliest planning stages, CEO William Deluce suggested to group vice-president Thomas Syme that Joseph Deluce be made the project manager of the F-28 program. Having regard to the evidence surrounding this management selection, I am satisfied that Joseph Deluce was appointed project manager without Air Ontario management having considered other candidates or critically discussing the appointment.

With the reorganization of the flight operations department in 1988, there was a formal posting of the position of F-28 chief pilot. Initially, Captain Joseph Deluce was the only applicant for the position. Somewhat surprisingly, he encouraged Captain Erik Hansen, a former Air Ontario Limited pilot with far more experience than Captain Deluce, also to apply for the position. Interviews were conducted of the two candidates by the vice-president of flight operations, James Morrison, the director of flight operations, Robert Nyman, and the vice-president of human resources and corporate affairs, Jack McCann. Captain Joseph Deluce was selected as the chief pilot for the F-28. It is significant that while Joseph Deluce was performing the function of F-28 chief pilot from as early as July 1988,[3] there was no formal posting for the position until August 1988.

---

[3] Thomas Syme in Transcript vol. 99 at p. 148

As the F-28 project manager, Captain Deluce was to coordinate operational and commercial aspects of the plan. In an undated status report written by him in late June or early July 1988 – after approximately one month of F-28 commercial service – Captain Deluce identified a number of F-28 program requirements that had not yet been completed (Exhibit 807). Included among these outstanding items were:

- Air Ontario F-28 training syllabus
- F-28 training manual
- F-28 standard operating procedures manual (SOPs)
- Securing appropriate F-28 spares

As has been noted elsewhere, two of these four items (completing the F-28 SOPs manual and securing appropriate spares), in addition to many others, were in fact still outstanding at the time that Air Ontario discontinued F-28 service, approximately one year later.

In the same status report, the F-28 project manager, Captain Joseph Deluce, pointed to scheduling reliability as the single most important problem with the F-28 program at that early stage. Inexperienced flight crews, low levels of expertise among maintenance personnel, and insufficient spares were identified as causing the reliability problems. To overcome the problems of inexperience and lack of expertise, Captain Deluce suggested that aircraft utilization, which he described as "poor," be significantly increased. He wrote:

> The second important problem with the F-28 is its poor utilization. The F-28 is presently only being scheduled for 1300 hours air time and there are approximately 200 additional hours of air time developed in the charter side of the operation. I can appreciate being reluctant to increase utilization until reliability improves but there should be some definite plans to increase it. The more experience we have operating the aircraft, the faster our learning curve and the more reliable our F-28 operation will become.
>
> Another factor of importance is that our economic analysis was based on much higher utilization and will be severely hampered by lower utilization.
>
> ...
>
> Increased utilization with adequate backup is also an important recommendation. It will speed up both flight crew and maintenance learning process. It will spread our lease costs over more flying and thereby decrease our cost of operations/hour.
>
> (Exhibit 807)

Captain Deluce was suggesting that, if they did not fly the F-28 more, their profit projections would not be realized. Further, he was suggesting that, because there was a lack of experience and expertise on the F-28, they should fly the plane more to gain experience. I find these two suggestions to be very troublesome. One would expect that any financial pressure would come from the commercial side of Air Ontario management, not the operational side. I find it curious that an individual who should have been concentrating on the operational deficiencies in the program, which were numerous, should be so concerned with meeting the company's profit projections for the aircraft. In the normal course one would expect, and rely upon, operational management to advocate conservative operational practice in the face of pressures from the financial side of the organization. In this case, in fact, the roles were reversed: the more conservative judgement of Mr Thomas Syme carried the day and the more restrictive F-28 utilization continued.

I find it ironic that Mr Syme, who had no real operational experience and who personally generated the financial projections for the F-28 acquisition, was directing Captain Joseph Deluce, described as the de facto chief pilot at this point, to take a more cautious and conservative approach to F-28 operations.

It has been demonstrated throughout this part of the Report that, when Captain Deluce was unchecked in his supervision of the F-28 program, pilots were left to determine their own standards and operational practices, and prudence and conservatism were often lost in the pilots' collective enthusiasm to see their first jet operation succeed.

Regulatory Requirements

ANO Series VII, No. 2, section 5, requires that air carriers have qualified managerial personnel employed on a full-time basis in the positions of managing director, director of flight operations, director of maintenance and engineering, chief pilot, and chief maintenance inspector or their equivalent. The ANO does not detail any qualifications for the director of flight operations or the director of maintenance and engineering. Instead, there is simply a statement that the individuals filling these management positions must have qualifications, background, and experience which "are satisfactory to the Director [of Civil Aviation]."[4] There is no further elaboration as to what is a "satisfactory" standard. The role of the director of flight operations is similarly undefined.[5]

Only marginally more helpful are the criteria for chief pilots and chief inspectors of maintenance. These criteria require, in essence, that chief pilots and chief inspectors be licensed to operate or maintain large aircraft, that they have knowledge of the operation of their air carrier,

4 ANO Series VII, No. 2, s. 6(1)

5 Passing reference is made to the director of flight operations position in ANO Series VII, No. 2, section 15, in the context of operational control and flight watch.

and that they have knowledge of their regulatory obligations "necessary for the proper performance of [their] duties." Neither the Air Regulations nor the ANOs specify the role or duties of the chief pilot and chief inspector.

Of the named mandatory managerial positions, the most enigmatic is that of the managing director. This position is undefined, but, given the structure of section 5 of ANO Series VII, No. 2, it can be inferred that the managing director is to perform some sort of senior management supervision of both the maintenance and the flight operations departments. Curiously, the reference in section 5(1)(a) is the only reference in the entire ANO Series VII, No. 2, to the managing director position. There is no definition of the role of the managing director, nor is there a statement of required qualifications. If the regulator is of the view that such a position is to be required of all Canadian air carriers, then the position should be defined in a meaningful way.[6]

Alternatively, if no function or qualification is to be specified for the managing director position, the reference in the ANO to the position should be eliminated. This criticism, though directed at only one example of vagueness in the ANO, is applicable to the entire aviation regulatory regime. Time and again I heard evidence of vague and imprecise regulation which defied meaningful interpretation. Such regulation serves no useful purpose: it provides no assistance to the good faith operator who seeks to understand what the regulator expects of it; and it is similarly unhelpful to the front-line Transport Canada inspector who seeks to monitor air carrier operations and to enforce minimum standards.

I am of the view that the ANO, in its present form, has no meaningful standard by which air carrier management is to be scrutinized and approved. This problem with the ANO was acknowledged by some of the Transport Canada witnesses who appeared before me, including Mr Neale MacGregor, Transport Canada regional manager air carrier operations in Pacific Region. Mr MacGregor testified that, in the absence of precise regulation or direction from Transport Canada headquarters, his group, on its own initiative, began interviewing chief pilot candidates before approving them:

> A. ... I think we need to be tougher with management ... We implemented a system whereby we do reject chief pilots, even though the order doesn't say we can. We do.
>
> Q. Which order are you referring to?

---

[6] The Canadian regulatory regime will be discussed at length in chapter 34, Operating Rules and Legislation.

A. The Air Nav Orders, 2, 3 and 6, that lay out the requirements for chief pilots.

...

A. ... We do have the candidate for chief pilot and operations manager come in. At least two inspectors interview the individual. If I'm present, I also take part. And we also give them an exam and we've rejected quite a few. And I think we have to be tougher in that area.
Q. What characteristics are you –
A. Get responsible people in those positions.
Q. ... What characteristics are you looking for when you interview for chief pilots?
A. Well, I think it has to be a very sound individual, someone who has a good knowledge of aviation and sound practices. Somebody has a backbone not to knuckle under to management in every instance.
We do spell out that it's a job that we are approving. If you foul up, don't ever look for that authority again, no matter what carrier you are with.
We look for a good solid background in aviation and in the individual himself. If he has had violations against him, I don't believe that person should wear a collar forever, but he has to be accounted for. He is accountable.

(Transcript, vol. 141, pp. 78–79)

While Mr MacGregor is to be commended for his initiative in identifying a deficiency in the ANO and attempting to rectify the deficiency by way of internal regional policy, I am of the view that this ad hoc type of solution to the problem of imprecise regulations is altogether undesirable and unacceptable. It is the responsibility of Transport Canada senior management at headquarters, not individual regional managers, to establish regulatory standards of universal application. Without leadership from Transport Canada senior headquarters management, an air carrier operating in good faith would be vulnerable to an unfair application of idiosyncratic standards at the regional level. The acceptability of an individual candidate for chief pilot could, for example, vary greatly from region to region or inspector to inspector.

Transport Canada's standards for the selection of air carrier management are clearly deficient; the method by which Transport Canada applies these standards is equally lacking. Regardless of the deficiencies of ANO Series VII, No. 2, the requirement that the qualifications, background, and experience of management candidates be satisfactory to the director must nevertheless be applied.

Air Ontario described the structure of its flight operations management, and the positions involved, in its Flight Operations Manual, which was submitted for regulatory approval in September 1987, and finally approved in February 1988.[7] In the manual, the duties and responsibilities for the director of flight operations, the chief pilot, and indeed all operational positions – except the vice-president of operations – are defined as per the requirement of the ANO. Presumably, the qualifications of the individuals performing the flight operations management functions were appropriately reviewed by Transport Canada and found to be satisfactory.

Further evidence of a regulatory review of the Air Ontario management is seen in the Air Ontario application to add the F-28 to its operating certificate. The application, dated January 24, 1988, lists four supervisory managers with a notation that their résumés were on file with Transport Canada. Again, because the Air Ontario operating certificate was amended to include the F-28 aircraft in June 1988, presumably the qualifications of the named supervisory managers were scrutinized and found to be acceptable.

Similarly, in November 1988, when Captain Joseph Deluce formally became the F-28 chief pilot, his qualifications were submitted to Transport Canada for review. In this résumé, which was signed by Captain Joseph Deluce and Mr James Morrison, Air Ontario vice-president of flight operations, there is a statement that the chief pilot nominee, Captain Joseph Deluce, is suitable for the duties of chief pilot as laid out in the Air Ontario operations manual and that he meets the requirements set out in schedule A to ANO Series VII, No. 2.

These were the only examples cited at this Inquiry of a Transport Canada review of the management personnel requirements of Part I of ANO Series VII, No. 2.

On the basis of the evidence, I would have to say that there are deficiencies in both the substance of the ANO criteria for management and the method of review and enforcement of the criteria. To reiterate my earlier comments, the ANO Series VII, No. 2, management criteria are deficient because the ANO does not adequately define, in function and qualification, the required management positions.

It is the responsibility of Transport Canada headquarters to promulgate comprehensive, well-defined operational standards, including standards for operational managers.

Mr Syme testified that his principal indicator of the F-28 program being on track was the successful amendment of Air Ontario's operating certificate. Mr Syme's evidence suggests that, for him, the approval of the regulator was the external check he relied upon. Having reviewed the Air Ontario F-28 program and the role of Transport Canada in

---

[7] See chapter 32, Audit Program, for a description of the circumstances surrounding the delay in manual approval.

licensing the F-28 operation, notwithstanding several material deficiencies, I am of the opinion that the reliance of Mr Syme, and indeed the reliance of the travelling public, on Transport Canada to provide an external check and assure a level of safety and integrity of air carrier operation was misplaced.

Findings

Transport Canada's Review of the Air Ontario F-28 Program

- The air carrier certification process is a very important Transport Canada regulatory function which, if properly performed, provides the opportunity for the regulator to interdict, at the approval stage, potential safety problems.

- Transport Canada should have withheld the necessary regulatory approval of the Air Ontario application for amendment of its operating certificate to include the F-28 aircraft until all operational prerequisites were in place at Air Ontario.

- The review by Transport Canada of Air Ontario's application for an amendment of its operating certificate to include the F-28 aircraft was wholly inadequate.

- Some of the material representations made in Air Ontario's application in January 1988 for an amendment to its operating certificate to include the F-28 aircraft were no longer valid in June 1988 when F-28 commercial service commenced. This fact went undetected by Transport Canada.

- The regular inspection and audit functions of Transport Canada should have detected the material discrepancies between what was represented in Air Ontario's application for the operating certificate amendment and that which was actually in place at the air carrier when commercial F-28 service commenced in June 1988 and thereafter.

- Air Navigation Order Series VII, No. 2, does not adequately describe the qualifications, duties, and responsibilities of the mandatory air carrier management positions of managing director, director of flight operations, director of maintenance, chief pilot, and chief inspector.

The treatment of these positions in ANO Series VII, No. 2, is so ill-defined and vague as to provide little meaningful assistance or guidance to either the regulator or the air carrier.

Air Ontario Management Supervision of the F-28 Program

- It was the duty of the Air Ontario senior management to ensure that the implementation and operation of the F-28 program under the direction of Captain Joseph Deluce, as the F-28 project manager, was properly monitored and supervised.

- The senior management of Air Ontario failed to supervise properly and effectively the implementation and operation of the Air Ontario F-28 program under the direction of the F-28 project manager, Captain Joseph Deluce, as it was their duty to do.

- The lack of proper monitoring and supervision of the F-28 program by senior Air Ontario management contributed to the deterioration of that program's operational standards to unacceptable levels.

- Of the senior Air Ontario management personnel who testified, Mr William Deluce, Mr Thomas Syme, Mr James Morrison, Mr Kenneth Bittle, Captain Robert Nyman, and Captain Joseph Deluce were the Air Ontario senior managers principally responsible for the Air Ontario operation in general and the F-28 program specifically.

- As the F-28 project manager and F-28 chief pilot, Captain Joseph Deluce was the manager having direct day-to-day responsibility for the implementation and operation of the F-28 program. The deficiencies noted in the F-28 program reflect poorly upon his performance as the responsible manager.

- The demonstrated deficiencies in the Air Ontario F-28 operation were, at least in part, attributable to the lack of a program manager possessing substantial experience on the F-28 aircraft and to ineffective management of the program.

- The senior management of Air Ontario did not exercise good judgement in allowing the obvious overburdening of its F-28 program manager, Captain Joseph Deluce, with several other onerous and concurrent responsibilities, including those of F-28 chief pilot, F-28 training pilot, F-28 company check pilot, Convair 580 chief pilot, and F-28 line pilot.

- The merit principle was not always the primary criterion for management selection at Air Ontario. It is a compelling inference from the evidence that Mr Bruce Deluce and Mr Joseph Deluce were selected for key Air Ontario management positions, in part because they were members of the family which had a significant ownership interest in the company. Certainly an ownership interest should not disqualify an individual from management positions within an airline; however, the merit principle should be one of the primary hiring criteria.

- The dislocation among both the employee and management groups at Air Ontario, in the period following the merger of Air Ontario Limited and Austin Airways Limited, and the demands upon senior management created by the merging of the two disparate air carrier operations contributed to the poor management and supervision of the F-28 program.

- The lack of senior management supervision of the F-28 program was partially attributable to senior management involvement with other pressing concerns, and partially to an apparent unwillingness or inability on the part of senior Air Ontario management to scrutinize the performance of its F-28 program manager.

- Captain Joseph Deluce, as the F-28 program manager, was as unwilling to accept advice from his management supervisors as they were unwilling or unable to exert any influence over him.

- The F-28 project manager, Captain Joseph Deluce, although clearly a well-intentioned individual, ought to have recognized his own human limitations and not allowed himself to become so overburdened with multiple responsibilities that he became overwhelmed by them, as indeed occurred.

- Air Ontario was not ready in June 1988 to put the F-28 aircraft into service as a public carrier.

RECOMMENDATIONS

It is recommended:

MCR 104 That Transport Canada ensure that Air Navigation Order Series VII, No. 2, section 5, be amended to provide a clear statement of the duties, responsibilities, and qualifications for all air carrier management positions set out therein.

MCR 105 That Transport Canada develop standard criteria for the qualifications of all air carrier management positions set out in Air Navigation Order Series VII, No. 2, section 5. Such criteria should include consideration of the following attributes of the respective management candidates:

- aviation and management experience;
- flying experience;
- professional licences, such as aircraft maintenance engineer or airline transport rating;
- incident and occurrence record;
- knowledge of the *Aeronautics Act*, Air Regulations, and Air Navigation Orders, including air carrier certification requirements and procedures; and
- knowledge of the appropriate air carrier manuals necessary for proper performance of duties and responsibilities.

MCR 106 That Transport Canada ensure that, once standard criteria referred to in MCR 105 are established and published, all air carrier management candidate approvals be subject to such criteria being fully satisfied.

MCR 107 That Transport Canada ensure the ongoing and adequate surveillance and monitoring of new aircraft implementation programs by Canadian air carriers.

MCR 108 That Transport Canada proffer for enactment legislation imposing upon an air carrier concurrent responsibility with the pilot-in-command for the safe and proper crewing, dispatch, and conduct of a flight over which the air carrier exercises any degree of operational control. (The adoption of the United States Federal Aviation Regulation 121 would address this area of concern.)

MCR 109 That Transport Canada ensure that the investigation of any violation of the Air Regulations or Air Navigation Orders committed by an air carrier pilot or an aircraft maintenance engineer include an examination of the air carrier's contribution to the circumstances or environment that may have led to such violation. Where such an investigation reveals that the air carrier's contribution was significant, appropriate and parallel enforcement action should be taken against the air carrier as well as against the individual.

26 THE ROLE OF AIR CANADA: PARENT/SUBSIDIARY IMPLICATIONS

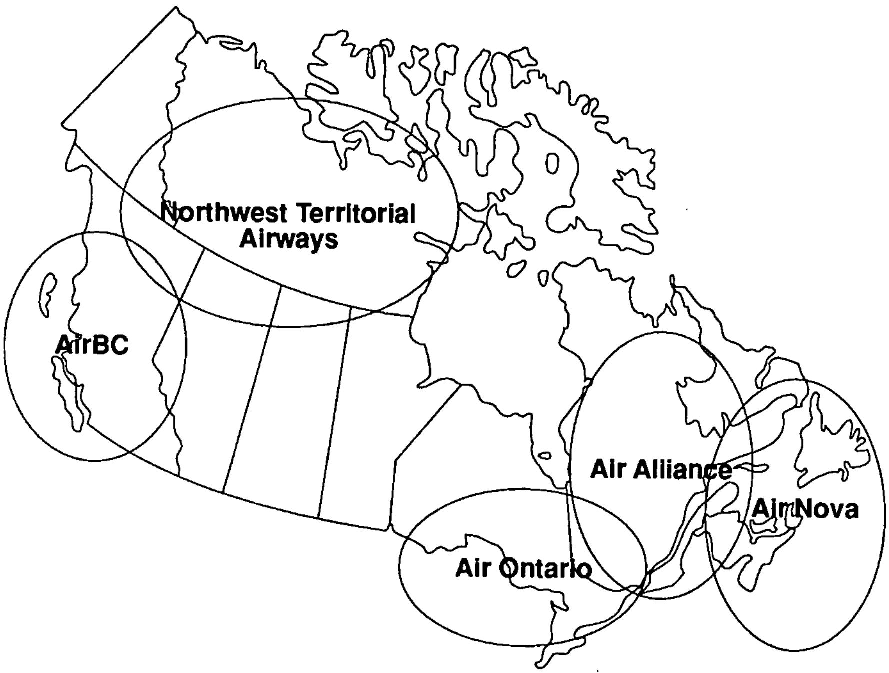
One of the focal points of aviation accident investigative scrutiny is the management of the air carrier under whose operational control the aircraft was being flown at the time of the accident. A proper assessment of the operational environment surrounding the Dryden accident required that the investigation go beyond the management of Air Ontario Inc., the operator immediately involved. A controlling interest in Air Ontario is, and was on March 10, 1989, owned by Air Canada. More significantly, Air Ontario's corporate vision, in large measure, was to serve the competitive requirements of Air Canada which were heightened and refocused by the deregulation of the Canadian airline industry. Further, Air Ontario was marketed as part of Air Canada's transportation network. For these reasons, I felt it necessary to review the respective roles of Air Canada and Air Ontario management as part of a system-failure investigation of the Dryden accident.

Air Canada is Canada's largest airline. According to its 1990 Annual Report, Air Canada's passenger route network offers scheduled service to 24 North American cities. Through its domestic connector carriers, another 57 Canadian communities and 12 cities in the United States are linked to the Air Canada network. Further, 26 cities in Europe and the Caribbean are served by Air Canada. Air Canada holds equity interest, directly or indirectly, in five Canadian regional airlines: AirBC, Northwest Territorial Airways, Air Ontario, Air Alliance, and Air Nova (figure 26-1).

A great deal of evidence was heard about the commercial rationale behind the new Air Canada/Air Ontario parent/subsidiary relationship and how Air Canada management set about marketing Air Ontario as being part of Air Canada's transportation network. The evidence also revealed that these initiatives were not in any way directed towards verifying and monitoring the operational procedures and flight safety standards of its new subsidiary. On the contrary, Air Canada deliberately maintained its corporate distance from the operational end of Air Ontario.

Air Canada's lack of involvement in the operational end of Air Ontario allowed Air Ontario to operate, in some instances, to lower

Figure 26-1 Air Canada Connector Carriers



levels of flight safety than those existing within Air Canada, notwithstanding the significant amount of marketing energy expended to convince the travelling public otherwise. The evidence regarding these different safety levels therefore raises the question whether Air Canada, as a licensed air carrier having a majority interest in and effective control of a feeder airline, and marketing the feeder airline as part of its own system, had any obligation to take a more active role with Air Ontario operations.

I would stress that my reference to the term "obligation" is not to any specific regulatory or legal obligation on the part of Air Canada to assume responsibility for Air Ontario's operational procedures. Despite Air Canada's majority interest, the fact is that Air Ontario operated as a distinct legal entity under its own operating certificate. Similarly, Air Ontario's relationship with the regulator was direct and independent of Air Canada. My reference is, rather, to an obligation based on common sense and corporate integrity. I must say I found it neither sensible nor forthright that Air Canada expended virtually none of its operational expertise on Air Ontario's operations while portraying that operation to the public as part of its own.

Particularly offensive to this sense of obligation, and specifically related to this Inquiry, was the lack of application of Air Canada's extensive expertise in scheduled jet transport operations to the fledgling Air Ontario F-28 program. The evidence disclosed that Air Ontario's management had virtually no experience in this type of operation, a fact of which Air Canada was or should have been aware.

Air Canada management witnesses offered explanations for this lack of operational involvement that were founded on a variety of internal corporate concerns. I have no reason to question either the sincerity of the explanations or the legitimacy of the concerns. However, I did find them at odds with Air Canada's professed commitment to the primacy of flight safety, as expressed in the following excerpt from the evidence of Mr William Rowe, an Air Canada vice-president and representative on Air Ontario's board of directors:

> A. ... You must understand, Counsel, and I'm sure you do, that the reputation for safety and concern for safety is paramount in the operation of an airline. There is no permissiveness in that regard.
>
> (Transcript, vol. 121, p. 108)

How the professed concern for flight safety appears to have become inappropriately subordinated to other corporate ends is addressed in this chapter. A full understanding requires a review of the options that were open to the management of Air Canada at the time of the deregulation of the airline industry and of the choices that were taken. The testimony surrounding the corporate decisions taken by Air Canada vis-à-vis Air Ontario also contains, in my view, an interesting chapter of Canadian aviation history.

The Coming of Deregulation

By the early 1980s it was becoming clear to the management of Air Canada and other carriers that the Canadian government was contemplating the adoption of a policy that would largely deregulate the Canadian airline industry. As a result of observation of the prior United States experience with deregulation it was also clear that, once implemented, any such policy would significantly affect the industry's commercial and operational parameters and, in turn, the competitive position of Air Canada and other carriers.

While endorsed by Air Canada, deregulation, introduced by the Canadian government in 1985, would require hard management decisions to maintain and perhaps enhance the corporation's share of the Canadian market in competition with this country's other major carriers. As stated, my present concern is with the effect of these management decisions, made to satisfy new competitive demands, on operational aspects of the commercial air transportation system.

An important point to note at the outset is that the policy of deregulation was to apply only to the commercial or "marketplace" side of the industry and not to the operational side. Transport Canada was to maintain its regulatory responsibility over the safety of air transportation. That is, the licensing of pilots and aircraft maintenance engineers, the granting of operating certificates, the certification of aircraft types, and all of the traditional safety-related functions of the regulators were to remain the responsibility of Transport Canada. It was, in short, the government's intention that safety obligations were not to be compromised under the new policy (see chapter 29, Economic Deregulation and Deficit Reduction).

To what degree was this non-compromise of safety possible within the new regime? More precisely, was it realistic to expect that when the commercial side of a heavily regulated industry was detached from the overall regulatory framework, the still-regulated operational side would remain unaffected? To put this question into context, a brief description of the operation of the old commercially regulated regime and the forces acting for change follows.

The Regulated versus the Deregulated Aviation Industry

In the commercially regulated regime that existed prior to 1985, it was generally felt that, along with the application of operational regulations and constraints on carriers, the regulators should grant to the carriers a degree of monopoly protection to ensure a more stable marketplace within the airline industry. The principal method by which this protection could be assured was by granting a measure of exclusivity of operation over licensed routes or markets. In turn, the principal method of assuring exclusivity was by putting strictures on access to these markets by would-be competitors.

Prior to deregulation in Canada, carriers wishing to compete with an existing licence holder for the right to provide a commercial air service on a particular route could apply to the regulator for a licence to do so. However, the applicant would be under an onus to prove to the commercial regulators that its proposed service met the test of "public convenience and necessity" in order to be granted a licence. Needless to say, any existing licence holder for the same service could oppose such applications, which, in turn, often meant lengthy and expensive regulatory hearings. The vigour of the opposition to new licence applications was generally commensurate with the profitability of the service in question. Indeed, a more expeditious method of establishing or expanding a commercial air service was simply to purchase the carrier already holding the desired licences.[1]

Mr Rowe described how a route came to be serviced under the old system:

> A. Well, under a regulated environment, one has to apply for a licence to fly a particular route, that is, between pairs of cities or multiple pairs, as the case might be.
>
> That was regulated by a transport commission in Ottawa, to which one applied. One had to show the need for, demonstrate the need for, the service itself and your ability to actually take the service on.
>
> Often, this took quite a political-type role, because the communities themselves had a vested interest in the service. If there was no service previously, obviously, there would be quite strong pressures by those communities to get a service and, hence, a very strong support. If there was existing service there, there might be some opposition because of worries of diminishing the existing carriers' service, if it was deemed to be satisfactory by the communities themselves.
>
> So there was quite a play – interplay, both on the commercial side, that is, looking at the viability of the routes themselves, as well as considerable political pressure by both community – by the communities involved.
>
> (Transcript, vol. 121, pp. 15–16)

In a regulated environment an objective of carriers is to ensure marketplace stability on the economically attractive routes. An objective of the regulator is to provide adequate routes for smaller communities.

Smaller communities, even in a regime of regulated fares, often did not provide adequate "load factors" to make them economically attractive to larger carriers like Air Canada. This load-factor problem intensified proportionately as larger jet aircraft were forced to compete with smaller commuter aircraft. To the political leaders in these smaller communities, however, adequate air transportation service was viewed as essential to economic growth and, consequently, they would apply pressure to achieve it. As might by expected, adequate service became

[1] As can be seen in chapter 13, Corporate History, this was the method chosen by the Deluce family to transform their original holdings in White River Air Services to the largest air transportation network in Northern Ontario.

synonymous with jet service – and, ideally, from the community point of view, Air Canada jet service. Mr Rowe explained the problem:

> A. It became apparent about this time that there was increasing pressure by a number of communities for service ... airline service, for economic development. It became almost a tenet of economic development that airline service was an absolute essential ingredient.
>
> Simultaneous with that, the ... use of larger aircraft precluded frequency of service to an area, because you were using a large aircraft on a very small population base, and, hence, at one time when we may have had seven services to a particular spot with a smaller aircraft, as that aircraft was phased out and larger ones phased in, the service frequency fell quite markedly.
>
> It also became, of course, more expensive on shorter-haul routes to use larger aircraft and jet aircraft, in particular. And, simultaneously, there was this ... pressure for economic development, with the airline being the ingredient itself.
>
> (Transcript, vol. 121, pp. 24–25)

This sensitivity to the jet bias of smaller communities carried over after the inception of deregulation and became a competitive factor, as in the marketing considerations behind the choice by Air Ontario of the F-28. Mr Thomas Syme, chief operating officer of Air Ontario, was asked to expand on the considerations contained in the F-28 acquisition proposal:

> Q. "In addition, acquisition of F-28 aircraft by Air Ontario presents certain longer-term benefits to Air Canada in its route rationalization efforts. Air Canada's reduction in frequency or even eventual withdrawal from certain markets in Ontario would be far more palatable in both a commercial and political sense if Air Ontario could offer a mixed jet/turboprop replacement service."
> Could you elaborate upon that particular aspect of the acquisition proposal for us?
>
> A. I guess the underlying issue there is that at that time, there existed a ... a fairly strong bias in the market-place for jet equipment over turboprop equipment. And ... the statement just reflects that.
>
> Q. In particular, what is meant by political sense? What are the political considerations?
>
> A. The airline industry seems to be one that attracts a lot of political attention. And as Air Canada pulled out of markets in northern Ontario, that was of great interest to the local politicians.

> And one of the issues that they raised was the loss of jet service, and what is being suggested here, that if we are able to offer alternate jet service, that that will thereby reduce the political sensitivity.
>
> (Transcript, vol. 98, pp. 135–36)

In the regulated environment, when the servicing of marginal markets with existing equipment proved to be an economic strain on Air Canada, a process of "cross-subsidization" was employed. Mr Rowe explained:

> Q. ... Was there any kind of subsidy given to Air Canada under the old regulated environment if indeed the politicians deemed that a flight from Sudbury to Toronto was necessary?
>
> A. No, not that I'm aware of, Counsel. There was a formula – or I shouldn't use the word "formula." There was a methodology of cross-subsidization. In other words, carriers, trunk carriers, such as ourselves, were granted either exclusivity or rights with some limitations to rather lucrative routes, and it was generally expected that we would use ... the proceeds from those routes to cross-subsidize less economic routes.
>
> And it was a principle, I suppose, which the airline industry grew up in a regulated environment. It was one of the principles of regulated environment, cross-subsidization.
>
> (Transcript, vol. 121, pp. 19–20)

By the decade of the 1980s this degree of commercial regulation was widely viewed as being economically counter-productive and archaic in a mature industry. By adopting the policy of deregulation, the government hoped to achieve an efficient allocation of resources within the airline industry through the mechanism of a more unfettered marketplace. The expectation was that increased competition would result in lower fares for the travelling public. One of the principal means employed to achieve this end was to reduce the regulatory constraints on carriers that wanted to establish a commercial air service.

Under the new policy, instead of the former requirement to establish "public convenience and necessity," an applicant seeking to operate a commercial air service had only to show that the carrier was "fit, willing and able" to service a particular market. In essence, a carrier was now to establish to the satisfaction of Transport Canada that it was properly insured and could operate safely. From a number of perspectives, deregulation was going to represent a substantial change in the airline industry.

The Impact of Deregulation

Existing airlines, large and small, were faced with the prospect of altering their operating and marketing strategies significantly in order to accommodate the change from a regulated to a deregulated marketplace.

Two features of the new commercial environment had an impact on Air Canada. First, its relatively large equipment and high unit labour costs would result in some of its already marginally economic routes to smaller communities becoming even less tenable. With open access and unregulated fares now available on the economically attractive routes, Air Canada's ability to maintain the level of profitability it had enjoyed under the protection of a regulated environment was in doubt. Without these protected proceeds from the more lucrative routes, the ability to provide cross-subsidization to less profitable routes would similarly be gone. These routes would be lost to smaller carriers, which could now compete openly and, with smaller equipment, could accommodate the lower, now unsubsidized, load factors.

At the heart of this competitive advantage enjoyed by the newer carriers was their ability to offer more frequent service to less populous markets through the use of smaller equipment. With fewer seats, the smaller aircraft could operate closer to capacity more often than the larger Air Canada jets.

In the world of airline marketing, according to Mr Rowe, "frequency always wins." His evidence on the topic was helpful in understanding the trunk airline's dilemma:

> A. ... Certainly the advent of additional competition on prime routes, the ... larger and more expensive aircraft entering the fleet, made it quite evident that frequency of service to smaller communities simply could not be provided by carriers the size of Air Canada and would be probably ... even less so in the future. So we had to start laying the groundwork for what we perceived to be and the industry perceived to be an evolving picture, and in a very drastically changing environment.
>
> ...
>
> ... the prime ingredient of commercial viability in the airline business is frequency of flights and frequency has to be a function of size of population, things of that nature, and size of aircraft, and it was apparent that to serve smaller centres with any decent frequency, one had to have smaller aircraft.
>
> (Transcript, vol. 121, pp. 37–38)

The loss of these smaller markets may have been acceptable to Air Canada had they represented intraregional traffic only. However, many of the passengers on these smaller or "spoke" routes were potential connecting or "feed" traffic to Air Canada's trunk routes out of "hub" airports such as Toronto's Lester B. Pearson International Airport.

This connecting traffic was considered essential to the economic health of Air Canada. The incorporation of regional feed traffic into Air

Canada's overall route structure represented the second and by far the most significant area of management concern resulting from deregulation. Accordingly, management set about devising the means to ensure that the feed came Air Canada's way and not to competing trunk carriers (see figure 26-2).

Control of the Feed

Air Canada's dilemma at the advent of deregulation can be described as follows. On the one hand it could not economically operate its relatively large jet equipment in the smaller, low load-factor routes with sufficient frequency to remain competitive with carriers using smaller, usually turboprop, aircraft. On the other hand, if it left these routes to the smaller operators, there was the distinct possibility that in the now deregulated environment it would lose essential connecting traffic from these markets to another trunk carrier.

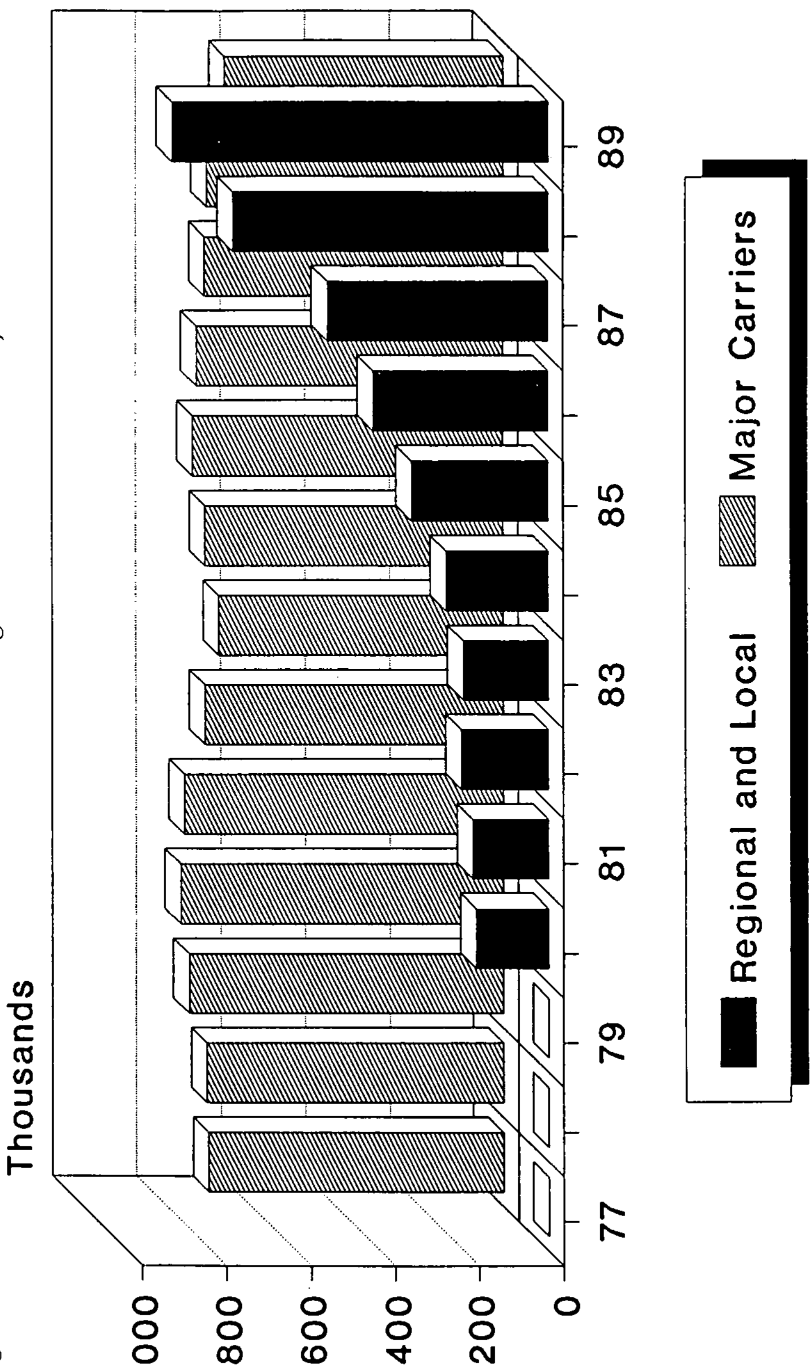
With the advent of a deregulated commercial marketplace, both trunk and regional carriers were free to enter and compete on all routes with relative ease. Further, extended possibilities for commercial arrangements between the two types of carriers became available. In the context of regional markets, the abandonment of regulation meant that a trunk carrier could capture the feed traffic of a particular region either by operating its own aircraft on less travelled routes or, more likely, by gaining control of a regional carrier already serving these markets.

Given the necessity of feed control, Air Canada could not allow regional carriers to fall under the control of rival trunk airlines. By one means or another, sufficient regional connecting traffic across the country would have to come under Air Canada's control. The Ontario Region, given its large population base, would naturally become the object of considerable interest in this regard.

The problem of controlling the flow of feed traffic from marginally economic markets did not suddenly arise for Air Canada because of deregulation. It existed in the regulated environment, but was then capable of easier resolution. Air Canada had previously dealt with feed control in southern Ontario, for example, by entering into a commercial agreement, in 1975, with Great Lakes Airlines, a predecessor corporation to Air Ontario (see chapter 13, Corporate History).

Great Lakes Airlines was a regional carrier that had licences to serve regional markets out of its base in London. One of Great Lakes's main

Figure 26-2 Historical Air Carrier Aircraft Movements, Regional/Local versus Major Carriers



Source: Transport Canada: Aviation Forecasts 1990–2003 routes was London, Ontario, to Toronto, a route flown by many connecting passengers to Toronto, but one that Air Canada could not economically serve with its larger equipment. As the evidence disclosed, the objective of Air Canada's commercial agreement with Great Lakes Airlines was the same as that which followed deregulation: to ensure by means of through-ticketing, coordinated connections, and ease of transfer that connecting passengers from Great Lakes were carried onwards from Toronto by Air Canada. The commitment of the trunk carrier, however, was quite different from that required after deregulation.

The 1975 arrangement between Air Canada and Great Lakes Airlines consisted of a straightforward interline agreement between the parties with no equity participation. The limited flexibility of regional carriers within a regulated environment meant that their "loyalty" to the trunk could in large measure be secured through a simple interline agreement, without the necessity of actual equity involvement. Given the degree of route monopoly prevalent in the regulated environment, there was little fear of overbidding or concern that one party would rescind the agreement. This being the case, the trunk carriers would naturally opt for a commercial arrangement with the regional carrier that allowed the trunk carrier to secure the commercial objective of feed control without requiring any financial outlay to secure an equity position.

This method of feed control by trunk airlines, employing simple contractual or non-equity relationships with regional carriers, became more precarious after deregulation. The pre-deregulation absence of equity involvement on the part of the trunk carriers is the essential difference between the trunk/regional arrangements entered into before deregulation and those consummated after. As Mr Rowe explained:

> A. ... we followed common practice in the United States or that had evolved in the United States earlier, and that was entering into contractual agreements with carriers that were very, very much tighter and more definitive than heretofore, and covering a wider variety of services. As a matter of fact, covering, for example, all ground handling services, things of that nature, trying to tie the smaller carrier very closely in with us.
>
> Also following experience in the United States, exploring the possibility of equity investment in the carriers, again to exert commercial control.
>
> (Transcript, vol. 121, pp. 36–37)

Mr Rowe summarized the rationale for equity participation by the trunk carriers as follows:

> A. For control of the company and to ensure that a company didn't change its allegiance, as happened numerous times in the United

> States. That's how the equity program evolved in the industry in total, not just in Canada.
>
> (Transcript, vol. 121, p. 41)

Air Canada faced a dilemma with respect to feed control at the advent of deregulation. Because the simple interline agreement had become too problematic a device, there were two possible options. First, Air Canada could purchase its own smaller commuter aircraft to service the low volume routes instead of using its existing fleet of large aircraft. Second, it could purchase an equity interest in an existing regional carrier already providing service with appropriate equipment on feeder routes.

Mr Rowe expanded on the relative merits of these two options. While Air Canada could have bought and operated its own feeder aircraft, there were "pros and cons" to such a decision:

> A. The pros and cons were firstly, the cost of the capital involved to do that. It's always nicer to share that cost with someone else, and that was one of the prime reasons.
>
> A second reason was that we would have absolutely imposed our own style and hierarchy and bureaucracy of a very large company upon a smaller situation, and would virtually have reverted to what we had seen previously, an era we had to withdraw from when we simply couldn't afford to operate some routes because of our own cost and operating style.
>
> So it was deemed to be much more efficient to go to a different scale. It's a scale thing, I think.
>
> (Transcript, vol. 121, p. 43)

With the "cons" thus outweighing the "pros" with regard to the first option, Air Canada was left with the second option of securing equity interests in existing regional carriers, and it set about to purchase those interests where available. Such purchases within the heavily populated regions of Ontario loomed as an absolutely essential aspect of Air Canada's feed control program.

In Ontario, at the inception of deregulation, the bulk of the potential connecting traffic within the province was carried by the two predecessor corporations of Air Ontario Inc., Austin Airways and Air Ontario Limited. This fact made control of these two regional carriers vitally important to the competitive positions of the Canadian trunk carriers. It also put the owners of Austin Airways and Air Ontario Limited in an extremely favourable bargaining position.

Air Canada, having settled on the strategy of gaining equity participation in existing regional carriers, was faced with an additional issue that required further Air Canada management consideration: whether to acquire a non-controlling or minority shareholding position in the targeted regional carriers or to purchase a majority interest.[2] Eventually, through some intermediate steps detailed in chapter 13, Corporate History, Air Canada came to own a controlling 75 per cent interest in voting stock of Air Ontario, with the Deluce family owning the minority 25 per cent interest. In addition, Air Canada obtained a substantial number of non-voting Air Ontario preference shares, which resulted in the trunk carrier owning more than 90 per cent of the total equity of its feeder.

The rationale behind Air Canada's decision to purchase a majority interest in Air Ontario eventually determined the commercial and operational relationship in the new parent/subsidiary arrangement. More particularly, it influenced the degree of involvement by Air Canada in the affairs of Air Ontario.

As the evidence disclosed, there was significant involvement by Air Canada on the commercial side of its new regional subsidiary, Air Ontario, and virtually none on the operational side. The evidence also disclosed that this lack of operational involvement by Air Canada, combined with the increased demands of the new trunk/feed relationship, may have had a detrimental effect on the safety of Air Ontario operations. Air Canada's rationale for its non-involvement in the operational aspects of its subsidiary was grounded in concerns related to its now majority ownership of Air Ontario. These concerns were explored during the course of the hearings of this Inquiry.

Minority versus Majority Equity Interest

To the major carriers, there were pitfalls in having either a majority or a minority ownership stake in regional carriers. Mr Rowe offered the following explanation of the negative aspects of a minority position and why Air Canada opted for a majority position in Air Ontario:

> Q. ... Could you tell the Commissioner why this change in thinking between a minority and a majority interest, equity interest?
>
> A. With a minority interest, one is always subject, of course, to the whim of the majority holder. Over time, this proved to be less satisfactory to the larger carrier, simply because in the deregulated environment, there was this freedom to move, freedom to do whatever one wished to do.

---

[2] As explained in chapter 13, Corporate History, early in 1986 Air Canada and Pacific Western Airlines, had each purchased a minority interest of 24.5 per cent in Air Ontario Limited. This gave the two major carriers a 49 per cent interest in Air Ontario Limited, with the remaining 51 per cent under the control of Delplax Holdings, a corporation in turn owned equally between some Deluce family members and Mr James Plaxton.

> In many cases, the larger carrier would want the smaller carrier to operate within a defined area for economic reasons more than anything else, and also, for the reasons that expansion required capital, increasing amounts of capital, because the newer aircraft, even though they were small, were getting increasingly expensive.
>
> (Transcript, vol. 121, pp. 41–42)

In short, Air Canada wanted to have a strong influence upon the growth ambitions of its feeder in order to protect its own interest.

Despite the seemingly overriding advantages to majority control in a deregulated marketplace, there was one significant potential drawback, which, if realized, could put the trunk carrier back into a similarly untenable economic position with regard to smaller routes than it had faced prior to deregulation. This drawback lay in the area of employment law and the prospect of having Air Canada's unionized, high-unit labour costs and working conditions imposed on Air Ontario because of the new ownership structure. It was referred to throughout the evidence as the "common employer" issue and centred around an application, by the unions involved, to the Canada Labour Relations Board for a common employer declaration. Mr Rowe verified that this issue was a concern for Air Canada:

> Q. Mr Syme [chief operating officer for Air Ontario Inc.], in his testimony, mentioned that there were advantages to a minority relationship in that it was a method whereby a common employment application may not be successful in that there was only a minority interest.
>
> Do you recall that being a concern or a consideration on the minority versus majority aspect?
>
> A. Yes, it was.
>
> (Transcript, vol. 121, pp. 47–48)

Once Air Canada's majority ownership of Air Ontario became a fact, however, the common employer issue had to be faced by Air Canada, and strategies were developed to deal with it.

Implications of Common Employment

Collective bargaining agents dealing with employers with shared ownership (typically parent/subsidiary relationships), who believe the employers to be under "common control or direction," can apply to a labour relations tribunal having jurisdiction for a declaration that they constitute a single employer for the purposes of collective bargaining. The essential test to establish common employment is common direction and control of the employers. The appropriate tribunal in the case of Air

Ontario and Air Canada, both being federal works, undertakings, or businesses, was the Canada Labour Relations Board (CLRB).

Such applications can be launched by any trade union representing employees within the corporations and, if successful, the decision may apply to all other bargaining units. In fact, such an application was launched by one of the certified bargaining units, the International Association of Machinists and Aerospace Workers (IAM), in September 1987, shortly after the merger of Austin Airways and Air Ontario Limited to form Air Ontario Inc. as "controlled" by Air Canada.[3]

After IAM launched the application, "one of the paramount considerations" of Air Canada management, to quote Mr Rowe, was the possibility that the CLRB might make a single-employer declaration if there was sufficient evidence of day-to-day control and direction over the operations of Air Ontario by Air Canada (Transcript, vol. 118, p. 50). In proceedings before the CLRB, Air Ontario argued in opposition to the IAM application that, despite its majority ownership, Air Canada had no day-to-day involvement at Air Ontario.[4]

It appears that the single-employer problem was also a consideration behind the seeming reluctance of Air Canada's flight operations department to do an operational review of Air Ontario after the 1987 purchase and merger. This operational review by Air Canada did not occur until well after the Dryden crash, in the fall of 1989. Captain Charles Simpson, vice-president of Air Canada flight operations, was questioned on this delay:

> Q. ... Sir, would you comment on one point: Was the apprehension of having a common employer application before the Canada Labour Relations Board a factor which gravitated against an early flight operations review being conducted?
>
> A. I would give a qualified "yes" to that. Certainly, in the very beginning, when we were very new in the connector business and there ... was talk of the common employer status case, we were proceeding slowly ... it wasn't so much we couldn't do an operational review as ... we did not want to become involved in their work. They were an independent airline, they were operat-

---

3 The application in fact did not succeed: CLRB decision no. 771, December 29, 1989. The board in essence held that the tests for common employer were made out; however, it did not exercise its discretion to issue the common employer declaration. It so held on the grounds that bargaining rights had not been, nor were they likely to be, affected by the status quo.

4 CLRB decision no. 771, p. 26: counsel for Air Ontario, to quote from the board's decision, argued that "Potential control should not be viewed as actual control and that, in fact, there was no working relationship between Air Canada and Air Ontario except for the commercial agreements."

> ing independent of Air Canada, and we did not want to confuse that issue.
>
> But, certainly, in the first few months, we were not gearing up to do a review, one of the reasons being the common employer status case was being pursued.
>
> (Transcript, vol. 118, p. 168)

Mr Rowe offered an additional explanation for this managerial distance – to give the management of the newly created Air Ontario Inc. more flexibility to make decisions, unfettered by what he described as the Air Canada bureaucracy. I found this explanation, although plausible, to be somewhat disingenuous and obviously secondary to the "paramount" concern about common employment.

Air Canada's common employment concern was in fact well grounded in light of the economics of a deregulated airline industry. As already stated, Air Canada was faced, under deregulation, with the necessity of operating its feeder routes at a lower-unit labour cost in order for these routes to be economically viable. The fear was that this would not be possible should Air Canada's wage structure and working conditions be imposed on Air Ontario, since this would simply reintroduce marginal economics to these routes, much as was the case on the eve of deregulation.

Mr Rowe explained that feeder routes such as Sudbury–Toronto, if made less viable economically because of extra costs, would fall prey to the new "deregulation" competitors. Thus, Air Canada would not only face the same dilemma as at the outset of deregulation – namely, losing the "Sudbury" feed – it would now have no method of regaining it economically.

The competitive position of carriers under deregulation was affected beyond the direct imposition of higher wages through collective bargaining. The unit labour cost was also being affected by the concomitant imposition of more narrowly defined working conditions on employee groups. This problem manifested itself in the Northern Ontario (Austin Airways) operations that became incorporated into the merged Air Ontario Inc. route network and eventually led to the divestment of these operations (see chapter 13, Corporate History). In that case, both Air Canada and Air Ontario management perceived that once the working conditions of the Air Ontario collective agreement were imposed on the old Austin route structure, those routes could no longer be operated economically. They saw, for example, that once the loading and unloading of aircraft and other "bush" activities fell outside of the pilot's new scope of employment, the cost of supplementing the labour force to do that work would render the operation unviable. This diminished profitability would in turn result in these routes falling prey to the now unimpeded competition. As Mr Rowe put it:

> A. ... At the time of the organizing, a delineation of duties took place, and the multiple duties that the pilots once had were not carried forward any further. They had refused to continue in that line.
>
> ... that whole cost structure was now going to be eroded by virtue of the union contract and the ... results of the merger, and be attacked from a competitive position of much less expensive operators and smaller entities.
>
> We then decided that it would be best to divest ourselves of the routes of Austin as much as possible, while they ... still had value, and while there was a buyer available for them.
>
> (Transcript, vol. 121, p. 149)

A fascinating sidelight involving the economics of deregulation is the process by which the traffic from these former, now uneconomic, Austin routes came to be regarded as potential feed to Air Ontario. As was the case with the original Air Canada/Great Lakes arrangement in 1975, commercial agreements were entered into between Air Ontario and the purchasers of these northern routes, with the same lack of equity involvement. This cascading method of feed control was described by Mr Rowe, using the example of the sale in late 1988 by Air Ontario to Bearskin Airlines, a Northern Ontario operator, of the Pickle Lake to Thunder Bay route:

> A. It was hoped under this scheme or the plan that Air Ontario would enter into agreements with some of the successor carriers that would guarantee the continuance of feed to Air Canada, which incidentally was quite minimal from many of these areas, and where opportunity existed, for continuance of feed from these areas to Air Ontario.
>
> Q. And how was this Pickle Lake to Thunder Bay feed captured or ... what was the thrust?
>
> A. Oh, eventually, it worked out for the instance you mention that there was a formal commercial agreement between Air Ontario and Bearskin Airlines.
>
> Q. I see, and was there ever any equity interest taken by Air Ontario in Bearskin?
>
> A. No.
>
> (Transcript, vol. 121, p. 153)

Air Canada's lack of operational commitment to the Air Ontario operation resulted in a lower level of flight safety being available to Air Ontario passengers than that available to Air Canada passengers. On the commercial side, however, full advantage was taken by Air Canada of the new parent/subsidiary relationship to increase its market share. The evidence before me shows that Air Canada operates at a significantly higher level of safety than that required by Transport Canada; Transport Canada regulatory standards represent the threshold level of operational safety. Air Canada management, while imposing on Air Ontario its own high marketing standards, required Air Ontario only to comply with Transport Canada's threshold operational safety standards. The evidence is overwhelming that the joint Air Ontario/Air Canada initiatives in the marketing of Air Ontario service to the public were designed to create the public impression that the Air Ontario operation was in fact an Air Canada operation. The average air traveller would be completely unaware of the double standard applied by Air Canada in the area of operational safety. These factual circumstances raise the question of what obligation, if any, does a licensed air carrier, holding a majority interest in a regional feeder airline, have to the air travelling public? This question and the Air Canada/Air Ontario relationship are addressed in greater detail later in this chapter. This double standard of safety arose, I find, in part from Air Canada's concern with common employment. I shall now deal with Air Canada's inappropriate lack of operational involvement with Air Ontario, given its emphasis on and attention to common marketing.

The Commercial Relationship

Under deregulation, marketing strategies became not merely a matter of maintaining control over potential connecting passengers but of competing for them. To this end, Air Canada engaged in a marketing strategy to portray to passengers a close identity between itself and its new subsidiary airlines: in essence, that to fly Air Ontario was to fly Air Canada.

This intention is set out clearly in the recitals to the commercial agreement, entered into in January 1987, governing the relationship between Air Canada and Air Ontario.[5] The recital in question was put to Mr Rowe:

> Q. ... "AND WHEREAS Air Canada and Austin (being Air Ontario) wish to establish a consistent image for Air Canada connectors

[5] Exhibit 783. As explained in chapter 13, Corporate History, Air Canada purchased Austin Airways in late 1986 and was by that time a minority owner of Air Ontario Limited. Austin and Air Ontario Limited were merged to form Air Ontario Inc. in June 1987. The commercial agreement of January 1987 was originally entered into between Air Canada and Austin Airways. The agreement survived the merger of Air Ontario Limited and Austin, and governed the commercial relationship between Air Canada and Air Ontario Inc. from the merger onwards. Accordingly, references to Austin Airways have been substituted by Air Ontario.

in order that a homogeneous products can be delivered to air travel customers in Canada."

Could you describe for the Commissioner what you took to be the meaning of homogeneous product?

A. We wished the product, Your Honour, to be as similar to that experienced on Air Canada as possible, given the limitations of the aircraft involved and the communities being served.

(Transcript, vol. 121, pp. 161–62)

This expression of intent was given force throughout the commercial agreement and resulted in a far deeper integration between the companies than in any previous arrangement.

The lengths to which the two parties went to indicate to the travelling public this degree of integration can be seen throughout the agreement. Several items were directly related to the public perception of the two carriers.

Common Livery

The colour scheme of Air Ontario was to match that of Air Canada and the term "Air Ontario–Air Canada Connector" was to be displayed along with an agreed-on logo.

Interiors

Seat material and carpeting were to be provided by Air Canada and were to be "similar to Air Canada hospitality class."

Use of Air Canada's AC Designator

Air Ontario was granted the right to use the AC designator beside its flight numbers. Mr Rowe explained the significance of this practice, known as "code-sharing," particularly in the connector airline area:

Q. Now, I take it the AC or the company's designator is a rather important proprietary item?

A. That's correct.

Q. And could you explain for the Commissioner the significance of giving this over to the connector, Air Ontario?

A. Your Honour, in the airline industry, there developed a ... marketing practice of the use of the company's designator on carriers other than its own, from a marketing point of view, to simply enhance the reach of the marketing of that carrier into areas it did not serve.

...

In the connector area, it identifies that carrier closely with Air Canada. And since we are providing services, customer services such as check-in, telephone numbers for reservations, et cetera,

> it becomes a ready identification for the public to know where to go.
>
> (Transcript, vol. 121, pp. 170–71)

Standards of Service

Air Canada was obliged to develop minimum standards for inflight service, customer service, and passenger and baggage handling for Air Ontario.

Timetables

Air Ontario flights were to be included in Air Canada's published timetable, both those connecting to Air Canada and those served by the two carriers. The importance to Air Ontario of this practice was expressed by Mr Rowe as being "absolutely vital":

> A. It's vital, absolutely vital, to them.
> Q. Just explain that, please.
> A. Well ... you must have your product distributed as widely as possible, and this is to be associated with a major carrier who has a wide distribution network. It's absolutely essential to be included in his network.
>
> (Transcript, vol. 121, p. 176)

Needless to say, once Air Ontario's flights were included in the Air Canada timetable there was heightened concern about Air Ontario's on-time performance. If this was poor it would have reflected badly not only on the parent corporation but on the entire parent/feeder network as well, and the evidence disclosed that there were daily conferences between the operational control centres of the two corporations regarding scheduling and on-time performance.

Computer Services

Air Canada's computer reservation services were to be shared by Air Ontario, and the complete Air Ontario schedule was to be included. Air Ontario flights were to be treated as equivalent to those of Air Canada for purposes of display on all computer reservation terminal (CRT) screens. Mr Rowe described the commercial importance of this arrangement:

> A. Well, Your Honour, it's all part of the electronic distribution network that is so essential for the airline industry in the sale of its products. To be listed in the carrier's electronic distribution system allows access by all travel agents and other sellers of the product to know of your product and be able to access the inventory.

> Also, the sets provide other ancillary services that may be useful to the carrier in the managing of its entity.
>
> (Transcript, vol. 121, pp. 176–77)

As to the importance of equivalency of CRT display, Mr Rowe stated:

> A. Your Honour, I would ask you to recall my earlier mentioning of services to smaller communities wherein we might provide two flights a day and the connector carrier provide many others.
>
> This would allow a proper sequencing of flights so that the customer would get a display by hour of day instead of by carrier and, hence, be of better service to that customer in selecting the type of service they need.
>
> (Transcript, vol. 121, pp. 177–78)

Telephone Answering

Air Canada was to provide Air Ontario customers with the same telephone answering services as for its own customers. The phone was to be answered "Air Ontario – Air Canada Connector" for the purposes of flight bookings. In fact this answering method never came to pass and the telephone calls to Air Ontario were answered simply with "Air Canada."

Ticketing

Air Canada was to provide ticketing services for Air Ontario customers and the tickets were to be issued on Air Canada stock. Mr Rowe testified that the intention of this provision at the time of the writing of the contract was identification between the carriers. The relevance of the provision lessened with the introduction of standardized International Airline Transport Association ticket stock, which came to replace the old Air Canada stock.

Ground Handling

At points served by both carriers, ground handling was to be done by Air Canada. Air Canada agreed it would endeavour to ensure that Air Ontario's passengers, cargo, crews, and baggage received the same treatment as Air Canada's.

Aircraft Services

Under the commercial agreement, Air Canada, in keeping with the spirit of providing to Air Ontario passengers equivalency of service, agreed to provide a number of ground-handling services at stations where Air Canada had facilities. This extended to items such as allowing Air Ontario to park its aircraft "as close as reasonably possible" to its terminal building slots to minimize the exposure of Air Ontario passengers to inclement weather. Air Canada was also bound, at stations of mutual use, to de-ice Air Ontario aircraft on Air Ontario's request.

Advertising

The terms of the commercial agreement also called for Air Canada's *Enroute* magazine to feature Air Ontario, its new relationship with Air Canada, and its new route system.[6] Mr Rowe was shown the following section of the agreement and was asked to comment on its commercial significance:

> Air Canada will use its best efforts to feature Austin in its inflight magazine including, in particular:
> (a) Austin's [Air Ontario's] scheduled air services on the Air Canada route map and illustrating the various types of aircraft operated by Austin in support of its scheduled passenger service.
> (b) Austin's name on the cover of the magazine.
> (c) A feature article on Austin, its services and its relationship with Air Canada to be included in the first edition published after start-up.
>
> (Exhibit 783, tab E, pp. 5–6)

> A. Your Honour, it would be relevant to the promotion of Austin's [Air Ontario's] services and the identification of Air Canada with Austin Airways, similar to that which we would have with any affiliated group with our company. It's strictly a commercial identification and advertising mechanism.
> Q. Identification between the connector and the parent, you're talking about?
> A. Yes, that's correct.
>
> (Transcript, vol. 121, p. 185)

Aeroplan

Air Ontario passengers would receive equivalent Aeroplan points. The competitive advantage offered by these in the context of a parent/subsidiary relationship was explained by Mr Rowe as follows:

> A. ... Your Honour, they are primarily a brand name loyalty device, that is, adhering the loyalty of customers to the use of the Air Canada product in its many forms. And Austin [Air Ontario], of course, would benefit immensely by that.

---

[6] *Enroute* is Air Canada's onboard publication, a copy of which is available free of charge to Air Canada passengers. Passengers can find a copy in the seat pouch on every Air Canada and Air Ontario flight.

Q. When you say benefit, are you talking about a competitive advantage to other carriers on routes?
A. Yes, that's correct. Austin [Air Ontario] would have a competitive advantage, we believe, at any rate.
Q. Well, that's the point of the exercise, I take it?
A. That's right.

(Transcript, vol. 121, p. 186)

The object of this marketing exercise was clearly to convince the travelling public that the choice of Air Ontario as a carrier was the same as choosing Air Canada. Given the record of years of familiarity and trust between Air Canada and the Canadian air-travelling public, this marketing technique was of no small significance. That the strategy worked is evidenced by the testimony of some passengers on flight 1363 who thought they were in fact travelling on Air Canada, right up to the point when they were about to board the aircraft at Dryden. Passenger Michael Ferguson stated the following:

A. We arranged the flight through a local travel agent in Thunder Bay.
Q. Can you tell me who you arranged it through?
A. It was Go-Rite Travel.
Q. All right. Now, what airline did you believe that you were flying on?
A. Air Canada.
Q. And when did you first learn that you were flying on Air Ontario flight?
A. After we cleared the security area and we were walking on to the tarmac towards the plane.

(Transcript, vol. 13, p. 3)

Mrs Susan Ferguson, who was accompanying her husband, gave similar evidence. This testimony was not surprising since, on the face of the passenger tickets, the flight was described as "AC 1363."

I cannot but conclude that Air Canada was holding out to the public that Air Ontario was de facto an Air Canada operation or an extension of Air Canada. Obviously, there were good business reasons for doing so. Yet it strikes me that, if Air Canada was seeking to improve its competitive position in the deregulated environment by marketing Air Ontario as an extension of itself, then there was a concomitant responsibility to ensure that Air Canada operational standards, and not just its colour schemes, were being matched by its regional feeder.

The Operational Relationship

At the time of purchase of its controlling interest in Air Ontario, Air Canada had years of experience in scheduled jet operations and a worldwide reputation in the safe operation and maintenance of jet transport aircraft. The management of Air Ontario had neither. Yet, when Air Ontario commenced its scheduled jet operations, carrying the very passengers Air Canada wanted in its network, Air Canada management consciously and deliberately avoided any involvement in the operations of Air Ontario. This position was based on real concerns created by deregulation regarding profitability. When weighed against Air Canada's own espousal of the primacy of flight safety and the legitimate expectations of Air Ontario passengers, I find this non-involvement inappropriate.

The effect of this non-involvement in the functioning of the air transportation system was evident in the differences in operational standards acceptable to Air Canada and to Air Ontario.

The principal Air Canada witness called on the subject of operational differences between Air Canada and Air Ontario was Captain Charles Simpson, vice-president of flight operations for Air Canada. In the areas of maintenance and operational control it was readily apparent from his and other evidence that Air Canada operates to standards that are higher than the threshold minimums required by Transport Canada.[7] Captain Simpson confirmed this interpretation in his evidence:

> Q. In your evidence, and you probably have stated this already, sir, but you would agree with me that the standards set by Transport Canada for the industry, for the aviation industry, are minimum standards?
> A. That's correct.
> Q. And I think you would also agree with me that Air Canada's standards are higher than Transport Canada's standards?
> A. We believe so.
>
> (Transcript, vol. 123, p. 97)

As already mentioned, some passengers on Air Ontario flight 1363 believed they were in fact flying with Air Canada. This misconception was clearly the result of the marketing effort of Air Canada and Air Ontario and is proof of its effectiveness. The marketing of the Air Canada image to its new feed passengers included not simply efficient

---

[7] The requirements for all aspects of a commercial air carrier operation using aircraft weighing more than 12,500 pounds are set forth in Air Navigation Order, Series VII, No. 2. The adequacy and other aspects of these obligations are dealt with in chapter 34, Operating Rules and Legislation.

point-to-point and connecting travel but also the Air Canada reputation for safe travel. When this proposition was put to Captain Simpson he testified as follows:

Q. And if I buy an Air Canada ticket, part of the product that I buy is that very high standard that Air Canada keeps, is that not correct?
A. We believe so.
Q. And that's a selling point for Air Canada, is it not?
A. I think so.
Q. Passengers can have confidence in Air Canada?
A. Yes.
Q. But if I buy an Air Canada ticket, I might end up on one of the feeder carriers, and I might only find out that I am on one of the feeder carriers when I get my boarding pass, is that not correct?
A. Yes that's correct.
...
Q. And you would agree with me that as far as a lot of passengers are concerned, they consider themselves Air Canada passengers?
A. Correct.
Q. And I take it, and my friend Mr Knutsen covered this, but I would like to make it clear because I think it's important, that you believe, Air Canada believes, that Air Canada passengers that fly on Air Canada connectors are entitled to the same standards of safety as Air Canada passengers that fly on a DC-9 or a 767 on Air Canada?
A. That's correct.

(Transcript, vol. 123, pp. 98–99)

To get an understanding as to the quality of operational differences between the parent and subsidiary airlines, Captain Simpson was first presented with a number of examples brought out in evidence and then asked for comment.

Auxiliary Power Unit

In light of the evidence surrounding the inability of C-FONF to restart its engines in the event of a shutdown in Dryden because of its unserviceable APU and the lack of ground-start capability, I heard with considerable chagrin that Air Canada would not itself have dispatched the aircraft into Dryden under similar circumstances. Captain Simpson stated this to be Air Canada policy:

Q. All right. And under the Air Canada dispatch system, is it not a fact that you would not dispatch an aircraft with an inoperative APU to a station that has no ground support in order to start the aircraft?

A. That's right. It's a policy.
(Transcript, vol. 123, pp. 116–17)

The Introduction of Jet Service

Specific to the introduction of the F-28, Captain Simpson was asked about certain shortcomings in the program. Prior to testifying, he was unaware of any difficulties in the program. He was not familiar with the evidence before the Commission.

Minimum Equipment List

Captain Simpson was made aware of the fact that Air Ontario operated C-FONF for the first six months of revenue service with no approved Minimum Equipment List (MEL). His evidence was that Air Canada would not commence revenue service with an aircraft in the absence of an approved MEL, and it certainly would not tolerate use of an aircraft without one. When asked about the importance of having a workable MEL prior to the commencement of revenue service, Captain Simpson offered the following rationale and example, which I felt put the issue into useful context:

Q. Sir, why is it important for an airline to have an MEL at the time an aircraft is put into operation? Why is that important?
A. Well, in order to be able to operate the airplane, you from time to time will have some minor deviations on it where you may want to move the airplane back to a main station to get it fixed. It may be something of an insignificant nature, but without any document that allows you to do it, you're not allowed to operate the airplane.
So it's a straight case of – and, as far as the pilot is concerned, both pilots and maintenance personnel need some guidance, so this is the document by which they can look at their airplane and decide if it can be dispatched in that condition.
For example ... you might have a problem with the reverse mechanism on an engine. It's not required, it's not part of the certification, but to operate the airplane, there are certain things that have to be checked.
So you go to the MEL list. It says what maintenance have to do. It says what operations have to do. And then the airplane may be moved.
Q. To the best of your knowledge, sir, has Air Canada ever operated an aircraft in revenue service without an approved MEL?
A. Not to the best of my knowledge.
(Transcript, vol. 118, pp. 112–13)

Captain Simpson, in addition, provided his views on the operation of an aircraft in revenue service in the absence of an MEL:

> Q. Captain, with your background and knowledge and experience, how would you view the operation of a new aircraft for six months with no MEL?
> A. Well –
> Q. When I say the operation, I'm talking revenue operation.
> A. Yeah. Well, I would be surprised that Transport Canada would allow that to go on, as the regulatory authority.
> Q. Would you permit that as a senior officer –
> A. No.
> Q. – of your airline?
> A. No. We would not accept that, as an airline.
> (Transcript, vol. 118, pp. 116–17)

Manuals

The evidence before this Commission is that Air Ontario did not have in place its own F-28 operating manual prior to the commencement of revenue service with the F-28; in fact, although an operating manual for the F-28 was drafted, it was not submitted to Transport Canada for approval until June 1989, the same month Air Ontario discontinued F-28 operations. In addition, some of the Air Ontario pilots were using the Piedmont Airlines F-28 Operations Manual and others were using the USAir F-28 Operations Manual, a fact that could lead to operational mistakes or confusion.[8]

Captain Simpson stated that Air Canada would not have allowed an aircraft into revenue service without developing its own aircraft operating manuals or standard operating procedures. Air Canada, for example, has its engineering department calculate slush-correction factors for each aircraft type adapted to Air Canada's own operation. All such work is completed and inserted into the aircraft operating manuals prior to the entry of the aircraft into revenue service. As I did in the preceding section, I found Captain Simpson's testimony regarding these matters particularly telling, having in mind his vast experience and the practices of Air Canada:

> Q. How would you view, sir, crews operating for approximately 12 months on new equipment without an approved AOM?

---

[8] This problem stemmed from the takeover of Piedmont Airlines by USAir during the course of the Air Ontario F-28 training program. The first groups of Air Ontario pilots were trained to the Piedmont manual, the latter groups to the USAir manual. See chapter 19, F-28 Program: Flight Operations Manuals.

A. I would be quite surprised that the regulatory authority would allow that to happen.
Q. Would you view that as highly abnormal?
A. Yes.
Q. ... How would you view, sir, having crews operate a new aircraft in a fleet with an unapproved AOM from another carrier, with no amendment service being provided?
A. Highly abnormal.

(Transcript, vol. 118, p. 119)

The evidence is that Air Ontario crews operated the F-28 aircraft for approximately 12 months without an approved aircraft operating manual, using an aircraft operating manual from another carrier, with no amendment service.

Aircraft Defects (Snags)

The evidence on aircraft defects revealed that a practice developed within Air Ontario of some F-28 flight crews recording aircraft defects or snags on pieces of paper and passing them on to subsequent crews rather than entering the defects in the aircraft journey logbook as required by the Air Regulations (see chapter 16, F-28 Program: APU, MEL, and Dilemma Facing the Crew). The object of this practice was to prevent the grounding of an aircraft during a day's operation, away from the maintenance base. This practice arose in part from the absence of an approved minimum equipment list.

It is clear that Air Canada would not tolerate the passing of snags on pieces of paper between pilots; it would expect its pilot to enter a defect in the journey log of the aircraft as soon as the defect was discovered. As Captain Simpson explained:

Q. Again, from your experience and background, sir, would you – how would you view the practice of crews passing snags on pieces of paper and not noting them in the journey logbook at the time they arise?
A. I don't know what kind of a snag they would pass on a piece of paper. I would like to think if there's something wrong with the airplane, they would put it in the logbook.
I would hate to think that my own crew members would do such a thing.
Q. Would that kind of a practice be condoned by Air Canada?
A. No, because I think you are putting a liability on the next pilot.

(Transcript, vol. 118, p. 117)

Refuelling

While flight 1363 was at the Dryden station stop it was refuelled with an engine running, a procedure referred to as "hot refuelling." During the procedure the passengers remained on board. Leaving passengers on board during "hot refuelling" was regarded as unsafe by Air Canada and was not a permitted practice. Captain Simpson's attention was directed to Air Canada aircraft flight manuals, and he was asked to describe both the Air Canada hot refuelling procedures and the circumstances under which they were to be used:

> Q. And could you tell us generally, what is the policy, for example, on the L-1011, and then you can tell us what the policy is for Air Canada.
>
> A. Well, I included it as an example that while we don't refuel with an engine running, it is possible to do that. And we have very specific instructions laid out on how it has to be done.
>
> For example, the procedures to be used when it is necessary to refuel, obviously if you have to refuel and you don't have the capability of starting the engine because of no APU or no ground power, number 2 engine is left running. It must be noted this is a special procedure and must only be used when the aircraft APU is unserviceable, so it lays down the conditions. It's not a frivolous procedure. In fact, it's one that's very rarely ever used.
>
> And at the very bottom of that section, we must ensure that prior to refuelling, apologize for the inconvenience and deplane all passengers and cabin crew. And they can't be reboarded until the refuelling is complete.
>
> (Transcript, vol. 118, pp. 125–26)

Passengers remained on board during the hot refuelling of flight 1363 in Dryden on March 10, 1989 (see chapter 5, Events and Circumstances Preceding Takeoff).

De-icing

Air Canada's de-icing procedures, as attested to by Mr Paul Lefebvre, an Air Canada station attendant, allowed for either or both the maintenance personnel and the aircraft captain to make the decision regarding the need for de-icing. As well, subsequent to spraying, it is Air Canada policy that an independent check be carried out on its aircraft to ensure that the de-icing was effective.

Air Canada de-ices other carriers' aircraft under ground-handling contracts, including those of Air Ontario, pursuant to the procedures of those carriers. Mr Lefebvre testified that Air Canada does not carry out an independent check of the aircraft surfaces after such contract de-icing, nor is such a check carried out by Air Ontario or any other carrier, either by ground personnel or flight crews. Mr Lefebvre recalled occasions when an independent check of his own work disclosed an incomplete job, and he was of the firm opinion that the check was a worthwhile safety feature.

Mr William Deluce, president and chief executive officer of Air Ontario, acknowledged during the course of his evidence that he had become aware of the lack of an independent checker in his corporation's de-icing procedures only as a result of the evidence before this Commission. He assured the Commission that a suitable arrangement would be sought with Air Canada for the checking procedure to be included as part of Air Ontario's de-icing procedures.

Operational Control and Flight Planning: Air Canada versus Air Ontario

It was the opinion of Captain Simpson, after examining the Air Ontario flight release issued to Captain Morwood on the day of the accident, that the information contained in it was minimal compared with that issued to Air Canada flight crews (see chapter 23, Operational Control). The lack of sufficient information in the Air Ontario flight releases was noted during the Operational Review of Air Ontario carried out by Air Canada in the fall of 1989, some months after the Dryden accident. The lack of information concerning such matters as fuel burns, flight levels, and wind components was targeted for correction subsequent to this review.

It was obvious from Captain Simpson's description of the Air Canada information package (AFPAC) given to its pilots prior to flight departure that Air Ontario's flight release paled in comparison.[9] Air Canada's AFPAC was described by Captain Simpson as a combination flight release and flight plan, containing all information relevant to weather, altitude, fuel consumption at various points, headwind and shear component, taxi fuel, landing weight, NOTAMs (notices to airmen), as well as all the relevant alternate, terminal, and passenger information required to minimize the workload of the flight crew.

Air Canada exercises its delegated responsibility of operational control over its flights through a full co-authority dispatch system that closely integrates the role of flight crews and dispatchers. The operational flight plan is generated and signed by both the dispatcher and the flight crew members. Flight planning is considered a joint responsibility, and, in the case of a dispute, the most conservative approach prevails. This was by no means the case at Air Ontario, which fulfilled its operational control

---

[9] AFPAC is the designator for Automatic Flight Planning, Air Canada. Captain Simpson described in great detail how the information for the flight crews comes to be generated and how it is distributed to flight crews (Transcript, vol. 118). An Air Canada AFPAC was entered as Exhibit 899.

obligations pursuant to the less sophisticated "pilot self-dispatch" system, a system sanctioned by Transport Canada.[10]

The Air Canada co-authority system of operational control would obviously have been better for Air Ontario. Such a co-authority system, however, requires dispatchers who are very well qualified.

The essence of the testimony of Mr Daniel Lavery, the Air Ontario dispatcher responsible for flight 1363 on March 10, 1989, and his superiors was that his training could only be described as rudimentary. Along with the errors contained in the flight release for flight 1363, the aircraft was dispatched into Dryden with an unserviceable APU at a time when the latest Dryden terminal forecast called for freezing precipitation. A senior Air Canada dispatcher gave evidence that an experienced Air Canada dispatcher would have had flight 1363 overfly Dryden on the day of the accident.

Somewhat ironically, Captain Simpson had occasion to meet with a group of Air Ontario pilots in November 1988 during an Canadian Air Line Pilots Association (CALPA) annual meeting. Captain Simpson described the meeting as informal, but the pilots expressed an interest in Air Canada's intention towards Air Ontario with regard to, among other things, training and dispatch. The Air Ontario pilots had been introduced to Air Canada's system of operational control as a result of being in the Air Canada system and they enquired whether it was to become available to them.

As might be expected, the pilots were impressed with the amount of information Air Canada's flight planning facility made available to flight crews as compared with their own. They were interested in knowing whether it was the intention of Air Canada, as Air Ontario's parent corporation, to make its superior flight planning facilities available to Air Ontario crews. As Captain Simpson described it:

> A. ... The whole thrust of their argument was that it would be nice to have the Air Canada system, because they flight planned in our area in Toronto where they had access toall the information, and you know, after you have seen Paree, it's hard to get you back on the farm.
> Q. Very true.
> A. They had seen a much nicer system.
> Q. They had seen Air Canada.
> A. That's right.

---

[10] The Air Ontario dispatch system was described as a "hybrid" between a pilot self-dispatch and a full co-authority dispatch system by Mr Robert Nyman, Air Ontario director of flight operations (Transcript, vol. 108). The complete description of the difficulties with Air Ontario dispatch is contained in chapter 23, Operational Control.

Q. And they asked you for the Air Canada system?
A. They did.

(Transcript, vol. 123, p. 116)

Captain Simpson did not assign a high priority to the meeting and did not raise the concerns addressed by the pilots to anyone at Air Canada, to the Air Canada representatives on the Air Ontario board of directors, or to Mr Larry Raymond of Air Ontario, as had been suggested by the pilots prior to the accident. Captain Simpson was questioned on the lack of follow-up to this meeting:

Q. Would it be fair to say that you just didn't follow up on the meeting?
A. No, I gave consideration to it, and, in due course, we would talk about it. That meeting with the pilots was not to identify a serious safety problem. There was no urgency to the matter. And, to some degree, sir, it was a bitching session on their part to get the Deluces to spring for more money.

(Transcript, vol. 123, p. 126)

The Air Ontario pilots were in fact raising problem areas that later manifested themselves as legitimate safety concerns. However, the informality of the meeting must be kept in perspective. As Air Ontario captain Monty Allan explained, "he made us no promises, and we had no firm expectations. It was an informal meeting" (Transcript, vol. 91, p. 156).

Dispatcher Training

Air Canada's dispatch and flight-following departments are of genuine assistance to its pilots, a result in large part of the superior training Air Canada's dispatchers receive and the superior operational flight release information provided to its flight crews.

Compared with Air Ontario, Air Canada dispatchers receive extensive training, both on the job and through courses. There can be no doubt from the evidence that Mr Lavery did not meet the minimum dispatch standards set forth in ANO Series VII, No. 2. Indeed, it was the opinion of Mr Adrian Sandziuk, an experienced Air Canada dispatcher, that flight 1363 would have been better off with no dispatcher being involved at all; at least in that scenario the pilot would have been forced to do his own calculations. He considered it "unbelievable" that Air Canada would allow Air Ontario to permit a dispatcher with two weeks' training to have flight watch over a transport category jet operation. Mr Sandziuk also stated that Air Canada had the resources and expertise to bring Air

Ontario's "terribly inadequate" flight watch up to an acceptable standard (see chapter 23, Operational Control).

These examples of operational discrepancies show undeniably that Air Ontario operated to lower operational standards than Air Canada, although for the most part within standards set and authorized by Transport Canada. This conclusion was put to Captain Simpson and he agreed:

> Q. ... Would you not agree with me from the series of examples I have given you, and there are others, that Air Ontario, at that time, was not meeting Air Canada standards?
> A. That is correct.
>
> (Transcript, vol. 123, p. 108)

Flight Safety Overview

There were other areas besides direct operational involvement in which Air Canada could have exercised some influence over the safety of operations at Air Ontario. It could, for example, have conducted a timely operational review of Air Ontario, particularly at the commencement of jet operations, and it could have ensured the presence of a properly functioning flight safety department.

It is regrettable that Air Canada did neither.

Operational Review

The evidence shows that Air Canada had decided to do an operational review of Air Ontario shortly after its purchase of the 75 per cent interest in January 1987. Such a review, however, did not occur until the fall of 1989.

Captain Simpson agreed that it would have been desirable for Air Canada to have done an assessment of Air Ontario at the time of the purchase of Air Canada's controlling interest in order to ascertain any operational deficiencies:

> Q. Would it not have been desirable for you to do an assessment at the time you purchased it in order to determine whether or not there were deficiencies?
> A. That's right, and shortly after the purchase, we had made that decision to do an assessment.
>
> It appears to have been a long time from the time we made the decision till the time we did it. It involved some of the personnel problems in our own airline. We didn't have the personnel available. So while it appeared to be a long period of time before we completed our own operational review, from

> time of purchase, I had personally recommended that we examine that aspect.
>
> (Transcript, vol. 123, pp. 108–109)

Aside from the labour relations or "common employer" concerns discussed above, an additional reason given by Captain Simpson for the delay in conducting Air Canada's operational review of Air Ontario was the fact that Transport Canada was doing its own audit of Air Ontario in the fall of 1988 and he did not want an overlap. Captain Simpson was under the misapprehension that Transport Canada had performed "quite a decent audit" of Air Ontario:

> A. ... In the fall of '88, the – Transport Canada were doing an audit on Air Ontario, and I had suggested to all our people that we shouldn't become involved until the audit was over.
> Q. That is, the Transport Canada one?
> A. The Transport Canada audit, which, incidentally, was quite a decent audit, gave the airline reasonably good marks. So, of course, then the – in the early winter, the accident occurred and personnel from Air Ontario were deeply involved in that, so our audit didn't take place until the summer of '89.
>
> (Transcript, vol. 118, pp. 167–68)

In fact the evidence irrefutably disclosed that the Transport Canada audit of Air Ontario was anything but a "decent" audit; to the contrary, that audit can only be described as a travesty, both in its execution and in its long-delayed delivery. The audit, incredibly, did not assess Air Ontario's new F-28 jet program (see chapter 33, Audit of Air Ontario Inc., 1988).

Air Canada's reliance on an audit that did not even assess the F-28 program, the very operation where Air Canada's assistance was most urgently needed, represents yet another of the ironies underlying the tragedy at Dryden. It is illustrative of a degree of corporate inattentiveness unbecoming to Air Canada's otherwise hard-won worldwide reputation for safety.

As has already been pointed out, Air Canada finally did conduct an operational review on Air Ontario in the fall of 1989. By that time the remaining F-28 C-FONG had left the fleet, and the F-28 service had ceased.

I found Captain Simpson's very frank and unequivocal answers as the head of flight operations for this country's largest carrier illuminating as to his perception of both the regulator's and the operator's function in this area.

Flight Safety Organization

The evidence describing the operation of the Air Canada Flight Safety Department and its role within the organization is discussed in chapter 24, Flight Safety. Most revealing was the fact that neither Mr Rowe, the Air Canada representative on the board of directors of Air Ontario, nor Mr Jack Mitchell, Air Canada's director of flight safety, appeared to have been aware that, for well over a year, and, more importantly, during the introduction of the F-28, there was no flight safety officer or flight safety organization in place at Air Ontario.

As outlined in chapter 24, the only meaningful contact between Air Canada and Air Ontario in the area of flight safety consisted of two accident response courses: one in 1985, in fact given to a predecessor corporation, Air Ontario Limited, and one in May 1989, after the Dryden accident. The latter course was at the request of Air Ontario.

The evidence indicates that it was only in the event of a major accident that there were to be any intercorporate dealings between the respective flight safety departments of Air Ontario and Air Canada. Participation in post-accident response courses, however, can hardly be equated to participation in operational flight safety programs.

Having listened to the evidence of Mr Mitchell, I was most impressed by Air Canada's flight safety organization and the corporation's dedication to flight safety. I therefore have had a great deal of difficulty understanding Air Canada's failure to assure itself that there was in place at Air Ontario a functioning flight safety department. The only explanation appears to be that Air Canada's management was so determined to avoid a single employer declaration under the Canada Labour Code that flight safety and operational monitoring of Air Ontario were relegated to the bottom of the priority bin.

Parent-Feeder Operational Standards

The role and obligations of a parent carrier with respect to its operating feeder carriers has been a difficult issue to address. Intuitively, one is drawn towards the position that it should be mandatory for a parent carrier, whose operational standards are higher than those required by Transport Canada regulations, to impose its own operational standards on its feeders, notwithstanding the economic implications. This is particularly so where the parent is holding out the feeder operation to the public as being its own operation, as is the case with Air Canada and Air Ontario. Upon reflection, however, it becomes clear that to impose such a requirement without any reservations would be tantamount to establishing one operational standard for both the parent and the feeder;

that is, the higher parent-carrier–generated standard in place of the Transport Canada threshold standard now followed by the feeders. Within the aviation industry, feeders would obviously operate to one of these standards, but most likely to the Transport Canada threshold standards, depending on ownership considerations, as indeed was the case with Air Ontario. Given the attendant cost differences associated with the two operational standards, a requirement that the feeder carrier operate to the parent carrier's operational standards would be seen as clearly discriminatory if it is not confined to those parent-feeder relationships in which the feeder is held out to the public as being part of the parent carrier's operation. Even within that relationship, the imposition of the parent carrier's higher operational standards upon the feeder must be tempered by the tests of relevance and reasonableness. Having made these observations, I strongly encourage a dialogue between Transport Canada and the Canadian air carriers on this subject.

Conclusions

Subsequent to the Dryden accident, Air Canada proceeded to take a long look at its connector carrier network, as evidenced by the series of operational reviews commenced in 1989. The latest information available to the Commission is to the effect that Air Canada was, in June 1991, in the process of purchasing all equity interests in its connector carriers not already owned by it, including the minority equity interest of the Deluce family. In addition, with its corporate reorganization of April 17, 1991, Air Canada announced its creation of a single corporate entity within Air Canada to manage the company's connector carrier interests. Whether these initiatives will result in a more appropriate level of corporate overview of Air Ontario by Air Canada remains to be seen. It is to be hoped that this will be the case and that the lessons from the Dryden tragedy will be not be lost on Air Canada's management.

Those lessons, as clearly demonstrated from the evidence outlined in this and other chapters, can be distilled into one overriding theme. Simply stated, in the pursuit of its corporate objectives, management must remain true to the primacy of safety considerations. The corporate mission statements of Air Canada and Air Ontario both contain words to this effect. The evidence disclosed that other corporate concerns, important in their own right, were allowed to intervene and subordinate safety. The difference between the attention and resources expended by Air Canada and Air Ontario on marketing, as compared with safety of operations, must, when held up to their respective mission statements, be described as inadequate and short-sighted.

Aviation safety should not be looked on as merely a selling point or marketing device, nor should it be viewed as some abstract goal by which to satisfy the minimum standards required by the regulator in order to maintain an operating certificate. Rather, to maintain its place of primacy within an organization, aviation safety must be viewed, from management on down, as an obligation of trust to the travelling public; and management must set the example. Here management fell short of the mark.

FINAL REPORT

TECHNICAL APPENDICES

1 Occurrence No. 825-89-C0048: Structures/Site Survey Group Report LP 38/89: Accident: Fokker F28, Mk 1000, Registration C-FONF, 10 March 1989
Canadian Aviation Safety Board Investigation Team

2 Fokker Aircraft B.V. Amsterdam, Fokker Aerodynamics, Report No. L-28-222: Note on the Aircraft Characteristics as Affected by Frost, Ice or Freezing Rain Deposits on Snow

3 Fokker Aircraft B.V. Amsterdam, Report No. VS-28-25: Flight Simulator Investigation into the Take-off Performance Effects of Slush on the Runway and Ice on the Wings of a Fokker 100

4 A Report on the Flight Dynamics of the Fokker Mk 1000 as They Pertain to the Accident at Dryden, Ontario, March 1989
J.M. Morgan, G.A. Wagner, R.H. Wickens

5 Wind Tunnel Investigation of a Wing-Propeller Model Performance Degradation due to Distributed Upper-Surface Roughness and Leading Edge Shape Modification
R.H. Wickens and V.D. Nguyen

6 Freezing Precipitation on Lifting Surfaces
Myron M. Oleskiw

7 Human Factors Aspects of the Air Ontario Crash at Dryden, Ontario: Analysis and Recommendations to the Commission of Inquiry
Robert L. Helmreich

DSS cat. no. CP32-55/4-1992E
ISBN 0-660-14383-6

COMMISSION OF INQUIRY INTO THE AIR ONTARIO CRASH AT DRYDEN, ONTARIO

Final Report

Volume III

The Honourable Virgil P. Moshansky
Commissioner

COMMISSION OF INQUIRY INTO THE AIR ONTARIO CRASH AT DRYDEN, ONTARIO

This Final Report consists of three volumes: I (Parts One–Four), II (Part Five), and III (Parts Six–Nine and the General Appendices). The table of contents in each volume is complete for that volume and abbreviated for the other two volumes. Seven specialist studies prepared for this Commission have been published separately in a volume entitled Technical Appendices; the contents of the Technical Appendices are given at the end of this volume.

COMMISSION OF INQUIRY INTO THE AIR ONTARIO CRASH AT DRYDEN, ONTARIO

Final Report

Volume III

Parts Six–Nine

The Honourable Virgil P. Moshansky
Commissioner

Printed in Canada
Cat. No. CP 32-55/3-1992E

This volume has been translated by the translation services of the Secretary of State, Canada, and is available in French.

The aerial photograph reproduced in the endpapers was taken by CASB investigators on March 11, 1989, the day following the crash of Air Ontario flight 1363. It depicts the area of the Dryden Municipal Airport (upper right), surrounding road system, and crash site. McArthur Road runs vertically up the middle of the photograph, curving to the right at about the centre of the book on the right-hand page. (The cleared straight line is a hydro right of way.) Middle Marker Road angles to the left off McArthur in the lower left-hand section. The path of Air Ontario flight 1363 through the trees begins not far from the end of runway 29, and the crash site can be seen just above Middle Marker Road. Many survivors walked out to Middle Marker Road immediately after the crash.

CANADIAN CATALOGUING IN PUBLICATION DATA

Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario (Canada)

Final report
Issued also in French under title: Rapport final.
Includes bibliographical references.
ISBN 0-660-14382-8 (Vol. 1–3)
DSS cat. no. CP32-55/1992E (Vol. 1–3)

1. Aeronautics — Ontario — Accidents — 1989.
I. Moshansky, Virgil P. II. Title.

TL553.5.C65 1992 363.12′492 C92-099547-0

CONTENTS

VOLUME I

PART THREE *CRASH, FIRE-FIGHTING, AND RESCUE SERVICES*

PART FOUR *AIRCRAFT INVESTIGATION PROCESS AND ANALYSIS*

VOLUME II

PART FIVE *THE AIR CARRIER - AIR ONTARIO INC.*

VOLUME III

PART SIX *TRANSPORT CANADA*

PART SIX

TRANSPORT CANADA

27 ORGANIZATION

Transport Canada Mandate

The Civil Aviation Role of Transport Canada

Transport Canada is the federal agency responsible to the people of Canada for ensuring that commercial and private aviation activity in this country is carried out effectively at an acceptable level of safety. To quote from Transport Canada's 1990-91 estimates, part III, one of the department's key objectives is "to ensure a safe National Civil Air Transportation System, to attend to the development and operation of the National Civil Air Navigation System for the efficient and safe movement of aircraft and to contribute to the safety and efficiency of Canadian aircraft operating in international and foreign airspace." In simple terms, Transport Canada sets and applies civil aviation safety standards and provides an infrastructure in the form of airports, navigation, radar and communication facilities, and air traffic control services in addition to a number of other facilities and services for both commercial and private aviation.

The Aeronautics Act

The *Aeronautics Act*, R.S.C. 1985, c.A-2, in section 3.2 states: "the Minister [of Transport] is responsible for the development and regulation of aeronautics and the supervision of all matters connected with aeronautics." The Act empowers the minister to administer the air regulations made pursuant to the *Aeronautics Act*. These include the licensing of pilots, aircraft maintenance engineers, and air traffic controllers, the certification of air carriers and airports, and the registration and airworthiness certification of aircraft.

The Act also empowers the minister to take appropriate enforcement action where provisions of the Act, the Air Regulations, or Air Navigation Orders have been violated. Such enforcement action could take the form of a licence suspension, withdrawal of an operating certificate, an administrative fine, or court action. Conspicuous by its absence from the *Aeronautics Act*, however, is specific mention of the minister's responsibility for aviation safety.

The 1981–82 report of the Commission of Inquiry on Aviation Safety by Mr Justice Charles L. Dubin pointed out the lack of specific delineation of responsibility within the *Aeronautics Act* with respect to aviation safety. The report prepared for Transport Canada by the consulting firm of James F. Hickling in September 1990, "Evaluation of Aviation Regulation and Aviation Safety Programs," again addressed this apparent anomaly at some length.

A reading of the various orders and regulations in their entirety reveals an implicit intent, however, that the minister and Transport Canada are responsible for aviation safety. Indeed, this acknowledgement is reflected in the role and mission statement of the department's Aviation Group: "The mission of the aviation group is to provide a safe and efficient civil aviation system." Further, in a recent judgement of the Federal Court of Appeal in *Swanson et al. v. The Queen in Right of Canada*, 80 D.L.R. (4th) 741 (also known as the "Wapiti" case), Linden J.A. agreed with Justice Walsh of the Federal Court of Canada, Trial Division, when he stated:

> The *Aeronautics Act* and Regulations made thereunder if not explicitly imposing a duty of care of the general public, at least do so by implication in that this is the very reason for their existence. The flying public has no protection against avaricious airlines, irresponsible or inadequately trained pilots, and defective aircraft if not the Department of Transport, and must rely on it for enforcement of the law and regulations in the interest of public safety.

I am of the view that such an important duty should be clearly delineated and, accordingly, that the *Aeronautics Act*, which is the foundation of ministerial responsibility for civil aviation in Canada, should be specific in defining the minister's responsibilities for aviation safety. This is a flaw that should be remedied by appropriate amendments to the *Aeronautics Act*. A finding and recommendation in that regard is contained in chapter 37, Safety Management and the Transport Canada Organization.

The Air Regulations and Air Navigation Orders (ANOs)

The *Aeronautics Act* authorizes the minister, through Transport Canada, to perform certain functions pertaining to civil aviation. It also enables the Governor in Council and the minister to make regulations and orders that will assure that the provisions of the Act are addressed. These are called the Air Regulations and the Air Navigation Orders (ANOs).

Part VII of the Air Regulations sets out the rules that define the conditions under which a commercial air service may be operated. For example, Air Regulation 700 states that "No person shall operate a commercial air service in Canada unless he holds a valid and subsisting certificate issued by the Minister certifying that the holder thereof is adequately equipped and able to conduct a safe operation as an air carrier." This rule requires that before a carrier can operate in Canada as a legally sanctioned commercial airline, it must meet the requirements set out by Transport Canada in the Air Regulations and Air Navigation Orders. Transport Canada has a corresponding obligation to ensure that the applicant carrier meets the required standards prior to issuing an appropriate operating certificate.

The Air Regulations enable legal standing to other documentation that is too voluminous or technical to be contained in the regulations. For example, Air Regulation 211(1) states that the minister may initiate publication of an airworthiness manual and an engineering and inspection manual. These documents set out airworthiness, maintenance, and inspection standards that must be complied with before an airworthiness certificate for an aircraft may be issued and retained. Air Regulation 403(2) states that every person applying for the issue or renewal of a licence as a flight crew member, an aircraft maintenance engineer, or an air traffic controller shall comply with the requirements applicable to that licence that are set out in volumes 1, 2, and 3 of the Personnel Licensing Handbook.

Air Navigation Orders are generally structured in a form analogous to the Air Regulations but, like the manuals referred to above, provide greater technical detail. Of particular interest to this Inquiry was ANO Series VII, No. 2, which sets out standards and procedures for air carriers using large aircraft. This was the primary operating standard or benchmark that Transport Canada applied to Air Ontario's F-28 operation.

The director-general, aviation regulation, Mr Weldon Newton, testified that efforts are being made by Transport Canada to merge the existing Air Regulations and Air Navigation Orders into one level of legislation. A great deal of evidence was heard, however, pertaining to an apparent lack of progress in the decade-long period since the 1981 recommendation of the Dubin Inquiry for the adoption by Canada of the United States design and operating rules as a model for the Canadian regulatory framework.

Structure of Transport Canada

Major organizational changes and associated changes in reporting relationships occurred within Transport Canada on April 1, 1991. These changes are discussed in relevant sections of my Report.

Transport Canada is one of the largest federal government departments in terms of size and it is one of the more complex in terms of areas of responsibility. Some idea of the size and scope of this department can be gleaned from the evidence given by Mr Ramsey Withers, the department's deputy minister from 1983 to 1988:

> A. While it is correct to say that the department itself was about 20,000 individuals, one is dealing with the national transportation system and, therefore, there are many others involved, an extensive number of Crown corporations.
>
> If I recall accurately at my time about 20 Crown corporations that formed part of the whole system.
>
> (Transcript, vol. 164, p. 4)

Transport Canada has responsibility for the regulation and, in some cases, the actual operation of various transportation components encompassing air, surface, marine, and even pipelines. This Report will focus attention on that area of the department responsible for civil aviation and, in particular, aviation safety.

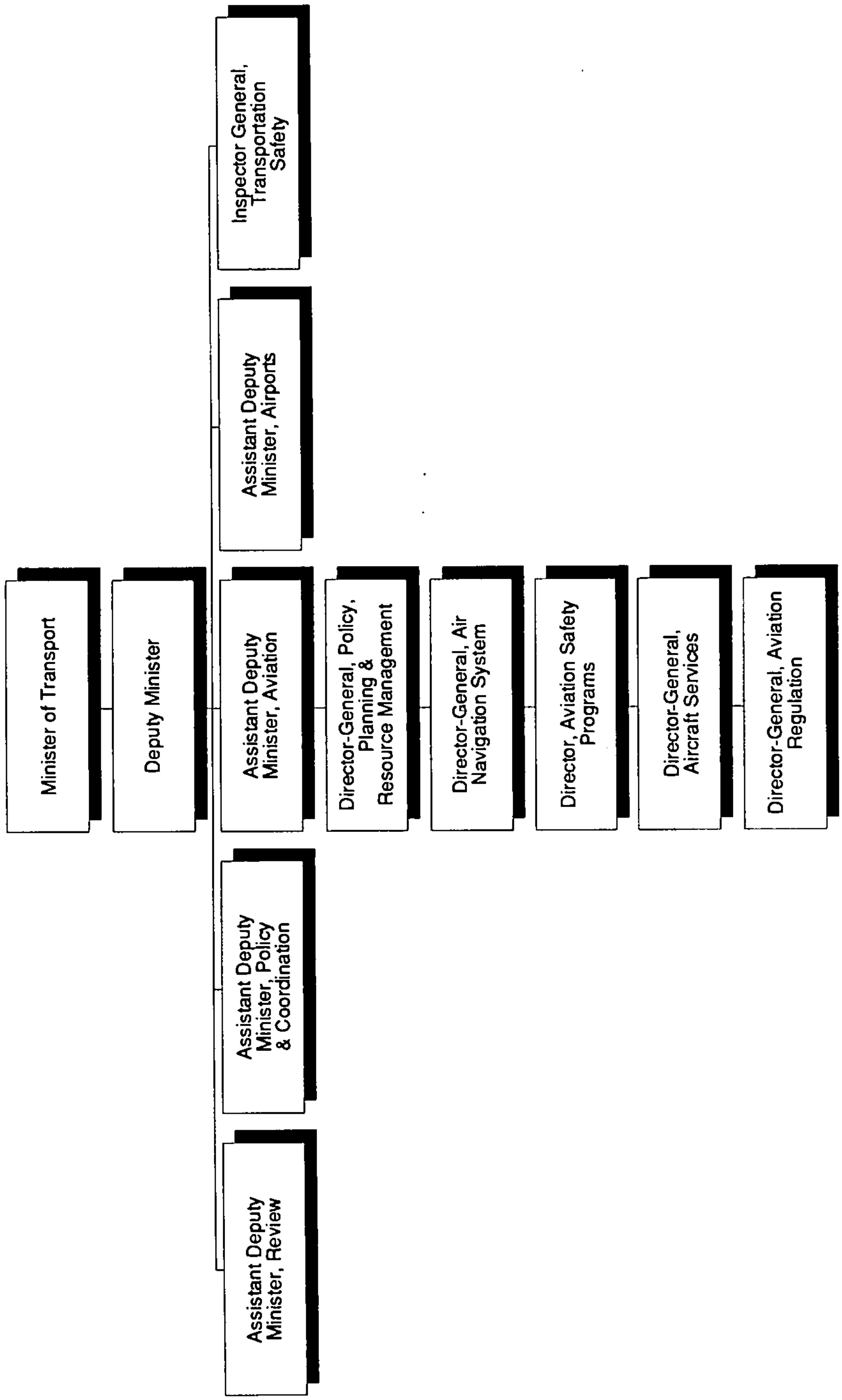
On March 10, 1989, there were two groups within Transport Canada that were of particular interest to this Commission: the Aviation Group, reporting to an assistant deputy minister, aviation, and the Airports Authority Group (Airports Group), reporting to an assistant deputy minister, airports. Within the Aviation Group there were four principal directorates, namely policy, planning, and resource management; air navigation system; aviation regulation; and aircraft services; as well as one branch – that of aviation safety (figure 27-1).

Of primary interest during the Inquiry was the Aviation Regulation Directorate, particularly the Flight Standards and Airworthiness branches at both the headquarters and the regional level. Figure 27-2 sets out the organizational structure and the reporting relationships of the Aviation Regulation Directorate.

Aviation Group

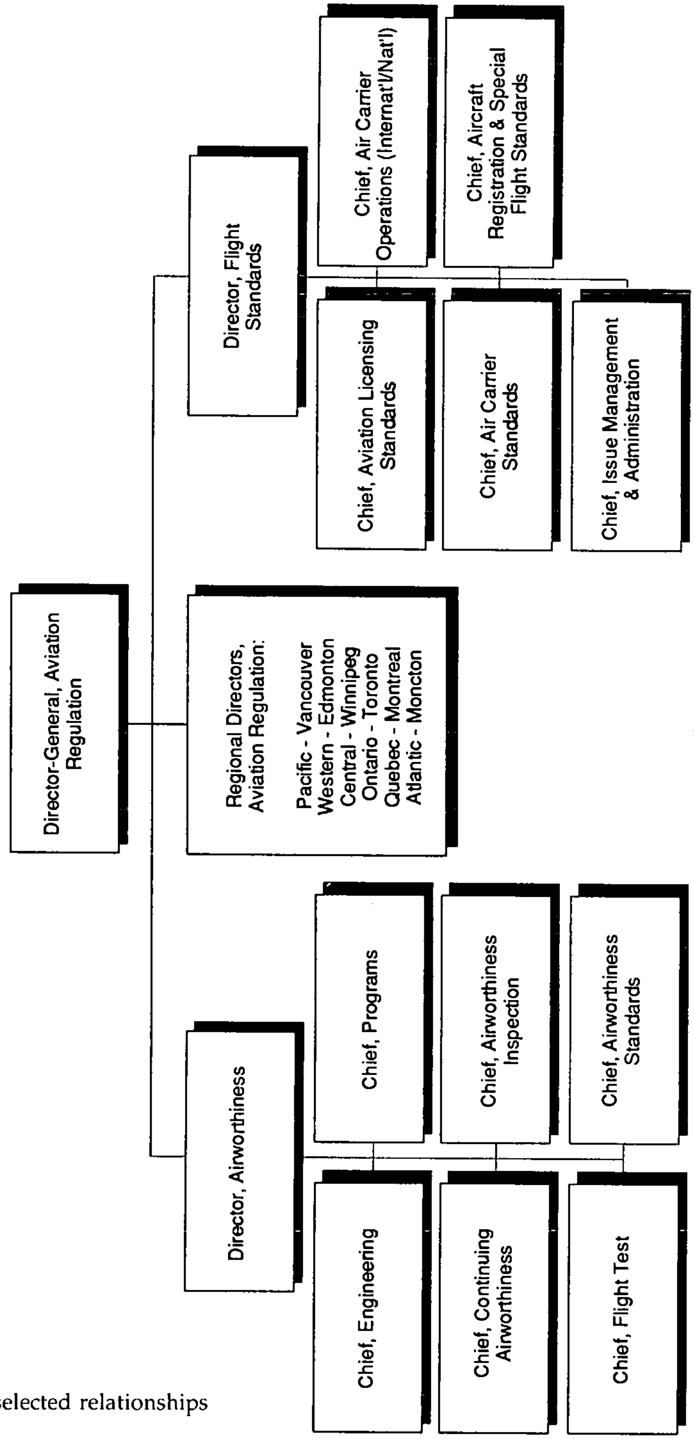
The objective of Aviation Group is "to ensure a safe National Civil Air Transportation System, to attend to the development and operation of the National Civil Air Navigation System for the efficient and safe movement of aircraft and to contribute to the safety and efficiency of

Figure 27.1 Transport Canada Organization, March 10, 1989*



* Depicts selected relationships

Figure 27.2 Transport Canada: Aviation Regulation Directorate, March 10, 1989*



* Depicts selected relationships

Canadian aircraft operating in international and foreign airspace."[1] Aviation Group, then, has three main functions: safety regulation, safety promotion, and the provision of facilities and services to allow for the operation of aircraft in both visual and instrument weather conditions.

From the perspective of safety regulation, the Aviation Regulation Directorate develops and promulgates safety-related legislation, regulations, and standards. It licenses pilots, aircraft maintenance engineers, and air traffic controllers. It certifies aircraft and aeronautical products that meet the required standards of airworthiness. It certifies commercial air carriers and airports that meet safety standards. Finally, it enforces the *Aeronautics Act*, Air Regulations, and Air Navigation Orders through investigations, warnings, licence or certificate suspensions, administrative fines, and prosecutions.

Aviation Regulation Organization

The structure and activities of the Aviation Group were assessed in the course of this Inquiry. Following the conclusion of the hearings, it was learned in May 1991 that Mr David Wightman, the assistant deputy minister, aviation, was restructuring Aviation Group at both the headquarters and the regional levels. The effect of successive structural changes from a safety standpoint, including the April 1, 1991, reorganization, are addressed in chapter 37, Safety Management and the Transport Canada Organization.

Within the Aviation Regulation Directorate there are two branches whose responsibilities are linked most directly to the Transport Canada issues with which this Inquiry was primarily concerned: Flight Standards and Airworthiness.

Flight Standards Branch The headquarters Flight Standards Branch has responsibility for personnel licensing standards for flight crews, the registration of aircraft, as well as certification and operating standards for air carriers. In addition, the Air Carrier Certification Manual, the Personnel Licensing Procedures Manual, and related guidance material are produced by staff from the Flight Standards Branch. Other specific functions of the Flight Standards Branch include approval of air carrier flight operations manuals; minimum equipment lists; training programs for both flight and cabin crews; as well as setting policy related to passenger safety, pilot proficiency checks and in-flight inspection procedures, and air carrier audit procedures. The above list of responsibilities and duties is by no means exhaustive.

---

[1] Transport Canada, *1990-91 Estimates*, part III, p. 2-51

In a general sense, Flight Standards headquarters is responsible for setting the policy and uniform standards that are applied by the regional offices in the day-to-day regulation of civil aviation. An exception to this general rule occurred in 1988, with the establishment under the Flight Standards Branch of the Air Carrier Operations (International/National) Division, commonly referred to as the Seventh Region. This division performs direct inspection duties, using air carrier inspectors based in Ottawa, Vancouver, Toronto, and Montreal who are qualified on large transport aircraft. In addition to their hands-on inspection duties, these air carrier inspectors are required to approve flight operations manuals, minimum equipment lists, and air carrier training programs. The rationale that led to the introduction of this operational headquarters division was described in evidence by Mr Donald Sinclair, a former Ontario Region manager of air carrier operations:

> A. Well, I believe it was done to establish one contact point only with the people who had the expertise resident with them to provide the surveillance and the service.
> Q. Whereas previously they [the carriers] may have come under your jurisdiction, but you would have to then borrow expertise from headquarters to service them properly; is that right?
> A. That's correct.
>
> (Transcript, vol. 142, p. 13)

This blending of staff and line functions proved to be less than satisfactory as air carrier certification demands increased substantially in the latter part of the 1980s. A great deal of evidence focused on Economic Regulatory Reform (ERR), introduced in 1984–85, and its effect on staff work, including the examination and approval of operations manuals and minimum equipment lists.

Airworthiness Branch Like their Flight Standards counterparts, the headquarters Airworthiness staff develop airworthiness standards policies and procedures. The areas addressed by this branch include standards and procedures for approval of air carrier maintenance programs, as well as inspection and approval of maintenance organizations and facilities required by a carrier applying for an operating certificate. The branch also sets standards and policy pertaining to the approval of organizations designing and manufacturing aeronautical products.

A major operational role performed by the Airworthiness Branch is the examination, testing, and certification of new aircraft types either designed and manufactured in Canada or imported into Canada. Airworthiness inspectors from headquarters also conduct audits on companies that manufacture aviation products and on major repair and overhaul facilities. In both the Airworthiness and Flight Standards branches, headquarters inspectors also participate in national audits of air carriers. The inability of such inspectors to perform all of their duties during the post-ERR era was the subject of much evidence.

Airports Authority Group

The objective of the Airports Authority Group is "to ensure the availability and reliability of a safe, secure and efficient national civil airports system in Canada."[2] Transport Canada operates 8 major airports and 97 national, regional, and local airports. The primary function of the Airports Group is the formulation of policy and standards for airports and the operation and maintenance of airport facilities and services in Canada, including the provision of terminal facilities. Of particular interest to this Inquiry relating to Airports Authority Group were those areas of responsibility associated with crash fire rescue, aircraft refuelling standards and services, and de-icing facilities.

Regional Organizations

There are six Transport Canada regional offices in Canada (see figure 27-2). The regional director and his managers were responsible for Transport Canada air carrier operations and airworthiness programs that affected carriers residing in their region. The exceptions to such regional responsibility were the operations of the major carriers assigned to the headquarters Air Carrier Operations (International/National) Division. Airworthiness responsibilities for those same major national and international carriers, however, continued to rest with the airworthiness inspection organization in the region in which the carrier resided.

In the course of the Commission hearings it became increasingly obvious that the lines of responsibility in air carrier inspection and certification were fragmented. This fragmentation precluded effective coordination between the overlapping operations and airworthiness areas.

District Offices

District offices, reporting to regional offices, were created to provide improved services to and surveillance of the aviation industry in areas where the level of aviation activity was high but where there was no Transport Canada civil aviation presence. As the licensing and certifi-

---

[2] Ibid., p. 2-71

cation demands escalated dramatically during the latter part of the 1980s in response to deregulation of the airline industry in Canada, the number of district offices was increased to approximately 20. These offices are located in such places as Victoria, Kelowna, Calgary, Saskatoon, London, Timmins, Quebec City, and Halifax.

These district offices deal primarily with airworthiness issues, and district office managers report to the regional managers of airworthiness. In some centres where demand requires it, air carrier and licensing inspectors are also resident in the district offices. These inspectors report to the regional manager of air carrier operations or the regional manager of licensing.

In summary, Transport Canada is a complex organization serving a dynamic industry which experienced tremendous growth during the 1980s. Concurrent with such growth was the introduction of government policies designed to bring about deregulation and deficit reduction. The aviation sector of the department undertook organizational changes intended to meet the associated challenges. It is beyond the scope of this Inquiry to assess the effectiveness of such organizational changes except as they may have had an impact on aviation safety. My remarks in the following chapters of Part Six are limited to that extent.

28 CONDITIONS AT TRANSPORT CANADA IN THE EARLY 1980s

Concerns about unmanageable workloads generally, and insufficient numbers of air carrier and airworthiness inspectors and support staff specifically, were raised as far back as 1982 by the Canadian Air Transportation Administration (CATA), the predecessor before the 1985–86 reorganization of Transport Canada's Airports and Aviation groups.

The Commission of Inquiry on Aviation Safety headed by Mr Justice Charles L. Dubin was established in 1979 with a broad mandate to advise the minister of transport on issues relating to the safety of the civil air transportation system. The Commission's report, issued in three volumes in 1981-82, pointed out the need for increased staffing in several areas in Transport Canada, particularly in the inspection of air carrier maintenance and operations.

A document released by Transport Canada in November 1984, Final Report, A-Base Review, Volume II, Regulatory (TP 5876E), provides insight into the capacities and capabilities of the Aviation Regulation Directorate in the aftermath of the Dubin Inquiry. The document resulted from the concern of the Treasury Board that CATA's Human Resources Requirements Plan, submitted to the Treasury Board at its meeting of October 28, 1982, did not demonstrate clearly that the staffing requirements (person-years) specified in that plan represented the minimum number of people needed to carry out the program.

In response to these concerns, Mr Gordon Sinclair, administrator of CATA, put in place an A-base review (a review of all ongoing programs within the air administration) to identify the most efficient and economical level of resources required by CATA to meet its mandate, taking into account the changes initiated in response to the report of the Dubin Inquiry. A project review committee was set up to oversee and review the recommendations of the A-base review team. The members of this committee consisted of a director from the Treasury Board secretariat, Transport Canada's assistant deputy minister, personnel, and the director-general, review. In other words, with the exception of Mr Sinclair, the management of the review process was attended to by individuals external to CATA.

The process of examination to which CATA was exposed was exhaustive. The authority and mandate that CATA claimed for each task was checked and validated by aviation law experts from McGill University. Task times were established and challenged by the review team members through comprehensive on-site evaluations, audits, comparisons, and recordings.

The review team found that the Aviation Regulation organization had significant shortages in resources and that these shortages were adversely affecting the organization's ability to conduct its affairs efficiently and to ensure an adequate level of safety. It also noted a number of activities where efficiency and effectiveness could be achieved through changes in existing practices. The A-base review team recommended that the Aviation Regulation organizational unit for fiscal year 1983–84 be allocated an additional 117.5 person-years. For those groups reviewed within the Aviation Regulation Directorate, using fiscal year 1984–85 as the base, an additional 52 person-years were recommended.

These recommendations did not include additional resources that would be required as a consequence of the deregulation that allowed a dramatic increase in activity in the air carrier industry. The section of the A-base review dealing with the inspection of air carriers offers significant findings as to the state of Transport Canada's capability in this area in 1983 and 1984. It cited the following results:

> a) The resource allocations to the regional Air Carrier Operations divisions have been insufficient to meet the required workload. The shortfall has, to varying degrees, affected the quantity and quality of most tasks. Bases have been inspected only 70 per cent of the required number of times and only by omitting certain procedural steps.
>
> b) The initial inspections of new carriers are frequently delayed and the initial inspections of new aircraft and equipment are often postponed until the next annual inspection. As a result, aircraft can be operated in commercial transport service without meeting all the required standards ...
>
> ...
>
> d) The level of administrative support provided to the function results in professional staff spending significant amounts of time on clerical and stenographic activities. This, of course, aggravates the problem of insufficient time to perform primary tasks.
>
> (From para. 2.8.17, pp. 61–62)

The review team also identified shortfalls in resources that generated flight safety concerns: "Lack of an adequate increase in resources will adversely affect aviation safety through continuation of unsatisfactory performance as detailed in paragraph 2.8.17 above" (p. 62). They warned that "[c]ontinued provision of insufficient resources for this function will result in a perpetuation of the undesirable if not unacceptable, situation which exists as a result of 'corner-cutting' by inspectors. Their attempts to cope with an unmanageable work-load, and in continued non-completion of required inspections all of which could have an adverse effect on flight safety" (p. 64).

Specific findings and expressions of concern about the lack of resources and its impact on aviation safety made by the review committee in 1984 in relation to the situation in 1983 can be repeated, word for word, to describe the situation that has existed in the Aviation Regulation Directorate since 1984, and, in fact, as it is in 1992. As early as 1983–84, Transport Canada's Aviation Regulation body and, in particular, the air carrier certification and inspection groups were unable to fulfil effectively their mandated tasks. The evidence shows that during the 1980s Transport Canada did not have sufficient human resources to discharge its mandate. Further, the evidence demonstrates that Transport Canada had been repeatedly warned at the highest levels of bureaucracy about this unsatisfactory state of affairs.

29 ECONOMIC DEREGULATION AND DEFICIT REDUCTION

Throughout the hearings of this Inquiry into the Dryden accident, I heard repeated concerns expressed by Transport Canada witnesses regarding their inability to respond effectively as regulators to an increasing demand for air carrier certification, inspection, and surveillance services. According to the witnesses, the certification, inspection, and surveillance workload created by a rapidly changing air carrier industry was not matched by a commensurate increase in resources for Transport Canada's regulatory agency. The resource squeeze stemmed from the almost simultaneous introduction of two federal government policies in 1984, namely Economic Regulatory Reform of the air carrier industry and deficit reduction, a program imposing fiscal restraint on federal government services. The combined effect of these two policies created a difficult set of circumstances for the Transport Canada personnel responsible for air carrier safety.

Economic Regulatory Reform

The changes in regulation of the air carrier industry in Canada followed similar activity in the United States by several years. In 1978 the United States embarked upon a program of deregulation of its aviation industry, removing air carrier route protection as a regulatory requirement and opening the marketplace to any domestic carrier desiring to compete. The United States government's objective was to allow increased competition within the air carrier industry that would result in substantially lower air fares for the consumer.

A similar move was contemplated in Canada when the minister of transport, the Honourable Lloyd Axworthy, on May 10, 1984, announced a new Canadian domestic air policy appropriately termed "Liberalization of the Canadian Air Transportation Industry." Mr Ramsey Withers, who was then deputy minister of transport, gave evidence before this Commission. He summed up the policy proposal as follows:

> A. And, really, the gist of the announcement was that the Minister would change, alter or vary any decision that the Canadian Transportation Commission might take with respect to denying the right or the authority for an air carrier, Canadian air carrier,

> to serve two points in Canada. New Section 64 of the National Transportation Act [sic] [was] to do that.
>
> And so this had the impact of then saying, all right, carriers, away you go. You can, if you want, these routes that are, you know, designated between city pairs in Canada for one carrier that in the future, two, three or four even might be able to provide service. So that happened in 1984.
>
> (Transcript, vol. 164, p. 8)

Transport Canada's Ontario Region office reacted to the Axworthy proposal on deregulation by initiating an independent assessment into the potential impact of the policy. Of particular concern was the ability of the Aviation Regulation division to fulfil its mandate of ensuring that the air carrier industry was operating in compliance with safety standards. This assessment, entitled "Impact of Deregulation" (May 10, 1984), cited a number of expectations as a consequence of the new policy that, in retrospect, were remarkably accurate.

On July 24, 1984, these concerns were communicated to Transport Canada in Ottawa in a memorandum titled "Deregulation – Regional Impacts" from the Ontario regional administrator, Mr Douglas Lane. One of the conclusions of the accompanying assessment report was that there were already, in 1984, some indications of a heavier workload associated with deregulation due to a greater number of air carriers, mergers of existing carriers, and increases in the number of aircraft types being operated. The report warned that significant further increases in workloads were almost certain to be experienced in air carrier certification, airworthiness inspection, personnel and aircraft licensing, and enforcement and surveillance.

Mr Lane's memorandum to Transport Canada senior management was a clear warning that certain steps needed to be taken immediately to deal with the escalating workload, beginning with staffing of the regulatory function to the A-base level. He stated in his memorandum:

> [T]here needs to be discussion and decision at the most senior levels on the priorities of accommodation and tasking together with acceptable levels of staff diversions in all elements of the organization from certification through surveillance in the regulatory functions to CFR in the airport functions for each of new, expanding and existing services. As an immediate and minimum first step, however, staffing the Regulatory function to the accepted A-Base levels should be authorized.
>
> (Exhibit 1147)

On August 21, 1984, the administrator of CATA, Mr Gordon Sinclair, responded to Mr Lane's memorandum by congratulating him and citing it as "an excellent managerial effort to cope effectively with change"

(Exhibit 1146, pp. 2–3). Mr Sinclair went on to say that he agreed that obtaining adequate regulatory resources was a top priority:

> I agree strongly with several of your key points ... Specifically, I agree that:
>
> (1) Obtaining adequate additional regulatory resources is a top priority. We must maintain adequate surveillance and we must process carrier applications and proposals sufficiently quickly that CATA does not become the bottleneck obstructing quick implementation of the new Canadian air policy, yet without lowering our standards.

While the headquarters reaction was positive, I could find no substantive response to Mr Lane's proposal. In fact, the Ontario Region was left with its existing staff to cope with ever-increasing demands for certification and inspection services as the air carrier industry sought to reorganize itself in an economically deregulated operating environment.

In late 1984 a change in government occurred. The new transport minister, the Honourable Donald Mazankowski, modified not only the name of the air carrier deregulation policy, which now became Economic Regulatory Reform or ERR, but also its scope, which was expanded to include rail and the trucking industry. In the summer of 1985 the government produced a White Paper called *Freedom to Move: A Framework for Transportation Reform*. The essence of the paper is as follows:

> The Government wants a new legislative framework for Canadian transportation that will minimize government control over shippers and carriers while ensuring that the public interest is met. Competition will be emphasized. Dispute resolution will be streamlined and made less cumbersome. A new Regulatory Agency will be smaller and more accessible. The emphasis will be on providing transportation services at the lowest possible cost, subject only to the overriding priority of a high level of safety.
>
> (Exhibit 933, p. 2)

In response to concerns expressed by groups such as the Canadian Air Line Pilots Association that ERR would have a detrimental effect on safety, the minister of transport offered the following commitment in his opening statement in *Freedom to Move*:

> I would like to indicate unequivocally that the Government will neither propose nor permit any economic regulatory reform that might be detrimental to safety standards.

In a December 1985 brief submitted to the House of Commons Transport Committee, the Canadian Air Line Pilots Association predicted that under deregulation, efficiency and profit would become all-important to the carriers and that the self-policing aspect of the industry would fade. The brief stated:

> The level of aviation safety in Canada is, ostensibly, the responsibility of the Minister of Transport, who, through his Department, is charged with establishing certain standards and monitoring the industry to ensure compliance. In practice, the level of safety we have enjoyed in Canada has been dependent on air carriers' willingness and ability to operate to standards well above the minimum demanded by the Department of Transport, and on the efforts of dedicated individuals. Under deregulation, the Department of Transport will, of course, continue to monitor and enforce the same minimum safety standards, but as "efficiency" and profit become all important, the self-policing aspect of the industry will fade. Capital will be forced to trade as closely to the marginal line of safety as the enforcement agency will permit.

The brief further cautioned that the airlines' efforts to reduce costs in order to compete effectively would put negative pressure on safety standards:

> In Canada, "Freedom to Move" anticipates new entrants in the airline industry, all of whom will require an operating certificate from the Department of Transport after investigation as to their fitness. "Freedom to Move" also anticipates that airlines will have to reduce their costs to compete effectively, which will put negative pressure on safety standards. At the same time we see a reduction in air inspectors – but are assured that safety will not suffer.

It is noteworthy that the auditor-general, in his report to the House of Commons for the fiscal year ending March 31, 1985, stated that "none of the (Transport Canada) regions was able to inspect all carriers in its jurisdiction at least once a year."

Deficit Reduction: Downsizing

A major factor that contributed to the difficulties encountered in the Aviation Regulation Directorate during the latter part of the 1980s can be traced back to late 1984, shortly after deregulation of the air carrier industry had first surfaced as a government policy. A restructuring of the industry was by then beginning to get under way. Over the next three to four years demands for increased certification, inspection, and surveillance resulting from mergers, realignment of routes, and the introduction of new carriers and new equipment would be unprecedented. When questioned on the witness stand about the implementation of the policy set out in the *Freedom to Move* paper, Mr Withers, former deputy minister of transport, referred to the dilemma facing the Aviation Regulation Directorate as a result of the two incompatible government policies, ERR and deficit reduction:

> A. You can't talk about it [ERR] without talking about another government policy because while I said a moment ago that, yes, we would implement the policy laid down to us by the Minister of Transport, one is essentially saying in these major policy initiatives, that one is implementing the policy of the government, of the Ministry, of the decisions, the policy decisions of the government.
>
> Yet, another high priority policy decision of the government was deficit reduction. And the first blush of deficit reduction measures hit in Mr Wilson's economic statement of November 1984. And these – these measures that were in that impacted upon the department.
>
> The department took a second blow in terms of deficit reduction targets in the May 1985 budget which was, in financial planning terms, is hard on the heels of November '84.
>
> (Transcript, vol. 164, pp. 18–19)

Memorandum of Understanding, 1985

A memorandum of understanding (MOU) reached in 1985 between Transport Canada and the Treasury Board was to have great influence on operational groups within the department over the long term. Mr Kenneth Sinclair, assistant deputy minister, policy and coordination, in his testimony before this Commission described the MOU as follows:

> A. Yes. The Memorandum of Understanding which emerged from the budget of early 1985, I believe, the M.O.U., sir, was an agreement, an accountability agreement, between the Deputy Minister and the Treasury Board – and the Minister, I would say, and the Treasury Board that in return for the necessary discretion and authority to manage within its resources in a more unrestricted manner than is normal in the public service, the department would be asked over a five-year period to reduce its annual expenditures by approximately $400 million.
>
> So that at the end of the fifth year our operating reference level would be $400 million less than at the beginning and you would gradually work down. And that the department in terms of person-years would have reduced its size by approximately

> 1680 person-years, and that would represent about – approximately 7 percent of the department's resources.
>
> (Transcript, vol. 165, pp. 44–45)

Program Control Board

Mr Withers testified that he became deputy minister of Transport Canada in 1983. The secretary of the Treasury Board advised him at the time that Transport was considered to be a "fat" department with substantial room for overhead reduction. A subsequent consolidation of the department's financial and administrative services was undertaken. In 1984 the Program Control Board (PCB) was set up under the direction of Mr Withers.

Through the deputy minister, the Program Control Board managed the resources of Transport Canada, a department that in early 1991 involved some 21,000 person-years with an annual budget of some $3.2 billion.

The evidence of Mr Withers highlights both the origins and the intended function of the PCB. Mr Withers stated that in his previous position as Canada's chief of the defence staff, he had used a similar mechanism to appropriate resources at the Department of National Defence (DND). Referring to the DND Program Control Board, he testified:

> A. And the Program Control Board had the task of taking reference levels which were never enough to meet the operational requirements, and making them fit within the envelope, if you will, of that – of the money that was going to be provided to Defence.
>
> That has been an extremely successful method of resource allocation. And, of course, having chaired the board for three years and then as Chief of Defence Staff, having had it – its work serve me, I was very interested in doing exactly the same thing in Transport when I saw, number one, we were faced with substantial overheads; number two, we got a hit November 1984 with the economic statement; number 3, we got a bigger hit in May 1985. Then we – we did set up the Program Control Board, and if I recall correctly, I think we had it running by – about the time that the first hit came out, the November '84 statement.
>
> And its role was to – well, I want to back up again a bit from that. Knowing the status or, if you will, the image that we had in Treasury Board, one of the things that we definitely wanted to achieve was credibility. In large measure, we had advocated the responsibility to challenge to the Treasury Board.
>
> National Defence had done that 15 years previously, and National Defence rebuilt credibility with its Program Control Board to show that anything that was coming forward from

> National Defence was really a requirement, and you can count on it being valid and bang. We wanted to use the same devices to get our credibility, to take our responsibility in-house.
> (Transcript, vol. 164, pp. 20–21)

Mr Kenneth Sinclair, who has long experience on the PCB both as a member and as chairman, described in his evidence the purpose of the PCB:

> A. To ensure that the department was establishing and maintaining its credibility in terms of the justifications and the ... qualifications required in putting forward submissions to the Treasury Board through the Minister to get the Department the resourcing it requires.
>
> The Deputy Minister also expected the group to – this being the Program Control Board and the secretariat, to be of assistance to the groups in ensuring that all of the elements required in satisfying the central agency were, indeed, fully put forward on a best-case basis.
>
> The Deputy made it very clear that he had an order of priority that was to be used in the assessing of all submissions put forward by the various groups, and that the most pressing priority that was to be given top consideration for the allocation of resources was firstly, safety, security and the health of Canadians.
>
> Recently, we would add to that the environment.
> (Transcript, vol. 165, pp. 9–10)

Nielsen Task Force Recommendations, September 1985

In the fall of 1984, one of the government's first actions was to set up the Ministerial Task Force on Program Review under Mr Erik Nielsen to review all government programs and to recommend cuts and consolidations. Nineteen study teams were established to look at different areas. The task force study report dealing with transportation programs recognized the air safety concerns brought out in the A-base review. It recommended as follows:

> a. Immediately increase the resources devoted to licensing, certification and enforcement in the regulation of air safety to the levels advocated in the recent A-base review so as to ensure that the travelling public is protected, and that the industry is offered a reasonable level of service having regard for current and proposed economic regulatory reform.

b. Pursue the development of meaningful workload determinants to ensure resources keep pace with requirements.
(Economic Growth: Transportation, A Study Team Report to the *Task Force on Program Review* (1985), p. 64)

The study reiterated the need for additional funding of the regulatory arm to assure aviation safety in a deregulated environment:

> It seems apparent that the commitment by the federal government to assure aviation safety, particularly in light of the initiatives to reduce economic regulation, will require additional resources. The availability of these resources within the department's proposed budget, i.e. after the significant reductions mentioned in the May 1985 budget paper, has not been obvious. Moreover, the department is going through an internal downsizing exercise that has the potential for exacerbating the shortage in resources that currently exists.
> (Exhibit 1145, tab 4, p. 127)

Federal Aviation Administration (FAA) Experience, September 1985

By September 1985 there was, within the Aviation Regulation Directorate in Ottawa, sufficient awareness of a potential problem to cause its management to undertake a number of field trips to the United States. The purpose of the trips was to obtain the benefit of the experience gained by their FAA counterparts after six years of United States air carrier deregulation. The results of these visits are reflected in a trip report prepared by Mr Donald Douglas, then Transport Canada's director of licensing and certification.[1] Mr Douglas's testimony before this Inquiry vividly reflects the FAA perception of the impact of deregulation on that organization, including a doubling or tripling of its certification workload:

Q. Now, generally, what did they tell you?
A. They told me that there was a very, very big workload thrown on them in the certification area, and there was real urgency to expedite things, new people were wanting to start up airlines without any notice, some of the people that wanted to start up new airlines had never been in the airline business before, and they didn't really know what was involved.

---

1 "Notes on a CATA Visit to the FAA Headquarters in Washington, D.C. – September 20, 1985" (Exhibit 1104)

> And the FAA workload doubled or tripled in certification and trying to educate new carriers as to what was required. A very heavy workload.
>
> (Transcript, vol. 143, p. 42)

The observations contained in the report prepared by Mr Douglas on his Washington trip are revealing. The biggest mistake that the FAA made, according to one of their managers, was its failure to anticipate the tremendous increase in certification and inspection workload that would be generated by deregulation. In addition, the substantially lower experience and competency levels of new entrants to the air carrier industry imposed a tremendous extra workload on the air carrier inspectors:

> In [the view of the FAA], "bottom line" drives the operator [carrier] today. This was not the case prior to deregulation ...
>
> ... Instances of operators moving into equipment [aircraft] that they were not prepared to handle exist. This resulted in problems with maintenance management. In many cases, it was not possible for the many carriers to find maintenance people with the proper background. It was somewhat easier to find pilots, however, this also resulted in a great need for training.
>
> The demand for training and monitoring of training became very time consuming for FAA people and combined with this, many management people in the new companies were not familiar in any way, shape or form with aviation operations and this created a tremendous work load for air carrier inspectors.
>
> (Exhibit 1104)

Mr Douglas's focusing of attention on the doubling and tripling of the certification workload experienced by the FAA after deregulation should have been a clear and salutary warning to senior management in Transport Canada who were charged with the responsibility of fulfilling the minister's commitment not to permit ERR to compromise safety standards.

It is interesting to note that Mr Douglas makes the following statement in his report on the Washington trip: "At the time of deregulation in the United States, there was a major political thrust to reduce the size of government and this complicated the work of the FAA." There is no doubt that the situation in Canada to a large extent paralleled the American experience. The fact that the FAA experience, as reported by Mr Douglas, did not trigger alarms in the upper management strata of Transport Canada is incomprehensible. The two policies, Economic Regulatory Reform and deficit reduction, produced predictable side effects. A substantial escalation in new air carrier certification activity and a greater need for surveillance of existing air carriers created workload increases of as much as 400 per cent. At the same time, there were insufficient and diminishing numbers of qualified certification inspectors and support staff.

Mr Ian Umbach, superintendent of air carrier operations, large air carriers, in his testimony made reference to the Douglas Report and provided graphic insight into the problems facing air carrier inspectors, as seen at the working level:

> Q. And were you making submissions to your superiors saying, look, I need more staff?
> A. Yes.
> Q. So your numbers were a part of that 1,150 [person-years] requested?
> A. Yes.
> Q. And what signals were you getting from above, from your superiors?
> A. Other than losing a PY [person-year], we were getting no response.
> Q. And what were the reasons – what was your understanding?
> A. We were downsizing.
> THE COMMISSIONER: You were what; you were downsizing –
> THE WITNESS: Downsizing.
> THE COMMISSIONER: – in staff?
> THE WITNESS: Yes, sir.
> Q. So in effect, you were asking for more inspectors, but in fact, they were taking inspector positions away from you?
> A. Yes.
> Q. And what about your workload? Were they reallocating your workload or requesting you to do less work?
> A. No.
> Q. What was happening?
> A. We were doing more with less.

Mr Umbach went on to say:

> A. And we were increasing our overtime. We were waiving more PPCs [pilot proficiency checks] than we used to do. We were paying less attention to certain areas than we used to.
>
> I was trying to offload some of our normal surveillance responsibilities. And we, in effect, were trying to do as much as we could with the people we had.
>
> (Transcript, vol. 138, pp. 80–82)

Mr William Slaughter, director of Transport Canada's Flight Standards Branch, when questioned as to the transport minister's commitment that ERR would not adversely affect safety, expressed his view that the minister of transport never at any time retreated from that commitment.

Mr Slaughter, however, acknowledged that at least one level of aviation safety had been compromised:

> Q. So the Minister has never backed down from that particular commitment; has he?
> A. Not that I am aware of, no, sir.
> Q. But isn't it a fact that the evidence we have before this Commission from Mr Umbach, from Mr MacGregor, from the Douglas report and from your own agreement, in general, with those reports that safety has been compromised by economic regulatory reform, that it has stretched your resources to the point where you cannot assure the public that the same level of safety is being maintained as was being maintained before?
> A. Yes, sir, we certainly have indicated that we can't maintain the monitoring of the industry that we would intend to in the interests of safety, yes.
>
> (Transcript, vol. 147, p. 88)

30 THE EFFECTS OF DEREGULATION AND DOWNSIZING ON AVIATION SAFETY

"Aviation Safety in a Changing Environment," May 1986

By May 1986 the warnings generated by the Federal Aviation Administration (FAA) experience with deregulation, combined with the already present effects of Canadian Economic Regulatory Reform (ERR), prompted the Aviation Regulation Directorate to prepare a report, "Aviation Safety in a Changing Environment," for the department's senior management. This report, referred to throughout the Inquiry as the Douglas Report, after the principal author Mr Donald Douglas, warned of the impact of ERR on the Canadian air carrier industry. It recommended measures for Transport Canada to take in order to cope with the anticipated increased workload resulting from ERR. It is of significance in this review of the effects of ERR to recall Part Five of my Report wherein I examined in detail the experience of Air Ontario as it positioned itself to meet the challenges and opportunities of a deregulated Canadian air carrier industry. The Douglas Report of May 28, 1986, outlined a number of already occurring and anticipated consequences of ERR, many of which appear prophetic in their application to the Air Ontario scenario:

- Higher rate of formation of new companies;
- Expansion of the number of bases of operation of existing companies, especially in geographic regions outside of their existing field of operations;
- Introduction of new and larger aircraft into existing companies;
- Increased leasing of foreign aircraft;
- Sharing of aircraft between carriers;
- New management personnel for expansion of companies;
- Thinning of existing management;
- Hiring of personnel who may not be fully qualified;
- Rapid expansion into unfamiliar areas of operation;

- Rapid acquisition of new equipment;
- Increased contracting out of services (training, maintenance, etc.);
- Fixed wing carriers following the lead of rotary wing carriers in becoming more migratory.

All of the above make the regulatory task far more complex than it was prior to 1984.

(Exhibit 1057, p. 11)

In addition, in 1985, following certain accident investigations shortly after deregulation in the United States, the FAA undertook a full-scale inspection program that it called the National Air Transportation Inspection Program (NATI). From NATI, the FAA produced the following list, which was included as Annex B in the Douglas Report.

DEFICIENCIES ENCOUNTERED IN 1985
NATIONAL AIR TRANSPORTATION INSPECTION PROGRAM

1) OPERATIONS

a) Improper weight and balance control procedures and inaccurate or incomplete records and/or computations.

b) Inaccurate or incomplete flight and duty time records.

c) Lack of, inaccurate, or incomplete flight and cabin crew training records.

d) Lack of, inaccurate, or incomplete flight crew qualification and currency records, including medicals.

e) Non-compliance with approved manual procedures and checklists.

f) Flight crews not recording maintenance deficiencies in aircraft log books.

g) Inexperienced, unqualified, over-extended, and/or ineffective management personnel.

h) Lack of control of carry-on baggage.

i) Non-compliance with approved training programs.

j) Use of training programs inappropriate for the aircraft being used or the operation being conducted.

k) Flight and cabin crews not having required certificates, charts, equipment, and current manuals in their possession.

l) Lack of current company manuals at stations.

m) Lack of knowledge and improper application of the intent of the Minimum Equipment List (MEL).

2) <u>AIRWORTHINESS</u>

a) Personnel not properly trained or authorized to perform Required Inspection Items (RII) procedures.

b) Improper or lack of performance of RII work.

c) Lack of or inadequate training programs.

d) Lack of, inaccurate, or incomplete training records.

e) Unfamiliarity with company policy, procedures, and maintenance manual requirements.

f) Continuing analysis and surveillance programs improperly implemented.

g) Lack of knowledge and improper application of the intent of the Minimum Equipment List (MEL).

h) Maintenance programs inappropriate or incompatible for the aircraft being used or the operation being conducted.

i) Inappropriate or absent checklists for maintenance tasks performed or for type of maintenance concept approved for the air carrier.

j) Incomplete, inaccurate or lack of records of Airworthiness Directive compliance or time control requirements.

k) Aircraft not properly equipped with required emergency equipment.

l) Unauthorized or improper modifications and/or repairs.

m) Inexperienced, unqualified and/or ineffective management personnel.

n) Open discrepancies after performing major maintenance.

o) Stations not properly equipped.

p) Special tools and equipment not available or out of required calibration.

Once again, a number of the items listed in Annex B find direct application in the study of Air Ontario.

The expectations outlined in the Douglas Report proved to be accurate and were realized over the next three years as the Canadian air carrier industry, in response to ERR, underwent a major restructuring. Mr Douglas, in his report, summarized the profound effect of ERR on the Canadian situation as follows:

> Economic Regulatory Reform, combined with earlier reform measures and the rebound from the recent economic recession, is having a profound effect on our safety regulation system. These effects are not only in terms of increased workload, with some 80 new air carriers being certified annually, but also in the complexity of the task at hand. Mergers, inter-airline leases, contract maintenance and training are all relatively new phenomena that make the inspectors job more difficult and time consuming. We face these challenges along with the Minister of Transport's public directive that safety will not be compromised by any changes in economic regulation.
>
> (Exhibit 1057, p. 30)

Among the report's 28 recommendations is a call for a detailed review of current resources. The report pointed to the need for increased resources to cope with the demands of the larger and more complex Canadian air carrier industry. The report received wide distribution and was used as a basis for briefing the deputy minister of the day, Mr Ramsey Withers, as well as Commons and Senate committees examining the various implications of ERR.

The Lafleur Memorandum, May 1986

The rapid changes occurring within the air carrier industry had a significant influence on Aviation Regulation personnel, particularly in the Ontario and Quebec regions. On May 22, 1986, some six days prior to the release of the Douglas Report, a comprehensive memorandum produced by R.S. Lafleur, director-general, aviation regulation, to Claude LaFrance, his superior and the assistant deputy minister, aviation group, indicated that the Aviation Regulation Directorate was already in serious difficulty:

> I am writing to apprise you of the resource situation in the Aviation Regulation Directorate. As you know, the Directorate carries out the Regulatory Program on the basis of safety standards which require specific numbers of certificates and licences to be issued each year, and specific numbers of inspections and audits to be carried out. Over the past eighteen months, the Minister has made a number of public statements that regulatory reform would not be allowed to compromise safety. In order to ensure that this is the case, the Regulatory Program must be carried out in accordance with the established safety standards. I am concerned that due to resource limitation, particularly as a result of staffing freezes, the Aviation Regulation Directorate is not able to fully carry out the Regulatory Program. For some time now, my managers have brought to my attention increasing curtailment of program activity made inevitable by resource limitations.
>
> (Exhibit 1157, p. 1)

Mr Lafleur pointed to a substantial shortfall in Aviation Regulation Directorate personnel that was being exacerbated by a staffing freeze:

> Based on established safety standards, the total requirement of the Directorate is therefore slightly over 1200 person-years. With a current strength of 859, the total shortfall in actual people carrying out the program is 341.
>
> This year, an interim allocation of 909 is being delegated to the Directorate. While this is substantially less than the total requirement of the Directorate, it nevertheless represents an increase over the allocation in previous years. However, with recurring staffing freezes, it has not yet been possible for us to make use of the increase and every time a position becomes vacant, the staffing freeze prevents us from staffing it in a timely fashion. As a result, the Program is losing strength rather than gaining it.
>
> (Exhibit 1157, p. 2)

Given the aviation safety implications contained in Mr Lafleur's memorandum, one would expect it to have been accorded a formal response. I believe it is significant that, despite vigorous investigative efforts on the part of Commission staff, a reply to this forceful and urgent memorandum was not discovered in Transport Canada records, nor could its recipient, Mr LaFrance, while on the witness stand, recall a specific response. The fact that there was no response to the memorandum can only be regarded as a serious omission on the part of senior management in Transport Canada.

Preliminary Review of Aviation Regulation, June 1987

In the months following Mr Lafleur's memorandum, the assistant deputy minister, review (ADMR), conducted a preliminary review of the Aviation Regulation Directorate. A report was not published until June 1987. The objectives of the ADMR preliminary review were:

> - to assess the impact of ERR on the Directorate's activities vis-a-vis the American experience with deregulation; and
> - to provide a planning base for the upcoming comprehensive audit (1987-88) of the departmental regulatory activities, of which Aviation Regulation comprises an important element.
>
> (Exhibit 1158)

The 1987 report confirmed the fears expressed in the original deregulation impact assessment carried out independently by Ontario Region almost three years earlier. The rate of change within the air carrier industry resulting from the new air policy began in 1985, increased steadily through 1986 and 1987, and peaked in 1988 and 1989. Concerning the explosion of activity in the Canadian aviation industry that begin in 1985–86, Mr Withers testified as follows:

> Q. In any event, although the legislation ... was promulgated and became fixed in '88, the activity, the allowance to deregulate in Economic Regulatory Reform, when would that happen and start to affect your department?
>
> A. Well, the impact started to be felt, to the best of my recollection, in about the '85 –'86 time frame, in there, we started to see the emergence of new carriers. We started to see mergers taking place. We started to see what is today for Canadian Airlines International its Canadian Partner system. We had Air Canada's connector system, all of these started to move during that period.
>
> (Transcript, vol. 164, pp. 56–57)

This evidence, indicating that the impact of ERR started to be felt in 1985–86, echoed that given previously by virtually all of the Transport Canada witnesses involved in Aviation Regulation and is confirmed by a large body of Transport Canada internal correspondence provided to the Commission.

If Aviation Regulation was to be in a position to respond to the escalating aviation industry demands upon its regulatory and certification areas, it would have had to take urgent measures to have the required resources and procedures in place in 1985 or 1986 at the latest.

The evidence is clear that this was not done and that the air carrier certification and inspection personnel of the Aviation Regulation Directorate, despite their best efforts, were unable to cope in an effective way with rapidly increasing certification and inspection workloads. When the ADMR Preliminary Review report was published in June 1987, the time for preparation for the onslaught of industry activity had long since passed and the regulators had already been overcome by the events. The executive summary to the report emphasises that this was in fact the case and that the senior management of Transport Canada was, in effect, paralysed by reason of the incompatible policies of ERR and fiscal restraint:

> Regulatory Reform of the domestic airline industry was introduced at a time when the department possessed neither sufficient trained resources, the required planning and operational processes nor the necessary enforcement capability required to effectively monitor and foster aviation industry compliance with established safety legislation, regulations and standards. In this respect, the Department has generally paralleled the American experience with deregulation.
>
> The 1984 decision to relax the regulation of the domestic airline industry, combined with an improved economic situation and the expansion of the Aviation Regulation mandate, have all served to amplify problems which have compromised the Directorate's effectiveness in the past. Specifically, the following major areas of concern were noted during the preliminary (1987 ADMR) review:
>
> a) The shortage of trained, experienced inspection staff and other personnel has seriously impacted on the Directorate's ability to effectively perform its mandated tasks;
> b) The increase in certification workload under ERR, resulting from the need to service new and expanding air carriers, is affecting the Directorate's ability to effectively complete its ongoing inspection program, and thereby assure industry compliance with established legislation, regulations and standards;
> c) The Directorate's current program of monitoring air carriers and related maintenance organizations is inadequate to assess the level of compliance of the commercial aviation industry with established legislation, regulations and standards;
> d) The lack of a sufficiently integrated enforcement program and comprehensive system of administrative fines may negatively impact on the Directorate's ability to foster commercial aviation compliance with safety legislation, regulations and standards;
> e) Concerns regarding the system of actioning departmental responses to CASB findings, combined with the possible legal implications arising from the performance of confidential safety surveys, may also implicate the Department should a serious accident occur. Limitations in the area of aviation occurrence

> analysis and the perceived need for a more coordinated regional effort in the performance of safety analysis and promotional tasks, may involve some duplication of effort and could preclude the most effective allocation of limited resources to areas of greatest aviation risk.

The report went on to state:

> Meanwhile, a vast array of studies of various organizational issues have been completed or are in progress, addressing other management concerns, not necessarily directly related to regulatory reform.
>
> Despite these initiatives, it would appear reasonable to assume that the Directorate is presently unable to provide senior management with sufficient assurance that the aviation industry is in compliance with existing safety legislation, regulations and standards.
>
> (Exhibit 1145, tab 7)

This was the first sign of recognition within the department's corporate body that the warnings of 1984, 1985, and 1986 had become reality and that Transport Canada's Aviation Regulation Program was in serious trouble. That conclusion, drawn in 1987, certainly was supported by evidence before this Inquiry and, indeed, the situation has further deteriorated since that time.

The Inspection/Monitoring Function

As deficiencies in the operation of the Air Ontario F-28 program and in Air Ontario operations and procedures were revealed during the hearings, questions arose as to why these shortfalls had not been identified by the regulator through its inspection process. The Airworthiness and Flight Standards organizations direct the regulatory function of Transport Canada as it applies to the air carriers, and the actual hands-on monitoring of that sector of the aviation industry is performed by inspectors. Compliance with regulations, orders, and standards pertaining to flight operations is monitored by air carrier inspectors and by cabin safety and dangerous goods inspectors. Similar monitoring pertaining to airworthiness and maintenance is conducted by airworthiness technical inspectors.

The testimony of numerous witnesses revealed that many of the inspection programs were in serious trouble during the time leading up to the Air Ontario F-28 accident at Dryden. There was a high turnover of inspectors and a shortage of qualified applicants for replacement, particularly in the Ontario Region. As a consequence of the explosive demands upon Transport Canada, the training of inspectors was sporadic, inspector competency became questionable, and workloads associated with the increasing aviation activity were excessive.

Air Carrier Operations Inspection

The duties and responsibilities of air carrier operations inspectors are outlined in the Air Carrier Inspection Manual, which sets out the policies and procedures for monitoring air carrier flight operations conformance with the Air Regulations and Air Navigation Orders. The inspectors monitor air carrier operations by conducting in-flight inspections, check rides, audits, and reviews. They also participate in the approval process associated with company certification, including operations manuals as well as flight and cabin crew training programs.

The allocation of responsibility for the inspection of companies utilizing large aircraft was in the process of change at the time of the introduction of the F-28 aircraft to Air Ontario. This transfer was occurring as a result of increased activity associated with ERR whereby regional carriers that were previously equipped with smaller aircraft were in many instances acquiring large aircraft. As a result, some of the responsibility for inspecting companies equipped with large aircraft was transferred from the headquarters heavy air carrier inspector group to the regions. Mr Donald Sinclair, former Ontario Region manager of air carrier operations, reviewed the changes in the operational structure of commercial air carriers as far back as 1980. He advised that these changes had been brought about by a number of companies acquiring larger and more advanced aircraft. Previously, air carriers such as Air Canada, Wardair, and Canadian Pacific were the only companies operating large jet transport aircraft. As companies like Air Ontario and Bradley First Air acquired aircraft such as the F-28 and the B727, regional inspectors had to have type qualifications to conduct check rides on those aircraft. Mr William Slaughter, director of Transport Canada's Flight Standards Branch, explained in his evidence:

> A. So now we have gotten away from weight of aircraft [as a criterion for assigning inspection responsibility]. In fact, some of the traditional regions have large aircraft. Witness Ontario region has First Air as one of their carriers, and First Air, of course, is flying 727s.
>
> (Transcript, vol. 144, p. 24)

Another change at the organizational level was the formation of the headquarters-based Air Carrier Operations International/National Division (Seventh Region). As Mr Slaughter described it:

A. Fundamentally, the regions apply the operational standards and do the inspections and the headquarters develop the programs.
The seventh region, or the international organization, although they were located in Ottawa, really had regional responsibilities, because they were applying the standards to the specific carriers that were assigned to them.
(Transcript, vol. 144, pp. 22–23)

The changeover in responsibility between region and headquarters was occurring at a time when the full impact of expansion in activity was being experienced. Implementation of such a jurisdictional changeover presented its own problems. Mr Donald Sinclair indicated that the intent of these changes was to consolidate responsibility for the operators of the large air carrier aircraft within the Seventh Region. The process became unwieldy, however, in dealing with companies that operate several types of aircraft; for example, Bradley First Air operated not only the large B727 and the HS-748, but also the smaller Twin Otters; Air Ontario operated not only the large F-28 and Convair 580, but also the Dash-8 and the smaller Beech 99 aircraft.

The reorganization, although designed to improve the regulatory monitoring capability, experienced some difficulty in its early stages. Mr Donald Sinclair addressed the situation:

Q. When is the first time, sir, that you heard of this new, if I can call it, the new methodology going towards the seventh region concept? When did that first come to your attention?
A. It would be some time in the fall of, I believe, 1988. It would have been passed on to me by the regional director, having been discussed at the aviation regulation management board that met four times yearly.
Q. Mr Sinclair, would it be fair to say that in the years '88, '89, when this evolution was ongoing, that the lines of jurisdiction between regions, headquarters, seventh region were fuzzy, to say the least?
A. That is a good description.
(Transcript, vol. 142, p. 16)

The regions were also expected to become more directly involved in inspection processes involving more advanced equipment. In order to deal with the large aircraft now in use in the Ontario Region, Mr Donald Sinclair created the Air Carrier Inspection, Large Aeroplanes Division, in his branch in January 1988. Mr Martin Brayman, superintendent of the section, explained his understanding of its establishment:

A. ... all the existing regional carriers were moving up into bigger equipment. Several new carriers had made applications for operating certificates. And I believe Don's idea was to develop a shop in the Ontario region, parallel to heavy air carrier in Ottawa, in order to speed up the certification and inspection process so that we could meet the requirement.

Q. So it was an attempt to meet the perceived and actual expansion of air carrier activity in your region, being Ontario region?

A. That's true.

(Transcript, vol. 131, p. 9)

In this transitionary period, the Ontario Region was faced with the introduction of the F-28 operation into Air Ontario.

Ontario Region, Air Carrier Inspection, Large Aeroplanes Division

Mr Brayman assumed the position of superintendent, air carrier inspection, large aeroplanes, in the Ontario Region in January 1988 and shortly thereafter was assigned two new inspectors. Mr Randy Pitcher joined Transport Canada in mid-February 1988 and Mr William Brooks arrived in March 1988. Mr Brayman described the background of these new inspectors as follows:

A. Bill Brooks was an extremely qualified captain. He had been flying Dash 8s for quite some time with City Express and because of that background and experience, fitted in very, very well because, as you know – or don't know – at that time, Air Ontario was undergoing a terrific expansion in London and ... our Dash 8 inspector had left the department, and Bill fitted in and took up the slack.

... Randy's background was somewhat limited. We needed ... someone to go on the F-28.

(Transcript, vol. 131, pp. 10–11)

Mr Pitcher's flying background included time on the Grumman G2 aircraft and the BAC 1-11, which were somewhat similar to the engine output and weight classification of the F-28.

Mr Brayman explained his plans for these two new inspectors. Mr Pitcher was to proceed on the F-28 course as soon as possible, so he could become lead inspector for the F-28 operation with Air Ontario, a position forecast to commence in the summer of 1988. Mr Brooks was to become the principal company inspector for Air Ontario. Air Ontario at that time was commencing its transition to the Dash-8 aircraft, which would eventually replace the existing Convair 580s.

It is symptomatic of the pressures of the times that plans were being made for these two new inspectors to assume such responsibility within the early months of their employment with Transport Canada. Mr Brayman testified that the time required for an inspector to be fully qualified in all respects was from two to two-and-a-half years. Similar estimates were provided by Mr Donald Sinclair and other inspectors. One of the contributing factors to this fast-tracking of neophyte inspectors into positions of full responsibility was the difficulty encountered by Transport Canada in keeping experienced inspectors. Mr Brayman addressed that subject as follows:

> A. Every time we got a well-qualified inspector, he would either disappear off to the airlines or be snatched up by heavy air carrier in Ottawa. So we went through a lot of inspectors.
> Q. So there was competition for some of your well-qualified people?
> A. During that period, there was competition everywhere. Industry was competing for more qualified people, we were competing for more qualified people. Ottawa, and I refer to air carrier in Ottawa, they were competing. It was a very difficult time for the whole industry.
>
> (Transcript, vol. 131, pp. 25–26)

Operations Inspector Training

As this Inquiry heard of the rapidity with which new inspectors were assigned to responsible positions, I came to doubt the adequacy of their preparedness to assume such authority. Applicants for inspector positions must have certain qualifications, including pilot licences, instrument ratings, endorsements of proficiency on certain types and classes of aircraft, and, in some cases, instructor ratings. There is, however, no available course of instruction or study external to Transport Canada that provides the special skills, knowledge, and techniques peculiar to and necessary for inspection duties.

On March 11, 1991, Mr Richard Peters, chairman of the Aircraft Operations Group (AOG), submitted a brief to this Commission. The AOG represents the civil aviation inspectors of Transport Canada. Mr Peters was granted observer status to this Inquiry. At appendix G of the brief is a memorandum dated February 28, 1991, from the senior inspector of the Vancouver Air Carrier Operations Branch addressed to the superintendent, Air Carrier Operations (International/National). The memorandum emphasizes the importance of training for air carrier inspectors and the inadequacies of present systems:

> 8. Among new inspectors and CCPs [company check pilots] the most often heard remark concerns being thrown to the wolves without adequate training. While Transport Canada has a basic inspectors course, it does not have a program other than OJT [on-job-training] to prepare inspectors for the pitfalls inherent in working with the large aircraft segment of the industry. Similarly, while CCPs

> receive training of an ICP [instrument check pilot] nature they are not well informed or aware of their legal responsibilities towards the Crown, nor are they formally advised of pitfalls, or of the support which the Crown would provide in event of challenge or legal proceedings resulting from their actions. These things need to be addressed. We believe that a proper instructional program professionally taught would be of benefit and suggest that a full time person could be employed to develop and instruct a program designed to meet the specific needs of inspectors and CCPs operating on large aeroplanes.
>
> 9. Since Air Carrier Inspectors sit in judgement of, and make decisions which can seriously effect the livelihood of others it is important that they have and be perceived as having the full right of and qualification for such authority. Nothing could be more counter-productive to a safety inspection program than to have unqualified people making the observations and decisions. It is, therefore, imperative that the training and qualifications of all of our inspectors be of the highest order (both in the field and at headquarters) and that it be perceived as such. Surely, only the very best people with the best training, would be acceptable for advising the Minister regarding the duties assigned to him by the people of Canada.

During the Inquiry, Mr Pitcher, who joined Transport Canada in mid-February 1988, was questioned about his training with Transport Canada:

> Q. ... I just want to narrow down this issue of the delegation of authority first.
> If you can recall generally when you received your delegation of authority?
> A. I don't recall. I believe it likely was the latter part of March 1988 or April. I really don't remember.
> Q. So it would have been within a couple of months, perhaps, of your starting in the position?
> A. Yes.
> Q. At the time that you received your delegation of authority, was there any explanation or briefing given to you as to the significance of the delegation of authority?
> A. I believe I was briefed on what not to do. I can certainly tell you that I was not encouraged or sent out into the field to, sort of, you know, wear my black hat, as it were.
>
> (Transcript, vol. 126, pp. 155–56)

Mr Pitcher provided the Inquiry with an air carrier inspector's work diary (Exhibit 982), which included the following significant items:

1988	
April 22	Received authority to conduct instrument rating and renewal check rides on behalf of TC
May 9–13	Attended audit training course
May 19	Conducted aircraft inspection on F-28 aircraft at Air Ontario
July 29	Commenced training on F-28 aircraft with Piedmont Airlines
October 17	Commenced TC orientation course and enforcement course
November 7	Conducted first check rides as check pilot on F-28 aircraft
1989	
January 16	Commenced air carrier inspectors specialist course

The points of concern here are that Mr Pitcher had been delegated inspector authority and was conducting flight checks for instrument rating renewals and pilot proficiency checks on candidates within ten weeks of joining Transport Canada. The instrument flight check instruction he received to qualify him for conduct of check rides was done through a monitoring system with the Transport Canada flight operations organization based at Lester B. Pearson International Airport. The training he had received by that time did not include the Transport Canada basic orientation, introduction to enforcement, or the air carrier inspectors training courses. The remainder of the job-related knowledge he acquired prior to performing these functions was obtained through self-study or by accompanying other inspectors on their routine duties. Most importantly, by November 7, 1988, he was conducting check rides on F-28 pilots, was designated the lead inspector for that aircraft, and was therefore the primary Transport Canada authority for Air Ontario regarding operation of their newly acquired F-28s. He did not, however, attend the air carrier inspectors formal training course until January 1989.

Mr Brooks's training was provided in a similar manner. In fact, Mr Brooks, although appointed Air Ontario principal inspector in the spring of 1988, took the orientation and enforcement courses at the same time as Mr Pitcher. Neither inspector received his air carrier inspector specialty training course until January 1989, yet both had been performing inspection functions since early 1988. They were placed in highly responsible positions during that critical transitionary period in which Austin Airways was merging with Air Ontario Limited to form Air Ontario Inc.

I doubt very much that the air carriers and the travelling public were adequately served considering the level of knowledge, training, and inspector competence acquired by inspectors under such circumstances.

The aviation industry and the fare-paying customer are entitled to expect that the inspectors representing the regulatory authority are adequately trained and qualified to perform the duties expected of them, and that they are capable of providing sound judgement in the discharge of their responsibilities. In the case of Mr Pitcher and Mr Brooks, however, there was no formal scheduled training and no certification program provided by Transport Canada to assure the competency that should be a prerequisite to the all-important air carrier inspection responsibilities.

Air Carrier Airworthiness Inspection

Mr Ole Nielsen, airworthiness superintendent of air carrier inspection for the Ontario Region, explained in evidence before this Inquiry that while the region is responsible for the direct monitoring of air carrier maintenance programs, there is ongoing contact by the region with headquarters for policy direction and guidance for unusual situations. Principal airworthiness inspectors are assigned to specific air carriers to monitor carrier operations and to ensure compliance with airworthiness standards.

At the time of the introduction of the F-28 aircraft into Air Ontario's operations in June 1988, Mr Nielsen, as principal inspector for that carrier, was directly involved in the formulation and approval of the initial Air Ontario Maintenance Control Manual (Exhibit 319). He had also participated in the initial airworthiness inspection of the F-28 aircraft being leased by Air Ontario from Transport Aérien Transrégional (TAT) in Europe. In early 1988 Mr Nielsen was promoted to his position as superintendent and was succeeded by Mr Wesley Watson as principal airworthiness inspector for Air Ontario. The inspector filling this position is responsible for followup action with respect to deficiencies identified in audits carried out on Air Ontario's operations. Shortly after Mr Watson's appointment, he too was replaced as the principal inspector by Mr Alexander Brytak of the London District Office. This lack of continuity in the position of principal inspector of the Air Ontario F-28 program was not, in my view, conducive to proper monitoring of that critical program by Transport Canada.

In addition to these personnel and organizational changes in the Ontario Region, Mr Nielsen explained that the Airworthiness Branch of the Ontario Region was beginning to suffer from a lack of experienced inspectors. He said that the more senior inspectors were being attracted to positions with industry, which in effect doubled the salary they were offered by Transport Canada. As a result, less experienced inspectors were expected to assume fairly senior positions because there was no one more qualified left to fill their jobs. Mr Nielsen described the inspection situation in 1988:

> A. We were seven or eight, and so we lost three ...
> So Mr Watson ended up taking over as sort of the odd man out, because we didn't have anybody else at the time to handle that, because the other inspectors were already charged with their workloads.
> (Transcript, vol. 129, p. 74)

Mr Nielsen confirmed that Mr Watson had, at that time, been less than a year with Transport Canada and had not, to Mr Nielsen's recollection, completed his training or received full delegation of authority. He agreed that Mr Watson had been "sort of thrust into this job in June 1988" because the more experienced inspectors were leaving Transport Canada for higher-paying jobs.

Airworthiness Inspector Training

Mr Nielsen's description of the cursory and unstructured training program that was provided by Transport Canada for its airworthiness air carrier inspectors bears similarities to that provided for air carrier operations inspectors:

> A. So the majority of the training for the first year was on the job. I took a five-week course in Oklahoma City. At that time, it was called the air carrier avionics inspector indoctrination course, and it dealt mainly with the Federal Air Regulations and the application of those regulations in the U.S. It had limited application in Canada, but it was certainly of great benefit to me.
> And then the next training we had over that first year – or that I had over that first year was an in-house course on flight authorities, and following that course, and the on-the-job training that I had taken for that first year, I was issued delegation of authority at which time I became responsible for Bradley Air Services, and ... my responsibility for Bradley evolved either concurrently with my delegation of authority or slightly before, I just don't recall.
> (Transcript, vol. 129, p. 18)

Mr Nielsen, in addition to his qualifications as an airworthiness inspector, was an experienced albeit not current pilot, a training officer, and a supervisor before he joined Transport Canada. Notwithstanding his previous experience, he testified that it was one-and-a-half to two years before he "felt comfortable in making any relevant regulatory decisions" (Transcript, vol. 129, p. 73).

Both the Airworthiness and Operations branches, then, were having difficulty in the deregulated environment obtaining candidates to be trained as inspectors. At the same time, Transport Canada failed to provide a consolidated and timely training program for its inspector-trainees to enable them to acquire the competency necessary for credible inspection and surveillance of the air carrier industry.

Inspector Training: General

The entire subject of inspector competency and training has been studied on numerous occasions by internal Transport Canada organizations and through external studies. A preliminary review of the Aviation Regulation Directorate was conducted by the Internal Audit Branch in June 1987. With regard to training, its report stated:

> Historically, the Aviation Regulation Directorate has lacked a comprehensive internal training program. Progress is being made but currently there exists no national data base to capture training backlogs and to identify who has been trained and who requires what training. Most of the work to date has been performed without the benefit of a formal comprehensive training policy, with the regional managers being primarily responsible for the identification of training requirements. The development of such a training policy is, however, scheduled for completion in December 1987.
>
> (Exhibit 1158, p. 8)

This report clearly documented the Aviation Regulation Directorate's lack of attention and dedication to training, particularly in view of the increasing shortage of experienced inspectors. It pointed out that, as a result, mandated tasks were performed with "a significant number of new, inexperienced staff."

In 1988 a special report was prepared for the director-general, aviation regulation, that was intended to assess the impact of the issues raised by the Internal Audit Branch. Following are excerpts from that document with respect to training:

> Although recruitment provides candidates with basic qualifications there is no source-market of fully trained and qualified inspectors. The aviation industry has the right to be assured that inspectors, who will assess its performance, have the necessary skills, knowledge and experience. Failure to provide that assurance leads to reduced credibility, distrust and eventual disdain of the regulatory function. It is imperative therefore that sound training be provided and inspectors be certified as having achieved accepted levels of competency prior to assuming an official inspection role.
>
> ...
>
> [Transport Canada should] [d]esign a comprehensive training policy to address the entire training needs of Aviation Regulation from entry-to-retirement. The policy should assure certification and

> recertification of competencies throughout careers thereby ensuring technical knowledge and expertise at a level which should be expected by industry and consistent with a clear role statement.
>
> (Exhibit 1313, pp. 10, 14)

In August 1989 the Management Consulting Services Branch of Transport Canada issued the Review of Civil Aviation Inspector/Engineer Technical Training Program, which reiterated many of these recommendations, particularly with regard to basic training:

> The initial basic training for all Civil Aviation inspectors/engineers, with the exception of Air Worthiness inspectors, should be provided in a single segment course string consisting of the Introduction to Enforcement Course followed by the Basic Specialty Course. This training should be provided to new inspectors/engineers within the first three to six months of employment.
>
> (p. 39)

The study called attention to the delay in providing a sound training policy for the Transport Canada aviation organization:

> A Civil Aviation Inspector/Engineer Technical Training Policy has been in draft form for over two years. This policy endeavours to specifically describe the key mandatory elements of the inspector/engineer technical training program and the role of AARE [Director Inspector/Engineer Training and Development] and the other organizations in support of them.
>
> The policy has never been fully developed to categorically define the technical training program and the associated roles and responsibilities of not only AARE but the other Aviation Group organizations supporting the program. A recent revision to the policy has been proposed for senior management approval. This policy is a basic statement identifying the framework and sequence for technical training courses for inspectors/engineers.
>
> The policy should cover the total technical training lifecycle in terms of structures, process and associated roles and responsibilities, to ensure that all critical elements of an effective training program are clearly enunciated. The policy should also address other areas of inspector/engineer training to ensure the organizational mandate for each aspect of the total program is well understood.
>
> (p. 55)

The subject of inspector training has been studied over a considerable period of time, but with little result. Inspector training that ensures the operating integrity of our nation's air carriers is in my view essential. The time has come for Transport Canada to take positive action to provide clear policy in this vital area and to implement an effective inspector training program.

Delegation of Authority

The minister may delegate authority to approved individuals and agencies, both within and outside the government. A document, known within Transport Canada as "The Delegation Document" (Exhibit 958) dated May 28, 1990, contains 58 schedules, each of which indicates the authorities that may be delegated to the incumbent of a specific Transport Canada position. The document contains a proviso that "This authorization may be limited by superior officers in respect of subordinates who lack the knowledge, experience or training needed to exercise the powers listed in the schedule or who are not required to exercise responsibilities related to such powers." A statement on an individual inspector's identification card indicates which of these schedules of authorities have been so delegated. Inspectors also receive credential cards identifying them as persons authorized to make inspections and inquiries in accordance with the provisions of the Air Regulations.

Delegation may also be made to appropriate segments of industry such as designated flight-test examiners, company check pilots, and approved maintenance organizations. These persons or agencies may be approved to provide services, perform inspections, and conduct check rides, and their authorities are usually provided in the form of written letters of authorization.

These two aspects of delegated authorities were addressed in some detail during the hearings. Points of concern were raised regarding the apparent inability of Transport Canada to provide enough qualified inspectors to perform all of the inspection duties demanded of them. Time and again, when faced with questions why a certain regulatory function, such as an inspection, was not performed or a Transport Canada check ride waived, the responses were that there were insufficient qualified personnel available to meet such demands. Inevitably, questions arose as to alternative methods to provide such surveillance and the possibility of delegating further authority to qualified sectors of the aviation industry. Questions also arose as to the competence of inspectors to perform their delegated functions as well as their availability to conduct such activities.

Delegation of Authority to Inspectors

Transport Canada was experiencing obvious post-deregulation problems in attracting suitable applicants for inspector positions, retaining them, and providing adequate and timely training. Inspectors Brayman, Donald Sinclair, and Nielsen expressed the view that inspectors were not qualified to conduct all of their inspection duties until they had been on the job for anywhere from 18 months to two-and-a-half years. Nevertheless, these witnesses testified that inspectors such as Mr Pitcher and Mr

Brooks were issued credentials authorizing their delegation of authority as trained and competent inspectors prior to completion of their formal training. The training that was planned or proposed for these inspectors seems to have been designed to prepare them, in terms of knowledge of their duties and the regulations, to a level that would support the delegation of authority. However, evidence indicates they were assigned these tasks and responsibilities before they were properly trained to fulfil them.

I have concluded, therefore, that the Transport Canada training policy and program for such inspectors was inadequate and, as a consequence, the organization was not able to assure the competency of inspectors at the time they were issued their delegated authority. In view of these inadequacies, the workload expected and demanded of the Aviation Regulation Directorate exceeded the capability of its workforce. Other means should have been devised to provide surveillance at a level necessary for the assurance of aviation safety. Further delegation of some regulatory functions was one option.

Delegation of Authority to Industry

Additional delegation of aviation regulation authority to external agencies has been the subject of previous studies conducted by or on behalf of Transport Canada in 1982, 1986, 1987, and 1988. Although each of these studies recommended additional delegation, there is little evidence of any consequent action. The latest study, conducted by Transport Canada's Management Services Branch in 1990, examined the present system of external delegations, alternatives of additional delegations, and their impact on the regulatory programs and its resources. Recommendations were, once again, made for further delegation of certain authorities to persons or agencies external to Transport Canada.

The 1990 Management Services study concluded that a potential exists for delegation in several areas that would yield an annual estimated savings to Transport Canada in the range of 86 to 90 person-years. The study warns, however, that its specific recommendations should form only a basis for discussion and that detailed risk assessment must be made as part of the analysis process. Many of the proposed delegations would require the cooperation of industry and considerable consultation. The report suggests there is potential for additional delegation of the following regulatory functions:

- Expansion of the check pilot program to individuals outside of air carriers (e.g., qualified freelance training organizations);
- Registration of aircraft and approval of markings;
- Development, administration, invigilation of certain functions of personnel licensing;

- Expansion of the airworthiness inspection representatives' (AIR) authorities;
- Expansion of the designated flight test examiner (DFTE) program to include foreign-based IFR flight tests for renewal of Canadian pilot licences; and
- The designated amateur-built inspection program.

(Based on Exhibit 1315, pp. 2–3)

The study also recommends in-depth consideration of the possibility of delegating flight standards and airworthiness audits to third parties.

The study observes there is a need for consensus within Aviation Regulation as to the desired focus of Transport Canada programs for the future. The questions raised by the study include the extent to which the focus should be on service versus regulation; the extent to which service activities contribute towards improved compliance; and what the implications for safety will be.

Mr Weldon Newton, then director-general of aviation regulation, expressed his views on this subject as follows in his testimony:

A. The delegation document focuses primarily, if not exclusively, on the level of service to the industry. Can we structure our programs that are services to the industry so that they can basically self-serve, get our resources out of these delegated areas and put them into the discretionary areas of monitoring and surveillance and investigation.

In other words, can we extricate ourselves from the service areas and put these into the more hard-core regulatory activities. That is the madness in the method if you will.

Q. The madness is or the rationale I take it then is if industry can do it, and you can monitor the industry's activity, you can do so with less inspectors and less PYs [person-years]; is that fair?

A. Well, I can take those PYs and put them into other activities. The activities like audits, surveillance and those types of things. I'll reprofile them. I won't let those people go. If I can delegate an activity and I save 14 PYs, the objective is not downsizing, the objective is to take them out of that activity and put them into these discretionary things like surveillance and vigilance and monitoring of the industry.

Q. Recognizing that you still have to monitor what you have delegated out?

A. Correct. That is ... in the model.

(Transcript, vol. 161, pp. 93–94)

In summary, Mr Newton supported the proposal of further delegation of some inspection duties he considered non-critical, thereby allowing more dedication to surveillance and monitoring of safety-sensitive activity.

Mr Slaughter expressed views which, if accepted, would see further delegation of authority to industry. In his opinion, there would not be any further loss in safety assurance, provided there was adequate monitoring. He explained his priorities in a memorandum of October 9, 1990, outlining operational priorities:

> More and more the Air Carrier Inspectors will change from active and direct participation in conducting PPCs [pilot proficiency checks] on air carrier pilots to a function of overseeing and monitoring the safety of the air transportation system by ensuring that designated Check Pilots are closely monitored to ensure that they are providing the highest possible standard of operational safety, and by monitoring and evaluating the air carrier operational activities on a continuing basis.
>
> (Exhibit 1119, p. 2)

One section of the AOG brief mentioned above outlines the regulatory functions performed by the air carrier inspectors and their concerns regarding possible further delegation of such inspection authority to the private sector. The brief addresses the conduct of proficiency checks and the conditions under which those checks could be delegated to air carriers. The submission represents the concerns of the civil aviation inspectors at present engaged in such operations and points out the pitfalls of further delegation. Particular emphasis was placed on possible conflict of interest, pressures of an economic nature, lack of proper training courses for company check pilots (CCPs), and the likely pressures of additional duties usually assigned to persons to whom the CCP authority might be delegated. The consensus of this group is that the delegation of CCP authorities to industry has reached its maximum effective and safe limit and that any further delegation would have an adverse effect on the assurance of aviation safety. There is a case to be made for both sides of the argument on further delegation of inspection authority to the private sector.

In September 1988 the deputy minister of transport initiated an Evaluation of Aviation Regulation and Safety Programs. The consultant firms of James F. Hickling and Sypher-Mueller International were engaged to assist with that study. On receipt of their final reports to the deputy minister's committee, the staff of Transport Canada's assistant deputy minister, review, produced a consolidation of those studies that was provided to the Commission. In regard to delegation of authority, that review stated in part:

> In view of the shortage of experienced trained inspection staff, it is suggested that much more regulatory activity be delegated to appropriate segments of the industry: for example, initial and

> renewal PPCs to Designated Flight Test Examiners (DFTEs); IFR checks (to the extent they are still needed) to DFTEs; greater approval authorities for DARs [design, approval representatives], and Approved Maintenance Organizations (AMOs); more delegation to Company Check Pilots; etc.
>
> (Exhibit 1323, p. 10)

The review recommends "more effective use of resources through delegations and training" (Exhibit 1323, p. 27). It suggests a number of other areas for further delegation, with the proviso that emphasis would then be placed on a Transport Canada role of checking-the-checkers. The document proposes careful selection of agencies to be granted such authority, based on demonstration of a high level of competence over several years. Programs that delegate authority to outside agencies have been in effect for years and have been quite successful. In fact, some of these programs were implemented and delegated to industry.

Witness Views Regarding Delegation of Authority to Industry

In general terms, there seem to be two opinions that evolve from the evidence received. At the working level – the inspectors, lead inspectors, principal inspectors who deal with the air carriers on a regular basis, and those members of the regulatory group involved in enforcement – there is concern about further delegation. Mr Brayman was not averse to further delegation of pilot proficiency check authority to company check pilots, provided the check system assured their competency. Mr Umbach, however, expressed the view that the maximum practicable level of delegation had been reached and that further delegation would degrade the level of safety assurance. The inspectors who testified before this Inquiry in general were of the view that more hands-on participation by Transport Canada inspectors in the ensuring of conformity with regulations is necessary to improve the effectiveness of the regulatory program.

At the more senior levels, which are more directly subjected to pressures to manage better with fewer resources, there is a tendency to favour more delegation to industry. Numerous studies support delegation under responsibly controlled conditions.

It seems certain that economic restraint will limit available resources even for the important Aviation Regulation program. Further delegation seems the only reasonable alternative to a desirable but unattainable increase in resources. I am convinced that such additional delegated activity can be conducted in a satisfactory manner, provided vigilant monitoring of the process is sustained and supported by prompt and firm enforcement action where warranted. Care must be taken, however, to redirect resultant resource savings to bolster safety assurance programs that require additional resources.

Inspection Performance

Discretionary/Non-Discretionary Tasks

The tasks performed by aviation regulation inspectors are described as being either discretionary or non-discretionary. The classification of these tasks has bearing on the priorities that are allotted to them and the weight factors applied to their value in the formulas used for identification of human resource requirements.

During the testimony of various witnesses from Transport Canada, the use and interpretation of the terms "discretionary" and "non-discretionary" received considerable attention. Witnesses Mr Ronald Armstrong, Ontario Region's director of aviation regulation, and Mr Weldon Newton, Transport Canada's director-general of aviation regulation, both described discretionary activities as those such as audits, surveillance, and ramp inspection. Non-discretionary activities were described as those that were required by regulation to allow an air carrier to operate. For example, activities pertaining to the issuance of an operating certificate would be non-discretionary.

Mr Newton explained the implications of this requirement to give priority to non-discretionary tasks versus those classified as discretionary:

> A. So what you tend to do is you will take your resources from the audit, the surveillance and those activities and you put them into the certification activities. You know, as the client is screaming at the door and saying, I want you to certify my carrier, that you will add the necessary resources from – you will basically take them from the discretionary surveillance side and put them into the level of service side to certify that carrier.
>
> It is a short-term solution to serve the industry but on a sustained basis, it becomes a problem because you then are taking your resources and you are reprofiling them into these service areas at the cost of the surveillance of the industry.
>
> (Transcript, vol. 161, p. 95)

This statement succinctly described the dilemma Mr Newton faced as the senior aviation regulator providing direction and stating priorities for his staff. Federal legislation requires that certain standards of certification and licensing be observed by the air carriers. These regulations include applications for and issue of operating certificates, operational specifications, manufacturing and maintenance procedures, pilot licences, instrument rating tests and renewals, and pilot proficiency checks.

Having legislated such requirements, it follows that the Aviation Regulation organization is bound to provide the inspectional and administrative services required by those regulations. Such services must be delivered as a matter of priority. Other inspection functions of surveillance and monitoring of the performance of the industry through audits, ramp inspections, and in-flight inspections, although high in safety assurance value, fall into the category of non-discretionary tasks.

This is the dilemma that the regulator must confront in the allocation of priorities to workloads. The problem is particularly acute when periods of high demand combine with deficit reduction and associated resource limitations.

Inspection/Surveillance Priorities

The value of various forms of air carrier surveillance and inspection became a contentious point during the Inquiry. A memorandum dated October 9, 1990, from Mr William Slaughter, director of flight standards, to the air carrier inspection group outlining operational priorities was introduced as Exhibit 1119. A number of witnesses expressed disagreement with the order of those priorities, which placed air carrier audits ahead of in-flight inspections.

Mr Ian Umbach, superintendent of air carrier operations, offered the opinion that in-flight inspections provide the greatest value in assuring industry compliance with safety-related regulations and practice:

> Q. Now, as an inspector, what is the best way to maintain what I will use as safety assurance? Your knowledge that you have a good feeling for safety assurance?
>
> A. I feel the best is in-flight inspections, what we call in-flight inspections.
>
> (Transcript, vol. 138, p. 51)

Mr Umbach stated that he and other inspectors on his staff had become increasingly uneasy because of their inability to monitor a broad enough spectrum of the industry. He pointed out the fact that some of the pilot proficiency checks were being waived and that in general the regulator was unable to provide the safety assurance monitoring required during that period. He was emphatic in his support for in-flight inspection, pointing out that it is the most effective means, in his view, of monitoring the entire company. On Mr Slaughter's priority list, however, in-flight inspections ranked number 10 on the list of 12 priorities.

Mr Martin Brayman, another very experienced inspector, commented on the value of in-flight inspections as follows:

> A. A flight check [in-flight inspection] is different. A flight check is carried out by an air carrier inspector, and it not only checks on

the conduct of the flight by the pilots but it checks upon all other aspects of the company operation. And in fact, could almost be classed as a mini-audit en route.
Q. A mini-flight audit?
A. Exactly. But more than just a flight, because you are checking – you are checking their bases and the way they turn airplanes around. You are checking quite a list of areas.
Q. So I take it, then, there's a lot of value in doing a flight check by Transport Canada inspectors?
A. It's probably the primary method of establishing compliance.
(Transcript, vol. 131, pp. 161–62)

Mr Newton stated that there had been a difference of opinion within the aviation regulation program, for as long as he had been director-general, as to the relative merit of in-flight inspections and audits. He said there was no unanimity or solidarity among the inspectors that in-flight monitoring is of high value. Mr Newton's evidence indicated his disagreement with the inspectors who regarded in-flight inspections as an in-depth examination and an excellent method of assessing a company's overall operation:

A. ... I am talking of an inspector that walks in an aircraft, sits in a jump seat for two legs of a flight, okay, and just simply observes crew coordination and walks off at the end of the flight without filling out any test failing anyone, okay.
(Transcript, vol. 161, p. 106)

Mr Newton expressed his preference for audits of air carriers rather than in-flight inspections:

A. ... I tend to favour audits.
Q. Which looks at the system?
A. Which looks at the system. But with audits there's bureaucracy, there's reports, there's controversy, there is a whole process.
An inflight inspection, you get on the aircraft, you get off after two legs, there is very little bureaucracy.
(Transcript, vol. 161, p. 108)

If Mr Newton's perception is correct, then one would be hard pressed to disagree with him. There would be little value in an in-flight inspection conducted in such a manner. However, Mr Newton's concept of how these inspections are conducted is at conflict with the actual inspection process as delineated in the Air Carrier Inspection Manual. Further, Mr Newton's opinion is clearly in conflict with the opinions of technical experts in his directorate. Having heard all of the evidence, and not in any way discounting the value of audits, I am convinced that a properly executed in-flight inspection provides the best opportunity to view all components of an air carrier's operating system in a day-to-day operation. Mr Brayman described such inspections as "mini audits." Surely, if properly conducted, there can be no better way to monitor a flight operation.

Mr Newton's preference for the accounting precision provided by the inspection and systems examination inherent in audits is understandable. They are, however, resource intensive, and may not provide the most cost-effective method of safety measurement within existing resource constraints. In the case of Air Ontario, the Transport Canada audits clearly did not provide better safety measurement within the limits of existing resource constraints. It appears that the values of audits may be more appreciated by the senior management of Transport Canada, who may use the results to indicate work accomplished. Perhaps that viewpoint is understandable in an atmosphere of continual pressure to demonstrate greater productivity with diminishing resources.

Workload

Mr Donald Sinclair, Ontario Region's air carrier operations manager, explained at considerable length the serious effects resulting from the lack of trained inspectors in his area of responsibility:

> Q. Now, with the kind of experience that you have had during the years '87, '88, '89, do you think that aviation regulation could deliver safety assurances with the kind of staffing that was available?
>
> A. Not what we had in the Ontario region, in my particular area, no.
>
> (Transcript, vol. 142, p. 100)

Mr Martin Brayman, superintendent of heavy air carrier inspection in the Ontario Region during the period of transition of Air Ontario, made several references in his testimony to the seriousness with which he viewed the increased workload and shortage of personnel. He explained that there was a continually increasing demand on inspector time and that the lack of experience and the dearth of qualified inspectors seriously affected the ability to monitor the industry. He expressed the opinion that during the expansion period 1987–88, no inspector "kept up with all the areas that he was responsible for" (Transcript, vol. 131, p. 105) and that "telephones in those days were melting down going from morning till night" (Transcript, vol. 131, p. 20).

Mr Ronald Armstrong, Ontario Region's director of aviation regulation, provided a concise description of the background and "explosion of activity" affecting the regulatory workload during this period of expansion:

Q. ... So would you agree that there was a fair amount of expansion, aviation expansion, in '88, '89?
A. I'd say before that. '88 '89, I think, were just at the end of the expansionary, pretty well at the end of the expansionary period. The big bulk would have been '86 to mid '88, early '89.
Q. And what was going on in region at that time, your understanding?
A. Basically, an explosion of activity. The *National Transportation Act* had been amended so the filter that the Canadian Transport Commission used to give the department had been removed.
   Previously you needed to prove public need and necessity and go through the challenge process there and then the successful candidate would come over to us for an operating certificate.
   Well, that filter was removed, and anybody who wanted to start an air carrier service and could find the funding for it could apply.
   So ... that was what was happening. Charter companies came and have subsequently gone. Some even tried to come, Regent comes to mind, and although a lot of activity gets put into it, it never comes to fruition and never is issued the operating certificate and got up and running and that.
   So there was a lot of certification activity taking place. New companies coming on stream, changes in equipment of the companies, and a general lessening of the experience level at the regional carrier as ... the pilots tended to get drawn up the hierarchy. Had probably its most dramatic effect on the flying training industry where the senior people there were taken into the regionals.
   Coincident loss of experienced inspectors within the region, not necessarily the department as a whole. Changeover in management, new route structures.
Q. And mergers?
A. Mergers, failures.
Q. What sort of workload was this placing upon your region?
A. A very heavy one. The activities rather dramatically increased in the number of pilot proficiency checks that went on. Air carrier branch would have gone, from '84–'85, from 782 PPC instrument rides to '89–'90, 1,921. Almost threefold increase in PPCs.
   Inflight inspections doubled during that period, '84–'85 to '90. The basic number of companies pretty well stayed static. As somebody would come in, somebody else would drop off. So it wasn't per se the number of air carriers, it was the activities that those air carriers were getting up to and then the workload involved with bringing somebody on and somebody dropping off the bottom.

Pretty steady, about 30 new companies – 30 to 40 new companies every year, but 30 to 40, almost, companies failing every year.

Q. And I take it a lot of this activity was occurring right in your region?

A. Yes.

(Transcript, vol. 124, pp. 115–17)

Mr Ian Umbach, superintendent of air carrier operations, large air carriers, described the demands on workload, particularly the similarity of effects in Canada with the introduction of ERR to those experienced in the United States during deregulation:

Q. Now, did this similar circumstance happen in Canada?

A. Indeed it did, yes.

Q. Can you comment on it, what was happening?

A. It presented us with an enormous workload that we had great difficulty coping with. We had to virtually lead each carrier by the hand into the jet transport world, starting with top management right down to the flight crews.

We ended up, in many cases, including me, going 30 days at a stretch without a day off.

(Transcript, vol. 138, p. 29)

And similarly:

Q. Can you describe to us your experience in Canada as a result of ERR and the rapid expansion of the carrier industry?

A. It was – as described here, it was an extremely difficult time for us. We – as I pointed out earlier, it was not uncommon for us to go 30 days at a time without a day off.

We were losing inspectors to new carriers, usually our most experienced and most capable inspectors. Recruitment was extremely difficult.

The atmosphere was one of constant crisis, increase in pressure, incessant and strident demands for our services from industry, from the regions and internally.

...

Q. ... what do you mean by incessant and strident demands?

A. The phone would never stop ringing. Carriers needed approvals immediately for a training program. We had sometimes little or no notice for PPCs. The schedule would change. A new carrier would appear out of nowhere saying, I want to start flying.

The regions were experiencing exactly the same problem we were and they would come to us for help. We had a large number of flight operations manuals that required approval, a large number of training programs that had to be approved, and a large number of MELs that required approval.

> Each of those, naturally, to the carrier, was a priority. To the region, it was a priority. And we would get priority on top of priority, and ... I can truthfully say it was probably the worst experience of my professional life. I would never want to go through that again.
>
> (Transcript, vol. 138, pp. 41–42)

Perhaps the best example of the frustration levels reached by the inspection groups because of their inability to meet increasing workload demand was expressed in the memorandum from Mr Neale MacGregor, acting chief, air carrier operations, to the director of flight standards, aviation regulation directorate, January 20, 1989. The memorandum states in part:

> Prior to ERR the Section was staffed with 30 Air Carrier Inspectors (ACIs) and it was established that an additional 11 were required to meet workload expected to result from increased certification requirements. Since ERR, the workload has increased by over 400%, the Section has lost 5 PYs [person-years], and presently has 3 vacant positions. Of the 22 ACIs on strength, 3 are new-hires and will not be effective until completion of their 2 year training period. This leaves 19 ACIs, including Supervisor staff from an original strength of 30, and a required strength of 41.
>
> As a consequence, we have virtually ceased all monitoring and surveillance of the industry to concentrate exclusively on initial type ratings, captain upgrades, CCP monitors, and certification of new carriers.
>
> The strain on the ACIs is illustrated by accumulated overtime and it is not uncommon to work 30 days without a break. This pace cannot be sustained. To illustrate this point, the Section's overtime budget for FY [fiscal year] 88/89 was $85,000. In December 1988, authority was received for an additional $100,000 merely to cover overtime for the remainder of this fiscal year. The overtime equates to 8 PYs, and the problem will become more acute as ACI burnout takes its toll. One Regional ACI is now on extended sick leave (3 months) to recover from overwork, and a Headquarters ACI is also on sick leave due to stress.
>
> (Exhibit 1106, pp. 1–2)

In summarizing the overall situation, Mr MacGregor's memorandum continued:

> As one can see, Air Carrier Inspection is no longer capable of meeting even minimum requirements necessary to ensure safety. In fact, it is no longer able to assure the Minister of the safety of large air carrier commercial air services in Canada.
>
> (Exhibit 1106, p. 5)

Seven weeks before the Dryden crash Mr MacGregor warned in the same memorandum that the situation had reached the point where "every ACI [air carrier inspector] and an increasing number of industry pilots are convinced that a major accident is inevitable in this country." He called for an urgent application of resources to correct a rapidly deteriorating situation:

> It should also be noted that Air Carrier Inspection is in a similar situation to the ATS crisis currently in media focus at L.B. Pearson International. The situation is to the point where every ACI and an increasing number of industry pilots are convinced that a major accident is inevitable in this country. The trends towards such an occurrence are no doubt irreversible, but the urgent allocation of additional resources to Air Carrier Inspection would at least be the first step in correcting a rapidly deteriorating situation.
>
> It is our contention that any plan to proceed with the National Audit Program should take the foregoing into consideration.
>
> (Exhibit 1106, p. 5)

The reaction to Mr MacGregor's memorandum within Transport Canada, particularly at the senior management levels, was no doubt stimulated by the fact that the memo was leaked to the media. Subsequent internal correspondence within the department tended to discredit the concerns expressed by Mr MacGregor as inflammatory in nature. In that respect, I must say that I have heard evidence regarding rushed introduction of aircraft into service, rushed training without adequate flight simulator access, lack of available spare parts, inadequate flight manuals and amendment services, and inexperienced personnel. These factors, when considered against the existence of a regulatory agency that by its own admission was incapable of assuring senior management that carriers were operating in compliance with regulatory safety standards, lead me to believe that Mr MacGregor's actions were justified, and, indeed, I commend him for his courage.

Clerical Support Staff

A number of Transport Canada witnesses before this Inquiry complained of the apparent lack of understanding at senior levels in Transport Canada of the importance of providing adequate clerical support staff. As a consequence, frequently when staff reductions or staffing freezes are imposed, the support positions are the first to be affected. Situations were described whereby staffing levels did not allow adequate support staff and, consequently, the inspectors ended up doing clerical work at the sacrifice of their regulatory and inspection duties.

Mr Donald Sinclair explained this situation at some length during his testimony. He pointed out that, particularly during staffing freezes, he would on occasion have one clerk to meet the clerical requirements of a staff of about 28 (Transcript, vol. 142, p. 105). In such circumstances, when temporary staff were allowed to fill the position, their lack of knowledge of the administrative process further complicated the situation. His office was responsible for mandatory certification work, including approvals of MELs, flight operations manuals, and recommendations for check pilot authorities, in addition to the inspection/surveillance duties expected of the branch.

This situation was addressed by a series of documents from the Ontario Region (Exhibits 1142, 1143, and 1144). These documents were passed to the assistant deputy minister, aviation, in June 1986. One of these documents, a memorandum from the regional director of aviation regulations, described the situation as "completely intolerable," and added:

> Those problems are not simply a lack of staff but include additional workloads imposed by the freeze; compilation of forms, preparation of statements of justification; attempts to interpret circulars, letters, messages, phone calls and discussions on implementation of the restrictions; proceeding with staffing actions, cancelling those actions, re-activating the actions; attempting to overcome critical support staff shortages with a parade of untrained temporary support staff, students and persons from special consideration groups; waste of effort of highly capable clerical staff in training short term help; and finally, serious diversion of the efforts of Managers and supervisors away from their operational and management duties to deal with crises attributable to staffing-freeze-related problems.
>
> (Exhibit 1143)

Based on the evidence I have heard, I find that the conduct of necessary administrative tasks by the inspectors caused a reduction in their ability to discharge their surveillance responsibilities. I view this as particularly critical at a time of obvious increased activity in the aviation industry.

Staffing Problems, Ontario Region: Toronto Area

Ontario Region was more directly affected by regulatory reform than others. Toronto was the centre of the activity associated with expansion in the industry and the base for many new companies entering the business. This situation placed excessive demands on the region's Airworthiness and Air Carrier branches. The staff were subjected to overwork, stressful conditions, and remuneration that did not match the soaring living costs of the area or bear reasonable comparison to private industry. The qualifications and experience of this group were desired by industry, and the inspectors became targets of air carriers' recruiting programs. Mr Ole Nielsen, airworthiness superintendent of air carrier inspection, indicated in his testimony that two of his senior inspector colleagues were enticed into accepting positions with startup airlines offering remuneration half again or double their salaries as senior airworthiness technical inspectors. Similar situations were occurring with pilots and air carrier inspectors.

This increasing demand for talent affected the recruiting programs for the Toronto offices in particular. Mr Armstrong, in his testimony, indicated the difficulty faced in attracting qualified pilots into civil aviation inspector positions, primarily because of the high cost of living in the Toronto area. Mr Sinclair gave similar evidence regarding civil aviation inspectors and Mr Nielsen confirmed that such constraints also applied to airworthiness technical inspectorate candidates. It was shown, by way of example, that it was practically impossible to attract candidates for heavy air carrier inspector positions of the Seventh Region Toronto office. In normal times those positions were considered quite attractive in that they offered upgrading of inspectors to high-performance aircraft of the B747, L1011, or the new B767 classification.

Public service pay rates are based on a classification system without location consideration; thus an inspector or clerk in Toronto receives the same rate of pay as those in similar positions in Moncton or Winnipeg. In such circumstances, recruitment in and for Toronto-based positions was unable to compete with the high wages of the private sector necessary to meet spiralling living costs.

Findings

- Based on the information before this Commission, the Aviation Regulation Directorate was not adequately prepared to perform its functions in the latter 1980s.

- The warning flags raised early in the 1980s and repeatedly thereafter had seemingly negligible effect. The forecasts of safety assurance deficiencies were soundly based and progressively confirmed, yet there was no proper response by the senior management of Transport Canada in the form of urgent planning or action to meet the inevitable challenge.

- It was known that significant increases in personnel would be required to meet demand, yet such increases were not authorized, let alone acquired.

- Inadequate training policy and supporting programs failed to ensure inspector competency and placed new inspectors in positions of responsibility for which they were not qualified.

- Forecasts of inspector workloads predicted that the directorate would be overwhelmed, yet there is little evidence of effort to manage the crisis either through further delegation of tasks, contracting out or withdrawal of non-critical services, or other innovative programs to reduce resource requirements. Such lack of planning, preparation, and managerial direction placed junior managers and staff in the position of being unable to perform adequately all of their duties.

- Had the Transport Canada Aviation Regulation Directorate been in a position to discharge all of its responsibilities in an effective and timely manner, some of the factors that contributed to the Dryden accident may not have arisen.

RECOMMENDATIONS

It is recommended:

MCR **110** That the Aviation Regulation Directorate focus adequate resources on surveillance and monitoring of the air carrier industry, with emphasis on in-flight inspections and unannounced spot checks.

MCR **111** That Transport Canada establish a policy that identifies surveillance of existing air carriers as a non-discretionary task.

MCR **112** That Transport Canada establish a contingency policy in order to meet unusual resource demands without jeopardizing adequate staffing of inspection and surveillance functions.

MCR 113 That Transport Canada pursue extension of the delegation of authority to industry in accordance with the recommendations of Transport Canada's Management Consultant Branch studies completed in 1990 on this subject. Where additional delegation of authority to industry can be achieved safely, such delegation should be authorized in order to allow more effective use of Transport Canada inspectors.

MCR 114 That Transport Canada establish a policy to ensure that required support staff will be provided so that inspector staff will not be misdirected from their operational safety–oriented surveillance duties in order to perform tasks more appropriately conductedõ¼ by support staff.

MCR 115 That Transport Canada establish an air carrier inspector training policy to be put into force without further delay, and that the policy ensure the following:

(a) A clear statement of the requisite competencies for each inspector position in the Airworthiness and Flight Standards directorates of Transport Canada.

(b) A statement of the training courses required to be completed successfully by inspectors before they are delegated authority and before their probationary periods end.

(c) Successful completion of training to be required before air carrier inspectors are delegated their authority credentials.

(d) Establishment of a recurrent training program for each discipline of inspection to ensure continued competence.

MCR 116 That Transport Canada improve staffing and recruiting programs to enable aviation regulation requirements to be filled on a high-priority basis. The capability to fast-track such staffing requirements should be achieved as soon as reasonably possible.

MCR 117 That Transport Canada, in consultation with the air carriers, work out an arrangement to accommodate the requirement of no-notice in-flight cabin safety inspections and surveillance on charter flights.

31 AVIATION REGULATION: RESOURCING PROCESS

Operational Plans

Each year branch managers in Transport Canada regional offices and in the Ottawa headquarters initiate the operational planning process by identifying their resource requirements for future years. The process is long and convoluted, with resource submissions passing through numerous examinations including seven or more individual challenge processes. Mr Ronald Armstrong, Ontario Region's director of aviation regulation, described the process in the course of his evidence:

> A. The process goes, the instructions come down on how to prepare it and they may or may not change from year to year, how we prepare our operational plan that's eventually going to get wrapped up into the department's plan and submitted on to Treasury Board.
>
> The branch managers work with their staff, they develop their plans, they come to me, I perform a challenge process on them, do you really need this, do you really need that, can you put it in a different way, and then they are sent from my office to my manager, Weldon Newton, who then puts them into his resource management unit.
>
> At that point they're taken apart, the submission, and it's sent down to the functional directors, the director of flight standards, the director of airworthiness, the director of enforcement and legislation, and then they look at each of the regional submissions for the areas for which they are responsible, and they do the same thing. They question, they ask, they probe, they augment, they eliminate, as they see it, from a national perspective looking at all of the regions.
>
> They then put their submissions, their national submissions for their program back to the director general who performs the same function, and then it goes to ... our Assistant Deputy Minister who will send our resource allocation to Mr Mousseau's organization, the director general, policy planning and human resource management, who will do exactly the same thing, and in turn, then, the Assistant Deputy Minister provides it to the program control board, again for their vetting, criticism, whatever.

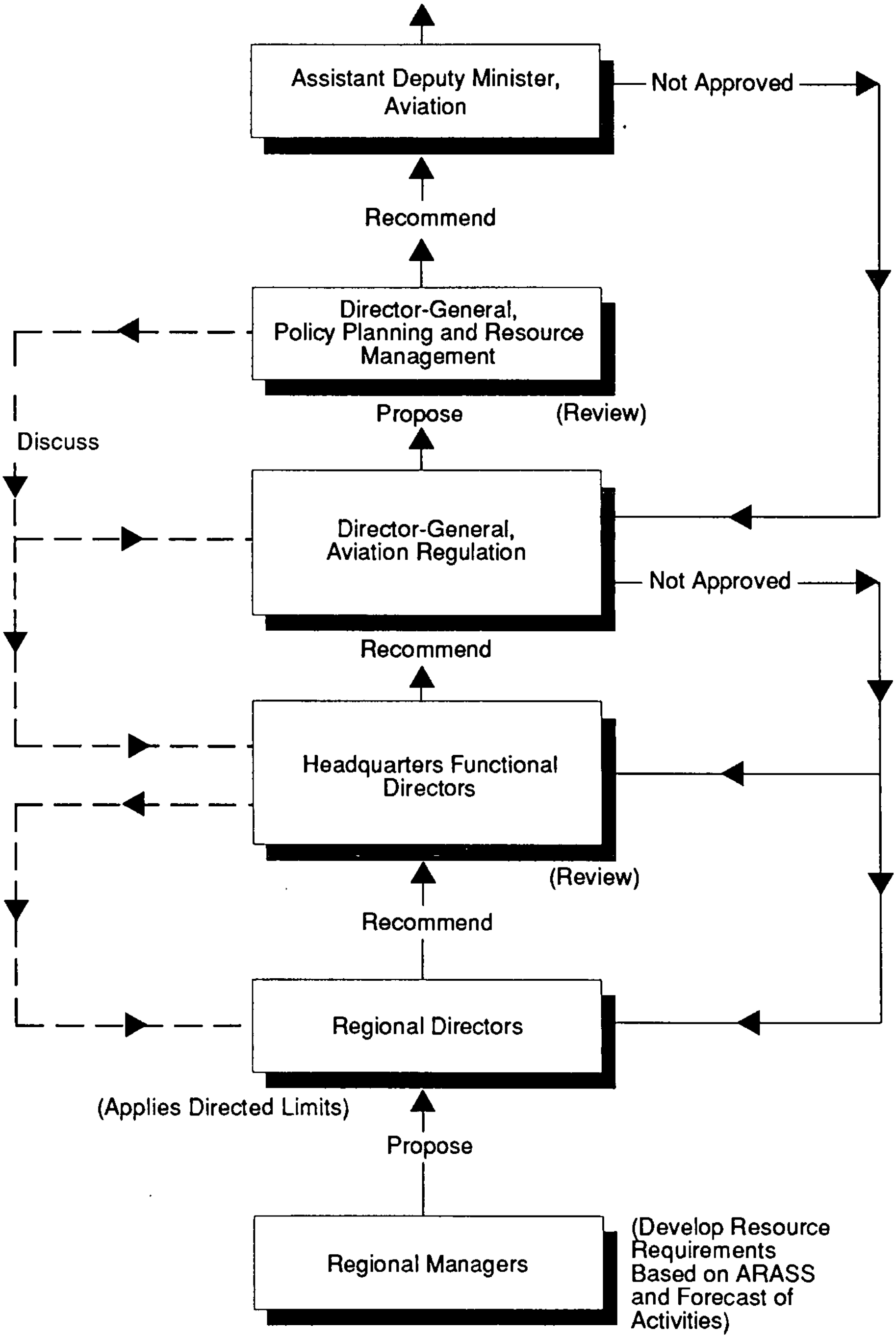
> It's modified back and forth, and then whatever's accepted at the departmental level and the program control board would be, in essence, the Deputy Minister sends it to Treasury Board whereupon they do their same evaluation, and then from that comes back the resources to the Deputy Minster, and then it's up to him to decide how many he's giving out to each of the units within his organization, and then all the way down the line. The resources are given to a manager and then they are allocated out.
>
> (Transcript, vol. 125, pp. 25–26)

The description of the resource identification and allocation process provided by Mr Armstrong outlines the numerous managerial levels of review and the complex system of challenges to which the resource requirement requests of branch managers are subjected. Figure 31-1 shows the convoluted system whereby the resource requests are subject to a minimum of eight review levels, and can be sent back to previous levels for whatever reason. The process is discussed in more detail further in this chapter.

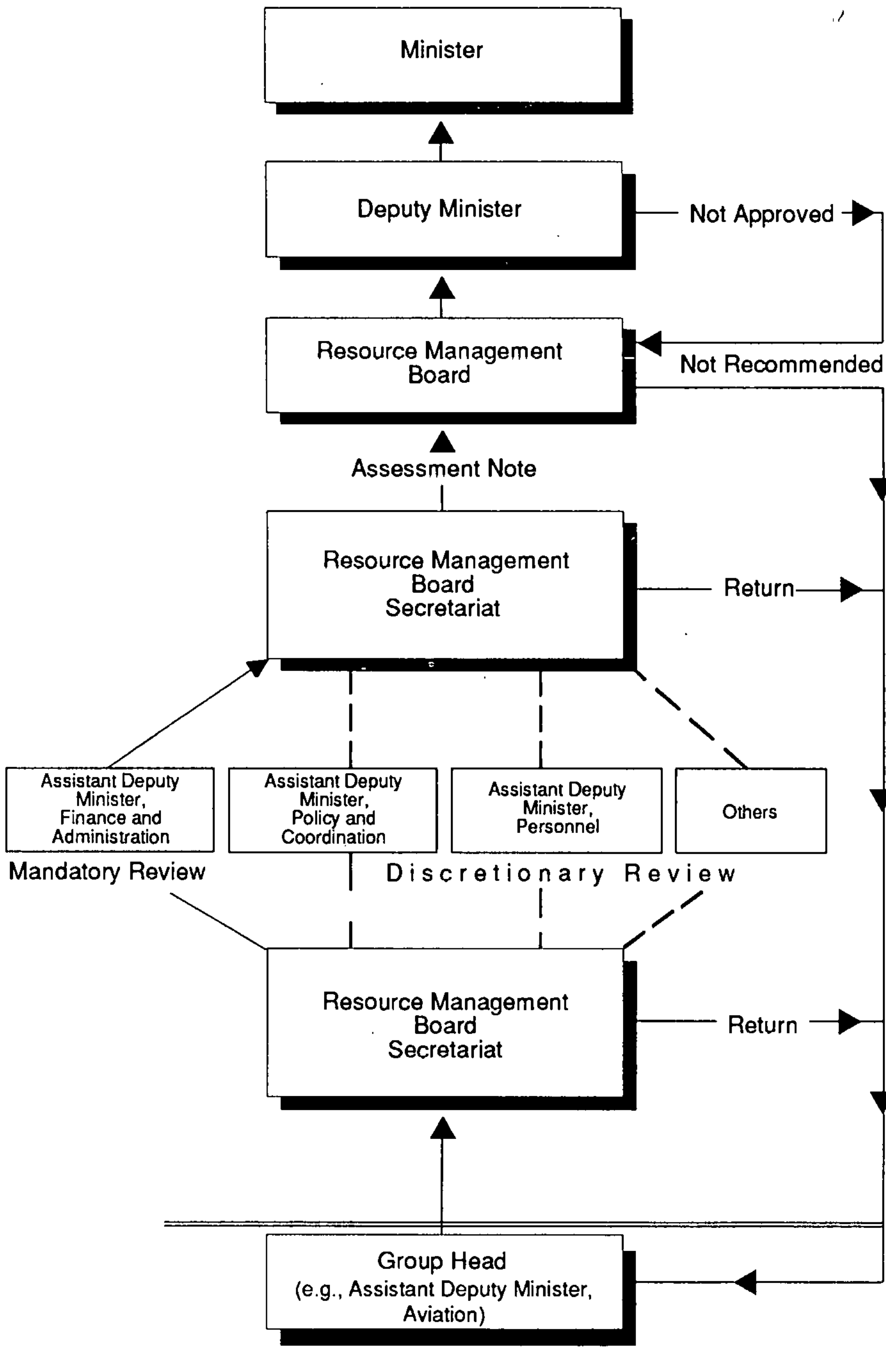
For line managers beset with their day-to-day operational commitments, the time involved in such a process, when combined with the time required to staff and train inspectors and to carry out staffing actions for vacant positions, precluded any meaningful response to demand-driven work assignments in real time. Evidence from a number of witnesses indicates that from the time an additional person-year is approved until a person is actually on the job can take in excess of two years. By the time a person is hired, trained, and qualified, the demand may well have come and gone. Mr Armstrong explained:

> Q. So you're talking from the time you make your request, it takes a year before the request has been approved?
>
> A. Yeah, we generally – well maybe six to eight months, because generally we start the new fiscal year and our years run April 1 to March 31st, so you'll hear us talking '86/'87 and it would be March 1st, '86, April 30th of '87.
>
> We generally get our allocation of how many person-years we're going to have well after the start of the fiscal year. Hopefully by the end of the first quarter, but about six months.
>
> Q. So, by my calculation, it takes two to three years from the time that you need the resource until you have somebody in your hands you can let loose to be an airworthiness inspector or an air carrier inspector?
>
> A. We would have them doing work prior to that time, yes, but completely finished all of their formalized training and experienced that they can conduct the whole gamut of responsibilities that they could be tasked with, yeah, that's a fair estimate.
>
> (Transcript, vol. 125, pp. 46–47)

Figure 31-1 The Resourcing Request and Approval Process



Source: From Exhibits 1285 and 1286


Minister
Deputy Minister
Not Approved
Resource Management Board
Not Recommended
Assessment Note
Resource Management Board Secretariat
Return
Assistant Deputy Minister, Finance and Administration
Assistant Deputy Minister, Policy and Coordination
Assistant Deputy Minister, Personnel
Others
Mandatory Review
Discretionary Review
Resource Management Board Secretariat
Return
Group Head (e.g., Assistant Deputy Minister, Aviation)

This evidence graphically demonstrates the need for a system within the Aviation Group to fast-track additional qualified personnel into critical areas involving safety, when required.

Program Control Board

The origins and role of the Program Control Board (PCB) have been described by Mr Ramsey Withers (see chapter 29, Economic Deregulation and Deficit Reduction). The final challenge to a resource submission from within the department is carried out by the PCB or, as it is now called, the Resource Management Board (RMB). A key component of the Program Control Board is its secretariat, a staff support group of program analysts. The secretariat reviews resource submissions and provides assessment notes to the board to assist in its deliberations. There is apparently no requirement for program analysts with the secretariat to have expertise in the specific areas in which they are assessing resource requests. In my view, this is a serious weakness in the system. I am persuaded by the evidence that the lack of operational aviation expertise within the PCB secretariat contributed to the failure by Transport Canada management to recognize the aviation safety implications that would be caused by the shortage of air carrier inspector resources after 1985. Mr Kenneth Sinclair, assistant deputy minister, policy and coordination, described the role of the secretariat as follows:

> Q. [A]nd if a case has been made on paper by Mr [David] Wightman [Transport Canada's assistant deputy minister of aviation] that I need A, B, C, and D to deliver the program that I am responsible for, what steps does the secretariat take in order to review, assess, challenge this document which is put forward by a group head which represents, as we have heard from Mr [Claude] LaFrance [former assistant deputy minister, aviation], the bottom line from their perspective?
>
> A. Well, the analysts, again, as I say, would speak to the Director General or the Director level to obtain that necessary information. If there is a disagreement, they will either ... reach agreement on it through their discussions, or if they ask for additional information. In some cases that is obtained by speaking to experts outside the department, having a consultant look at things and submit a report. Quite often the consultant would be hired by the group to do the work to submit that to the secretariat.
>
> If, at the end of the day they have not reached a consensus on it, then the differing view is put forward, both views are put forward. The secretariat does not, in any way, put forward a filtered or one-sided case, they put forward the case of the

> group and their comments on it, along with the recommendations which are then submitted to the Program Control Board for the board to review independently of the working of the secretariat.
>
> (Transcript, vol. 165, p. 24)

While the principles upon which the PCB mandate is based may have merit, the evidence of assistant deputy ministers for Aviation Group and the decision records of board meetings are less reassuring. Mr LaFrance, a witness before this Inquiry, held the position of assistant deputy minister, aviation, from October 1985 to March 1989. According to Mr LaFrance, he ran his own challenge on resource submissions put forth by his managers. When asked to explain the role he played when requests for resources were put forth by his managers, he stated that he personally challenged the resource requests of his directors and he was unequivocal that all of his resource requests submitted to the PCB were absolutely minimum requirements:

> A. Yes. It was very important to get the resources that I needed. It was very important that I had full professional credibility at Program Control Board. And to do that, I challenged the resource requests that I got from my Directors General very strongly on technical operational terms on Aviation, professional Aviation terms.
>
> There was a very strong challenge and I was quite satisfied that in all my requests to PCB I was coming with requests that were, number one, fully justified in Aviation terms; and secondly, that they were the absolute minimum. I was being very frugal.
>
> (Transcript, vol. 163, p. 21)

On the subject of the difficulty of obtaining the necessary resources to fulfil his mandate of assuring aviation safety, Mr LaFrance testified that almost without exception his resource requests were not granted by the PCB. His evidence highlighted another example of the methods employed by senior Transport Canada management in order to circumvent and avoid the allocation of resources in areas impacting on aviation safety. Such methods used by the PCB were simply to require "further justification" for the resource request. The effect was to deny the resources for the year of the request. Mr LaFrance stated:

> Q. ... Did you have difficulty obtaining resources, the resources in terms of person-years and in terms of budget? Did you have difficulty in obtaining ... the amount that you wanted over the years that you were ADMA?

A. Yes, absolutely. The paper trail shows that my requests were, most of the time, not granted. There were very few instances I believe where it was an outright turndown.

It was more normal to just send me back to the drawing board and say, we need further justification. But if I'm sent back to provide further justification again and again for a period of a year, the net result is a denial of the resources for that year.

Q. And when you say you were sent back, I take it that you were sent back by Program Control Board?

A. That is right, yes.

(Transcript, vol. 163, p. 47)

The rejection or referral-back for additional justification to which Mr LaFrance refers occurred at other subordinate challenge levels, not just at PCB. The flow charts at figure 31-1 display the review and challenge process that could involve up to ten levels of management. Sending the resource requests back for further justification could become a delaying tactic precluding fast-tracking and effectively denying the requested increases. The process was extremely cumbersome and debilitating.

Mr LaFrance was sufficiently concerned about the resource situation within his organization to advocate that a memorandum to cabinet be prepared to warn about the potential safety impact of the cuts in personnel and dollars. He is quoted in the PCB minutes of August 17, 1987, as follows:

> ADMA [LaFrance] opened his remarks by noting that he wished to address those issues or areas of difference he had with the PCB Assessment Note entitled "Operational Plan – Aviation" dated August 17, 1987. Annex C ...
>
> ADMA pointed out that, with respect to the impact of the deficit reduction program, he felt it was important for Cabinet to be aware of the impact of the cuts, particularly as they may affect flight safety. He further expressed the feeling that safety programs across the Department likely would have similar impacts, and suggested that an overall strategy should be developed on an approach to Cabinet.
>
> (Exhibit 1326, tab 10, pp. 7–8)

It was subsequently confirmed in evidence by Mr Kenneth Sinclair, chairman of the PCB, that no action was taken by the PCB to present to cabinet the concerns of the Aviation Group with respect to the impact of the deficit reduction program on aviation safety programs. Instead, a Treasury Board submission covering the merged resource needs of all four transportation modes within Transport Canada was developed and forwarded to the Treasury Board for approval. Mr Sinclair testified as follows:

Q. Are you aware, sir, whether a submission, in fact, did find its way to Cabinet on safety matters?
A. This will require a short explanation.
Q. Certainly, please.
A. A memorandum to Cabinet is a document that goes to Cabinet. Cabinet is not a committee that allocates resources, it is a committee of Cabinet called the Treasury Board that allocates resources.
So, in the process of developing a memorandum to Cabinet, we realized what we really were doing was preparing a request for additional resources under the heading of ERR which we were entitled to do under the M.O.U., so, the MC became an omnibus Treasury Board submission encompassing the ERR requirements of Transport Canada in all of the modes, not just in the Aviation mode.
Q. So, it became a global submission to Treasury Board on the issue of resource allocation?
A. Affecting a – as a result of ERR. And that document did go forward to the Treasury Board.
Q. All right. Do you recall what happened with that submission to Treasury Board, sir?
A. Yes, they responded to it. They did not give us all the resources that we had requested.

(Transcript, vol. 165, p. 77)

Mr David Wightman, Mr LaFrance's successor as assistant deputy minister, aviation, fared no better in his efforts to obtain resources. When questioned on the witness stand as to the PCB secretariat's assessment of his 1990 operational plan, Mr Wightman gave the surprising evidence that approximately 70 per cent of the Aviation Group's resource submission to the PCB for 1990 was not recommended for funding by the analysts:

A. And we reached the point where we submitted our operational plan and then ... there was a period of at least a week, usually more than that, where the analysts of the Program Control Board do their business on our submission. And they then produce what is called the PCB assessment note in which they discuss each of the items that we have submitted.
And I receive that assessment note before the meeting is called to consider it, and all of the other members of the Program Control Board also receive the assessment note.
I was disappointed with the assessment note because it was clear to me, I'm just quoting numbers here off the top of my head, but approximately 70 per cent of our submission was not funded – was not recommended for funding.
Q. Seventy?

> A. Seven zero per cent of the additional resources that we were asking for over-target, including PYs [person-years] and dollars, operations and maintenance dollars, were not recommended for funding. And so, at the meeting of August 27th, I objected strongly to the conclusions of the secretariat and I also said that I thought that the process was flawed for the reasons that I have already mentioned; that it invites an open-ended submission when it's clear that most of it is not going to be able to be funded.
>
> (Transcript, vol. 166, pp. 56–57)

This phase of the hearings unmasked a deep-rooted sense of frustration among all levels of personnel in the Aviation Group, the vast majority of whom are unquestionably dedicated public servants, over the annual budgetary process. This sense of frustration was well founded.

The time has clearly come for the government to put an end to the cumbersome and costly resource challenge process required by Transport Canada, and to put in place a less cumbersome and more realistic process for assessing aviation resource requests. It is unrealistic to require the already undermanned Aviation Group to participate in an excessively time-consuming process, ostensibly designed to identify and to justify resource requirements, through a multitude of challenges, only to have the PCB analysts then arbitrarily reject as much as 70 per cent of what has been identified as the absolute minimum resource level necessary to maintain an acceptable level of aviation safety.

The upper management of the Aviation Group has shown itself to have been either unwilling or unable to persuade those public servants in charge of final resource allocation of the merits of their aviation safety-related resource requests. At the same time, the evidence leaves little doubt that the PCB, preoccupied as it was with the resource restrictions imposed upon it by the government, was insensitive to the aviation safety concerns that were brought to its attention for resourcing.

Program Needs versus Program Affordability

Mr Wightman referred to a process of identifying person-year requirements, based on a staffing formula that originated in 1984 before deficit reduction was implemented. The subsequent formula, referred to as Aviation Regulation Activity Standards System (ARASS), had been refined over a three- to four-year period. It is essentially a work-tracking mechanism based on a formula of recognized tasks, task frequencies, and completion times that identified existing and anticipated inspector and support staff requirements to meet the needs of the Aviation Regulation Program.

The root source of Mr Wightman's disappointment in having his operational plan cut by 70 per cent is to be found in the different basis of assessment of resource needs used by his staff and that used by the PCB secretariat. Mr Kenneth Sinclair addressed the issue as follows:

> Q. It seems to me from a lay point of view that if Mr Wightman prepares a document using the same benchmarks, the same criteria, the same accepted standard, that your body, PCB uses, and comes to you and gives you a document and says, Mr Sinclair, we've done our homework. We've used the same criteria that you use. We've come up with this bottom line, why do you then have to go through this elaborate reassessment and re-inventing the wheel of what is then before you at that point in time. Could you help us with that?
>
> A. Yes. I will try ... the resourcing model that is used is based on subjective material. It is ... forecasting a future need for resources, it is not dealing with a historical requirement of a demonstrated workload. So, there are some assumptions made before you put together the model which would tell you the resourcing requirements. That is one area that you look into, are the forecasts that are used to then predict the resource requirements, are they valid, that has to be looked at and considered.
>
> And then whatever figure comes out of it, the submission would then – we would then have to deal with what resources are available to allocate to it, the affordability issue.
>
> (Transcript, vol. 165, pp. 38–39)

The fact of the matter is that the entire assessment process before the PCB is little more than a pretence. The absence of a national resource approval process is a key issue. Mr Wightman summed up his view as follows:

> A. The trouble is that the thing begins to break down when you know perfectly well that when the man who is responsible for analyzing all of these inputs, starts adding it all up and he finds that the ... total is so large that there is not any remote chance that those resources are going to be made available. So then what do you do about it?
>
> (Transcript, vol. 166, p. 49)

In other words, regardless of the legislative and regulatory requirements and the workload entailed in meeting those requirements, based on a standard developed and approved within the department, it ultimately comes down to what is affordable in the minds of a corporate body that has little, if any, background or expertise and no accountability pertaining to aviation safety regulation.

The individuals making decisions on resource allocation at the PCB were, on the basis of the evidence before the Commission, basing their decisions primarily on affordability. The evidence indicates that these individuals had little, if any, background knowledge with respect to the minister's obligations under the *Aeronautics Act* to enable them to understand the necessity of delivering a program that ensured that air carriers were in compliance with safety standards. Nor is there any indication that they have any accountability with respect to ensuring the accomplishment of these safety requirements. I am left with the distinct impression from the evidence that the PCB and the senior managers at and above the ADM level failed to recognize that programs such as aviation regulation are not discretionary but are in fact mandatory under the laws of Canada. As Mr LaFrance indicated in testimony before this Commission: "You are not inspecting because a carrier wants to be inspected. This is a need of the government. The government has to budget" (Transcript, vol. 163, p. 85).

I concur with Mr Wightman's assessment of the futility of the present system of resolving the conflict between program needs and affordability, and with his proposal for improvement:

> A. The difficulty I have with the process is that it starts with what, essentially, is an open-ended invitation to all of the Transport Canada managers to submit their requirements. And ... this raises tremendous expectations on the part of managers. It also generates an immense amount of work. Paper is ... just generated over and over again and in huge quantities. Paper which does not have a hope of ever succeeding in what it's trying to do.
>
> So ... my contention in my proposal to the RMB when we do finally get around to discussing the process, as Mr Sinclair said we will do, will be that we need to establish a framework at the beginning of this process. We need to ... make a corporate decision and I will propose that this decision be made by the DM within the TMX committee which is the Transport Management Executive committee consisting of ADMs and the DM.
>
> And I think at that stage a strategy has to be developed, that this year we are going to go forward to Treasury Board for an increase in the overall Transport Canada budget of "X" per cent or whatever it might be. So that when that is decided at the highest level in Transport Canada, then we can give each of the ADMs a target, and we can tell them, now, develop your documentation, develop your operational plan based on this target. And do all the paper work that's necessary for that, but

> don't waste your time on the paper work of anything beyond that target.
>
> And then you've got to look at what you've got in this Operational Plan, and if there are clear safety requirements that remain unfunded after that process has been done, then you've got to do what we were hedging around about yesterday and with Mr LaFrance, you've got to state the case clearly to the Deputy Minister.
>
> (Transcript, vol. 166, pp. 51–53)

It is reassuring to have the current assistant deputy minister, aviation, make such an unequivocal statement with respect to his responsibility to go to the deputy minister with respect to unfunded safety requirements. The PCB chairman, Mr Kenneth Sinclair, was asked what right of appeal a group head (ADM) might have should he or she disagree with the PCB recommendation, with respect to the allocation of resources, to the various groups within the department. This was, obviously, an area of considerable interest in light of the apparent conflict between the need, on the one hand, to satisfy the requirement that the industry was in compliance with safety standards and, on the other, to live within the resource levels imposed as a result of budgetary restraint. His response was that it was clearly understood that the practice was for an assistant deputy minister who was not satisfied with the PCB resource recommendation to go to the deputy minister to express concerns, particularly those related to safety:

> A. The Program Control Board is a staff organization serving the Deputy Minister. It is not part of the line accountability regime in any way.
>
> It's clearly understood by all of the Assistant Deputy Ministers and the members of the executive committee that each group head, each ADM, is totally responsible and accountable to the Deputy for the conduct of the program and the mandate of the program for which they are, indeed, the ADM.
>
> The deliberations of the board are done on a consensus discussion basis, and a consensus is reached normally reflecting the general agreement of the members of the board and ... that is what is recorded in the minutes.
>
> If any ADM ... does not agree or is troubled by the decision, then it was clearly understood practice that as the accountable ADM, they would go, and they have the right to go and, indeed, are expected to go to the Deputy to express their concerns, particularly, as related to safety.
>
> (Transcript, vol. 165, pp. 11–12)

I fully endorse the views expressed by Mr Sinclair and Mr Wightman as to the obligation of an assistant deputy minister to go to the deputy minister in situations where the safety obligations imposed on the government by federal statutes go unattended because of financial considerations. I would go one step further and recommend that it also be mandatory that the deputy minister, in such event, promptly advise the minister in writing of the safety concerns which are so communicated to him.

Communication within Senior Management

Mr Wightman, in his evidence dealing with the alternatives that a group head (assistant deputy minister) has when faced with an apparent lack of resources to meet program responsibilities, used the expression "hedging around." What he was referring to was an earlier examination of Mr LaFrance and a frustrating attempt on the part of virtually all counsel at this Inquiry to find the answer to an obvious question. That question was, Why didn't Mr LaFrance, as assistant deputy minister, knowing that his Aviation Regulation Directorate could not assure senior management that the air carriers were in compliance with safety standards and knowing that aviation safety was being jeopardized to the extent of justifying a memorandum to cabinet, not bypass the Program Control Board and go directly to his superior, Mr Withers, the deputy minister?

Mr LaFrance rationalized his actions by testifying that although he did not go directly to Mr Withers with his safety concerns, Mr Withers would have had the unfiltered information provided to him by the PCB:

> Q. ... Well, if the PCB reported to the Deputy Minister and you reported to the Deputy Minister, then when you went to the PCB to get these resources that you needed and you were denied those resources, did you then go to the DM and set out your plight to the DM?
>
> A. Well, as I mentioned in previous testimony, for a very specific purpose, the PCB and the DM were the same level, in a sense that, everything that I presented to the PCB was documented and I could review that documentation and correct it if I needed to, but I never did have to do that. And this is the documentation that was in front of the Deputy Minister
>
> Q. ... So the PCB wouldn't filter out documentation that you gave it? The presentations that you made to the PCB would go before the DM, is that right?
>
> A. There wouldn't be any filtering of the information that I provided. It was provided directly to the Deputy Minister as part

of that, and this is why I did not need to go to the Deputy Minister in a separate way.

(Transcript, vol. 163, pp. 94–95)

When cross-examined on the obligations of an assistant deputy minister to his superior, in the context of Mr LaFrance's resource situation, Mr Kenneth Sinclair was very clear on his understanding of the situation. There was absolutely no doubt in his mind as to the options that were available to Mr LaFrance if he was not satisfied with the resource allocation provided:

Q. He [LaFrance] is saying, I can tell you right now we need resources. My inspectors are overwhelmed with work. We have got all of this activity as a result of deregulation but you won't give me any resources until you've finished your study.
Isn't that what he's complaining about?
A. And he finds it's acceptable. And this is what I'm suggesting to you, sir, that as we tried to find ways and means to resource his concerns, we reached accommodation and he is saying right there, this is acceptable.
Q. Well, what choice does he have?
A. He could have gone to the Deputy Minister.
Q. All right.
A. He could have disagreed on the record.
Q. Well, ... isn't that, in fact, what he did? He said, all right, I will make the best – I will do the best I can with what you give me, but you should tell members of Cabinet that safety will be adversely affected? Isn't that what he did?
A. No, he's saying we should alert Cabinet of the potential of what is coming on and if I don't get my resources, this could affect safety and in our minutes we agreed to alert them.

(Transcript, vol. 165, pp. 123–24)

While the PCB may have agreed to alert cabinet of Mr LaFrance's safety concerns, apart from Mr Sinclair's earlier evidence regarding an omnibus Treasury Board submission, it is clear from the evidence that no such action was ever taken. The failure of the PCB to alert cabinet through the deputy and the minister of Mr LaFrance's safety-related concerns is inexcusable.

The issue of Mr LaFrance making his safety concerns known was pursued with the deputy minister of the day, Mr Ramsey Withers. Mr Withers was adamant that Mr LaFrance had not expressed these concerns to him directly:

A. The facts are these: He never complained to me about the resource allocation he was given by the Program Control Board.

> He never came and said, Look, it is not enough. I have to have more this year.
>
> He never came forward and said, This situation is extremely bad. We are going to have to stop. We are going to have to slow down, or anything of that – and that is all I can say because that is all that happened.
>
> (Transcript, vol. 164, pp. 146–47)

It is difficult to reconcile the stated actions of Mr LaFrance and Mr Withers with their apparent lack of communication on a matter about which they both claimed to be concerned. Mr Withers knew about the Douglas Report and he knew about the ADMR Review of June 1987. Yet there is no evidence that he asked Mr LaFrance for status reports on how the situation was being handled.

Mr LaFrance knew that Aviation Regulation was in trouble, yet he, by his own admission, did not go directly to his superior, Mr Withers, and put his plight on the table. He indicated that Mr Withers knew of the situation, and he inferred that there was no need for him to do more. Mr LaFrance and Mr Sinclair both testified that Mr Withers would have been provided with this information by the PCB. The mystery surrounding how or if Mr LaFrance's concerns over resource shortfalls were communicated to his deputy ministers becomes even more complex when one considers that Mr LaFrance responded to questions in this regard with conviction equal to that of his superior, Mr Withers:

> Q. Do you feel that your Deputy Ministers at that time were made clearly aware of your concerns about the lack of resources and your inability to –
>
> A. Yes ... in specific terms, they were aware of all that I formally represented through the Program Control Board, not only through discussions with the chairperson of Program Control Board, but through the minutes with all this information here would have been in front of the Deputy Minister.
>
> So – and also in my discussions with two Deputy Ministers under whom I served, there was, certainly, an understanding of our concerns around the senior management table.
>
> I didn't bring at that table the specific aspects, because the specific submissions, of course, went through this channel. But I do know that they were aware of the difficulties.
>
> How they place this in the context of their broader responsibility is something that only they can answer.
>
> (Transcript, vol. 163, p. 75)

It is unlikely that the facts surrounding the question of who told what to whom will ever be fully known. But one thing is certain, communication at the senior management level left a great deal to be desired. Mr

Kenneth Sinclair's view that each manager in the chain has an obligation to pass on any concerns that might have an impact on the safety of the travelling public is clearly the correct approach. According to Mr Sinclair and Mr Withers, no such concerns were expressed to them. However, the evidence is irrefutable that their own internal review agency (the ADMR) had indicated in its report in June 1987 that Aviation Regulation could not assure senior management that the air carrier industry was operating in compliance with safety standards. Furthermore, Mr LaFrance had asked that a memorandum to cabinet be prepared to alert cabinet ministers as to the impact of deficit reduction on flight safety. The PCB minutes corroborate Mr LaFrance's evidence in this regard. Both Mr Withers and Mr Sinclair, seized of pertinent and relevant information, should have been aware of the concerns facing the Aviation Regulation Directorate as a result of lack of resources.

In the case of the departmental responses to the Douglas Report and the ADMR Review of the Aviation Regulation Directorate, it was evident that the deputy minister and the assistant deputy minister satisfied themselves that plans to address these critical issues were being made, but they did not ensure that the action being taken was timely and appropriate in the context of the actual workload demands. A typical example, as identified in the Douglas Report, was the need for a Human Resources Study. A group formed to conduct such a study did not produce its first report until 1988. The recommendations contained therein might have produced some additional help for the Aviation Regulation Directorate in 1989. However, that help was urgently needed in 1985 and 1986.

I was concerned to hear in evidence the widely varying perceptions of Transport Canada managers, particularly at the senior levels, as to how they were to discharge their obligations to respond to expressed aviation safety concerns. I could find no departmental policy that sets out the position of Transport Canada in that regard. The lack of departmental policy and clear direction in this area was highlighted during the testimony of Mr Withers:

> Q. Well sir, I think the evidence, the sworn testimony is – it's basically uncontroverted and it is quite clear that he [LaFrance] went before PCB asking for resources that he felt he needed and he didn't get them.
>
> Now, he didn't go the step further and come to you and that is where we have got two separate sets of opinion. We have your opinion which is, gee, I'm surprised. He should have come to me.
>
> And on the other hand, we have Claude LaFrance's opinion which is, I relied upon PCB to trust my judgement; that was my forum for making my case. And I have to assume that every-

> thing I said to the PCB, the Deputy Minister knew about because there was a direct link there. So, why should I waste his time going to the Deputy Minister?
>
> Now you see that's the difference of evidence that we're getting here.
>
> THE COMMISSIONER:
>
> There seems to be a breakdown somewhere in the area pointed out by Mr Bailey and if you can give us some possible insight as to recommendations that might rectify such a thing happening in the future, it would be helpful, sir.
>
> THE WITNESS:
>
> Thank you, sir. I suppose that about the only thing I can say is reiterate the fact of the operation – the modus operandi and the body; that if at any time any person charged with one of these functions feels that he or she has not been properly dealt with or listened to, then they must ... go to the Deputy Minister.
>
> ...
>
> THE COMMISSIONER:
>
> Perhaps you hit the nail on the head. There should be some very clear direction to the ADMs that in such and such situation [they] should come to the DM.
>
> (Transcript, vol. 164, pp. 191–92)

The difference of opinion on the subject of how safety concerns were to be communicated between managers at the highest levels in the department, and through their minister, is a cause for considerable concern. This kind of "misunderstanding" is unacceptable, particularly when, according to their own priorities, safety was number one. From Mr Wightman's evidence, it appears that he, as the current assistant deputy minister, has no misunderstanding of his responsibilities in that regard. Nevertheless, a clear and unequivocal policy direction should be put in place at Transport Canada to ensure that all managers, at any level, are obliged to communicate promptly and unequivocally to their immediate superior, both verbally and in writing, any significant safety concern that could affect the Canadian aviation industry and public. Furthermore, I am of the view that the failure to do so should be subject to sanctions appropriate to the gravity of the circumstances.

Changing the Scope of the Aviation Regulation Program

By the end of the hearings of this Commission it became obvious that during the latter half of the 1980s the Aviation Regulation Directorate of Transport Canada became increasingly less able to cope with the certification, inspection, and surveillance workloads being generated by the air carrier industry. It was equally obvious that they were not receiving and were unlikely to receive the resources necessary to fulfil their regulatory mandate. The Aviation Group produced their program resource requirements based on program needs, while the Program Control Board responded with allocations based on a very limited affordability. From at least 1985 until 1990, this process repeated itself each year. It is difficult to understand why someone did not face up to the fact that the rationale upon which the resourcing process was based was not only unsatisfactory, but was unrealistic. Either the resource levels had to be increased to meet the demands of the program, or the scope of the program had to be reduced to a level consistent with the resources available. Reducing the surveillance and monitoring program to match reduced resources, however, poses a major dilemma. To do so is to jeopardize the minister's commitment that aviation safety would not be compromised. Mr LaFrance, former assistant deputy minister, aviation, was asked if he had considered the possibility of reducing the scope of the program:

> Q. During your tenure, was there any thought or any ability to reduce the scope of the program?
> A. No, because from an Aviation safety point of view, the least damaging reductions would have occurred in the closures of some Air Navigation installations as I have mentioned. That this can be done through a reduction of service without increasing danger to aviation. That was the least damaging one.
>
> If that was denied to me, I was certainly not going to recommend some other reductions that would decrease the margin of safety. I couldn't professionally do anything like that.
> Q. And such things as decreasing the number of inspections, decreasing the audits?
> A. No ... I was not comfortable with any decrease in that area. There was no, no evidence that would allow us to justify a decrease in the frequency of inspections to any substantial extent, certainly not in the kind of environment in which we were at the time.
>
> (Transcript, vol. 163, pp. 80–81)

Whether decreasing the number of inspections and audits could be justified or not, the evidence shows that after 1988, audits did in fact decrease in number and quality and that in-flight inspections were, at best, minimal in number. This happened not as a result of any plan set out by management, but by default, because there was no one to do the work. During the hearings of this Inquiry in January 1991, Mr Newton's evidence provided some hope that Transport Canada management has finally recognized that the problem was not going to go away and that action would have to be taken:

> A. So as a manager I have, first of all, tried to get the resources to perform that additional workload. And I haven't been that successful. I have gained ... I have been able to obtain some 85 PYs in the last couple of years and if you think of that in a period of fiscal restraint, that has been a major accomplishment.

However, Mr Newton went on to say that growth continues to outstrip the allocated resources:

> A. But the problem has been that the growth has outstripped the resources that we have been able to obtain to the point that as a manager, recognizing that I probably cannot get more resources, I have started to redesign the program.
>
> In other words, I have to offload from the Aviation Regulation program about 130 PYs worth of work to protect my staff from burnout, from excessive stress and anxiety, and to ensure that ... they are performing at a level that they can enjoy sustained performance.
>
> (Transcript, vol. 161, pp. 83–84)

Mr Newton indicated that he was looking at ways to delegate certain air carrier inspector responsibilities to industry so as to free up inspectors for work that required more of a regulatory presence. Provided that it can be shown that such delegation will not result in a degradation of the level of proficiency within the industry or a lowering of the assessment standards through a less enthusiastic application by company check pilots, this would seem to be a sensible approach.

Mr Wightman completed a strategic review of Aviation Group in 1990. This resulted in an organizational change proposal dated January 1991 (Project 1682–342). The strategic review examined a fundamental question that should have been addressed at least five years earlier: Was the Aviation Group suitably organized to deal with an air carrier industry that had totally restructured itself over the past five or six years? It can be said with little danger of contradiction that Aviation Group was not suitably organized to deal with the industry restructuring as it was taking place after deregulation. Mr Wightman's evidence in that regard offers some encouragement for the future:

> A. From a strategic point of view, we felt that we were facing continuing resource constraints but, at the same time, an increase in demand for services; both the kind of services that have been referred to here as discretionary and non-discretionary services, although, I think there's been a certain amount of over-simplification there. We do, in fact, make people wait sometimes as attested to by some of the phone calls I get.
>
> But ... we have concluded, and I will be very brief about this because a strategy can get a long time to discuss, but we have

> concluded that we need to look at other ways of doing our business because we are unlikely to see large infusions of resources into the Aviation activity in the coming years; that is my best assessment now because of the continuing emphasis on deficit reduction.
>
> (Transcript, vol. 166, pp. 68–69)

Mr Wightman, in his testimony, discussed a new approach to the development of an operational plan using a fixed financial target level. He was quite clear in his recognition that unfunded safety requirements must be identified at the highest level of management in the department. To this I would add that unfunded safety requirements must not only be identified, they must be resolved if the Canadian public is to be assured that the system remains safe. While concurring that it is necessary to make all possible effort to structure a regulatory program that recognizes economic reality, I also firmly believe that safety standards must be maintained. The evidence is clear that the present Transport Canada safety standards are minimum standards. I do not believe that the Canadian public is prepared to accept less than full compliance with such minimum standards. Such compliance can only be assured through adequate surveillance and monitoring of the air carriers by the regulator.

If monitoring and surveillance of the aviation safety standards of Canadian air carriers are to continue to give way to fiscal restraints, this properly should be accomplished by way of reduction of the scope of the regulatory program, with clear notification to the Canadian public as to what compromises are being contemplated and what is transpiring.

It should also be noted, as is reflected in a recent Transport Canada internal report entitled "Evaluation of Aviation Regulation and Safety Programs," that there would likely be a greater safety benefit if regulatory efforts were to focus on operations deemed to be of a higher risk category. The report states as follows:

> The higher risk operators or individuals, who persist in unsafe practices (as contrasted with lesser regulatory violations), would be dealt with in the most meaningful way.
>
> This finding would imply a move away from a focus of compliance with regulations, which almost of necessity has to be an across-the-board activity, to focus more directly on risk and safety.
>
> (Exhibit 1323, p. 13)

Surely the purpose of compliance is the reduction of risk and the enhancement of safety. Focusing on higher risk operators is nothing more than good management of regulatory resources. I would go one step further and suggest that consideration should be given to some form of incentive to operators who have consistently demonstrated an exemplary safety record and a high operating standard through their in-flight inspections, audits, and the quality of their manuals and training programs.

According to the evidence of Dr Robert Helmreich during the human performance phase of the hearings, the FAA is attempting to stimulate United States carriers, through incentives, to adopt training programs based on line-oriented flight training (LOFT) in a total crew environment. An advanced qualification program (AQP) that includes LOFT as one of its components has recently been introduced in the United States. This program encourages the expansion of cockpit resource management programs to include all crew members. Based on the evidence I have heard from numerous aircraft crew members during this Inquiry, I am of the view that an AQP-type program is worthy of consideration and should be monitored by Transport Canada with a view towards its adoption in Canada. I would stress that any incentive program offered to carriers should be based on rigorous criteria carefully screened by Aviation Regulation staff to ensure that incentives granted are fully warranted. Such incentives are discussed further in chapter 39, Crew Coordination and Passengers' Safety Concerns.

Air Carrier Certification/ Surveillance Reporting Systems

As early as 1984, when the new domestic air policy was announced, there were documented concerns regarding the ability of the Aviation Regulations Directorate to respond to the anticipated increase in demand-driven certification and surveillance work. Throughout the Transport Canada phase of the Inquiry, evidence was placed on the record indicating that up to 80 new carriers were being certified annually, and that a six-month to one-year backlog in approval of flight operations manuals, training manuals, and minimum equipment lists was resulting in increasingly strident complaints from carriers. Unfortunately, there does not appear to be in place an effective reporting system that would allow senior managers to stay on top of demands being imposed on their staff.

During the testimony of Mr Ian Umbach, it was revealed that in July 1990, Transport Canada's in-flight inspections on international and continent-wide flights had virtually ceased as a result of a depleted overtime budget. Mr Umbach agreed that such a cessation of surveillance greatly reduces the margin of safety in the industry (Transcript, vol. 139, p. 60). Nevertheless, when the director-general of aviation regulation, Mr Weldon Newton, testified before the Commission on

January 16, 1991, he admitted that he was unaware that Transport Canada had ceased surveillance on international and continent-wide flights. When asked why he did not know the status of the situation, Mr Newton testified:

> A. I guess the nature of the program is such that I don't ask my directors every day about every component of their programs. I go on the basis that if they're having difficulties that they'll bring these things to my attention; be it Airworthiness, be it Licensing, be it whatever. If there's problems, I'd like to know about them.
>
> (Transcript, vol. 162, p. 7)

It appears that the flow of information available to Transport Canada's senior managers is subject to the discretion of the directors. If there was no complaint, then it was assumed that no problem existed.

It is clear from all of the evidence that a similar attitude prevailed at the highest level within the department. Even though the deputy minister, Mr Withers, had received warnings from his own internal audit review group that Aviation Regulation was in severe difficulty, he did not insist that his managers inform him of safety-related problems. As he explained in his evidence:

> Q. And, therefore, it's your evidence that you were unaware that your Aviation Group was not getting the resources that they felt they required?
> A. I want to put it the other way. I want to state that I knew that they weren't ... getting everything they wanted, but I also knew that they were getting enough to be able to do the job the way he felt he had to do it in Aviation.
> Q. Well, how did you know that, sir?
> A. Because he never –
> Q. What source did you have for that?
> A. He never complained to say that he didn't, did he?
> Q. So your touchstone is that unless he came to complain to you, he must be getting enough?
> A. That is right.
>
> (Transcript, vol. 164, p. 120)

Based on senior management's apparent lack of knowledge of the severe difficulties being faced by the inspector staff, it is obvious that reliance exclusively on the discretion and the reporting of safety concerns by immediate subordinates proved to be less than satisfactory.

It would seem almost elementary in management practices that all responsible Transport Canada managers would seek out or have at their disposal knowledge of the current demands being imposed on branches of the department for which they have responsibility. This is particularly so in those areas that have been identified as being critical to aviation safety. This expectation would have most certainly applied to air carrier certification and surveillance. Maintenance of a data base in those areas would facilitate quick identification of increased or decreased demand, which could be related to response ability. Resource needs would not then be based on perceptions alone, but on empirical data. According to the evidence of Mr Slaughter, efforts are currently being made to put in place two computerized information systems: national aviation company information system (NACIS), and audit information reporting system (AIRS). It is recommended that the data bases developed also include demand indicators that accurately reflect, on a real time basis, the workload being imposed on their own regulatory organization. These reports should be consolidated and produced for senior management consumption. In that way no one would be able to say they did not know because no one told them.

Policy Development: Impact Studies

According to an article written by Mr Lloyd Axworthy, the minister of transport in 1983-84, the first signal of government approval of a relaxation of domestic economic air policy was contained in the December 1983 Speech from the Throne. Mr Axworthy wrote:

> As CATA [Canadian Air Transportation Administration] and the CTC [Canadian Transport Commission] were opposed to reform, I built a policy unit in my own office. An official was seconded from Privy Council Office, an assistant was assigned full time to the task, a consumer advocacy lawyer was retained for counsel, and contracts were signed with several academics.
>
> (*Policy Options Politiques*, April 1985, p. 17)

The creation of such a policy unit in the minister's office may have served him well by excluding CATA and CTC opposition to reform. It may also, however, have denied him warnings of the aviation safety impact to be expected in association with such reform and about which the public servants of his department were well aware. Indeed, the impact studies produced by the Ontario Region office were completed not as the result of a request from any headquarters policy unit, but, rather, on the initiative of the region's senior management. The government announced its new air policy in May 1984. The Ontario

Region submitted its impact study to Ottawa in July of the same year, two months after the policy was in place.

With the change in government in September 1984, the policy was further developed to cover other modes of transport as well. In July 1985 the new minister of transport tabled a transportation policy paper called *Freedom to Move: A Framework for Transportation Reform*. As in the case of the Axworthy reform, this policy also carried with it implications that would be felt in many areas, not the least of which was safety regulation. Mr Kenneth Sinclair, chairman of the PCB, was examined on the need to conduct comprehensive impact studies as an integral part of the policy development process:

> Q. Sir, from your perspective and from the experience which you have, do you think that it is wise, sir, to do thorough impact studies and thorough implementation plan studies before a new policy is ventured into and implemented?
> A. Yes, I would agree – not only do I agree, it is compulsory now in the development of putting forward a policy proposal that the resource implications be included in terms of implementation costs and downstream costs.
> Q. Sir, do you think that this kind of impact study and, indeed, an assessment of an implementation plan was carried out as fully as it should have been during the years '84 and on, as we ventured into this new arena of Economic Regulatory Reform?
> Do you think that that was sufficiently done by the internal bureaucracy of Transport Canada?
> A. I wasn't sure. So I asked the Deputy Minister, Mr Withers, and his advice to me was that he was satisfied that there was no clear evidence that the resourcing strategies weren't adequate.
> Q. And that was the Deputy Minister's advice to you, sir?
> A. It was.
> Q. In what year, if you can recall, would that have been, sir?
> A. That was at the time of the whole ERR issue coming forward to us. And that would have been, I think, Oh, within a year of my becoming chair of the Program Control Board.
> Q. So it must have been around –
> A. About '87.
>
> (Transcript, vol. 165, pp. 71–72)

Findings

- The need for increased resources within the Aviation Regulation Directorate to meet the growth and demands expected to be generated by the policy of Economic Regulatory Reform was predicted and well documented in several reports and studies in the period prior to 1984 and thereafter.

- The Ontario Region's impact study of July 1984, conducted on its own initiative, identified serious emerging resourcing and staffing difficulties within the Aviation Regulation Directorate.

- The Nielsen Task Force strongly recommended in September 1985 an immediate increase in resources in the area of air carrier inspection.

- The 1986 Douglas Report set out the serious difficulties encountered in the United States as a consequence of deregulation, and identified emerging Canadian resourcing and staffing problems expected as a consequence of the introduction of Economic Regulatory Reform.

- The deputy minister's internal audit review group, in June 1987, issued a report that stated that the Aviation Regulation Directorate was at that time unable to provide senior Transport Canada management with sufficient assurance that the aviation industry was in compliance with existing safety legislation, regulations, and standards. In spite of these indicators, the deputy minister remained of the opinion that the resourcing strategies for the Aviation Directorate were adequate.

- Based on the evidence before this Commission, the Transport Canada resourcing and staffing strategies, since 1984, have been inadequate to meet the needs of the Aviation Regulation Directorate.

- Based on the evidence before this Commission, there is no indication that any impact studies pertaining to safety regulation were carried out or requested by the Transport Canada policy development group that produced the 1985 transportation policy paper.

- Of equal importance was the need for Transport Canada to conduct similar impact studies on safety regulation in the context of deficit reduction.

- The effect of Economic Regulatory Reform, combined with deficit reduction or, more specifically, the five-year Memorandum of Understanding between Transport Canada and the Treasury Board, created a synergy that, in my opinion based on the evidence before this Commission, had an adverse impact on the effective application of safety standards.

- There is no evidence of any in-depth examination by Transport Canada of the effects of downsizing in the face of a major restructuring of the air carrier industry that was to take place following the introduction of Economic Regulatory Reform.

- There is an urgent need for a system within Transport Canada to enable the fast-tracking of additional qualified personnel into critical areas involving aviation safety, when required.

- The multi-level resource-request challenge process employed by the Aviation Group of Transport Canada is an unduly cumbersome and time-consuming process ostensibly designed to identify and justify absolute minimum resource requirements.

- The Program Control Board, which was faced with resource restrictions after the introduction of Economic Regulatory Reform, did not respond appropriately to aviation safety–related resource concerns that were brought to its attention by the Aviation Regulation Directorate.

- The senior management of Transport Canada, Aviation, has been shown by the evidence not to have responded adequately to aviation resource concerns being expressed by lower and middle management regarding their inability to meet program responsibilities, particularly in the area of air carrier inspections, monitoring, and surveillance.

- It is not my intent to criticize the right of a government to embark on a policy of economic deregulation of the air carrier industry. Nor would I suggest that it is improper to attempt to reduce the size of the national deficit. It is the combined effects of these policies, as they relate to the safety of the public, that causes concern. The policies are not faulted in any way, but their application and overall administration left much to be desired.

RECOMMENDATIONS

It is recommended:

MCR 118 That Transport Canada, as an integral part of any future policy development process, ensure that thorough impact studies be carried out by experienced analysts, knowledgeable in the subject matter, as a prerequisite to government acceptance and implementation of policies that could have a bearing on aviation safety.

MCR 119 That, where a potentially adverse effect on safety is identified, appropriate measures be taken by the government to preclude the effect before the policy is implemented.

MCR 120 That all senior Transport Canada Aviation Group managers have at their disposal knowledge of the current demands being imposed on branches of the department for which they have responsibility.

MCR 121 That Transport Canada encourage all Aviation Group managers, at any level, to communicate to their superiors any significant aviation safety concern that has come to their attention and that could affect the Canadian aviation industry and public.

MCR 122 That Transport Canada put in place a policy directive that if resource levels are insufficient to support a regulatory or other program having a direct bearing on aviation safety, the resource shortfall and its impact be communicated, without delay, to successive higher levels of Transport Canada management until the problem is resolved or until it is communicated to the minister of transport.

MCR 123 That an air carrier activity reporting system providing a current and reliable picture of the industry be developed and utilized by Transport Canada to determine program resource needs, levels, and direction.

MCR 124 That the process of resource allocation, including staffing standards, be re-examined by Transport Canada with the following objectives:

(a) To establish a staffing standard based on realistic and measurable task performance and frequencies and accepted standards of time required for such tasks.
(b) To reduce the challenging levels from the present seven or more to a lower, more realistic level.
(c) To establish a resource contingency factor for aviation regulation that can, at the discretion of senior management of Transport Canada, be called upon to provide additional resources to meet exceptional safety-related circumstances.

MCR 125 That Transport Canada examine the role of the Resource Management Board, formerly the Program Control Board, with a view to attaining the following goals:

(a) To ensure that the deputy minister of transport will be informed of all aviation safety implications of any resource reductions or denials recommended by the Resource Management Board.
(b) To ensure that within the Resource Management Board and its secretariat there is an individual with aviation operational expertise who is cognizant of safety implications in resource reduction programs.
(c) To ensure that members of the Resource Management Board understand the implications of personnel reductions below the minimum level prescribed by accepted staffing standards.
(d) To ensure that the deputy minister of transport be informed of each instance in which the Resource Management Board or its secretariat returns plans to Transport Canada group heads asking for further justification of resource requirements for aviation safety–related items.

MCR 126 That Transport Canada's Aviation Regulation Directorate develop a system that focuses resources on the areas of highest risk.

32 AUDIT PROGRAM

Transport Canada had conducted an audit of Air Ontario in October 1988, five months prior to the Dryden accident. As set out in Part Five, the period 1987–88 was a particularly volatile time at Air Ontario. The recent merger, pilot strike, and introduction of the F-28 were a few of the destabilizing factors at that time. Had a thorough and complete audit of Air Ontario's operations and maintenance departments been performed by Transport Canada during this critical period, it would have provided valuable insight into the health of the company, and the audit team would have been well situated to identify deficiencies.

As it happened, the Air Ontario F-28 operation was not audited in the October 1988 audit. This serious shortcoming, in concert with other problems in Transport Canada's organization and execution of the audit, severely limited its effectiveness. The inadequacy of the audit represented a significant breakdown in the safety system that should have protected the passengers and crew of Air Ontario flight 1363 on March 10, 1989. Accordingly, a thorough investigation was warranted of the 1988 audit of Air Ontario (see chapter 33), and, more generally, of Transport Canada's inability to deliver its National Audit Programme effectively.

National Audits

Transport Canada's revised Manual of Regulatory Audits (1990) defines an audit as "An in-depth review of the activities of an organization to verify conformance with current regulatory standards and practices" (Exhibit 963, p. 1-1). These audits are conducted pursuant to the *Aeronautics Act*, c.A-2 and c.33, s.4.2(K), which empowers the minister to "investigate, examine and report on the operation and development of commercial air services in, to, or from Canada."

At the time of the Air Ontario audit, the director-general, aviation regulation (DGAR), was responsible for all aviation regulation audits and inspections. This responsibility was further delegated to the director of flight standards, the director of the Airworthiness Branch, and the regional directors of aviation regulation.

An audit is one of a number of devices available to Transport Canada to monitor regulatory compliance and the general health of Canadian air carriers. In this regard, an audit program serves as an important preventive measure in preserving the public trust in the safety of civil aviation.

Typically, audits involve a team of air carrier and airworthiness inspectors who, over a period of about two weeks, comprehensively review and monitor an air carrier's operations, including record keeping. An audit report, containing the "non-conformance" findings and recommendations of the audit team, is compiled and presented to the audited company within 10 days of completion of the audit.[1]

The regional director, aviation regulation, for Ontario Region, Mr Ronald Armstrong, capsulized in his evidence the reason for audits:

> A. The purpose of the audits is to take what you'll hear lots of us refer to as a snapshot of a particular carrier and their state of health at a particular point in time. We get the running movie picture of the state of health of that company through our day-to-day activity with those carriers, but as the inspectors are only looking at a one-of event at any given time, one PPC, testing the product of the training process via looking at the pilot's performance, or looking at a particular aircraft and testing the maintenance capabilities of that company by looking at the maintenance and airworthiness of that aircraft, we'd go in and look at a systemic approach when we're doing an audit. And that's what it's mainly about. It's to look at the company's systems and see whether there are any deficiencies in those systems.
>
> At the same time, there will be an examination of the product of that company, the pilot, the cabin attendant and the aircraft, as part of an audit – as part of a large audit, not necessarily the smaller audit.
>
> (Transcript, vol. 124, p. 167)

Under the National Audit Programme (NAP) (1983–90) it was intended, although seldom achieved, that headquarters would conduct three national audits per year and that each national carrier would be audited every three years. Under the 1990 revised Manual of Regulatory Audits (Exhibit 963), the frequency of air carrier audits depends not only on how much time has elapsed since the last audit, but also on the carrier's regulatory compliance and safety record. The manual sets out that carriers are to be audited every six to 36 months and that all carriers are to be audited six months after initial certification. In determining audit frequency within the six- to 36-month time period, the convening

---

1 Non-conformance is defined in the revised Manual of Regulatory Audits as follows: "deficiency in characteristics, documentation or procedure which renders the quality of a product or service unacceptable or indeterminate."

authority is to take account of the following risk management indicators that are intended to highlight potential problems in an air carrier:

- financial/labour/management difficulties
- poor internal audit/Quality Assurance programme
- change in operational scope or additional authority
- large change in contracting
- high turnover in personnel
- loss of key personnel
- addition to or change in product line
- poor accident or safety record
- merger/takeover, and
- previous audit history.

(Manual of Regulatory Audits, p. 1-12)

National versus Regional Audits

Transport Canada's first national audit was conducted on Air Canada in 1983. Prior to that time, audits, which were formerly referred to as base inspections, were convened and conducted solely at the regional level. In developing the National Audit Programme, Transport Canada headquarters assumed the responsibility of auditing Canada's larger carriers. This new audit program, however, did not drastically alter the status quo. National audits are basically similar to regional audits, the fundamental difference being the location of the convening authority. Mr Armstrong expanded on this distinction in his testimony:

> A. National audits and regional audits are ... the same, it just means who's doing them. Where is the convening authority located, and national audits would be conducted on those, if we're speaking air carriers, those air carriers which are regulated out of the seventh region: Air Canada, Canadian [Airlines International], Canadian Helicopters, those would be done as a national audit basis, with an audit manager and possibly team leaders from headquarters with ... working level resources coming from wherever they can obtain them in the organization, be that headquarters or regionally.
>
> Regional audit, the convening authority would be either myself [Ontario Regional manager] or the regional managers, and being resourced, again, most often out of the region but occasionally with resources from other regions.
>
> (Transcript, vol. 124, pp. 171–72)

Mr Henry Dyck, superintendent of large aircraft inspection, airworthiness, based at Transport Canada headquarters, was centrally involved in the incipient stages of the NAP. He also served as the manager of the

Air Ontario audit in 1988. Mr Dyck testified that the NAP did not establish a dedicated team to administer and conduct national audits. Instead, this substantial undertaking was added to the burgeoning workload of Mr Dyck and his staff in the Airworthiness Branch, as well as to that of his headquarters counterpart in Air Carrier Inspection. In October 1985, after the completion of five national audits, Mr Dyck aired his dissatisfaction with the NAP in an internal memo to his supervisor, Mr Roger Beebe, chief of airworthiness inspection in the Airworthiness Branch:

> I have supported these audits in concept, but I have also spoken out about the lack of availability of PYs [person-years] to carry out these audits under the existing staff allocation. We (ABMA) can no longer carry out national audits and continue to complete other work with any degree of efficiency. I cannot expect my staff to formulate policy and write staff instructions, (our main function), when they are busily engaged in national audits and the subsequent follow-up work.
>
> (Exhibit 1052)

In the same memo, Mr Dyck went on to recommend the formation of a permanent national audit team, not only to alleviate his own workload, but, as he added, "the permanent audit team would certainly be beneficial in concept to prepare and cope with the situations arising out of deregulation, i.e. the upcoming merger of CP Air, Nordair, EPA, and maintenance contracting to outside agencies, etc., etc." Although Mr Beebe responded to Mr Dyck's memo, his response did not address the proposed establishment of a permanent national audit team, nor did it satisfy Mr Dyck's concerns regarding deregulation.

By 1988 it had become clear that Transport Canada was experiencing acute difficulties in delivering its NAP. The issue came to the fore in January 1989, as a result of a series of internal Transport Canada memoranda that requested that no national audits be scheduled for fiscal year 1989/90 because of a lack of resources and an overwhelming workload. In a memorandum to Mr William Slaughter, director of flight standards, dated January 20, 1989, a memorandum commonly referred to as the "MacGregor Memo," Mr Neale MacGregor, acting chief of operations and certification, argued for a deferral of all national audits because of the "critical" situation in Air Carrier Inspection:

> The plan for the coming fiscal year was to conduct National Audits on Air Canada and Wardair. The size and scope of these two audits would completely denude AARCBA [Large Air Carrier Operations – Headquarters] of staff for up to a month at a time, and would make it impossible to review and approve the many documents required for certification (Operations Manuals, Training Manuals and

> MELs), or carry out non-discretionary commitments such as initial check-outs, captain upgrades and CCP monitorings.
>
> (Exhibit 1106)

Another serious impediment to the continued functioning of the NAP was revealed in a memo dated April 19, 1989, from Mr Beebe to his superior, Mr James Torck, director, Airworthiness Branch. What had been established as a joint venture between headquarters' Airworthiness and Operations groups had deteriorated. In his memo, Mr Beebe strongly asserted the Airworthiness Group's frustration and dissatisfaction in working with Operations and called for a rethinking of the program. As the following excerpt from the memo indicates, the audit of Air Ontario in 1988 (as discussed in chapter 33) exemplified the shortcomings of the Operations Branch:

> You may recall that the NAP was set up as a response for a uniform and consolidated approach to auditing the airline industry. At the time of its inception and to best address the administrative aspect of the program, Airworthiness relinquished the OPI [Office of Primary Interest] role to the Operations Branch. However, it would appear that this arrangement isn't meeting its intended goal. There are numerous indications pointing to the Operations Branch – falling short of delivering a quality program. Most recently the Canadian Airlines International Limited (CAIL) and Air Ontario National audits have failed to deliver their final reports within the prescribed time frames. In both instances, Airworthiness had completed their portion of the report, on time and delivered on schedule.
>
> ...
>
> ... This unwarranted delay has compromised the intent of the audit and seriously detracted from its credibility.
>
> (Exhibit 1093)

Mr Slaughter has held the position of director of flight standards since January 1988 and bears principal responsibility for the audit program. When he took up his new position, he realized that the audit program was "very poor" and in need of reform:

> A. ... I think it's become quite clear, and it was at the time, that as it progressed or immediately after the time, that the audit function that I had assumed when coming into the position was in place, was really less than ideal. In fact, it was very poor. I was most displeased with the whole audit process.
>
> And that, of course, came to light with such audits as the Air Ontario audit amongst one or two others. And for this reason, I took action to restructure the audit program to bring it into being more functionally responsible and responsive to our

> requirements as a regulatory agency and to the requirements of the industry.
>
> So that, fundamentally, that was what led to the creation of the audit program as we have it now.
>
> (Transcript, vol. 144, p. 27)

In 1989–90, in response to these and other concerns, the NAP was scrapped and audits were returned to the purview of the regions. These changes were in keeping with a new policy whereby headquarters assumed strict responsibility for development of policy and standards while the regions applied and enforced these standards. Nevertheless, the change to the audit structure does not appear to represent a significant departure from the previous order. Many of the carriers that would have been audited by the NAP now fit within the headquarters-based Seventh Region.

In addition, headquarters assigned four person-years, two each from Operations and Airworthiness, and created a permanent audit management team. Although termed audit management, this new group should not be confused in title or function with the audit manager appointed for each individual audit. Rather than participating in audits, this new group became responsible for developing the revised Manual of Regulatory Audits, reviewing the audit training of air carrier inspectors, and monitoring the regions in their conduct of audits.

Finally, in November 1989, the regional directors decided that Airworthiness and Operations should conduct their audits separately rather than jointly. This decision was commented on in a January 1990 document entitled "ADMA [Assistant Deputy Minister Aviation] Action Plan: Regulatory Audits":

> The consensus was that 80% of the aviation companies would never rate the time and effort of a combined audit and that specialist (flight standards or airworthiness) audits should henceforth be considered the norm.
>
> This approach has the advantage of allowing more resources to be directed to the problem areas, as well as increasing the number of companies that are likely to receive at least one annual check. At the same time, companies who receive a poor report in the specialist audit would be targetted for more attention, including a combined audit, if warranted.
>
> (Exhibit 1322, Annex 7)

While this policy of separating Airworthiness and Operations audits may reduce the opportunity for conflict between Airworthiness and Operations personnel, it also takes away the benefits of combined audits – most notably the ability to get a truly comprehensive picture of the company at one time, as well as the ability to address most effectively matters of joint responsibility.

Audit Manuals

In 1986, under the auspices of the director-general, aviation regulation, work began on an audit policy manual entitled Manual of Regulatory Audits (MRA). The office of prime interest (OPI) for the MRA – that is, the responsibility for its coordination, production, distribution, and amendment – rests with the director of flight standards (formerly the director of licensing and certification). A number of draft MRAs were produced and disseminated in the intervening years but during the hearings of this Commission, in December 1990, it was disclosed that the document had never received final approval. Two versions of the MRA were tabled before this Commission: the first (Exhibit 1034), dated June 25, 1987, was most likely used by the team that audited Air Ontario in 1988; and the second (Exhibit 963), compiled in 1990 by the newly appointed audit management team, is the most recent version of the MRA. It received approval on January 23, 1991, soon after the completion of the hearings of this Commission.

Mr Dyck testified that the MRA was not used as a primary document by auditors but, rather, was used as a reference document. Another document, the Audit Procedures Handbook (Exhibit 1033), although produced as a manual for auditor training, was more often used as a field document by inspectors. It was, in fact, also used by the audit team who audited Air Ontario.

Evidence given before the Commission revealed some confusion as to the status of these documents and their co-relationship. The MRA had been in existence in its various incarnations and had been widely circulated for approximately five years, but it had never been approved. The handbook, though widely used and circulated, was a training document. While no apparent conflict in policy or procedure between the manual and the handbook came to light, the lengthy approval process for the MRA, as well as the overlap in the documentation, reflects poorly on Transport Canada's management of its audit program.

Audit versus Other Compliance Checks

Audits are an important regulatory tool for measuring the safety level of a company at a particular point in time. Because Transport Canada's audit of Air Ontario just five months before the Dryden accident did not cover Air Ontario's F-28 program, the overall efficacy of the audit was brought into question and a thorough investigation of it was undertaken.

However, the degree of attention paid to the audit by this Commission should not be interpreted as in any way minimizing the value of other regulatory checks such as in-flight inspections, pilot proficiency checks (PPCs), and instrument rating renewals.

In addressing the value of audits relative to other compliance checks, and as is discussed in chapter 30 of this Report, Effects of Deregulation and Downsizing on Aviation Safety, Mr Ian Umbach, the superintendent of air carrier operations, rated in-flight inspections as a more valuable regulatory tool than audits:

> Q. Can you describe the value of audits, in your mind?
> A. Audits have a place in our monitoring and surveillance system. They are designed to ensure that the carriers record-keeping and infrastructure is acceptable, and they do have value.
> However, I feel that other things, such as in-flight inspections and PPCs, have more value.
> Certain audits, for example in the certification process, are very high value. An audit after a merger has a very high value.
> But a routine audit, I consider about midway to the bottom third of our, say, a scale of our inspection priorities.
> (Transcript, vol. 138, pp. 101–102)

Mr Slaughter generally agreed with this:

> A. ... the point I would like to make is that I see an audit as being part of a ... program of checks on the carrier.
> ...
> I heartily agree with the testimony that indicated that an in-flight inspection is probably one of the better methods of looking at ... the operation of that particular flight. And a series of these gives a great monitoring of the industry. And I think that's a very effective tool to use.
> ... my own opinion is that an audit has a place in the overall surveillance program, not the only place. I don't think we can get rid of the other things and concentrate only on audits, but by the same token, I don't think the other things in isolation has quite the same impact as included audits in the overall program.
> So fundamentally, the reason I put it in number 5 is that I have a little ... more confidence in the audit program, and secondly, it has been a recognized part of the directorate's thrust on regulating the industry ...
> Q. But what you are saying, Mr Slaughter, is that the audit per se is only one piece of an entire system which you would like to see in place; am I understanding you right?
> A. Yes, that's right, sir.
> (Transcript, vol. 144, pp. 74–75)

To deliver an aviation safety program such as the audit effectively, it is imperative that the program be thoroughly planned, ably managed, and adequately funded. Inspectors involved in an audit must be well trained and conversant with the audit's objectives and procedures.

These necessary ingredients were rarely seen through the life of the National Audit Programme – from its inception in 1983 to its dissolution in 1989. However, it appears that the problems that were experienced in the audit of Air Ontario in 1988, and which were exposed and analysed before this Commission, have jolted Transport Canada into taking action to rectify the deficiencies in its audit program. The revised Manual of Regulatory Audits, issued by Transport Canada in 1991, provides some organizational improvements to reduce the confusion that at times characterized the 1988 audit of Air Ontario, which I address in chapter 33.

33 AUDIT OF AIR ONTARIO INC., 1988

Transport Canada's Ontario Region was, at all material times, responsible for monitoring and inspecting the day-to-day operations of both Air Ontario Ltd and Austin Airways. Soon after the two companies merged in June 1987 to form Air Ontario Inc., Ontario Region began to plan an audit of the new entity. Because mergers often result in significant and complex changes in companies and because Air Ontario Inc. was also in the process of introducing a new aircraft type, Mr Donald Sinclair, Ontario Region's manager of air carrier operations, and Mr Martin Brayman, Ontario Region's superintendent of air carrier inspection (large aeroplanes), thought that it was an appropriate time to conduct an audit. As Mr Sinclair explained in his testimony:

> A. The decision [to audit Air Ontario] was based on the fact that they were undergoing this melding process of Air Ontario Limited and Austin Airways Limited. We wanted a snapshot in time as to how the company was coming.
>
> ...
>
> We had two diversely different operations being melded into one. We had ... what started out to be a bush operation way back by the Austin family which was operating principally up and down the coast of the [Hudson] Bay, we had it melding with a very neat scheduled operation in southern Ontario with larger airplanes.
>
> Q. Why would this cause you concern?
>
> A. How the two were going to meld together under one operational control, under one chief pilot, under one director of maintenance, et cetera.
>
> (Transcript, vol. 142, pp. 63–65)

After Economic Regulatory Reform (ERR) was implemented in 1985, the workload of Transport Canada's inspectors increased dramatically (see chapter 30, Effects of Deregulation and Downsizing on Aviation Safety). Mr Brayman explained that the decision to audit Air Ontario in 1988 reflected Ontario Region's concern over its ability to execute its mandate under the strain of ERR:

> A. During this period, we were under a great deal of stress, and there is no question we were worried that there might be some cracks in the door, that something might slip by us. We were

> hoping to use the audit as a back-up tool to ensure that that didn't take place.
>
> (Transcript, vol. 132, p. 221)

Organization of the February 1988 Audit

Initially, Mr Sinclair had planned to conduct a regionally based, in-depth, joint Operations Branch and Airworthiness Branch audit commencing in November 1987. As planning for the audit progressed, however, the audit was elevated from a regional to a national audit and rescheduled to February 1988. Ultimately the airworthiness portion of the audit went ahead in February 1988 while the operations portion was further postponed until October 1988.

Mr Brayman indicated that although the proposed audit of Air Ontario was first conceived as a regional audit, Ontario Region actually favoured some degree of headquarters involvement. Such collaboration would not only ensure the independence of the auditor from the carrier (Ontario Region was involved with Air Ontario on a day-to-day basis), but would also assist Ontario Region, which did not have the personnel needed to do the job:

> A. I think at the time we were very short of personnel and we didn't feel that we could put together an audit team in region, so we turned to the national audit team and requested they do the job for us.
>
> (Transcript, vol. 132, p. 3)

The involvement of headquarters and the upgrading of the audit to a national audit was not free of conflict. Because Transport Canada did not have permanent audit staff to assign to the audit, inspectors had to be recruited from various regions, including headquarters. However, the absence of an inspector seconded to an audit for two to three weeks inflicted tremendous strain on the affected headquarters or regional office already overworked because of ERR-related demands. When Ontario Region requested that headquarters provide an audit manager to ensure that this key position was held by someone not otherwise involved with Air Ontario, the request was accepted by Mr Donald Douglas, director of licensing and certification. He then made a specific request for Mr Henry Dyck to be made audit manager to Mr James Torck, headquarters director of airworthiness, who turned down the request in a memorandum of November 26, 1987:

> We are unable to accommodate your request because of other ERR related priorities and the possible national audit of Okanagan

> Helicopters in February. We also understand that PARD [Ontario Region] is able and willing to assign an audit manager for this audit.
> (Exhibit 1063)

In his testimony before the Commission, Mr Dyck expressed his own disinclination to participate in the Air Ontario audit and explained why he believed Ontario Region sought to include headquarters personnel in the audit. First, Ontario Region wanted to find auditors who had not been previously involved with Air Ontario. Second, although he believed that Ontario Region had the necessary manpower to do the audit, Mr Dyck described what he perceived to be an underlying feud between the Operations and Airworthiness branches at Ontario Region that precipitated the request to headquarters to supply the audit manager (see chapter 32, Audit Program):

> A. Well, again, as I recall it, and the conversation I had with the man at the time, Mr Al Bryson [Ontario Region superintendent of air carrier airworthiness], there was a bit of conflict ... between himself and the operations people as to who was going to do the audit. Call it inter-departmental feuding or rival – friendly rivalry is the best description.
>
> ...
>
> ... I asked, well, why aren't you doing the audit if you have the time and the people and the ability. And they [Airworthiness] said they didn't want them [Operations] involved in the process of it all.
> (Transcript, vol. 135, pp. 107–108)

Ultimately, the planned Air Ontario audit was changed to a national audit, which was scheduled to run from February 16 to March 3, 1988. Mr William Slaughter, director of licensing and certification (which became flight standards), assumed the role of convening authority, Mr Dyck was appointed audit manager, Mr Peter Saunders, airworthiness team leader, and Mr Bruce Ingall, operations team leader. According to Mr Dyck, the audit was given national status because Ontario Region had not been able to obtain the required personnel and funds:

> A. ... To call it a national audit, that would mean that we could now recruit people from other regions to do the job.
>
> From the perspective of the Ontario regional operations, people were not available or could not do the job, so they asked for additional help.
>
> In order to do it, they elevated it to a national audit, and that way they could get additional funding and the manpower that would ... They perhaps wanted money to do it and they didn't have it.

> Like I say ... I don't really know. From the airworthiness portion of it, the side of it, the people were there and they were available. So other than that, there was not much of a reason to make it a national audit.
>
> (Transcript, vol. 135, pp. 113–14)

Audit Personnel: Selection and Training

A major shortcoming of the Air Ontario audit centred around personnel. From the start, there were difficulties in assembling inspectors to conduct the audit. The person eventually appointed as operations team leader had never before participated in an audit, let alone served as a team leader; the audit manager interpreted his responsibilities in a manner that conflicted with the Manual of Regulatory Audits (MRA); and the audit manager and the operations team leader were unable to work together effectively to complete the audit report in a timely manner.

Convening Authority

The convening authority is described in the MRA as "the manager responsible for authorizing a regulatory audit" (Exhibit 963, p. 1–3). Since national and regional audits were distinguished according to the location of the convening authority, once the Air Ontario audit became national, Mr William Slaughter, director of licensing and certification, was appointed headquarters-based convening authority by the director-general of aviation regulation.

The convening authority is responsible for convening the audit and appointing the audit manager and team leaders, approving the audit plan, and assigning audit follow-up activities. In addition, the audit manager is expected to keep the convening authority informed of pertinent audit matters (Exhibit 963, pp. 1–24 and 1–41).

Audit Manager

The MRA defines the audit manager as "an individual designated by the Convening Authority who is responsible for planning and overall conduct of the audit, up to and including production of the final Audit Report" (Exhibit 963, p. 1–1). The audit manager may be an operations inspector, an airworthiness inspector, or an airworthiness engineer, and should have the following qualifications:

- completion of the Audit Training Module provided by the Inspector/Engineer Training and Development Branch

- experience related to the type of operation to be inspected
- experience with Transport Canada administrative procedures
- no conflict of interest in relationship to the Auditee.

(Exhibit 1034, Manual of Regulatory Audits, p. 1–2)

When the audit of Air Ontario became a national audit, Mr Dyck was appointed audit manager. He brought more than adequate training and experience to the task. Although it was his first appointment to the position, he had been a team member on a number of audits as well as the airworthiness team leader on the national audits of Air Canada in 1983 and Okanagan Helicopters in 1985. Moreover, he was involved in the establishment of the National Audit Programme in 1983, and validated, or critiqued, Transport Canada's Audit Training Module. In spite of his experience, Mr Dyck could not be described as an eager or willing participant. As the following excerpt from his testimony indicates, he reluctantly accepted the appointment in order to fulfil an obligation to alternate airworthiness and operations personnel as national audit managers:

> A. ... I was directed by my boss to do it ... my boss [Roger Beebe, chief airworthiness inspector] and the other – and Mr Corkett [chief of air carrier operations] had agreed to share the responsibilities of audit manager and it was now our turn.
>
> Although I declined it the first time and tried to decline it the second time, it was my assignment.
>
> (Transcript, vol. 135, pp. 114–15)

The audit manager has the responsibility to plan, coordinate, and "maintain the integrity of the audit process" (Exhibit 1034, p. 3-1). More specifically, and as set out in the Transport Canada policy/guideline documents, the Audit Procedures Handbook (Exhibit 1033), the Manual of Regulatory Audits (Exhibit 1034), and the revised Manual of Regulatory Audits (Exhibit 963), the audit manager's responsibilities include maintaining contact with the convening authority, communicating with senior management of the auditee, exercising line authority over assigned audit staff, ensuring that all functions of the audit team have been completed prior to the release of the individual members, and preparing the draft audit report.

The revised Manual of Regulatory Audits, which was approved by Transport Canada on January 23, 1991, contains similar but expanded provisions on audit manager training requirements and responsibilities. This new MRA appears to have addressed some of the areas of concern that arose in the 1988 audit of Air Ontario and that are the subject of my commentary in this section of the Report.

Audit Team Leader

The MRA and the audit handbook set out the duties of an audit team leader: to maintain ongoing communication with the audit manager; debrief auditee management upon completion of the audit; become familiar with the company's policies, instructions, and procedures; and draft sections of the report as required by the audit manager (Exhibit 1034, pp. 3–2, 3–3). Neither manual, however, offers guidelines on required experience or training.

The revised MRA, in contrast, is far more explicit in this regard. It requires that a team leader have the same qualifications as an audit manager – that is, that he or she be a flight standards or airworthiness inspector, or airworthiness engineer, and have participated in at least two large audits as a team member (p. 1–56).

Where the audit is a joint Operations/Airworthiness audit, as was the case in the Air Ontario audit, there will be two team leaders: operations and airworthiness. At the time the Air Ontario audit team was being assembled, there was no Transport Canada policy document or guideline establishing responsibility for appointing team leaders. As a result, the appointment to this important position was carried out in a haphazard fashion and resulted in the formation of ineffective working relationships. Mr Dyck testified that he had no involvement whatsoever in the selections of Mr Bruce Ingall, and subsequently Mr Leonard Murray, to the position of operations team leader.[1] In contrast, Mr Dyck specifically requested Mr Peter Sanders, whose credentials he was familiar with, as his airworthiness team leader. Since Mr Dyck's experience was in airworthiness, he was more familiar with the pool of potential airworthiness team leaders than the corresponding group in operations. Partly as a result of these appointments, I believe, the airworthiness audit was conducted smoothly, while the operations audit was to some extent impeded by the discordant working relationship between Mr Dyck, the audit manager, and Mr Murray, the operations team leader.

The convening authority, Mr Slaughter, was also not involved in selecting the audit team members, including team leaders, preferring to delegate the responsibility to his staff. As Mr Slaughter's testimony indicates, he had no knowledge of the experience of the appointees:

> Q. How are members of an audit team selected, sir? And let's now get back to the Air Ontario situation.

---

[1] Mr Ingall was appointed as operations team leader for the February 1988 audit. Because the operations portion of the audit was postponed, and not actually conducted until October 1988, Mr Ingall was unavailable and was replaced as operations team leader by Mr Murray.

...

Did you have any input after January '88 on team members?

A. Not really, as I recall. I didn't have anything constructive to contribute at that point.

Although it was my authority, I really didn't know the individuals, didn't know the circumstances, so I went with what was offered to me, and respected the opinion of the people that offered them.

(Transcript, vol. 144, pp. 37–38)

The revised MRA improves on the previous situation in that it establishes clear procedures for the appointment of team leaders: "The Audit Manager shall select and designate Team Leaders in consultation with the CA [convening authority], and confirm their appointment in writing" (p. 1–56). Since the team leader reports to the audit manager, it is vital that the audit manager have confidence in his or her team leader. Had the team-leader selection provisions from the revised MRA been in place to guide the appointment of the operational team leader in the audit of Air Ontario, I am convinced that many of the problems that hindered the audit could have been avoided.

Audit Team Members

The MRA and audit handbook in effect in February and October 1988, at the times of the Air Ontario audit, did not outline the responsibility for or the procedure to be followed in securing appropriate audit team members. Yet, in the absence of permanent audit staff to conduct national audits, the process of assembling an audit team would necessarily be replayed for each audit. For this reason, it is in my view a glaring omission, and an invitation to controversy, that a system was not in place to ensure the orderly secondment of inspectors. When the initially appointed operations team leader, Mr Ingall, experienced difficulties in arranging a team, Mr Dyck, the audit manager, was called in to lend assistance. Mr Dyck testified as to the negative impact of this ad hoc approach:

Q. Is there any established Transport Canada procedure or policy for national audits to recruit staff – to recruit team members?

A. No, sir, there is not. It is strictly on an as-available basis. At that point it was.

The issue was addressed at the next audit, national audit meeting, and I suggested we create an on-call list. And I believe that matter was talked about further down the road as a result of this experience.

Q. Okay, and did you find that to be a satisfactory state of affairs in getting audit members?

A. No, it's not. That was one of the constraints that we had to work under for this audit and all audits up to that point.

... you must appreciate that these audits are an ad hoc project and we do not have full-time staff members assigned, so we have to solicit the help of regional staff to do the function with.

(Transcript, vol. 135, pp. 147–48)

Without question, because of the pressures created by ERR, there was a severe shortfall of available, trained personnel to serve as audit team members. This was exacerbated by an inadequate system of accessing these inspectors for audit duty. Mr Dyck commented that his greatest staffing problem was trying to acquire operations inspectors, which was described as a "beg, borrow, and steal" situation:

Q. Well, was it – to use a common expression, was it a beg, borrow and steal operation that you were on, to try and get the personnel you needed to do this operations audit?
A. Well, that was an expression I used at some time, yes.
I would phone the regional director and I would state my case, I need a body to do a certain function, and the response would go something like, yes, give me a minute, I will phone you back in a day or two and see what I can do.
And the response would come back, well, this guy is free, you can have him for "X" number of days. That type of scenario is what I encountered.

(Transcript, vol. 136, pp. 161–62)

With respect to the qualifications required of audit team members, the MRA stated that "all members of the Audit Team, with the exception of those in training status or serving as observers, shall have completed the Audit Training Module" (Exhibit 1034, p. 1–3). In the Air Ontario audit, however, Mr Dyck testified it had not been practicable to comply with the MRA. He said that members of a national audit committee meeting had resolved "that we would try to at least have team leaders have the training, as compared to the members, because insufficient training had been accomplished to this point and it would have been an impractical policy to say that everybody had to have that training" (Transcript, vol. 136, p. 164).

Postponement of the Operations Audit, February 1988

In preparation for the audit due to begin on February 22, 1988, Mr Dyck, the audit manager, and Mr Ingall, the operations team leader, were briefed by Ontario Region on January 11, 1988, about Air Ontario's operations and maintenance (Mr Sanders, the airworthiness team leader, was absent). Then, on January 26, 1988, Mr Dyck and Mr Sanders (Mr Ingall was absent) met with Air Ontario executives to notify them formally of the upcoming audit and to apprise them generally of the audit process.

The audit teams assembled and commenced their audits as scheduled on February 22, 1988, but the operations portion was soon suspended. The merged entity, Air Ontario Inc., did not have an approved flight operations manual in place, and for this reason it was decided that it would be fruitless to conduct the audit at that time. Accordingly, the operations portion of the audit was postponed until June 15, 1988; however, the airworthiness, passenger safety, and dangerous goods portions of the audit continued as scheduled. As it turned out, the operations audit was finally conducted between October 18 and November 4, 1988, five months before the Air Ontario F-28 crash at Dryden. Ironically, the operations audit did not cover the problem-plagued Air Ontario F-28 program.

Air Ontario's Unapproved Flight Operations Manual

At the January 11, 1988, briefing from Ontario Region, the point was raised that Air Ontario's Flight Operations Manual (FOM) was not yet approved. This FOM represented the operating procedures of Air Ontario Inc., and was intended to replace the manuals that had been in use at Austin Airways and Air Ontario Ltd. An operations audit team relies on a Transport Canada–approved FOM as one of the principal standards against which it measures compliance. The minutes of the January 11, 1988, meeting state that "Bruce Ingall indicated some concern that Transport Canada may be conducting an audit without allowing the operator sufficient time to work with the new operations manual. Henry Dyck will determine the status of the operations manual as it relates to this audit" (Exhibit 1070).

Even though this warning regarding the lack of an approved FOM was raised six weeks in advance of the audit, it went unheeded by Transport Canada. Furthermore, this was not the first mention of the FOM's unapproved status. In October 1987, before the planned audit became a national audit, Mr Donald Sinclair, in a memo announcing the delay in the date of the audit, stated: "This will allow [the] carrier time to implement procedures etc. contained in the new maintenance control and operations manuals now being approved" (Exhibit 1060).

That it took as long as it did – five-and-a-half months – for Transport Canada to approve the FOM is symptomatic of the larger issue of insufficient resources to manage the ERR-generated workload. (Air

Ontario submitted its FOM to Transport Canada for approval on September 15, 1987. It was not approved until February 29, 1988.) Considering the effect that this agonizingly slow FOM approval process had on the audit, it is inexcusable that appropriate steps were not taken by Transport Canada between October 1987 and the commencement of the audit to ensure that the Air Ontario FOM was approved and in use.

Air carrier operations, the headquarters branch responsible for the FOM approval, and the audit manager, Mr Dyck, were situated in the same office building. While Mr Dyck is certainly not alone in bearing responsibility for having to postpone the Operations audit, I believe he could and should have insisted that the approval of Air Ontario's FOM be given high priority. It is clear from the minutes of the January 11, 1988, meeting that Mr Dyck was left with the responsibility of ensuring that the FOM was approved. It is also clear that the unapproved status of the manual had been brought to his attention in the audit's earliest planning stages.

Mr Dyck testified that because Air Ontario's operating certificate had already been issued, it was his understanding that all that remained in the FOM approval process was a "minor administrative task" (Transcript, vol. 135, p. 141). More important, from his perspective, was the fact that the company was still in a transitional stage and had not incorporated the procedures contained in the new FOM. Mr Dyck testified that he did not find out the company was still in a post-merger transition until he arrived in London on February 22, 1988, and began the audit, and he ascribed blame to both Air Ontario and Ontario Region for not having previously brought this to his attention:

A. But the point I'm trying to make, in – as far as the physical act of approving the manual, that could have done, if that's all we are looking at, we could have clarified that issue very quickly.
It wasn't the manual approval that was in question. It was the ability of the company to meet standards of that manual. And as Mr Nyman explained, they were still in transitionary stages, so it would have been fruitless to look at a situation that was in the stages of transition.
Q. And did you attach a lot of weight to what Mr Nyman was saying to you?
A. Yes, I did.
Q. Well, the merger between Austin and Air Ontario Limited occurred in June of 1987, which was approximately eight months before these discussions in February of 1988.
A. That is correct.
Q. Do you not think that eight months would be sufficient time for the company to absorb this transition period and be in a state where ... you could conduct a valuable audit?

A. Sir, I was not party to discussions, meetings concerning the degree and the depth of the transition and the elements of the work that had to go into it.

I assumed that was already in hand with the Ontario regional office and should have been addressed by them because, after all, the Ontario region had already issued the operating certificate for the company during our preparation meeting at Toronto regional office.

We were not informed that the company was in a transition stage or was still transitioning. We were led to believe that it was already done and the company was now operating to the new manual.

(Transcript, vol. 135, pp. 171–73)

Air Ontario must also bear some responsibility for the aborted operations audit. Inexplicably, when the audit team arrived in London on February 22, 1988, Mr Robert Nyman, Air Ontario's director of flight operations, claimed he had not been forewarned of the audit. This is peculiar in light of the fact that the audit team attended at Air Ontario's corporate offices on January 26, 1988, for the express purpose of briefing the company on the upcoming audit. I find it difficult to accept that the director of flight operations would not have been aware of the upcoming audit. However, if that was the case, such an omission strongly detracts from the credibility of the Air Ontario organization at that time and is further evidence of disarray in the company. This state of affairs should have been interpreted by Transport Canada as another reason to proceed with the operations audit of Air Ontario. In his testimony, Mr Dyck expressed his surprise at Air Ontario's unpreparedness:

A. And at that time, I was informed that the operations part would be redundant to do the audit on that part because the company ... was not finished amalgamating the two elements of Air Ontario and Austin to the new company. They were still in the stages of changeover.

I asked Mr Nyman, at that time, why he didn't tell me, or I wasn't informed of this, because we had been and officially presented our audit plan to the company back in the meeting of January the 26th.

His response to me was that he was not aware – made aware of the fact that we were coming until the previous morning [February 22, 1988], he knew nothing about –

...

Q. Were you surprised by that?

A. Completely. I was completely surprised. I didn't know what to think of it at the time.

However, that was not the main issue. The issue was, was the audit feasible to conduct under the circumstances or was it not.

> And it was Mr Nyman who pointed out to me that because the company was still in the process of changing over, that to conduct the audit with the new manual would have been redundant.
>
> In other words, you would have looked at a situation that was in a transition rather than a completion state, and the efforts of the audit team members would have been somewhat fruitless at that time.
>
> (Transcript, vol. 135, pp. 167–69)

Mr Dyck went on to testify that the "main factor" in the decision to postpone the audit was Mr Nyman's representation that it would not be an appropriate time to conduct the audit:

> A. The main factor was Mr Nyman's claim that the transition elements had not been completed. It was the manual – the approval of the manual itself was of little concern to me because the manual could have been approved in a few minutes. As a matter of fact, the person who approved it was there on site.
> Q. And who is that?
> A. Mr Len Murray.
>
> (Transcript, vol. 135, p. 171)

The audit team should not have permitted themselves to be influenced by Air Ontario in this way. It is probable that a thorough operations audit conducted on Air Ontario at that point would have exposed at least some of the operational deficiencies, merger pains, and safety risks that were subsequently uncovered at the hearings of this Inquiry. It is imperative that the regulator, in the public interest, maintain at all times a healthy suspicion in dealings with air carriers. Mr Dyck agreed with this premise when it was put to him in cross-examination:

> Q. Well, let's face it. You asked Mr Nyman, have you got any problem, is there anything we can help you with while we are here, that's – and he said no, there are no problems. That's the process, wasn't it?
> A. Well, it wasn't only Mr Nyman, it was Mr Ingall as well and Mr Sinclair and Neale MacGregor, all of those people who were part of the decision process, to defer it.
>
> The point was, I said, what can we do while we are here, is there anything we can do constructive.
> Q. But the thing is, you were there to determine whether there was any problem or not. I mean, that wasn't Mr Nyman's job to tell you about problems. You were there to do an in-depth audit to verify that there were no problems; weren't you?
> A. Correct.

Q. I mean, if Transport relied upon carriers to tell them when audits need to be done, there would never be any audits, would there?
A. That's correct.

(Transcript, vol. 137, pp. 75–76)

On February 23, 1988, the day after the operations and airworthiness audit teams commenced their audits at Air Ontario's base in London, the operations team leader, Mr Ingall, advised the audit manager that he felt the operations portion of the audit should be postponed because of the absence of the Flight Operations Manual. A meeting was convened between representatives of the audit teams and Air Ontario to discuss the audit.

When informed that the audit was in jeopardy, Mr Sinclair and Mr Brayman, who were flying a Transport Canada aircraft from Toronto to Windsor at the time, diverted to London for the meeting. After this meeting, the Transport Canada officials – Messrs Dyck, Ingall, Sinclair, Brayman, and MacGregor – got together to discuss the postponement of the audit. Mr Neale MacGregor, acting on behalf of Mr William Slaughter, the convening authority, discussed the matter by telephone with both Mr Dyck and Mr Ingall, and later briefed Mr Slaughter. The convening authority acceded to the recommendations made by the on-site audit team to postpone the operations portion of the audit.

In light of the difficulty in putting together an audit team at a time when inspectors' workloads were at a maximum and resources were scarce, it is inexcusable that planning efforts among Ontario Region, the convening authority, the audit manager, the operations team leader, and the carrier were not coordinated to ensure total readiness for the audit. The valuable time of every operations team member, not to mention the taxpayers' money, was wasted as a result of the postponement of the operations audit of Air Ontario.

The further question that arises is whether the audit could have proceeded without the approved FOM. Would the audit necessarily have been redundant because the company was not yet operating to the revised FOM, or would it have been an ideal time to audit because Air Ontario was in a state of transition? Mr Ingall, the operations team leader, whose view eventually prevailed, favoured a postponement of the audit. Both Mr Brayman and Mr Sinclair, in contrast, felt that the audit could have proceeded as scheduled. As Mr Brayman said in his testimony:

A. As a matter of fact, his [Mr Ingall's] opinion prevailed. Neither Don [Sinclair] or I felt that that was a good enough reason to postpone the audit, because an audit is nothing more than a snapshot that has taken place on a given period of time.

> And since companies are continually in transition, we felt that the fact that the ops manual was in a transitional process wouldn't really affect what the audit team would see. They would just see exactly what the company was doing at that time.
> (Transcript, vol. 131, p. 197)
>
> A. In a company such as Air Ontario, which is undergoing continuous rapid growth, the manuals are in continuous review. There is never a time when you really have settled down. There's always an amendment on its way.
> (Transcript, vol. 132, p. 4)

I agree fully with the approach attested to by Mr Brayman, and I am of the view, for the following reasons, that the operations portion of the Air Ontario audit should have proceeded, as scheduled, in February 1988:

- Audits are conducted for the protection of the public and the assistance of the air carrier.
- The functional merger that created Air Ontario Inc. had taken place in June 1987, eight full months prior to the scheduled audit. A transition period of such length raises warning flags and warrants an in-depth inspection of the carrier.
- It is a requirement of law (Air Navigation Order Series VII, No. 2, section 31) that a carrier provide an operations manual for the use and guidance of operations personnel in the execution of their duties. In the approximate eight-month post-merger period, but prior to the approval of the new Air Ontario Inc. Flight Operations Manual, Air Ontario Inc. crews continued to use both the old Austin Airways and Air Ontario Ltd operations manuals. The protracted circumstance of the company's functioning with two flight operations manuals created a potential safety hazard worthy of inspection.
- Even though operations audit teams rely on a Transport Canada–approved flight operations manual as the standard against which to measure compliance, in the absence of the new, approved, and integrated FOM the audit team, composed of experienced air carrier inspectors, could still have conducted an in-depth, effective audit of the company at that time.
- Since the audit team was already assembled and as resources were at a premium, every effort should have been made to conduct the audit, even though some minimal time would have been spent revising the audit plan.
- Separating the airworthiness, passenger safety, and dangerous goods portions of the audit from operations dilutes the effectiveness of the audit as a comprehensive snapshot of a company at a particular time.

A joint audit would have been more effective in that there are overlapping responsibilities among these different audit teams.

Finally, the circumstances surrounding the delayed operations audit again illustrate the existence of an interbranch problem between the Airworthiness and Operations branches. It appears that Mr Dyck's inaction with regard to the Air Ontario audit in the period between January 11, 1988, and the commencement of the audit on February 22, 1988, may have been influenced by his reluctance to prod the Operations Branch for work, such as the delay in the approval of the FOM. Mr Dyck agreed with a proposition put forth by his superior, Mr Roger Beebe, that the failure of the National Audit Programme to produce a quality program was attributable to the fact that the office of primary interest was held by the Operations Branch rather than the Airworthiness Branch. Mr Dyck placed the onus for the audit's downfall squarely on the operations side:

> Q. All right. Well, Mr Beebe is pointing to the operations branch as the party who is being blamed, it seems. Would you agree with that?
> A. Yes, to a certain degree, yes, I would.
> Q. And could you provide the Commissioner with your views on this airworthiness operations discrepancy?
> A. Well, using the evidence that we have discussed in the last few days as an example, from the inception of the audit, there is a lot of discussion and to-ing and fro-ing regarding selection of team members.
>
> Then there's also a discussion and changes of audit dates and schedules and trouble obtaining the audit manual. Then there's further trouble in re-scheduling the audit without our involvement. Then we have further trouble in completing the audit report.
>
> It is that type of scenario that we are talking about in general terms as being a difference between the way the operations branch operates and the way we, in airworthiness, operate.
>
> (Transcript, vol. 136, p. 106)

The apparent ability of the Airworthiness Branch to complete audits more promptly than the Operations Branch appears, at least in part, to be due to the differences in work priorities between the two branches. In fairness to operations inspectors, pilot proficiency checks (PPCs) are deemed non-discretionary work items while audits are discretionary. As such, operations personnel, to the chagrin of their airworthiness colleagues, have often been delinquent in completing their audit responsibilities because they have had check rides to conduct that took priority. Mr Dyck testified that he encountered that very problem in attempting to complete the final report of the Air Ontario audit:

> A. Well, again, in my experience with trying to complete the operations portion of the audit and trying to deal with Mr Murray, one of Mr Murray's other priorities was flying, for various reasons.
>
> And this other priority, of course, interfered with the completion of the audit report. That is basically, I believe, what he is talking about here.
>
> (Transcript, vol. 136, p. 109)

Conflicts between different factions exist in most if not all industries and workplaces, and the airworthiness-operations conflict might be seen as an overblown, petty rivalry. Petty or not, however, such conflicts may compromise the safety of the travelling public, as the cancellation of the Air Ontario operations audit illustrates. Nevertheless, the onus must rest with Transport Canada management to establish policies that neither conflict with one another, such as leaving discretionary work (e.g., audits) unfinished because of a non-discretionary obligation (e.g., pilot proficiency checks), nor cause conflict among the line personnel who implement the policy.

Approval of the Flight Operations Manual

Air Ontario's FOM received Transport Canada approval on February 29, 1988, a mere one week after the postponement of the operations audit. There can be little doubt that the haste with which the approval ultimately arrived was a direct result of the postponement of this audit. This view was confirmed by Mr Leonard Murray, who, on his return to Ottawa from London after the aborted audit, was assigned to finalize the FOM's approval:

> Q. And how long did it take for the manual to get its approval from the time you were dispatched into the assignment of having a look at it and providing an opinion on its – whether or not it should be approved?
>
> A. I can't give you exact – it wasn't very long. I can't, you know, it was maybe a day, two days.
>
> Q. All right. So you came back from the audit of Air Ontario on the 23rd of February, and by the 29th of February, the manual had been approved; is that right?
>
> A. That's correct.
>
> ...
>
> Q. As far as you are aware, did the cancellation of the audit at Air Ontario have anything to do with the approval of this manual within one week?

A. Yes.
Q. And could you elaborate upon that? What is your understanding of the connection between the two?
A. I'd say it speeded it up.
Q. After this memorandum of February 29th, 1988, that being Exhibit 1038, was it your understanding that you would be involved with the Air Ontario operations audit when it resumed?
A. I had a feeling that I would probably be asked to do the Convair work again on the next audit.

(Transcript, vol. 133, pp. 96–98)

Air Ontario submitted the Flight Operations Manual to Transport Canada for approval on or about September 15, 1987. As such, it took Transport Canada close to six months to approve and return the FOM. Despite the compelling evidence before this Commission of excessive workloads in the Air Carrier Branch as a result of deregulation, that alone is not a sufficient reason for failing to approve a crucial document such as the FOM in a more timely fashion.

The February 1988 Audit

Airworthiness Audit

In contrast to the operations portion of the audit, the airworthiness audit, under the guidance of airworthiness team leader Mr Peter Sanders, was planned and executed smoothly. This was also the case for the passenger safety and dangerous goods audits conducted by Ms Jacqueline Brederlow and Mr Paul Saulnier, respectively. A post-audit meeting was held on March 24, 1988, at which time the draft airworthiness, passenger safety, and dangerous goods portions of the audit report were presented to Air Ontario officials. Subsequently, the final versions of these portions of the audit report were sent to Air Ontario under a covering letter from Mr Dyck to Mr Douglas Christian, Air Ontario's chief inspector, on or about April 15, 1988. (This date is Mr Dyck's best recollection, since the covering letter was left undated.) The punctuality of the airworthiness, passenger safety, and dangerous goods inspectors in compiling their reports is in stark contrast to the five-month period taken by the operations team to complete its report.

The specific airworthiness audit findings did not reveal significant transgressions in Air Ontario's maintenance organization. It should be noted that the Air Ontario F-28 program was not audited, since the first F-28 was not acquired until May 1988. In general, Mr Dyck was satisfied with the conduct and results of the airworthiness audit, and described the findings and non-conformances as "typical ... for a company of that size" (Transcript, vol. 136, p. 17).

Passenger Safety Audit

The passenger safety portion of the audit was conducted from February 29, 1988, to March 4, 1988, by Ontario Region's superintendent of passenger safety, Ms Jacqueline Brederlow, with the assistance of Inspector Jennifer Johnstone.

Passenger safety inspectors are responsible for inspecting and approving all matters pertinent to interior cabin safety. Transport Canada's Ontario Region is structured in such a way that the passenger safety division reports to the regional manager, air carrier operations. For this reason, and because their responsibilities overlap, the operations and passenger safety audits were originally scheduled to coincide. However, because Ms Brederlow had prior commitments at a passenger safety training course, she did not arrive in London for the audit until February 29, 1988, by which time the operations audit had already been postponed and the operations audit team had disbanded. On the decision of the audit manager, the passenger safety audit went ahead as planned.

In light of the circumstances of the postponed operations audit, and the problems in coordinating busy schedules, it is difficult to fault the decision to proceed with the passenger safety audit in February-March 1988. However, the fact that Ms Brederlow found herself conducting an audit without the support of the operations team is yet another consequence of the poor planning and resultant cancellation of the operations audit.

Although little evidence was presented on the findings of the passenger safety audit, one example did come to light of an inconsistency between operations and passenger safety that could have been prevented with effective communications between the two groups. A document used by Ms Brederlow in her inspection, entitled Audit Checklist for Air Ontario Inc. National Audit 29 Feb – 4 Mar 1988, illustrates the importance of uniform procedures for the flight and cabin crews. The checklist included the following questions:

> Is the Cabin Attendant Manual procedurally consistent with the Operations Manual, Passenger Agent Manual, Aircraft Operating Manuals? Are Emergency Procedures and signals the same for cabin attendants and pilots?
>
> (Exhibit 1077)

Beside this question, Ms Brederlow had handwritten the response, "Yes. Based on draft Ops [Flight Operations] Manual."

The clear intention of the above-noted question is to ensure that the manuals guiding the operations of flight crews and cabin crews in a given situation are consistent. However, a comparison of Air Ontario's Flight Attendant Manual (Exhibit 137) and the Flight Operations Manual (FOM) (Exhibit 146) reveals an omission and/or inconsistency in the crucial area of hot refuelling. The Flight Attendant Manual sets out the following: "When refuelling is required with one engine running, all passengers are to be off-loaded and cleared from the area during the refuelling period. Flight Attendants should also leave the aircraft" (section 2.31, paragraph 12). The FOM, in contrast, is silent on this point.

Had the passenger safety and operations audits been conducted at the same time, it is possible that this variance would have been uncovered. Had this omission in the FOM regarding hot-refuelling procedures been exposed at the audit process and become the subject of review at Air Ontario, it is possible that the crew of flight 1363 would have been better equipped to respond to the hot-refuelling situation when it occurred on March 10, 1989. (Hot refuelling is discussed in chapter 21.)

Dangerous Goods Audit

The dangerous goods portion of the audit was conducted by Mr Paul Saulnier, regional superintendent dangerous goods, Atlantic Region. On March 11, 1988, upon completion of his audit, Mr Saulnier submitted his vertical analysis sheets[2] along with a dangerous goods overview to the audit manager. The dangerous goods overview included the following points:

- This audit seemed to be untimely considering the amalgamation of the two previous companies and the absence of an approved company flight operations manual.
- Considering the size of this company, it would be a definite advantage to all concerned for the company to appoint a dangerous goods coordinator.

---

[2] Vertical analysis is a reporting format whereby each audit finding is recorded on a separate form. Each form identifies a problem, provides examples and probable causes, and recommends corrective action. There are two types of findings and consequently two types of forms:

i) Non-conformance findings apply where legislative requirements or authorities delegated to the company have not been followed. They require a written response from the audited company and subsequent follow-up from Transport Canada.

ii) Observations are made where existing standards, practices, or techniques can be improved, but where such items do not relate directly to a requirement. The audited company may, but is not required to, respond to observations.

- The company must establish system-wide procedures to unify the present Air Ontario Inc. program.

(Based on Exhibit 1076)

Mr Dyck testified that he took no action on receipt of Mr Saulnier's dangerous goods overview:

Q. All right. And upon receipt of ... this summary, this overview from Mr Saulnier, what did you do with these remarks?
...
Did you pass these comments on to the company?
A. No, sir. I passed them on – his findings as they were spelled out in the company operations manual – or, pardon me, the vertical analysis sheets that he provided to me.
Q. All right, but not as stated in this overview?
A. No. I may add that since these are his personal views, that where there are findings, then they should have been substantiated in the vertical analysis forms.
And I may have used them – again, without looking at the report in any detail, they may have been included in the summary at some point.
In other words, if you look in the report, you will see summaries for different areas. And they may have been, I don't know. I would have to do some research to answer that question.

(Transcript, vol. 136, pp. 4–6)

I believe the substance of Mr Saulnier's recommendations is important and merited further action from Mr Dyck. Bearing in mind Mr Saulnier's unique expertise as a regional superintendent of dangerous goods, it would have been potentially beneficial to forward his comments to Air Ontario, even though they may not have fit within the vertical analysis format required for the report. If the time and money required to send experienced inspectors to conduct audits are being expended, then certainly the inspectors should not be discouraged from making observations or recommendations that may be of potential benefit to the carrier and the travelling public. The alternative is to check the company's conformance with standards, specifications, or regulations and to report only the non-conformances. While this approach more clearly delineates the inspector's duties and responsibilities, it runs the risk of engendering a "checklist mentality" in the inspectors.

The Operations Audit

Rescheduling and Restaffing the Operations Audit

What had initially been a 90-day postponement of the Air Ontario audit eventually stretched to eight months, and the operations audit team did not reconvene in London until October 18, 1988. The process of rescheduling and restaffing the audit, particularly the position of operations team leader, since Mr Ingall was not available to serve on the rescheduled audit, proved the major stumbling block.

Mr Slaughter announced in a memorandum dated July 21, 1988, that Mr W.A. (Bill) McKenzie, a small air carrier inspector, had been appointed as the new audit team leader for the audit of Air Ontario scheduled for October 18 – November 4, 1988. However, Mr McKenzie's appointment was short lived. He immediately wrote back that he was not qualified or endorsed on any of the aircraft in Air Ontario's fleet (except the DC-3) and would therefore not be an appropriate choice. Surely Mr McKenzie's qualifications should have been ascertained before his appointment.

As a result, on August 23, 1988, Mr Slaughter replaced Mr McKenzie with Mr Jack Rozon as the operations team leader. Mr Dyck, who was not involved in the selection process, was advised of Mr Rozon's appointment in a memorandum from Mr Slaughter:

> Because of circumstances beyond our control, W.A. (Bill) McKenzie's designation as Operations Team leader has to be withdrawn. Mr Jack Rozon of AARCBA [Large Air Carrier Operations – Headquarters] has been nominated in his stead and will be accompanied by Mr Len Murray of the same section who will profit from the opportunity to obtain on the job training.
>
> (Exhibit 1039)

As events unfolded, the passing reference that Mr Murray would "profit from the opportunity to obtain on the job training" became more significant, if not ironic. On or about October 5, 1988, less than two weeks before the starting date of the operations audit, Mr Murray, who had never been involved in an audit, was advised that he would be replacing Mr Rozon as operations team leader. Mr Murray related the events as follows:

> Q. And the expression, "profit from opportunity to obtain on-the-job training," as written by Mr Slaughter, what was meant by that?

A. I had never done an audit before, and that was the intent of it was to give me some on-the-job training.
Q. I see. So after August 23, it's a matter of record that now that you were a part of the audit team assisting or accompanying Mr Rozon. What was the next involvement you had with the Air Ontario audit, which would eventually occur in October, November of '88?
A. I can't remember the exact dates. It was around maybe the 5th or 6th of October, '88.
Q. The 5th or the 6th of October, 1988, what happened?
A. I was advised that Jack Rozon would be taking the A310 course in Toulouse.
Q. In Toulouse, France?
A. France.
Q. Yes.
A. And that they wanted me to do the audit as team leader.
Q. And who advised you of this?
A. Mr Gilchrist advised me first.
Q. And what was your response when you heard that they wanted you to be the audit team leader?
A. I did not want to do it.
Q. Why didn't you want to do it?
A. I had no experience in previous audits.

(Transcript, vol. 133, pp. 103–105)

Undoubtedly Mr Rozon's announcement of his unavailability a mere two weeks before the scheduled start of the audit was especially disruptive since he was the third team leader to step aside. The subsequent appointment of a reluctant, inexperienced Mr Murray was a "desperate act" to prevent having to postpone the audit yet again. Not only did Mr Murray not have prior experience as a team leader, he had never before participated on an audit in any capacity. (He was to have been a team member on the postponed audit in February 1988.) He had, however, taken Transport Canada's one-week audit training course in April 1988.

Amazingly, the convening authority, Mr Slaughter, had elevated Mr Murray's position from one where he would "profit from the opportunity to obtain on-the-job training" to team leader. Mr Slaughter admitted he appointed Mr Murray because "he was the only one left":

Q. Len Murray, on the other hand, who also wasn't qualified –
...
– unfortunately didn't have the luxury of being able to turn this down?
A. That's right.
Q. Why not?

A. Because by then, I was becoming rather impatient. It was suggested that I postpone the audit again from the October period, and my patience by this time, when I was starting to get a grasp of what was happening, wore a little thin and I recognized that anyone – or at least I assumed, based on the information I gathered, that an air carrier inspector with the guidelines that were presented should be able to perform the audit – or the team leader function without too much difficulty.

And just to assist him, I ensured that, to the chagrin of the Atlantic region, a chap by the name of Roy Wilson was attached to the team, albeit for an abbreviated period of time, but Roy had been one of the founders of the audit procedures program and training package, so that I wanted him there to assist Len Murray and brief him and get him started and directed.

And then I thought that under the circumstances, he would be able to handle it himself.

Q. To cut through all the words that you have just used, what is the reason that Len Murray finally got the nod?

A. He was the only one left.

(Transcript, vol. 144, pp. 41–42)

Surely the Canadian public and Canadian air carriers are entitled to expect more.

Mr Slaughter further explained that Mr Roy Wilson, an air carrier inspector from Atlantic Region who did have significant audit experience, was not made team leader because he would not have been available for the duration of the audit. Mr Slaughter was anxious to have the audit completed and he was frustrated by the long delay, as well as the difficulties in securing a team leader. Nevertheless, I find his decision to appoint as operations team leader a person who had never before participated on an audit an error in judgement. Although Mr Murray voiced his reluctance to be team leader because of inexperience and even suggested that the audit be further postponed, his concerns were rejected by his superiors. The following excerpt from Mr Murray's testimony illustrates his reluctance to be team leader:

Q. And what did Mr MacGregor tell you?

A. He said there was nobody else left to do the Canadian audit, all the other inspectors were busy, and that I was the only one left, and had the audit course and he thought I could do it.

Q. And what was your reaction to that?

A. I told him I did not want to do it.

Q. And why did you tell Mr MacGregor you didn't want to do it?

A. As I said before, I didn't want to do it because I didn't have any experience in doing audits.

Q. And what was ... Mr MacGregor's response to that concern?

A. Well, I – before his response, I did ask if there could be a postponement to a later date and they could – when the Canadian audit got completed, then they could pick somebody for a team leader had come off the Canadian audit with experience.
Q. And what was his response to that suggestion?
A. He said that there was no postponements, that the director had stated he wanted it done now.
Q. And who was the director?
A. Bill Slaughter.
Q. So Bill Slaughter said no more postponements, the audit had to be done now. MacGregor passed that message along to you and you were it; is that right?
A. That's correct.
Q. And how did you feel about that?
A. I didn't feel too good about it, but I worked for Transport Canada.

(Transcript, vol. 133, pp. 105–106)

To his chagrin, Mr Dyck, the audit manager, was not involved in the rescheduling or restaffing of the operations audit. In fact, Mr Dyck was not consulted or even advised when the date of the audit was again delayed from July 1, 1988, to October 18, 1988. (Initially the audit was postponed from February 1988 until June 15, 1988, and then until July 1, 1988.) Mr Dyck's dissatisfaction was apparent in a letter he wrote to Ontario Region's director of aviation regulation, Mr Ronald Armstrong, on September 8, 1988:

> During the initial company debriefing and my meeting with you, and in our letter to the company we had agreed on a tentative date for July 1, 1988 to complete the operations portion of the audit. Subsequently the audit dates were changed without my knowledge, agreement or notice to the company. To preclude any further misunderstanding, can you confirm at your earliest convenience if there are any matters or issues that may interfere with the operations portion of the audit, as scheduled.
>
> (Exhibit 1086)

That the audit manager was excluded from the replanning of the audit is another example of poor communication in the administration of the audit. At the time that Mr Dyck wrote to Mr Armstrong, Mr Rozon was still the scheduled team leader. Nevertheless, when Mr Rozon stepped down, Mr Dyck was not involved in the appointment of his replacement, Mr Murray. However, in that he had previously received a letter from Bill Slaughter stating that Mr Murray will "profit from the opportunity to obtain on-the-job training," Mr Dyck was aware that Mr Murray lacked audit experience. Furthermore, it appears from Mr Dyck's comments that the root of the problem once again stemmed from friction between the audit manager and the Operations Branch:

> Q. Did you feel that as the audit manager, you should be involved in the setting of dates and arrangements and so forth for the audit?
> A. Of course I should have been ... I specifically discussed the matter with the company on the very date that the initial part of the audit was cancelled. Not, pardon me, cancelled, deferred. And I specifically rescheduled it simply to avoid further embarrassment.
>
> And it was my understanding that that was an agreement, a commitment. That communication was undertaken by people, not by myself, and agreements were made without my consultation or knowledge, and the dates were changed.
> Q. Would it be fair to infer that you were frustrated and upset with Ontario region, how they were handling it?
> A. I was frustrated and upset with all of the operations side of the house, it wasn't just the Ontario region. It was a combination of the operator, the Ontario region and management on the operations side, that somebody had made this agreement and I was not informed about it.
>
> (Transcript, vol. 136, pp. 29–30)

Despite the difficulties experienced in staffing the operations audit in February 1988 and the fact that eight months were available to line up personnel for the October 1988 audit, staffing was still not attended to until the two weeks preceding the audit. The consequence of this poor management is that no F-28–qualified inspector was available at such short notice and the F-28 was not audited. Obviously, it would be far more difficult for an air carrier inspector to free up his or her heavily booked schedule for two weeks, on only two weeks' notice, than it would be on eight months' notice. It is no excuse to point to the unusual turnover of team leaders, and to claim that had there not been problems in the appointments of Mr McKenzie and Mr Rozon, a competent, qualified audit team would have been in place. Organization and competency starts at the top. In this instance, the convening authority and the audit manager, and their staffs, should have used their combined clout to assert the priority of the National Audit Programme and should have taken measures to ensure that the embarrassment of the February audit was not repeated.

Instead, the task of arranging for operation team members eventually fell to the team leader. Mr Murray, who had never before worked on an audit nor staffed an audit team, was saddled with the "beg, borrow and steal" task of staffing the audit on only two weeks' notice. Mr Dyck played no part in the selection of team members, nor did he have any knowledge of their audit experience or even if they had taken the audit training course.

Mr Murray tried to secure Mr William MacIntyre, a qualified F-28 inspector, for the F-28 segment of Air Ontario's operations audit, but was told Mr MacIntyre was otherwise occupied doing check rides. Thereafter, as his testimony indicates, Mr Murray became frustrated and his attempts to secure a qualified F-28 air carrier inspector (ACI) ceased:

> Q. Did you elicit the assistance of Mr MacGregor to secure Mr MacIntyre as an F-28 trained ACI?
> A. No, I was getting frustrated at that time. I did phone – I needed somebody badly to do the small – on the sub-bases of their northern operation, and I made a phone call to Don Sinclair in Toronto and he said the only one he could spare, again that would be on a limited days, possibly maybe only two days, would be – he could complete most of the audit but maybe minus a couple of days, he would be unable to attend.
> Q. And who was that? Who would be available?
> A. Gord Hill.
> Q. So after speaking with Don Sinclair, you were able to get Gord Hill to deal with small aircraft in the sub-bases in the north?
> A. That's correct.
> Q. Did you seek the assistance of Mr MacIntyre again to secure an F-28 trained person?
> A. No, I didn't.
> Q. Did you look anywhere else to see if there were F-28 trained people available?
> A. No, I did not, at that particular time, I didn't.
>
> (Transcript, vol. 133, pp. 110–11)

On October 5, 1988, two weeks prior to the start of the operations audit, Mr Dyck wrote to Mr Donald Sinclair, Ontario Region's manager of air carrier operations, to arrange a pre-audit briefing meeting. Ontario Region, as the branch principally responsible for inspecting Air Ontario Inc. (and its predecessors Austin Airways and Air Ontario Limited), should have been well placed to brief the audit team on the rash of changes that the company had recently implemented. Mr Dyck provided Mr Sinclair with a list of ten items required for the meeting, including previous audit reports. It is important for audit teams to review previous audit reports to ensure that former non-conformances have been rectified and that old transgressions are not being repeated. On October 12, 1988, when Mr Dyck and Mr Murray met with Mr William Brooks, principal inspector of Air Ontario in Ontario Region, they were frustrated to find that some of the requested information, most notably the previous audit reports of Austin Airways, were not available. (The previous Air Ontario Limited audit reports were made available.)

Even though Mr Dyck's letter provided adequate advance notice of the meeting (two weeks), the requested material was not made available. I find that Ontario Region was unsupportive of the audit team in this regard.

Failure to Inspect the F-28

If there was a silver lining to the postponement of the audit, it was that it provided Transport Canada with the opportunity to inspect Air Ontario's F-28 program. Air Ontario introduced the F-28, its first jet aircraft, into service in June 1988, close to four months after the audit was originally to have been conducted. However, the F-28 was not included in the audit of October 1988 and the opportunity was missed.

The evidence is clear that the operations audit team did intend to include the F-28 operation in the October 1988 audit. Mr Dyck prepared an audit plan and circulated it to the operations team members on October 7, 1988. Attached as part of the audit plan was a listing of the "Operations Audit Areas" (Exhibit 1040) prepared by Mr Murray, in which the F-28 was included along with Air Ontario's other aircraft types as aircraft to be audited. Moreover, the F-28 was listed as the responsibility of both Mr Murray (who was also responsible for the Convair 580) and Mr Edward Mitchell (who was also responsible for the HS-748).

Nevertheless, in light of the fact that there were no F-28 qualified inspectors on the audit team, the F-28 was relegated to a low-priority, "time-permitting" item. As Mr Murray said in his testimony:

> Q. Perhaps you can clarify that for me. Were you or were you not going to review the F-28 program in the areas listed?
>
> A. As I said before, we had nobody that was current on the F-28 and I do not like doing an aircraft that you are not current on.
> So my plan was, if time permitting in the air, we would complete a line check, either myself or Ted Mitchell, on the F-28.
>
> Q. Now, certainly it would have been preferable to have an F-28 trained person to assist, but the fact of the matter is you didn't, and the F-28 was one of the aircraft in the Air Ontario fleet.
> Again, wasn't it your intention to review the F-28 in a manner as you would the Convair 580 or the HS-748?
>
> A. We reviewed the main part, you know, of the pilots that were flying, we reviewed all the part that the pilots flying the F-28.
>
> Q. When you say – you reviewed what?
>
> A. Well, it would be the flight crew records –
>
> Q. So –
>
> A. – which would cover all their training and where they had their course and their pilot proficiency checks on type.
>
> Q. But you didn't do flight inspections; did you?

A. No.

(Transcript, vol. 133, pp. 132–33)

Although Mr Murray was not adequately supported by the audit manager and the convening authority in assembling an audit team, he exacerbated his difficulties by not requesting their assistance. For example, in the last few days of the audit he unilaterally decided not to audit the F-28. He stated that his decision was due partially to the fact that Mr Mitchell, who along with Mr Murray had been assigned to audit the F-28 program, had been called away from the audit to conduct pilot proficiency checks in Toronto for Air Canada. That Mr Mitchell was permitted to leave the unfinished audit to conduct simulator rides further demonstrates the audit's low priority with the audit management. Also, Mr Murray testified that he did not have prior notice that Mr Mitchell would be making an early departure. According to Mr Ian Umbach, superintendent of air carrier operations, Mr Mitchell's early departure from the Air Ontario audit was not an isolated incident. Mr Umbach testified that air carrier inspectors would quite often have to leave in the midst of an audit to do other tasks. He cited as an example the 1988 audit of Canadian Airlines International, at which time inspectors were conducting the audit through the day and doing pilot proficiency checks in the simulator during the night. Mr Umbach added that this undesirable, double-workload situation was one of the factors that inspired his memorandum of December 1, 1988, calling for a moratorium on national audits "due to lack of resources, and an overwhelming workload" (Exhibit 1105). (See chapter 30, Effects of Deregulation and Downsizing on Aviation Safety.)

Mr Murray also indicated that his decision not to audit the F-28 was influenced by his understanding that Ontario Region would be conducting surveillance of Air Ontario's F-28 program. However, this rationale conflicts with the following view expressed by Mr Donald Sinclair, Ontario Region's manager of air carrier operations and the person who had called for the audit in the first place, who had expected that the F-28 was being audited:

Q. Did you, sir, have any concerns from your position that there were no qualified F-28 persons assigned to the audit being done at Air Ontario?
A. I wasn't aware there wasn't an F-28 person involved.
Q. Would you have assumed that there was?
A. Yes, I would.
Q. That would not be an illogical assumption?
A. No.
Q. Were you surprised that there wasn't?
A. I'm surprised now to learn there wasn't.

Q. You didn't know?
A. No. The fact there weren't any non-conformances on the F-28 would not indicate that it wasn't examined by a qualified person.
...
Q. Mr Sinclair, from your perspective, do you think that a complete and satisfactory audit can be completed with no one on a team being qualified on one of the aircraft types being audited?
A. Not if it's a large aircraft, no, it's not complete.
(Transcript, vol. 142, pp. 77–78)

Either way, this again demonstrates a striking lack of communication and coordination between Ontario Region and the audit team.

Mr Murray made an error in judgement in not consulting with the audit manager at that time and in not maintaining communication with the audit manager, as set out in the audit handbook. Had Mr Murray advised Mr Dyck or Mr Umbach (Mr Murray's superior at headquarters) that he had not been able to recruit an F-28 qualified inspector, they may have seized on the importance of inspecting the new jet aircraft and used their rank to assist in obtaining qualified personnel. Similarly, Mr Murray should have reported during the course of the audit that he had not audited the F-28.

Mr Dyck confirmed in his testimony that it was his expectation that the F-28 would be audited, but that he did not know, nor had he enquired, if Mr Murray and/or Mr Mitchell were F-28 qualified. In fact, Mr Dyck testified that he only became aware that the F-28 had not been audited sometime after the audit report had been issued. (The audit report was sent to Air Ontario on April 3, 1989.)

Just as Mr Murray bears responsibility for not passing on information of this omission to his audit manager, Mr Dyck is similarly responsible for not having taken steps independently to assure himself that the F-28 operation was being inspected. Two days after the audit commenced, Mr Dyck returned from Air Ontario's base in London to his office in Ottawa, where, as the following testimony indicates, he remained for the two-week duration of the audit:

Q. All right, and did you know if the F-28 was being audited by the team members?
A. No. I did not. I assumed it was part of the overall audit. They would have done what the company was looking or operating at that time.
Q. Did you have any discussions at all during the course of the audit with Mr Murray, Mr Mitchell, any other team members, as to whether or not the F-28 was being inspected?
A. No, as I told you earlier, I was not on site until the completion of the audit, and when the inspectors returned back to London

after they had done their series of in-flight inspections and finished doing their on-site inspections.

And no, there was no conversation specifically that I can recall about the F-28 operation itself, no.

Q. Did you do anything during the course of the audit to satisfy yourself that items that had been ... in the audit plan were, in fact, being inspected?

A. Well, as I said, I was in Ottawa while the audit was being carried out. On site, I had little or no value there. I trusted the ops team leader would, in detail, look at the area, his area of responsibility. That's perhaps the best answer I can give you.

(Transcript, vol. 136, pp. 47–48)

Mr Dyck decided that his time would be more valuably spent attending to pressing certification tasks in Ottawa. Moreover, in that he was an airworthiness and not an operations professional, Mr Dyck felt that his utility on the audit site was limited. This is only partially true. While he may not have been able to assist on technical inspection matters, he would have been in a position, as set out in the audit handbook, to "exercise line authority over assigned audit staff" and "maintain ongoing communication with senior management of the company" (Exhibit 1033). Mr Dyck's approach contrasts directly with that of Mr Umbach, himself a former audit manager on an audit of Worldways. Mr Umbach described an audit manager's responsibilities as follows: "I feel he must be there throughout the duration of the audit to handle the day-to-day problems and questions that will naturally arise from an audit" (Transcript, vol. 139, p. 147).

Instead, Mr Dyck stated that he trusted that the operations team would look at their area of responsibility in the same independent, problem-free manner that the airworthiness and dangerous goods audit teams had. In this respect Mr Dyck erred. As a novice team leader, and distinguishable from the airworthiness and dangerous goods team leaders in that respect, Mr Murray sorely needed Mr Dyck's support and experience. Since Mr Dyck and Mr Slaughter were fully aware of Mr Murray's inexperience, they had a responsibility to monitor him closely. To this extent, it mattered little that Mr Dyck was not an operations expert. By being on site he, as audit manager, would have been in a position to ensure that the audit team inspected the F-28 operations. Also, as a committee member on the Regulatory Reform/Aviation Safety Working Group, Mr Dyck had direct experience with respect to what inspectors should be aware of in recently merged companies ("Aviation Safety in a Changing Environment," Exhibit 1057). He had developed a "Merger Procedures Guide" to be used by airworthiness inspectors and he was familiar with a similar guide for air carrier inspectors (Exhibits 1055 and 1056). These guides were not used by the auditors of Air Ontario.

Finally, it appears that the circumstances surrounding the October 1988 operations audit of Air Ontario, such as the postponements and staffing problem, served to create an environment where completing the audit took precedence over the quality and comprehensiveness of the inspection. I do not believe that this was caused by a general lack of professionalism or competence in the audit personnel but by the system itself. Rather than having dedicated audit personnel in place to fulfil the important audit function, the National Audit Programme operated by creating a second job (the audit) for inspectors who were already overburdened with their principal jobs. In the circumstances outlined above, it is small wonder that the priority and comprehensiveness of the audit suffered.

Mr Murray testified that the "heart of an audit in an operation, is the flight crew training records" (Transcript, vol. 133, p. 38) and that the training records are, in relative terms, more important than in-flight inspections or system operations control (SOC) inspections, which are usually conducted in the course of the audit. Both Mr Slaughter in his testimony (Transcript, vol. 144, p. 28) and Dr Robert Helmreich, who provided expert testimony to the Commission regarding the human performance aspects of the Dryden accident, disagreed with Mr Murray's characterization. Although audits provide a valuable opportunity to ensure that a company's training records and other paperwork are in order, the importance of the paperwork should not be overemphasized. In the audit of Air Ontario, Mr Murray testified that flight crew training records of F-28 pilots had been reviewed but that no flight inspections had been conducted. A review of the F-28 pilots' training records does not provide an audit team with any significant insight into the F-28 operation. Dr Helmreich's comment most aptly describes this point:

> The statement that examination of crew training records forms the heart of the audit certainly reflects an honest opinion. However, from the author's research experience, an alternative view can be proposed that the observable behaviour of crews in line operations is the key to understanding the level of safety and effectiveness in flight operations.
>
> (Exhibit 1270, Human Factors Aspects of the Air Ontario Crash at Dryden, Ontario: Analysis and Recommendations to the Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario. See technical appendix 7.)

Had the F-28 been audited by a professional air carrier inspector, even one without F-28 qualifications, it is reasonable to assume that a number of Air Ontario's questionable practices relating to the F-28 operation would have been uncovered. According to the Operations Audit Areas list, which formed part of the audit plan, Mr Murray had planned to inspect twelve facets of Air Ontario's operation. It should be noted that the Operations Audit Areas list was derived from the Audit Procedures Handbook, and that the Manual of Regulatory Audits provides audit checklists for use by inspectors "to ensure all aspects of requirements have been audited" (Exhibit 1034, p. 4–1).

However, a retrospective look at the work of the operations audit team revealed that a number of key areas of Air Ontario's operations, although set out in the audit plan and handbook, were not audited. The following enumeration of the intended operations audit areas is adapted from Exhibit 1040; a comment follows each point, F-28 specific where appropriate, on whether the area was covered in the audit:

1 Previous Transport Canada audit
   - The previous audit reports of Air Ontario Ltd were provided to and reviewed by Mr Murray. However, Ontario Region did not have the previous Austin Airways audit reports available for review.

2 Operating certificate (OC) and operating specifications (ops specs)
   - Mr Murray testified that the OC and ops specs were inspected.

3 Manuals
   - The F-28 Operations Manual was not reviewed by the audit team because, as Mr Murray testified, he was informed "verbally by other inspectors" that Air Ontario was operating with an FAA-approved Piedmont Operations Manual, which had been approved by Ontario Region (Transcript, vol. 133, p. 134). In fact, the approval granted by Transport Canada to Air Ontario on February 15, 1988 (Exhibit 857), enabled Air Ontario to use the Piedmont Airlines F-28 training syllabus, simulator, and instructors as an interim measure while transitioning to the F-28. However, Transport Canada's authorization did not explicitly extend to Air Ontario's use of the Piedmont manual as its F-28 operations manual.
   - Had the audit team investigated the situation surrounding the Piedmont F-28 Operations Manual themselves, they would have been in a position to observe and report on the problems with the manuals (see chapter 19, F-28 Program: Flight Operations Manuals).

- Mr Murray admitted in his evidence that a typical check of the Piedmont Operations Manual used by Air Ontario's F-28 crews would have disclosed the absence of an amendment service.
- Similarly, had the audit team inspected the manuals, they undoubtedly would have discovered that some Air Ontario F-28 pilots were using USAir manuals while others used Piedmont manuals, and that the company still had not prepared its own F-28 operations manual.
- The Air Ontario Flight Operations Manual was inspected.

4 Training program and company check pilot (CCP)
- The F-28 training program syllabus and CCP information were inspected solely to the extent possible by reviewing the pilot records. The CCPs were not interviewed or monitored.

5 Flight crew training records
- F-28 flight crews' training records were reviewed.

6 Simulator evaluation
- No action had been taken to establish that the F-28 simulator had been evaluated in accordance with Air Navigation Orders Series VII, No. 2.

7 Dispatch and flight watch
- Inspector Jerry Frewen, an air carrier navigation specialist, was the auditor responsible to inspect Air Ontario's dispatch and flight watch operation. Mr Murray testified that Mr Frewen's task included the inspection of flight dispatchers' training and competence.
- However, the operations audit report did not include any observations or non-conformance findings with respect to dispatch and flight watch.
- Despite extensive evidence heard by this Commission that the training of Air Ontario's flight dispatchers was seriously deficient (see chapter 23, Operational Control), this problem was not uncovered by the audit. Mr Murray explained that since he had been advised by Mr Frewen that Air Ontario's dispatch and flight watch were "satisfactory," there was no further discussion or follow-up.

8 Flight documentation
- Journey logs, primarily reviewed by airworthiness inspectors, are cross-checked with pilots' recurrent flying sheets to ensure that pilot flight times are accurate and in accordance with minimum requirements.
- The flight documentation section of the audit report makes no reference to the F-28.

9 Flight Safety Program
- Air Ontario's Flight Safety Program was reviewed in a most cursory fashion and there is no reference to it in the audit report. According to Mr Murray, auditors reviewed "some of the circulars the company put out on safety," but did not speak with the flight safety officer, Captain Ronald Stewart. Furthermore, Air Ontario's incident - reporting procedure was not reviewed even though the Manual of Regulatory Audits states as a guideline to the inspector responsible for the Flight Safety Program, "Review incident and accident reports for previous twelve months."
- Mr Murray acknowledged that a thorough investigation of the Flight Safety Department would have given the audit team a valuable insight into the actual level of safety at the company.

10 Aircraft documentation
- Aircraft documentation refers to reviewing the validity of journey logs, weight and balance, certificates of airworthiness, and certificates of registration. There is no reference in the audit report to aircraft documentation.

11 Minimum equipment list (MEL)
- The situation pertaining to the F-28's MEL was not inspected (see chapter 16).
- Mr Murray acknowledged that a typical flight inspection of Air Ontario's F-28 operation would likely have revealed the absence of an approved minimum equipment list (MEL) as well as the practice of deferring airworthiness snags pursuant to an unapproved document.

12 Flight inspection
- No flight inspection was conducted on the F-28.

Thus, notwithstanding the stated intention of the audit plan, the Air Ontario F-28 operation was not audited. Moreover, other key areas of Air Ontario's flight operations audit, most notably dispatch/flight watch and the Flight Safety Program, were unsatisfactory to the extent that serious operational deficiencies remained undetected.

Audit of Air Ontario's Northern Operations

Mr Gordon Hill, air carrier inspector and audit team member, inspected Air Ontario's small aircraft operation at its northern sub-bases in Thunder Bay, Timmins, and Pickle Lake. (Pickle Lake and Thunder Bay bases were checked to review the DC-3 and Beech 99 operations, and

Timmins base was checked to review the Beech 200 and Cessna Citation operations.) Because of the divestiture of the Air Ontario's northern assets, it was a time of considerable flux for northern-based personnel. A serious problem in morale resulted. On November 16, 1988, Captain Ronald Stewart, Air Ontario's flight safety officer, described the situation in a memorandum to Mr William Deluce, company president, as "Safety Deficiencies – Northern Operation" (Exhibit 745). It is unclear from the evidence whether Mr Hill was aware of the context or the extent of the transitionary tensions at Air Ontario at the time he conducted his northern base inspections. Nevertheless, he observed a number of problems, particularly at the Thunder Bay base, that he passed on in a report to Mr Murray:

> Thunder Bay is a busy hub for Scheduled operations. Many problems were found here. There is no Senior Pilot on this base nor is there a functional Base Manager. Scheduled flights at this base seem to operate smoothly due to the initiatives of the Counter staff and the Pilots. Many Pilots stated that they do not know who to report to on this base; particularly in cases of illness or duty time restrictions. The pilots decide between them what to do in these cases. There is no one to review the pilots' paperwork and check it for completeness and accuracy as required by Section 5 of the Company operations manual. This flight documentation is not kept on base as required above. Pilot Time records are not kept on this base or monitored by the Senior Pilot as stated in the C.O.M. [Company Operating Manual] A current regulatory library could not be located at this base which would normally be kept by the Senior Pilot here.
>
> <u>Training Programs</u>
>
> There is no one in Thunder Bay to co-ordinate recurrent pilot training ... I examined the training files of eight Beech 99 pilots and found that not one pilot record showed required recurrent training.
>
> <u>CCP [Company Check Pilot]</u>
>
> Captain R. Hall is the principal Beech 99 check Pilot. He has conducted many Pilot Proficiency flight tests and renewed the qualifications for pilots even though the required recurrent training has not been completed. There was no evidence of a monitor ride on Mr. Hall or Capt. S. Burton the other B99 check Pilot. Mr. Hall could not present me with a valid medical when I requested his Licence Documentation for review.
>
> (Exhibit 1043)

Despite the significant concerns raised by Mr Hill in his report, Mr Dyck, the audit manager for the Air Ontario audit, testified that he had never seen the report prior to his attendance before the Commission. Mr Dyck acknowledged that the report depicted an operation that would have caused him great concern as audit manager, perhaps warranting further inspection or follow-up action. Though unable to explain why it had not come to his attention during the course of the audit, Mr Dyck did admit that had he been in London rather than Ottawa during the audit, he would more likely have been apprised of Mr Hill's concerns.

I am also concerned by Mr Murray's response to Mr Hill's report. In notes prepared by Mr Murray for the post-audit exit briefing of company officials, he stated that "the general overall operation is considered safe and generally conducted in accordance with industry norms" (Exhibit 1044). Mr Murray when questioned on this point admitted he had not dealt with the matter as he should have:

> Q. ... Well, bearing all of these complaints in mind that your own inspector made, and bearing in mind that Thunder Bay was a busy hub, weren't you concerned when you finished reading this report about the situation in Thunder Bay?
>
> Weren't you concerned that there was a serious safety problem here? That ... paperwork was out of control, there wasn't a safety net under the pilots?
>
> A. Yeah, I guess it all points to that, yes.
>
> Q. All right. Then why, in Exhibit 1044 [Mr Murray's exit briefing notes], would you say that general overall operation is considered safe and generally conducted in accordance with industry norms?
>
> A. I guess that was a mistake on my part. That's all I can say.
>
> (Transcript, vol. 134, p. 126)

Mr Hill's report contained important audit findings that were treated too casually by an inexperienced team leader. This view is reinforced by the testimony of Mr Donald Sinclair, who has served with Transport Canada since 1956, for the last 13 years as Ontario Region's manager of air carrier operations. I attach significant weight to his opinion in this matter:

> Q. Now, do these notes, then, of Inspector Hill paint a picture of an operation in Thunder Bay which causes you great concern?
>
> A. Yes.
>
> Q. And do you believe that the concern raised by these notes should have been reflected in the audit?
>
> A. Absolutely. My own reaction in reading this for the first time is that, you know, they should not have left the audit to prepare their report without addressing the company right then and there to see whether action should be taken to shut that portion of the service down.
>
> ...
>
> It looks urgent enough that I wouldn't want to even, as I say, go back and even write my report knowing this was going on.
>
> (Transcript, vol. 142, pp. 120–21)

Delay in Completing the Audit Report

The operations audit team completed their on-site activities and conducted their post-audit exit briefing of Air Ontario management on or about November 4, 1988. Typically, exit briefings are used by audit teams to present their findings orally to the company audited. The audit handbook provides that, at the end of the exit briefing, the audit team shall advise the auditee that it will provide it with a draft copy of the audit report within 10 days (Audit Procedures Handbook, p. 69, Exhibit 1033). Mr Dyck had reminded the audit team members of this time limit before the commencement of the audit. Further, the audit plan states that "A draft report will be prepared by the audit manager and forwarded to Air Ontario Inc. within 10 working days of the completion of the audit." At the exit briefing, however, Mr Dyck advised an Air Ontario representative that he would "get the report out within two, three weeks" (Transcript, vol. 136, p. 54).

Despite Mr Dyck's good intentions and Transport Canada guidelines, it was not until April 3, 1989, that the operations portion of the audit report was submitted to Air Ontario – five months, rather than 10 days, after completion of the audit. This represents significant inefficiency, which is illustrated by the fact that the airworthiness, dangerous goods, passenger safety, and introductory sections of the report were submitted to the company in timely fashion after the February 1988 audit and make up 167 pages of the 182-page report, while the operations portion of the report accounts for merely 15 pages.

The task of compiling the operations portion of the audit report was a joint effort between the audit manager and the operations team leader. Because Mr Dyck was a maintenance and not an operations expert, he assumed a more administrative or editorial role, while Mr Murray was to compile the report in its vertical analysis format. Mr Dyck described his own role as follows:

> A. [T]o ensure that the report meets the standardized format that we already had established in the initial part of the report [the Airworthiness portion of the report], and that the readability, understandability and the format is in accordance with the procedure that we had established and in the final report that we already had set out. And ensure that all the information was there.
>
> When I say it was there, that we could read the various findings and try and understand them, edit them for obvious errors and omissions.
>
> (Transcript, vol. 136, p. 56)

The inordinate period of time expended to complete the report can be traced to three primary causes: Mr Dyck and Mr Murray did not work effectively together; they were occupied by other tasks; and they were not adequately supported by the air carrier group at headquarters.

Both Mr Dyck and Mr Murray testified that in the November 1988 to April 1989 period, their non-audit work responsibilities took them out of Ottawa (they were both headquarters based) on a number of occasions and they were also very busy with their usual duties. I have no doubt that this was in fact the case and that they were forced, yet again, to juggle the priority of the audit with other pressing matters. Nevertheless, I heard an overwhelming amount of testimony that chronicled a working relationship between the audit manager and the team leader that was unnecessarily bureaucratic, to the point of seriously delaying the completion of the report.

Mr Dyck stated that he returned Mr Murray's drafts to him a number of times because they were not in an acceptable format. However, rather than meeting directly to settle the report (their offices were in the same building), they communicated their comments to one another at times by means of cryptic "post-it" notes that stimulated more confusion than resolution. The delay was exacerbated by a serious lack of secretarial support in both Mr Dyck's and Mr Murray's offices. (Mr Dyck testified that, in his office, there was but one typist to support a group of 20 inspectors). Mr Murray admitted that the entire exercise "could have been accomplished in about a one-minute phone call" (Transcript, vol. 133, p. 211). Similarly, Mr Dyck admitted that the 15 operations vertical analysis sheets could have been completed within one to two hours.

As it became clear that Mr Murray was having difficulty completing the report in the form required by Mr Dyck, swift action should have been taken by Mr Dyck or by Mr Murray's supervisor, Mr Ian Umbach, to preserve the integrity of the report by ensuring its timely completion. As audit manager, Mr Dyck maintained line authority over Mr Murray as well as ultimate responsibility to assemble the audit report. However, in fairness to Mr Dyck, he was saddled with a most difficult predicament. Headquarters had assigned a team leader, who, through inexperience and inability, required assistance to complete the report. Mr Umbach testified that although he was surprised that a person lacking audit experience had been made audit manager, he was also surprised that Mr Murray needed help in writing the report (Transcript, vol. 139, p. 145). At the same time, as an airworthiness professional, Mr Dyck's contribution to the operations report was necessarily limited to matters of style or format as opposed to substance. Accordingly, since it was an operations audit convened by the air carrier group in headquarters, they must share in the responsibility for not acceptably supporting the audit team. In fact, Mr Dyck's frustration did prompt him, on two occasions, to forward the draft report to Mr Umbach for his assistance in completing it.

I have considered the testimony of Mr Umbach, as well as a memorandum written by Mr Roger Beebe, sympathetic to Mr Dyck's position, indicating that the operations group were chronically slow in completing audit reports. According to Mr Umbach, even though it is no easier for airworthiness to conduct their audit than for operations, it has been his experience that "operations are often slower." Mr Umbach ascribed much of the blame for the delay in getting out the audit reports to foot-dragging on the part of upper management:

> A. My experience has been that with the operations audit, on a national audit, the [operations] report is turned in to our superiors for review, and for various reasons, it doesn't seem to get sent out for sometimes months later.
>
> ...
>
> Q. Can you give us some examples of this type of review?
>
> A. The report on Canadian Airlines was submitted to our superiors for review, and I believe it was in excess of six or seven months before the report was sent out.
>
> (Transcript, vol. 138, pp. 105–106)

Once again, as in the other problem areas of this audit, responsibility must be shared. In the case of Mr Dyck, as frustrated as he may have been with the operations group, he should have taken the initiative to ensure completion of the report. Similarly, if Mr Murray was unable to complete the report in the prescribed format, it was his responsibility, as a professional, to solicit his superior's assistance. Indeed, to the extent that the problem stemmed from a personality conflict between Mr Murray and Mr Dyck and/or a conflict between the airworthiness and operations groups, I would expect them to recognize that their first priority as professionals was to attend to the business of aviation safety.

The intervening period between the Air Ontario operations audit in November 1988 and the completion of the report in April 1989 was, tragically, marked by the F-28 crash. The realization that the audit report was four months old and unfinished at the time of the accident undoubtedly was an embarrassment to Transport Canada. Both Mr Dyck and Mr Murray admitted that the accident expedited the completion of the unfinished Air Ontario audit report.

Nevertheless, Mr Dyck minimized the importance of prompt dissemination of the report:

> Q. What is the importance of getting the audit report out to the company in quick order?

> A. There is no specific importance other than we try and ... adhere to an administrative process that is timely.
>
> The significance, in a safety sense, is addressed in other manners. We don't necessarily wait for the report to go out to have a safety concern issued or issue discussed.
>
> I guess that's the best way to describe that.
>
> (Transcript, vol. 136, p. 57)

I am of the view, however, that the value of the audit was severely compromised by the tardy release of the audit report. I was convinced of this by the testimony of many Transport Canada witnesses, who, in contrast to Mr Dyck, believe that the release of the report must follow the audit immediately. On this point, Mr Umbach testified as follows:

> A. Because the impact has to be immediate. A lengthy delay and the report loses its impact. The carrier has gone on to other things and so have we.
>
> I believe that for the audit to be effective, the report must be out immediately. And also to get corrective action taken.
>
> (Transcript, vol. 138, p. 107)

Mr Brayman addressed the negative effects of the late report from the perspective of Ontario Region, which had requested the audit of Air Ontario in 1987 to provide a post-merger snapshot of the company. He ventured the opinion that, because of the protracted delay in the production the report, it was virtually useless at the time of its release:

> A. They [audit reports] have to be specific and they have to be punctual. We need them at a specific time.
>
> The whole problem with this report, it was too little and too late. We needed a ... snapshot of the company at the beginning of 1988, not in the spring of 1989.
>
> ...
>
> ... But in general, events had superseded the information that came through.
>
> (Transcript, vol. 132, pp. 11–12, 15)

Later in his testimony he went on to say:

> A. ... Well, you have to realize that we had been waiting for this audit for a long, long time. And we had – in our normal course of operations, audits were used specifically to clear up problem areas, make corrections.
>
> So the audit was a valuable tool if it was delivered on time. The fact that it was delivered before or after the crash I don't think is pertinent.

> I think that the length of time from when the audit was called for to the time that the audit was actually delivered in region is the pertinent issue. And because of that length of time, the audit became virtually worthless.
>
> (Transcript, vol. 132, p. 97)

Deficiencies in the Report

Ontario Region was also dissatisfied with the substantive aspects of the report. After a detailed review, Mr Brayman concluded that it "wasn't really a very well done report ... or of significant value to us" (Transcript, vol. 132, pp. 6, 174). Speaking from the perspective of Ontario Region, he expanded on some of the report's shortcomings, including the lack of reporting on Air Ontario's northern operation:

> A. ... during the whole period this audit was going on, the company was under continuous surveillance. We had inspectors and myself and my inspection staff and inspectors from small air carrier. We were in direct contact with the company on a continuing basis, and I knew that there were certain areas that required a fair degree of surveillance.
>
> And when this report come back, it didn't seem to fit what we had experienced up to the time that the report came in. In some cases it did. It overlapped.
>
> Q. Why didn't it fit? What did you expect to see in the audit?
>
> A. Well, I fully expected to see a good deal more about the problems in the north, with the transfer of control in the north.
>
> Q. The denuding of expertise in the north, I think you called it?
>
> A. Yeah.
>
> ...
>
> I expected to see more.
>
> We were quite concerned about Pickle Lake, which had been a base where we had had a lot of problems in the past. It was in the central region, but nonetheless, it ... still formed part of this company.
>
> And when I went through the report, I saw very little on some of those activities.
>
> (Transcript, vol. 132, pp. 174–75)

To the extent, therefore, that the audit of Air Ontario was called to provide an independent review of the company at a volatile point in its evolution, it clearly appears to have failed. Not only were the F-28 program, the system operations control (SOC), and the flight safety sections not adequately audited, but there is little evidence to indicate that the audit team devoted particular attention to Air Ontario's special circumstances, such as the merger, the devolution of northern assets, and the continual changes in senior operational management positions.

Moreover, because Ontario Region had expected the F-28 program to be inspected in the audit, the lack of F-28–related non-conformances in the audit report would lead to a natural assumption that Air Ontario was operating a good F-28 program. Both Mr Donald Sinclair and Mr William Slaughter agreed that such an assumption was an "insidiously dangerous conclusion to reach" (Transcript, vol. 142, p. 113; vol. 146, p. 128). Had Ontario Region based its decisions regarding Air Ontario's F-28 program on the basis of the audit report, it may have concluded that very little surveillance was required. Based on what is now known about Air Ontario's F-28 operation, that would have been an erroneous conclusion to reach and one obviously based on misinformation.

The Manual of Regulatory Audits that was available to the audit personnel specifically contemplates a pre-audit review of the following factors that might be indicators of instability in the auditee:

- company's last audit
- high turnover in managerial personnel
- high turnover in flight crew personnel
- change in scope, size, complexity of operations, type of aircraft used, type of service or area served since last audit.

(Based on Exhibit 1034, p. 4–7)

A review of the Company Overview section of the Air Ontario national audit report reveals an inaccuracy that creates the misimpression of stability in senior management. The following list and accompanying text appear under the heading "Senior Management":

Mr. W. Deluce	– President
Mr. T. Syme	– Vice President of Operations
Mr. R. Nyman	– Director of Flight Operations
Mr. K. Bittle	– Vice President of Maintenance and Engineering
Mr. R. Mauracher	– Director of Maintenance Production
Mr. W. Wolfe	– Chief Pilot
Mr. D. Christian	– Chief Inspector

> Mr. Deluce, the President, comes to Air Ontario Inc. from Austin Airways. The remainder of the senior management staff come to Air Ontario Inc. from Air Ontario Ltd. and have served in their current capacities in excess of five years.
>
> (Exhibit 1042, p. 2)

These data are erroneous. Mr Nyman and Mr Bittle came from Austin Airways and not Air Ontario Ltd; Chief Pilot Walter Wolfe was with Air Ontario for a total of 15 months – not "in excess of five years";

Mr Syme's first operational position was in 1986 and he was first made vice-president of operations in June 1987, so that at the time of the audit he had held that position for less than two years; and Mr Nyman did not become director of flight operations until April 1988. The imprecision of this section of the Company Overview is not in accord with the importance ascribed to it by the Manual of Regulatory Audits and it leaves a mistaken impression of management stability at Air Ontario. As such, it reflects poorly on its authors.

Air Canada's Reliance on the Audit

In chapter 26 I addressed Air Canada's acquisition of Air Ontario, as well as the subsequent course of their parent-subsidiary relationship. Although Air Canada was represented on Air Ontario's board of directors, Air Ontario's operations remained substantially independent from those of Air Canada.

Captain Charles Simpson, vice-president of operations at Air Canada, testified that in 1987 Air Canada had planned to conduct an operational review of its connector airlines. As circumstances unfolded, however, Air Canada put off its operational review of Air Ontario until the summer of 1989 – after the Dryden accident. Captain Simpson testified that one of the reasons for the delay of Air Canada's operational review of Air Ontario in the fall of 1988 was the Transport Canada audit; the other principal reason was an apparent lack of Air Canada personnel to assign to the project:

> A. And the straight reason we were so long was we were having – we weren't having problems but we were in the middle of some very major cutbacks at the time in personnel, and I simply didn't have the personnel to put on the project.
>
> In the fall of '88 ... Transport Canada were doing an audit on Air Ontario, and I had suggested to all our people that we shouldn't become involved until the audit was over.
>
> Q. That is, the Transport Canada one?
>
> A. The Transport Canada audit, which, incidentally, was quite a decent audit, gave the airline reasonably good marks. So, of course ... in the early winter, the accident occurred and personnel from Air Ontario were deeply involved in that, so our audit didn't take place until the summer of '89.
>
> ...
>
> Hindsight is a great privilege. Obviously, if we thought there was anything wrong with the operation, we would have taken the necessary steps. For some of the reasons I just mentioned, we did not get the operational review done as early as we would like to have conducted it.

> Then we saw the Transport Canada audit, which was relatively good.
>
> (Transcript, vol. 118, pp. 166–67, 170–71)

Captain Simpson's characterization of Transport Canada's October 1988 audit of Air Ontario as quite a "decent audit" simply is not in accord with the evidence before this Commission. It should be noted, however, that Captain Simpson testified that he had not read the audit in detail.

Air Canada did not conduct an independent inspection of Air Ontario's operation until the fall of 1989, some six months after the Dryden accident and close to three years after their acquisition of 75 per cent ownership.

Transport Canada is a custodian of the public trust to ensure the safety of civil aviation in Canada. Consequently, there is a clear danger inherent in the regulator passing off substandard work, as indeed occurred here. Air Canada's reliance on the misleading Transport Canada audit report of October 1988 exemplifies this danger and points to the benefits of a major carrier conducting its own monitoring and audits of the operational aspects of its regional subsidiaries. Had Air Canada not relied solely on Transport Canada's audit report, which indicated that Air Ontario was operationally sound, it may have conducted an independent audit of the company and uncovered the numerous Air Ontario operational problems that may have affected the F-28 program.

The audit process is a preventive mechanism designed and used to identify and rectify aviation safety deficiencies. As such, it is an important component in the system approach to aviation safety.

Although, as Captain Simpson stated, "hindsight is a great privilege," it may also be said that foresight is a great virtue.

Findings

- Transport Canada attempted to operate the National Audit Programme without provision of adequate numbers of properly trained or fully competent staff assigned to the task on a dedicated basis.

- Transport Canada management was ineffective in its control and supervision of its 1988 audit of Air Ontario.

- The Transport Canada audit of Air Ontario was poorly organized, incomplete, and ineffective.

- The process of staffing the audit of Air Ontario was neither systematic nor effective:

- The audit manager was not involved in the selection of the operations team leaders, and ineffectual working relationships resulted.
- Transport Canada's audit policy and procedures manuals in use for the 1988 audit of Air Ontario did not provide guidelines as to required training or experience of team leaders.
- The operations team leader of the 1988 audit had no prior audit experience, nor had he ever served as a team leader. He was underqualified and should not have been appointed operations team leader.
- Transport Canada's audit policy and procedures manuals in use for the 1988 audit of Air Ontario provided no system to ensure the orderly secondment of inspectors to serve as audit team members.

• The operations portion of the audit of Air Ontario scheduled for February 1988 should not have been postponed.

• Appropriate steps should have been taken by Transport Canada to ensure that Air Ontario's flight operations manual was approved and in use prior to the audit.

• Once the audit team assembled in London, in February 1988, to commence the audit, even without an approved FOM, every effort should have been made to proceed with the audit as scheduled.

• Although included in the Transport Canada operations audit plan for the October–November 1988 audit, Air Ontario's new F-28 operation was not audited. I find this to have a been a serious omission. Had the F-28 been audited, it is reasonable to assume that a number of deficiencies relating to Air Ontario's F-28 operation would have been discovered prior to the Dryden crash.

• Other key areas of the audit, most notably those covering dispatch/flight watch and the Flight Safety Program, were unsatisfactory to the extent that serious operational deficiencies remained undetected.

• Although Transport Canada policy states that audit reports are to be released within 10 working days of the completion of the audit, Air Ontario was not presented with the operations portion of the audit report until approximately five months after completion of the audit, and after the Dryden accident. This fact seriously detracted from the credibility and usefulness of the audit.

RECOMMENDATIONS

It is recommended:

MCR 127 That Transport Canada review and revise its aviation audit policy, under the direction and approval of the assistant deputy minister, aviation.

MCR 128 That Transport Canada ensure that the rationale for and the importance of the audit program be clearly enunciated to all participating departmental staff and to the aviation industry.

MCR 129 That Transport Canada ensure that the frequency of audits be based upon a formula that takes into consideration all significant factors, including safety and conformance records, changes in type of operations, mergers, introduction of new equipment, and changes in key personnel.

MCR 130 That Transport Canada policy confirm that joint air carrier airworthiness and operations audits are the accepted norm, particularly for large companies; however, other types of audits should be identified and flexibility provided to facilitate no-notice mini-audits or inspections, split airworthiness and operations audits where warranted, and audits of specific areas of urgent concern arising from safety issues that are identified from time to time.

MCR 131 That Transport Canada ensure the availability of qualified managers to manage and coordinate the audit programs.

MCR 132 That Transport Canada ensure the availability of adequate and qualified personnel to support the audit program.

MCR 133 That Transport Canada ensure that minimum training and competency requirements be established for specific positions in the audit process.

MCR 134 That Transport Canada ensure that personnel appointed to an audit have a direct reporting relationship to the audit manager from commencement until completion of the audit and the approval of the final report for that audit.

MCR 135 That Transport Canada reinforce existing policy that requires audit managers to be readily available to audit staff during the conduct of an audit.

MCR 136 That Transport Canada policy manuals provide that an air carrier document review process, including a review of prior audits, be completed prior to the commencement of an audit.

MCR 137 That Transport Canada ensure that time limitations be clearly specified and adhered to within which completion and delivery of audit reports are to be achieved.

MCR 138 That Transport Canada ensure that procedures for immediate response to critical safety issues identified during an audit be instituted and included in the appropriate Transport Canada manuals, and that such procedures be communicated to the Canadian aviation industry.

MCR 139 That Transport Canada ensure that trend analyses be produced from the results of audits and used in the formulation of decisions regarding the type, subject, and frequency of audits.

34 OPERATING RULES AND LEGISLATION

The Operating Rules

During the course of the hearings of this Inquiry, a considerable amount of evidence was heard indicating that the existing regulations and orders applicable to Canadian air carriers were deficient, outdated, and in need of overhaul or outright replacement. This was particularly true with respect to the air carrier operating rules, which are contained, for the most part, in Air Navigation Orders (ANOs) Series VII, Nos. 2, 3, and 6.

Flight dispatch requirements, minimum equipment list orders, shoulder harnesses for flight attendants, approval of aircraft operating manuals, and qualifications for air carrier managerial personnel were only a few of the items that were identified in evidence as areas of regulation that required strengthening or where regulation is nonexistent.

This concern is far from new. In 1981-82 the Commission of Inquiry on Aviation Safety under Mr Justice Charles L. Dubin recommended that Transport Canada adopt not only the airworthiness Federal Aviation Regulations (FARs) of the United States but also their companion operational regulations, the operating FARs. The airworthiness FARs were independently adopted by Transport Canada; the operating FARs were not. The following quotation from Mr Dubin's report, dated October 1981, highlights the reasons behind the recommendation:

> The proposal to adopt FARs 23, 25, 27, 29, 31, 33, 35 and 37, namely, the airworthiness FARs, caused a considerable debate during the hearings of this phase of the Inquiry. It is to be noted that the proposal of the DOT was to adopt the airworthiness regulations of the United States only, omitting from the proposed enactment the operational FARs previously referred to. It was the Department's position that the adoption of the operational FARs was not necessary because of the existence of adequate operation regulations in Canada. Following a request of this Commission, Mr Donald E. Lamont, Director of Licensing and Inspection, attempted to locate the regulations existing in Canada that would equate to those rules contained in operational FAR 121. Mr Lamont was of course handicapped by the fact that whereas FAR 121 contains all of the rules applicable to the subject, ANO Series VII, No. 2 must be read in conjunction with the Air Regulations, Air Navigation Orders and the Engineering and

> Inspection Manual. Mr Lamont presented to the Commission a detailed breakdown of equivalencies and differences. Some operating rules were to be found in flight manuals, and some other sections simply had no Canadian equivalent.
>
> (*Report of the Commission of Inquiry on Aviation Safety*, vol. 2, pp. 539–40)

This situation still exists today. The present Canadian aviation regulatory requirements reside in a mix of disjointed regulations, orders, manuals, and policy documents that are difficult to comprehend. During the course of the hearings of this Inquiry, many Transport Canada officials were unable to interpret the aviation regulations and orders clearly. A case in point was ANO Series II, No. 20, dealing with minimum equipment lists. The order uses the term "essential airworthiness item," but not one witness could with any degree of precision define an essential airworthiness item. The evidence of Mr Ronald Armstrong, then Ontario's regional director of aviation regulation, provides an example of this concern:

> Q. Nevertheless, the MEL order, as it is present – as it is currently drafted, simply does not help the pilots, because to interpret it, he's got to go on this goose chase from regulation to regulation and to documents, some of which may be in foreign languages.
>
> So the result is, the MEL order and the definition of minimum equipment – I'm sorry, essential aircraft equipment specifically is not helpful to pilots; right?
>
> A. No, it is helpful to them, but they have to apply interpretation and judgment in using it. But is it the ultimate answer?
>
> Is that what you're saying, that they can check off all the boxes to determine whether or not that particular piece of equipment is essential equipment?
>
> No, it's not at that level of specificity. Is it helpful? The pilot using it, I guess, will make that determination.
>
> Q. Well, I'm going to suggest to you that it's obvious that it's not helpful, because it refers the pilots to apparently other pieces of legislation which he wouldn't have, and that piece of legislation may refer the pilot to documents which he clearly wouldn't have, which maybe maintenance doesn't have and which may be in a foreign language.
>
> So the definition simply is not helpful to pilots. Can you not see that?
>
> A. In those bald terms, yes, I can see that.
>
> (Transcript, vol. 125, pp. 128–30)

Mr Justice Dubin in his 1981 report indicated that he was impressed by the evidence of Mr Robert Klein, then the chief airworthiness engineer with de Havilland Aircraft, who had stated the following:

> when you are trying to upgrade the total system, the only method available is to put into the operating rules that, after today, nobody may operate an airplane unless it has, for example, fireproof material in the inside and more fire extinguishers, and the upgraded standards.
>
> This sounds like an airworthiness standard, but it is in effect a retroactive application. The only way they can apply this is via the operating rules. But they fit together perfectly.
>
> The other thing that is very interesting is that an airplane that is designed on a certain date is operated in a certain manner, as laid down by the operating rules, and another airplane that is designed at a later date has a different set of operating rules. But one caters for the other in such a way that they seem like a great confusion. But they do fit together beautifully, and I admire the talents of the FAA to keep this can of worms sorted out and make it very clear as to just what everybody is supposed to do, and the operators and the designers understand this.
>
> (*Report of the Commission of Inquiry on Aviation Safety*, vol. 2, p. 540)

Another key area pursued with Mr Klein was the probability that a modification of an airworthiness standard might result in a corresponding change in the operating standard. Mr Klein pointed out that airworthiness certification rules, which are fixed, are interrelated with the operating rules, which are amended from time to time:

> You may upgrade one at a time if there is no need to make a corresponding change, but if they are inter-related, then the same amendment can be effective in Part 25 and 121. They are both upgraded simultaneously in the same Notice of Proposed Rule Making, and you get two different amendments to the two different books.
>
> ...
>
> The airworthiness rules are frozen. Once you have been certified to a certain basis of certification – for instance, the 727 that we are still buying new copies of, was designed to the standards of Part 4b. The Series 100 was the initial series and the Series 200 is the later series; but it is still to the original basis of certification, because the type is the 727, and there is nothing to stop them from coming out with a Series 300 and 400 and 600 and 900. For the next 50 years it will still be to the standards of Part 4b. So that there is no way that these later amendments of 25 [FAR 25] will ever show up.
>
> (Ibid., p. 541)

Mr Klein identified a fundamental problem with the structure of the Canadian regulations. While Canada has adopted the United States design and certification standards, we do not even today, some ten years after Mr Justice Dubin made the specific recommendation, have in place an equivalent set of operating rules to ensure that when a change is made to a design standard that effects a corresponding operating rule, the operating rule is amended simultaneously.

In many instances the existing Canadian airworthiness rules do not have corresponding Canadian operating rules. For example, nothing is mentioned in either the Air Regulations or the Air Navigation Orders setting out a requirement that turbine-powered commercial aircraft be operated in conformity with the takeoff limitations specified in the approved aircraft flight manual. It is an obvious operating requirement that, at present, has no home within Canadian operating rules. The Transport Canada airworthiness authority deals with this issue in the aircraft flight manual requirements as an airworthiness requirement as part of the airworthiness manual, which is enabled by regulation.

Unfortunately, for a commercial or airline transport pilot, the requirement and the regulatory process that make it a rule are so convoluted that it is nearly impossible to ascertain, first, what is the Canadian requirement; second, in what publications is it located; and, third, what makes it a regulation. In contrast, in the United States, FAR 121.189 entitled "Transport category airplanes: turbine engine powered: takeoff limitations," sets out the requirement for a commercial operator to adhere to factors such as weight, altitude, temperature takeoff limitations, accelerate-stop distances, and takeoff distances. The irony of the situation is that the analogous Canadian requirements, notwithstanding the complicated and bewildering manner in which they are set out, find their origin in FAR 121. It would have made much better sense to have adopted FAR 121 in the first place.

As a further example, the United States operational rule FAR 121.141 requires that each commercially operated transport category aircraft shall have on board an aircraft flight manual or an aircraft operating manual with revised (and more readily accessible) performance data and procedures, approved by the administrator. Transport Canada has no requirement to approve air carrier-generated aircraft operating manuals to ensure that they are in conformance with and are no less restrictive than the approved aircraft flight manual. It is worthy of note that the two pilots on board C-FONF on March 10, 1989, carried two aircraft operating manuals, differing in form and content and neither having an amendment service (see chapter 19, F-28 Program: Flight Operations Manuals). The manuals were not approved by Transport Canada, since there was no regulatory requirement to do so. The ramifications for flight safety are obvious.

Mr Justice Dubin recommended the adoption of FAR airworthiness standards. He indicated that in his view it would be wasteful of expertise, manpower, and funds for Canada to draft its own code. The evidence I have heard leaves no doubt whatsoever that he was right. However, he went beyond the airworthiness code and made recommendations for the adoption by Transport Canada of the corresponding FAR operating rules:

> Transport Canada has been moving towards the adoption of a series of the Federal Aviation Airworthiness Regulations, but proposes to delete from the Canadian code the Federal Aviation Operational Regulations. I am satisfied that to do so would be a mistake. What is needed is a complete code available from one source. The failure to adopt the Federal Aviation Operational Regulations which are interrelated with the Federal Aviation Airworthiness requirements would lead to future complication and uncertainty and would fail to achieve the necessary objective.
>
> (*Report of the Commission of Inquiry into Aviation Safety*, vol. 2, p. 542)

The point being made was that the United States operational rules were an integral part of the airworthiness regulations and were equally as important as the airworthiness regulations to airline safety:

> Although styled as the operational requirements, the Federal Aviation Operational Regulations include many airworthiness standards and, as is pointed out, the Operational Regulations are an integral part of an airworthiness code. The Operational Regulations update airworthiness requirements and are equally important in contributing to aviation safety. As previously noted, the current Canadian airworthiness standards are to be found in a myriad of documentation. A close study of them may disclose comparable standards to those that now form part of the operational FARs. In many cases, however, there is an absence of identical or equivalent standards. In my opinion the airworthiness FARs and operational FARs should be used and adapted as the model for a Canadian Airworthiness Code.
>
> (Ibid.)

These observations and recommendations are, in my view, as valid today as they were when they were made ten years ago. In 1982 the FAR design requirements, along with International Civil Aviation Organization (ICAO) Annex 6, Operation of Aircraft, and Joint Aviation Requirement (JAR) 22, were in fact adopted in Canada and now form the basis of certain chapters of the Transport Canada airworthiness manual. Inexplicably, Transport Canada did not adopt the FAR operational rules. Its failure to do so is very questionable.

Had Transport Canada adopted the FAR operational rules when it adopted the FAR design and certification requirements, Air Ontario aircraft C-FONF would in all probability have been equipped with flight attendant shoulder harnesses on March 10, 1989, and the flight crew of C-FONF would have been required to have a common and approved aircraft operating manual. Mr David Adams, an investigator from CASB seconded to this Inquiry, described the Canadian regulatory requirements for seats for flight attendants, as they existed at the time of the Air Ontario accident:

> Q. Now, I would like you to turn to page 110 of your report, and it deals with the FAR requirements and Transport Canada requirements for shoulder harness ... for cabin attendant seats.
> Can you discuss that for the Commissioner?
>
> A. Yes ... Canada, like many countries, accepts the U.S. specifications and regulations to do with a lot of things involved with aircraft operation.
> Now, the United States had a Federal Aviation Regulation 25.785, which is primarily a design regulation. And it basically said, okay, as of a particular date, all aircraft constructed and submitted for certification must have seats that provide back and arm and neck support, and they must have ... shoulder harnesses as part of the seat belt.
> Canada accepted that particular FAR.
> The Americans then introduced a second FAR which was a ... Federal Aviation Regulation – FAR 121.311. Now, it is an operational regulation as opposed to a design regulation.
> Now, that operational regulation basically said, all aircraft that are being used for major regular passenger transport services, irrespective of when they were designed or certified, must have the new seats that provide back and arm and neck support and shoulder harnesses.
> So, in effect, FAR 121 made FAR 25.7 retroactive so that it covered all aircraft.
> Whereas Canada accepted FAR 25.785, they had not at the time of the accident accepted FAR 121.311.
> So, in other words, in this country you were not necessarily required to have the new seats or the shoulder harnesses, depending on when your aircraft was certified. This was the case with the Air Ontario F-28 C-FONF. It was not, under Canadian regulations, required to have the shoulder harnesses or the new seats.
>
> (Transcript, vol. 157, pp. 81–84)

Adequacy of Canadian Operating Rules: The View of Transport Canada Operational Staff

The Transport Canada operational staff who testified at this Inquiry, when questioned about the adequacy of the existing ANO Series VII, No. 2, were unanimous in their view that the ANO was deficient in a number of areas. Mr Martin Brayman, a former superintendent of air carrier inspection for Ontario Region, gave the following evidence about the adequacy of the Canadian operating rules:

> A. There are numerous areas that are not covered specifically in the ANOs.
>
> ...
>
> Or in sufficient detail. And I would have to say that those areas dealing with dispatch centres, that's one area. There are several others.
>
> (Transcript, vol. 131, p. 112)

Mr Ian Umbach, Transport Canada's superintendent of air carrier operations (large aeroplanes) in Ottawa, was a witness whom I perceived to be genuinely committed to aviation safety. He expressed the obvious frustration that many Transport Canada witnesses, pilots, and air carrier officials who testified felt for the chronic inaction on the part of Transport Canada senior management in many areas of urgent concern, including the replacement of the outdated ANOs and regulations. Mr Umbach testified that more than eight years ago, "the department began a rewrite of the existing regulations and ANOs," but that "they have never appeared." He stressed that there is "an urgent need for current, topical and specific regulations." He stated that "in their absence, we end up improvising policy, publishing policy manuals, and the industry itself is advancing at such a rapid pace that we are having difficulty keeping up." He gave his view of what is necessary:

> A. ...
>
> And it's my strong belief that we need, as I said, current, topical regulations for the control and regulation of our air carrier industry, and we don't have them.
>
> (Transcript, vol. 139, p. 23)

Mr Umbach was asked whether, for large air carrier inspection, the Air Navigation Order Series VII assists him in the fullest extent in carrying out his duties and responsibilities. His reply was succinct and graphic:

A. No. It's outdated. It's vague. It's open to varied interpretation. It doesn't address a wide variety of the items now facing the air carrier industry and us.

(Transcript, vol. 139, pp. 23–24)

On his own initiative, Mr Umbach, while on the witness stand on November 17, 1990, presented a list of eleven recommendations for urgently needed regulatory changes, the first of which was: "Revise the air regulations and ANOs on a priority basis" (Transcript, vol. 139, pp. 23–24). When asked for his view of the United States operational rules, the FAR 121, Mr Umbach unequivocally stated before this Inquiry that the FAR 121 operating rules were exactly what is needed in Canada:

Q. What is your view of FAR 121?
A. I think it is exactly what we need. It is current, topical and specific.

(Transcript, vol. 139, pp. 25–26)

Mr Umbach agreed that special conditions, based on Canadian experience and required for Canadian aviation purposes, should be addressed in the context of an adoption of FAR 121. He was most emphatic when asked whether he recommended that the United States Operational Regulation, FAR 121, should be used and adapted for a Canadian airworthiness code:

A. Yes, I do.
Q. And when should it be done?
A. Immediately.

(Transcript, vol. 139, p. 26)

I could not agree more. The time is long past for action in this regard.

Mr William Slaughter, Transport Canada's director of flight standards, supported Mr Umbach's views in this regard. During his testimony before this Inquiry Mr Slaughter acknowledged that, although the *Aeronautics Act* has been rewritten to replace the original Act that dated back to 1919, "the regulations have not yet caught up with the Act." He gave the following evidence:

Q. Now, do you agree with me that at the time, five years ago, and still now, aviation safety legislation in Canada is in serious need of revision and overhaul?
A. Yes, sir, the regulations, I believe, and it has been documented here [during the hearings of this Commission of Inquiry], are woefully out of date.

(Transcript, vol. 147, p. 85)

Mr Slaughter testified that inadequate finances and personnel had a negative impact on the ability of the Aviation Regulation Directorate to carry out its daily tasks and to do the planning, developing, and reviewing of the regulations to meet the challenges of ongoing technology. He candidly admitted that given his workload and the resources available, he could not give the assurance that everything is being done in compliance with current regulations.

Mr Slaughter was unable to explain the failure by Transport Canada to adopt the operational FARs. He too left no doubt that adoption of the entire FAR system was appropriate and sensible:

> A. So the reason we did not adopt the FAR system as recommended by Justice Dubin, I don't know, and that's outside my area of responsibility and authority. But certainly I'm comfortable ... with using the FAR regulations and would be quite content if we adopted that system throughout, from my own opinion.
>
> (Transcript, vol. 145, p. 92)

Mr Slaughter's testimony implies that the reason for the failure to adopt the operational FARs lay beyond his area of jurisdiction and with the upper management of the Aviation Regulation Directorate. Mr Weldon Newton, director-general of aviation regulation, when questioned about the matter, simply indicated in his evidence that Transport Canada chose not to accept Mr Justice Dubin's recommendation for the adoption of the United States operational FARs concurrently with its adoption of the United States airworthiness FARs. Instead of following this recommendation, it is clear from the evidence that the Aviation Regulation Directorate has, in effect, attempted for the past ten years to restructure the Canadian air carrier operating rules so as to eliminate the ANOs and to have only regulations. According to Mr Newton's evidence, given in late January 1991, the draft regulations referred to by him had not yet been implemented but had recently been submitted to the Department of Justice for review.

It is a matter of major concern that the Aviation Regulation Directorate's decade-long waste of time, expertise, and resources on an as yet incomplete activity could and should have been avoided. Adoption of Mr Justice Dubin's recommendation regarding the United States FAR operational rules would have provided effective operating rules in many areas of Canadian regulations found deficient in the course of this Inquiry. In addition, although Mr Donald Douglas, in his report, identified a serious problem with Canadian air regulations as far back as 1986 (see chapter 30, Effects of Deregulation and Downsizing on Aviation Safety), the evidence before this Commission shows that little was done to address the problem effectively in the years that followed.

One of Mr Umbach's list of recommendations aimed at correcting the unsatisfactory state of Canadian air regulations concerned the issue of contracting-out within an international aviation environment:

> Q. Your next recommendation is improve regulations applicable to air carriers contracting maintenance, flight watch, et cetera.
> Can you generally deal with that recommendation?
>
> A. It generally refers to my first recommendation ... that we need better regulations to meet rapidly changing developments in the air carrier industry.
> New trends are developing constantly. Flight watch certification is inadequately addressed in current regulations. The present manuals, well, for flight watch, we don't have a manual. The certification manual isn't as specific as it should be to meet changing developments.
> New practices are being entered into on a global scale now that we are, at the moment, ill-prepared to meet.
>
> (Transcript, vol. 139, pp. 29–30)

The obvious solution to challenges posed by the new global aviation environment lies in the development and acceptance of uniform design, certification, maintenance, and operational regulations, a direction in which the European Community is now headed. It is known that Europe's Joint Aviation Authorities (JAA) and the FAA in the United States have both recognized the need for greater commonality not only in aircraft design and certification requirements but also in their respective operating regulations. In that regard, the JAA has set up a joint board of operations to address operational issues such as flight crew and cabin attendants' flight duty time limitations, crew operating procedures, aircraft operational procedures, flight operations, and aircraft operating manuals as well as carrier certification procedures. One of their prime objectives is to achieve close cross-reference compatibility with the FARs.

The international aviation community is thus, by necessity, being steadily drawn towards the development and adoption of universal, harmonized design, maintenance, and operating standards. The end product will no doubt be a compromise between upgraded versions of the FARs and the JARs. By adopting the FAR operating rules as the Canadian model, and enhancing these rules where warranted, Canada would be in a far better position to accommodate the changing international aviation environment than it would with its own unique code of operating regulations.

It is worth noting that Transport Canada's Airworthiness Manual uses a split-page approach displaying the FAR certification rule in the left column and the Canadian rule in the right column. If the two rules are identical it simply indicates "no change." However, if there is a difference, it is noted in the right column. This seems a sensible approach that should have been used as well for Canadian air carrier operating rules.

During Mr Newton's testimony he undertook to provide to this Inquiry a copy of the proposed revised operating rules. This undertaking was subsequently withdrawn by Transport Canada's counsel in a letter to commission counsel dated February 15, 1991, claiming Queen's Privilege under the *Canada Evidence Act* (see chapter 43). I found this position both surprising and disappointing, given that these draft regulations had already been submitted for review to various associations representing different segments of the aviation industry. Nevertheless, they were denied to a Commission of Inquiry charged with the responsibility of examining matters pertaining to aviation safety with the pledged full support of the minister of transport. I am therefore unable to offer comment on the suitability of the proposed changes but I would strongly urge that if they do not fully address the concerns expressed herein, the entire issue of the draft Transport Canada air carrier operating rules be reconsidered, with a view to expeditiously adopting the United States FAR 121 operating rules, while monitoring any future harmonization between them and the European JARs.

In the event that the FAR 121 operating rules are adopted as a model for a revised Canadian regulatory scheme, I suggest that Transport Canada retain an expert in the application of the FARs to assist in their transition to the Canadian regime and to point out any deficiencies in their current application in the United States. The goal should be to have an improved set of FARs applied to the Canadian scene.

The Legislative Process: Undue Delay in Rule Making

The evidence before this Inquiry leaves no doubt that it takes an inordinate length of time to put into place adequate legislation related to aviation safety, a problem that causes delays in the timely introduction of, or urgently required changes to, the operating rules. The Transport Canada Review Group, in May 1990, published a report on the Evaluation of Aviation Regulation and Safety Programs, which was conducted by direction of the deputy minister (Exhibit 1323). That report made specific reference to the problem of such delay and included recommendations for resolution. The following are excerpts from that document:

5.2 TCAG Rulemaking – Efficiency

The 1989 Federal Regulatory Plan listed 200 regulations that Transport Canada intended to adopt, of which Aviation's total is 43.

The process is slow, and not many regulations have been pre-published in Part I of the Gazette. From January 1, 1987 to June 30, 1989, twenty-one of the proposed regulations of those considered were the subject of such notices. Of comparable interest, only nine of the 21 regulations pre-published have yet passed into law. At this rate, even discharging the present burden of planned [Transport Canada Aviation Group] TCAG regulations will take nearly five years. As an example, the regulations (old ANO Series VII) relating to air carrier operations had been in process for over 7 years.

Accordingly, given the current track record, it is difficult to see how unexpected new demands and priorities, such as the possible rule on compulsory de-icing of aircraft arising from the Dryden Inquiry can be properly addressed.

5.3 Priority Setting

None of the three organizations in TCAG's rulemaking structure presently carry out priority-setting for regulatory developments. Indeed, there is no mention of priority setting in the AR Rulemaking Policy and Procedures Manual. Any priority setting to the extent it currently occurs at all, appears to be done on an ad hoc basis by the Minister's office.

The current practice regarding the decision in TCAG on whether to develop a particular rule, is made by the Civil Aviation Rules Committee (CARC). Only if there is disagreement do the Directors General concerned in TCAG become involved to settle the matter.

It is often the case for branch directors who are members of the CARC to be represented by their Chiefs of Standards. It appears therefore that decisions on whether to develop a particular regulation are effectively made at the Chief level.

An improvement to this system would be the development of priorities (based primarily on safety or risk considerations) by a senior departmental committee, for approval or change by the Minister. This could be revised every six months or so, and would represent the basis for regulatory priorities and development.

> Such a committee would also ensure that there are appropriate challenges to both the priorities and the rules themselves, so that only the most important regulations would be developed and produced. The committee would also help to concentrate departmental effort on blockages in the system (both internally and, more significantly, externally), and press for appropriate action to deal with them.

The recommendations contained in this excerpt from the Review Group report are, in my view, appropriate and a step in the right direction. I would go further, however, and suggest that a senior member of the Privy Council staff be included in the membership of the recommended senior legislative review committee, thereby assuring recognition of the importance of the issues at a level that could influence facilitation of appropriate priority in the legislative process.

Findings

- The recommendation made in the 1981 *Report of the Commission of Inquiry on Aviation Safety* that "the airworthiness FARs and operational FARs should be used and adapted as the model for the Canadian airworthiness code" is as valid today as it was in 1981.

- The decision by senior management of Transport Canada not to adopt the United States FAR operating rules at the same time as it adopted the United States airworthiness FARs, contrary to the recommendation of the Commission of Inquiry on Aviation Safety in 1981, was a fundamental mistake.

- As a result of the failure by Transport Canada to adopt the United States FAR operating rules, the Canadian aviation operating rules continue to reside in disjointed regulations, orders, manuals, and policy documents that are difficult to comprehend, even by those responsible for their enforcement.

- The decision taken by senior management in the Aviation Regulation Directorate to attempt to rationalize the chaotic situation regarding Canadian operating rules by drafting its own operating rules to complement the United States airworthiness FAR, which, paradoxically, it willingly adopted, has been an unnecessary and wasteful exercise, and one that has not produced any tangible results.

- The views of working-level inspectors regarding the urgent need for adoption of the FARs was either not transmitted to, or not accepted by, senior Transport Canada aviation management.

- The Transport Canada operational managers and staff who testified on the point were unanimous in their view that the existing Air Navigation Orders and operating rules were ambiguous and deficient and that Canadian adoption of the operating FARs would represent a significant improvement.

- There is an urgent need for a legislative mechanism to enable the expediting or fast-tracking within Transport Canada of necessary changes to regulations and operating rules that have the greatest impact on aviation safety.

- The recommendations contained in section 5.2 and 5.3 of the May 1990 evaluation of Aviation Regulation and Safety Programs, conducted by the Transport Canada Review Group, if implemented, would offer significant improvements in the area of priority-setting for regulatory developments.

- Had Transport Canada adopted the FAR operating rules at the same time that it adopted the FAR airworthiness rules, the unnecessary commitment of human resources and expertise and the expenditure of public funds since 1981 in the pursuit of the questionable goal of producing made-in-Canada operating rules could have been avoided.

- Had Transport Canada adopted the FAR operating rules, as recommended in 1981, they would have required that the aircraft C-FONF be equipped with flight attendant shoulder harnesses and that the flight crew of C-FONF have a common and approved aircraft operating manual.

RECOMMENDATIONS

It is recommended:

MCR 140 That Transport Canada ensure that managers and inspectors responsible for the application of operating rules are consulted on proposed changes to such rules.

MCR 141 That if the proposed draft operating rules currently being developed by Transport Canada do not fully address and satisfy the concerns identified by this Inquiry and expressed herein, then the entire matter of air carrier operating rules be reconsidered by Transport Canada with a view to adopting the United States Federal Aviation Regulation operating rules applying to air carriers for the Canadian regulatory scheme, amended or supplemented as necessary to accommodate Canadian conditions and purposes, on the highest possible priority basis.

MCR 142 That in the event that the United States Federal Aviation Regulation (FAR) operating rules are adopted by Transport Canada for a required Canadian regulatory scheme, Transport Canada retain an expert in the application of the FARs to assist in their transition into the Canadian regulatory regime.

MCR 143 That in the event of adoption of the United States Federal Aviation Regulation operating rules for a revised Canadian regulatory scheme, all the recommendations contained in this Final Report and in my Interim Reports proposing amendments or changes to existing Air Navigation Orders and Regulations be incorporated accordingly in order to give full meaning and effect to the subject matter under consideration.

MCR 144 That Transport Canada monitor the efforts of the United States Federal Aviation Administration and the European Joint Aviation Authorities to achieve greater commonality in aircraft design and certification requirements and in operating regulations, with a view to achieving harmonization of Canadian airworthiness and operating rules with the changing international aviation environment.

MCR 145 That Transport Canada adopt the recommendations contained in sections 5.2 and 5.3 of the May 1990 evaluation of Aviation Regulation and Safety Programs, regarding priority setting for regulatory developments and the rule-making process.

MCR 146 That a senior member of the Privy Council staff be included in the proposed senior departmental review committee for priority setting.

35 COMPANY CHECK PILOT

A company check pilot (CCP) is a pilot, employed by a carrier or agency, who has been authorized by Transport Canada to conduct certain tasks on behalf of the department in accordance with the Air Regulations and Air Navigation Orders. The issues regarding company check pilots gave rise to a great deal of testimony from a number of Air Ontario flight operations staff and Transport Canada witnesses.

Delegated Authority

A CCP may be designated as having "A" authority, "B" authority, or both. "A" authority allows the CCP to conduct pilot proficiency checks and instrument rating renewals. "B" authority allows a CCP to carry out line indoctrination and to conduct line checks, a process that each air carrier pilot is required to follow before being approved as a line pilot on a large aircraft.

Mr Ian Umbach, superintendent of air carrier operations, Transport Canada, testified that CCPs normally conduct only recurrent checks on experienced pilots, whereas Transport Canada air carrier inspectors carry out all the initial ratings and upgrades. The evidence shows, however, that during the latter part of the 1980s even initial type ratings were assigned to CCPs because there were insufficient air carrier inspectors to cope with the large numbers of pilot proficiency checks.

Simply put, Transport Canada delegates authority to qualified individuals to conduct tasks that would otherwise have to be carried out by air carrier inspectors. The evidence indicates that, generally, the process has worked well over the years. It offers a convenience to the carriers as well as a cost saving to Transport Canada.

CCP candidates are subject to a Transport Canada screening process prior to their receiving delegation of "A" or "B" authority. In the screening, both the carrier and the designee are required to meet a number of prerequisites that are set out in Transport Canada's Air Carrier Check Pilot Manual.

Further Delegation to CCPs

Throughout the latter part of the 1980s, Transport Canada's air carrier inspectors were almost totally occupied with pilot proficiency checks and certification paperwork. In-flight inspections were for the most part abandoned, notwithstanding the fact that the more experienced inspectors considered that in-flight inspections gave them the best picture of the health of a carrier's operation from a safety viewpoint.

Based on all of the evidence I have heard, I am of the view that Transport Canada should consider pursuing a program that would lead to further delegation of authority to CCPs with air carriers that have demonstrated an exemplary safety record and that have in place mature pilot training and checking programs. To such air carriers, the delegation of authority with respect to initial pilot proficiency checks and upgrades should be considered as well. It is essential, however, that Transport Canada provide a comprehensive CCP-monitoring program of both the designated CCPs and a representative cross-section of each air carrier's pilots, in order to ensure that the standards are being properly applied and maintained. Transport Canada should reserve the right to have its air carrier inspectors conduct any pilot proficiency check it sees fit, and without notice. Transport Canada should also conduct initial pilot proficiency checks and upgrades with every air carrier in cases where a new aircraft is being introduced, to ensure that the required standard is maintained within that carrier's operation.

The savings in person-years that might accrue to Transport Canada from such a program should be redirected to in-flight inspection and air carrier surveillance programs.

Air Carrier Check Pilot Manual Deficiencies: Conflict of Interest

The use of company check pilots raises a number of issues, including that of conflict of interest. This issue surfaced when it was disclosed in evidence that Captain Joseph Deluce, who had a significant financial interest in Air Ontario, was designated as an Air Ontario CCP. The Air Carrier Check Pilot Manual issued by Transport Canada (Exhibit 1022) contains two brief and extremely vague paragraphs pertaining to conflict of interest on the part of a CCP candidate, and nowhere does it define the term "conflict of interest":

> A pilot having an interest in a carrier will not be granted CCP authority where the facts and circumstances indicate a possible conflict of interest.
>
> (Exhibit 1022, Section 1, p. 3, section 1-11)

> The D.O.T. Manager Superintendent or Supervisor in the office of prime interest for a carrier may recommend approval of a nominee

> not meeting all of the stated requirements. Justification to be included on nomination for CCP form. A waiver to CCP qualification must be approved by Ottawa Headquarters.
>
> (section 1-14)

Although there was no evidence that Captain Deluce improperly exercised his authority as a company check pilot, the critical question, totally unanswered by the Air Carrier Check Pilot Manual, is under what conditions or circumstances is an interest in a carrier to be considered as representing a conflict of interest? According to the interpretation of Mr Martin Brayman, former superintendent of air carrier inspection (large aeroplanes) for Ontario Region, the appointment of Captain Deluce to the position of CCP within Air Ontario did not represent a conflict of interest. However, the existing Transport Canada criteria intended to provide guidance to the regulator in this regard are extremely sparse and, at best, a less than definitive basis upon which to determine conflict of interest. Mr Umbach, in his testimony, acknowledged discussing with Mr Brayman the possibility that Captain Deluce was in a position of conflict of interest because of his shareholdings in Air Ontario. He stated that he relied on Mr Brayman's advice that Captain Deluce could be considered a "working pilot," and therefore not in a conflict position. He conceded that conflict of interest was not well defined and that there were no guidelines provided to inspectors by which to assess financial interests in a carrier:

> Q. Now, in so doing, in granting the approval, did at any time you discuss – recall discussing with Mr Brayman or anyone else in Ontario region a matter of the issue of possible conflict of interest?
>
> A. I don't recall the details, but I recall Mr Brayman calling me about this matter.
>
> Q. And do you recall what – generally, what discussions took place?
>
> A. Mr Deluce had an interest in the company and that Mr Brayman had investigated it and that, in his opinion, the interest was small enough that Mr Deluce could be considered a working pilot for this purpose.
>
> Q. And I take it that you ... relied on Mr Brayman's recommendation?
>
> A. I did, totally.
>
> ...
>
> Q. But, as it stands now, conflict of interest is not really defined very well?
>
> A. No.

Q. Does Transport Canada, in your mind, have anything available to it to allow it to assess financial interests of any individual?
A. No.
Q. Would that be a good idea?
A. Yes.

(Transcript, vol. 139, pp. 19, 22)

The issue of conflict of interest, however, can have implications in areas other than a pure financial interest in a carrier. For example, a CCP who conducts a line check on a pilot with whom he or she has carried out line indoctrination could be seen as having a conflict of interest. A CCP who conducts a pilot proficiency check on a pilot who has been trained by that same CCP would be seen as in a conflict of interest. Clearly a pilot should not be put in the position of evaluating the product of his or her own training. Moreover, a CCP should not carry out pilot proficiency checks or line checks on his or her superiors. Such an arrangement would obviously be intimidating to the CCP because of the likely perception of potential career implications on the part of the CCP.

Mr Umbach, in his evidence, recognized that the term "conflict of interest," as it applies to CCPs, encompasses far more than financial interest in a carrier. His understanding of the term was as follows:

Q. Now, when you are dealing with conflict of interest, I take it – can you tell me what you mean – what your understanding of conflict of interest would be?
A. It would mean the person would have a division of desires or benefits in performing one task as opposed to the other.
In this case, it could mean he would have monetary benefits or other financial benefits by biasing himself towards his interest in the carrier rather than representing us as a CCP.
Q. And that's your interpretation?
A. That's mine.

(Transcript, vol. 139, p. 21)

These considerations are covered for the most part in the Air Carrier Check Pilot Manual, but were not always followed in the latter part of the 1980s owing to the fact that inspector workloads precluded strict adherence.

The inadequacies of the existing provisions should be reviewed by Transport Canada. The lack of criteria for use by the regulators in assessing conflict of interest on the part of CCP candidates is a problem that merits attention.

ACI and CCP Proficiency Requirements to Conduct Pilot Proficiency Checks

During the course of the hearings, evidence was heard that not all air carrier inspectors (ACIs) assigned to carry out pilot proficiency checks were type-rated on the aircraft in which they were conducting the checks. The Air Carrier Inspector (Large Aeroplanes) Manual indicates that air carrier inspectors conducting pilot proficiency checks on turbojet aircraft will normally be qualified and current, pursuant to ANO Series VII, No. 2, on the aircraft type used for the proficiency check. The manual further states that, when authorized by headquarters:

> (a) an inspector rated but not current on the aeroplane type may be used on temporary assignment or,
> (b) an inspector rated and current on a similar aeroplane type may be used on temporary assignment.
>
> (Exhibit 960, p. 1-11)

The key words are "similar aeroplane type."

According to a letter dated November 10, 1989, signed by Mr Richard Peters, chairman of the Aircraft Operations Group, to the then minister of transport, Mr Benoît Bouchard, air carrier inspectors were conducting proficiency checks on aircraft types for which they were not type rated. It was subsequently brought to my attention, during the Commission hearings, that the two aircraft types in issue were the Boeing 737 and the Boeing 747. My own view, and that of numerous inspectors and professional pilots who testified, is that the only similarity between the two aircraft is that they are both jet transport aircraft manufactured by the same company. Surely it is wrong in principle to assign a Boeing 737-qualified inspector to perform a proficiency check on a Boeing 747 pilot.

The evidence shows that this was not an isolated occurrence. Even Mr William Slaughter, Transport Canada's director of flight standards, agreed that this was a poor state of affairs. It was conceded by both Mr Slaughter and Mr David Wightman, assistant deputy minister, aviation, that action would have to be taken to ensure that such an occurrence would not be repeated. While acknowledging that the views expressed by Mr Wightman and Mr Slaughter in this regard are constructive, I believe it is essential that Transport Canada take appropriate steps to require that all pilot proficiency checks on aircraft over 12,500 pounds and on all turbojet aircraft be conducted only by air carrier inspectors or CCPs holding a current rating on such aircraft.

The Advanced Qualification Program (United States)

Dr Robert Helmreich in his testimony referred to a new program being instituted in the United States called the Advanced Qualification Program (AQP). This program provides a voluntary alternative that air carriers may use in order to meet the training and checking requirements of the Federal Aviation Regulations. If implemented, this program may result in different flight training and checking concepts. The AQP program is addressed in chapter 20, F-28 Program: Flight Operations Training.

Findings

- The system by which Transport Canada delegates authority to qualified individuals among the air carriers to conduct tasks that otherwise have to be carried out by Transport Canada air carrier inspectors has generally worked well, offering a convenience to carriers and a cost saving to Transport Canada.

- There is a strong case for further delegation of authority to CCPs with air carriers that have demonstrated an exemplary safety record and have mature pilot training and checking programs in place.

- There is an additional need for Transport Canada to conduct, from time to time, pilot proficiency checks on air carrier line pilots, without prior notice, to ensure that appropriate standards are maintained.

- Because of the inadequate number of air carrier inspectors it had throughout the latter half of the 1980s, the Transport Canada Aviation Regulation Directorate resorted to the unacceptable practice of assigning inspectors to perform pilot proficiency checks on aircraft types on which the inspectors themselves were not qualified.

- The existing Transport Canada provisions and criteria for use by air carrier inspectors, in assessing conflict of interest on the part of CCP candidates, are inadequate.

- Although the Transport Canada Air Carrier Check Pilot Manual prohibits the granting of CCP authority to a pilot "where the facts and circumstances indicate a possible conflict of interest," there is no definition in the manual of the term "conflict of interest."

- The lack of definition of the term "conflict of interest" in the Air

Carrier Check Pilot Manual is an omission requiring rectification.

- There is a lack of a clear definition of the term "generically similar aircraft" in all applicable Transport Canada regulations and supporting manuals.

- The air carrier inspectors are not provided by Transport Canada with any guidelines by which to assess financial interests of a pilot in a carrier in the context of a possible conflict of interest. This results in inconsistent decisions, varying from inspector to inspector, where consistency should be the norm.

- The Air Carrier Check Pilot Manual fails to spell out clearly that the issue of conflict of interest, as it relates to CCPs, can have implications involving matters other than pure financial interest.

RECOMMENDATIONS

It is recommended:

MCR 147 That Transport Canada pursue a program that would lead to further delegation of authority to company check pilots with air carriers that have demonstrated an exemplary safety record and have in place mature programs for training and checking pilots. To such carriers, delegation of authority with respect to initial pilot proficiency checks and pilot upgrades should be considered as well.

MCR 148 That Transport Canada provide a comprehensive monitoring program of both designated company check pilots and a representative cross-section of each company's pilots to ensure that standards are being properly applied and maintained.

MCR 149 That Transport Canada conduct, and reserve the right to conduct, pilot proficiency spot checks on all air carrier pilots, including designated company check pilots, as it sees fit and without notice.

MCR 150 That Transport Canada conduct initial pilot proficiency checks and line checks with every air carrier in cases where a new aircraft type is being introduced, to ensure that the required standards are met in that air carrier's operation of the new aircraft type.

MCR 151 That Transport Canada ensure that all pilot proficiency checks on aircraft over 12,500 pounds and on all turbojet aircraft be conducted only by air carrier inspectors or company check pilots holding a current rating for the specific aircraft type on which the check is being conducted.

MCR 152 That Transport Canada ensure that pilot proficiency checks on non-turbojet aircraft and on aircraft under 12,500 pounds be conducted only by air carrier inspectors or company check pilots who are type-rated on that aircraft type or on a generically similar aircraft.

MCR 153 That Transport Canada develop a clear and unambiguous definition of "generically similar aircraft" to be placed in all applicable regulations and supporting manuals.

MCR 154 That Transport Canada, on a priority basis, rewrite the conflict of interest section of its Air Carrier Check Pilot Manual so as to include the following objectives:
(a) to provide a clear and unambiguous definition of what is meant by the term "conflict of interest" as it relates to company check pilots;
(b) to specify those areas in which a conflict of interest can arise, in addition to the area of financial interest.

MCR 155 That Transport Canada provide explicit guidelines to its air carrier inspectors on the subject of conflict of interest for use in evaluating individual candidates for the position of company check pilot.

MCR 156 That Transport Canada conduct an evaluation of potential conflict of interest with respect to each company check pilot candidate, and that a written record be kept of each such evaluation.

36 CONTRACTING OUT, WAIVERS, AND SPOT CHECKS

Contracting Out

In the years preceding economic deregulation, it was not usual for large air carriers with well-developed maintenance and flight operations departments to take on contract work from other carriers. However, with the advent of Economic Regulatory Reform (ERR) in the mid-1980s, contracting out of aircraft maintenance, flight training, and even flight dispatch/flight following services became a far more frequent occurrence. The pattern that Canada followed was similar, on a smaller scale, to that which had occurred in the United States. Mr Donald Douglas, formerly the director of Transport Canada's Licensing and Inspection Branch, described the Federal Aviation Administration's experience with deregulation as follows:

> A. On the airworthiness side, they were discovering that there were new methods of doing things. There was always a tendency to make cuts, if the bottom line was running the show, to the maintenance side.
>
> If they didn't have a maintenance organization, they would be contracting out maintenance and doing new things that hadn't been common practice before. And this made it more difficult for the airworthiness people.
>
> Contracting out might not necessarily even be in the United States. The maintenance might be done in another country, and this created more travel.
>
> (Transcript, vol. 143, pp. 42–43)

The Canadian situation relative to contracting out, following the introduction of ERR, was touched on by Mr Henry Dyck, Transport Canada's airworthiness superintendent of large air carriers:

> A. ... We also had the big increase in contract maintenance being carried out outside the country in foreign repair stations, because the new entrants did not and could not put together maintenance facilities adequate to handle their work. The existing carriers in Canada couldn't handle the additional work,

> so it was quite common to go outside the country to have aircraft maintained.
>
> (Transcript, vol. 135, pp. 16–17)

There were two problems that Transport Canada experienced as a result of contracting out. The first related to a great deal of international travel for the Transport Canada inspectors. While the costs of such travel were borne by the air carrier, the travel consumed an inordinate amount of time in a period when Transport Canada was faced with escalating workloads and diminishing qualified and experienced staff. Mr Ian Umbach, Transport Canada's superintendent of air carrier operations (large aeroplanes), addressed this issue in his testimony:

> Q. The contracting of maintenance and training, were you, as operations inspectors, facing the same problem of monitoring the airlines as a result of contracting out?
> A. Yes.
> Q. Can you describe that?
> A. Frequently, the carrier would take training where he could find it, it could be in the States, it could be in the U.K., it could be at more than one location.
> I recall one carrier, we had five inspectors simultaneously doing PPCs at five different simulators, and it placed enormous loads on our resources.
> Q. And these five different simulators were located at different places in the world?
> A. Different places in North America.
>
> (Transcript, vol. 138, pp. 83–84)

The second problem with contracting out related to the absence of regulations and guidelines. It was not always clearly understood that the air carrier, not the contractor, was responsible for ensuring that the work or service met the appropriate Canadian standard. In some instances the air carrier did not have qualified personnel to provide such assurance.

In the early stages of ERR, there were no guidelines for Transport Canada inspectors applicable to their inspections of contractors' work or service. Guidelines were subsequently developed for airworthiness inspectors, but have not been enabled by regulation. Consequently, airworthiness inspectors at times found themselves in foreign countries assessing facilities and maintenance procedures that complied with the standards of that particular state. The inspectors would have little recourse but to use their own judgement in ensuring conformity with Canadian standards and hope that they were not challenged by the carrier or the contractor.

The problem is addressed in the Douglas Report, "Aviation Safety in a Changing Environment," as follows:

> In recent years, certain practices among air carriers have changed, such as the degree to which air carriers contract out services. Present regulations do not appear to adequately address these new and complex practices. While the FAA continually reviews the adequacy of specific regulations, there is a need to perform a comprehensive analysis of the overall air carrier regulatory structure in the context of the changed airline operating environment. While this task will be large, actions of a more immediate nature are being taken to address these issues.
>
> (Exhibit 1057, p. 5)

It should be noted that this statement was produced on May 28, 1986. While the intent of the statement is to be commended, evidence before this Commission shows that little was done in the years that followed. On November 17, 1990, Mr Umbach provided a page of recommendations to the Commission. One of these recommendations was, "Revise the Air Regulations and ANOs on a priority basis." When questioned about that recommendation during his testimony, he stated:

> A. ... New trends are developing constantly.
>
> Flight watch certification are inadequately addressed in current regulations. The present manuals, well, for flight watch, we don't have a manual. The certification manual isn't as specific as it should be to meet changing developments.
>
> New practices are being entered into on a global scale now that we are, at the moment, ill-prepared to meet.
>
> (Transcript, vol. 139, pp. 29–30)

Mr William Slaughter, director of flight standards, confirmed Mr Umbach's view when he was questioned on certain regulatory deficiencies requiring attention:

> A. Yes, improve the regulations applicable to air carriers contracting maintenance, flight watch, et cetera.
>
> I think we have seen in the last few days that there are areas of the regulations that need changing, significant changes, so I would have to support and agree on that.
>
> (Transcript, vol. 146, pp. 190–91)

I support the recommendation by Mr Douglas for a comprehensive review of regulations to enable inspectors to respond in a timely manner to meet the demands of a changing airline operating environment. Such a review was needed in 1985 and it is still required today. The need for an overall safety regulation reform is dealt with in chapter 37 of this Report, Safety Management and the Transport Canada Organization.

Waivers

The *Aeronautics Act* gives the minister authority to grant exemptions or waivers to regulations and orders:

> (2) The Minister may, on such terms and conditions as the Minister deems necessary, exempt any person, aircraft, aerodrome, facility or service from the application of any regulation or order made under this Part if in the opinion of the Minister the exemption is in the public interest and is not likely to affect aviation safety.
>
> (*Aeronautics Act*, c.33, s.5.9/2)

Authority has been granted to incumbents of certain positions in the Aviation Regulation Directorate to grant waivers to some specific regulations or orders: such positions are delineated in the relevant document. Where authority to grant such waivers is not enabled by a particular regulation or order, the director-general of aviation regulation has been delegated authority, on behalf of the minister, to grant such waivers and conditions as they pertain to his aviation regulation responsibilities. Mr Weldon Newton, who held the position of director-general, gave evidence on this issue:

> A. Where the legislation does not provide for an exemption, where the regulation doesn't say the words "unless otherwise authorized by the Minister," where the regulation contains a total prohibition "no person shall" or "everyone shall" do something ... to be in compliance, and no exempting circumstances contemplated by the wording, that the Minister has delegated that authority to me, to make one by one determinations.
>
> (Transcript, vol. 161, p. 166)

In the course of his testimony, Mr Newton gave a good example of a carrier requesting relief from a regulation. On the evening of May 31, 1988, he received a phone call from a representative of Air Ontario who requested a waiver from the requirement to have floor track lighting installed in Air Ontario's HS-748 aircraft. The requirement stemmed in part from recommendations arising from the Air Canada DC-9 accident in Cincinnati in June 1983. Carriers were given two years to acquire and install floor track lighting. The effective compliance date of the requirement was June 1, 1988. The reason given for noncompliance by Air Ontario, according to Mr Newton, was that the company had intended to dispose of these aircraft prior to the compliance date of the regulation, but was unsuccessful in doing so. The request for a waiver was denied, a decision that, based on the evidence I heard, I fully support.

I cannot say the same for the decision made in the case of the seat-belt order, an issue that is discussed at some length in chapter 22 of this Report. In July 1987 a proposed amendment to Air Navigation Order Series II, No. 2, set out a requirement that every person on board an aircraft shall keep a safety-belt fastened when the safety-belt sign is illuminated. An exception to the order allows crew members to perform safety-related duties in other than the takeoff and landing phases of a flight while the seat-belt sign is illuminated. The carriers' representative, the Air Transport Association of Canada (ATAC), lobbied to have the exception include "other duties as approved by the captain" (Exhibit 1168, tab 5). The intent of the ATAC proposal was to enable meal and bar service to continue at the discretion of the captain after the seat-belt sign had been turned on. Transport Canada accepted the ATAC proposal.

The flight attendants' union, the Canadian Union of Public Employees (CUPE), vigorously intervened to have the order applied as it was written. Its concern was that accident statistics showed that cabin attendants had sustained injuries as a result of in-flight turbulence and that pilots were not always able to anticipate turbulence in sufficient time to warn cabin crew to take their seats.

The CUPE final submission to this Commission on the outcome of this dispute suggests that the evidence from Mr William Slaughter, director of flight standards, is "clear on the power of the regulated, namely the Air Transport Association of Canada, to regulate the conduct of the regulators" (Transcript, vol. 166, p. 46). In this instance, in spite of the advice and warnings of their own technical specialists, Transport Canada management acceded to air carrier influence and permitted meal and bar service to continue at the discretion of the captain while the seat-belt sign was illuminated.

If the regulators are to be given the latitude of judgement in applying the regulations, they should recognize that a waiver is a provision that is to be considered and granted only in the most exceptional circumstances and only after thorough technical advice has been obtained and considered. They should also be required to exercise the same prudence in determining the point at which industry consultation ceases to become consultation and becomes a lobby on behalf of a carrier.

Spot Checks or No-Notice Inspections

The use of spot checks or no-notice inspections was identified by numerous witnesses as an effective means of ensuring compliance with air carrier operating rules and as an essential element of the surveillance and monitoring process. Mr Slaughter testified that there is a place for spot checks and that "the reason they aren't used more often is simply because we don't have the resources to do so." He stated that spot checks are used for "any number of reasons" and cited an example:

> A. ... If there was some reason to suspect there was a problem in a particular area of a company, we might just go in and do a spot check on that item.
>
> (Transcript, vol. 144, pp. 80–81)

The requirement for increased use of spot checks is recognized and supported as a means of ensuring that carriers are complying with the operating rules as a matter of standard every day practice and not just when regulatory authorities are on the premises conducting an audit.

Findings

- At the time of the hearings of this Commission, there were few definitive guidelines that set out the basis on which Transport Canada inspectors were to ensure that foreign contractors provided services that met Canadian standards.

- Transport Canada senior managers appeared in some instances to be most susceptible to industry demands to overturn safety-related regulatory amendments, in spite of advice to the contrary from their own Transport Canada technical specialists.

- No-notice inspections, although favoured by a number of witnesses as an effective means of ensuring regulatory compliance, were not often used owing to a lack of available inspector resources.

RECOMMENDATIONS

It is recommended:

MCR 157 That Transport Canada provide appropriate regulations governing the practice whereby air carriers enter into contracts with other companies or agencies for the provision of facilities or services required under the terms of the air carrier's operating certificate.

MCR 158 That Transport Canada inspectors be provided clear and direct guidance governing their aviation-regulation responsibilities for approval of arrangements and facilities to be contracted out to other companies or agencies by Canadian air carriers.

MCR 159 That Transport Canada set out a clear and unequivocal policy for senior managers specifying the basis upon which a waiver application is to be considered, ensuring that all safety implications are fully considered and satisfied before such waiver is granted.

MCR 160 That Transport Canada take steps to increase substantially the number of no-notice inspections of air carriers, with particular emphasis on safety-sensitive or high-risk areas.

37 SAFETY MANAGEMENT AND THE TRANSPORT CANADA ORGANIZATION

The Problem

The lack of a designated agency within Transport Canada charged with the responsibility for overall coordination of safety-related aviation activities was considered in various phases of the Inquiry. This became a matter of particular concern during the presentation of evidence concerning lineups of aircraft at Toronto's Lester B. Pearson International Airport during adverse winter weather conditions that caused wing contamination and required ground de-icing of departing aircraft.

In the *Second Interim Report* of this Inquiry I concluded that the evidence clearly confirmed the existence of a safety problem at Pearson International Airport, a problem that may also exist to a lesser extent at other Canadian airports. The evidence that led to this conclusion brought to light a concern with respect to Transport Canada's ability to monitor, identify, and correct safety deficiencies in the Canadian air transportation infrastructure. During the Transport Canada phase of the hearings, further evidence was heard which indicated that organizational problems within Transport Canada may have contributed to this safety assurance deficiency.

My mandate did not specifically direct an examination of the Transport Canada organization; in my view, however, it would be irresponsible to ignore the safety implications of organizational deficiencies such as were highlighted during this Commission's examination of the highly relevant aircraft contamination and aircraft ground de-icing issues.

The De-icing Example at Pearson International Airport

The evidence of witnesses regarding aircraft lineups at Pearson International Airport during periods of freezing precipitation provides explicit examples of the inability of the current Transport Canada establishment to identify, analyse, and deal with aviation safety issues in a coordinated manner. The three primary witnesses examined in that regard were Mr Clare Vasey, a unit operations specialist with the Airport Control Services at Pearson International, Mr John Holm, superintendent of air operations at Pearson International, and Dr Lloyd McCoomb, director-general of safety and technical services of Transport Canada.

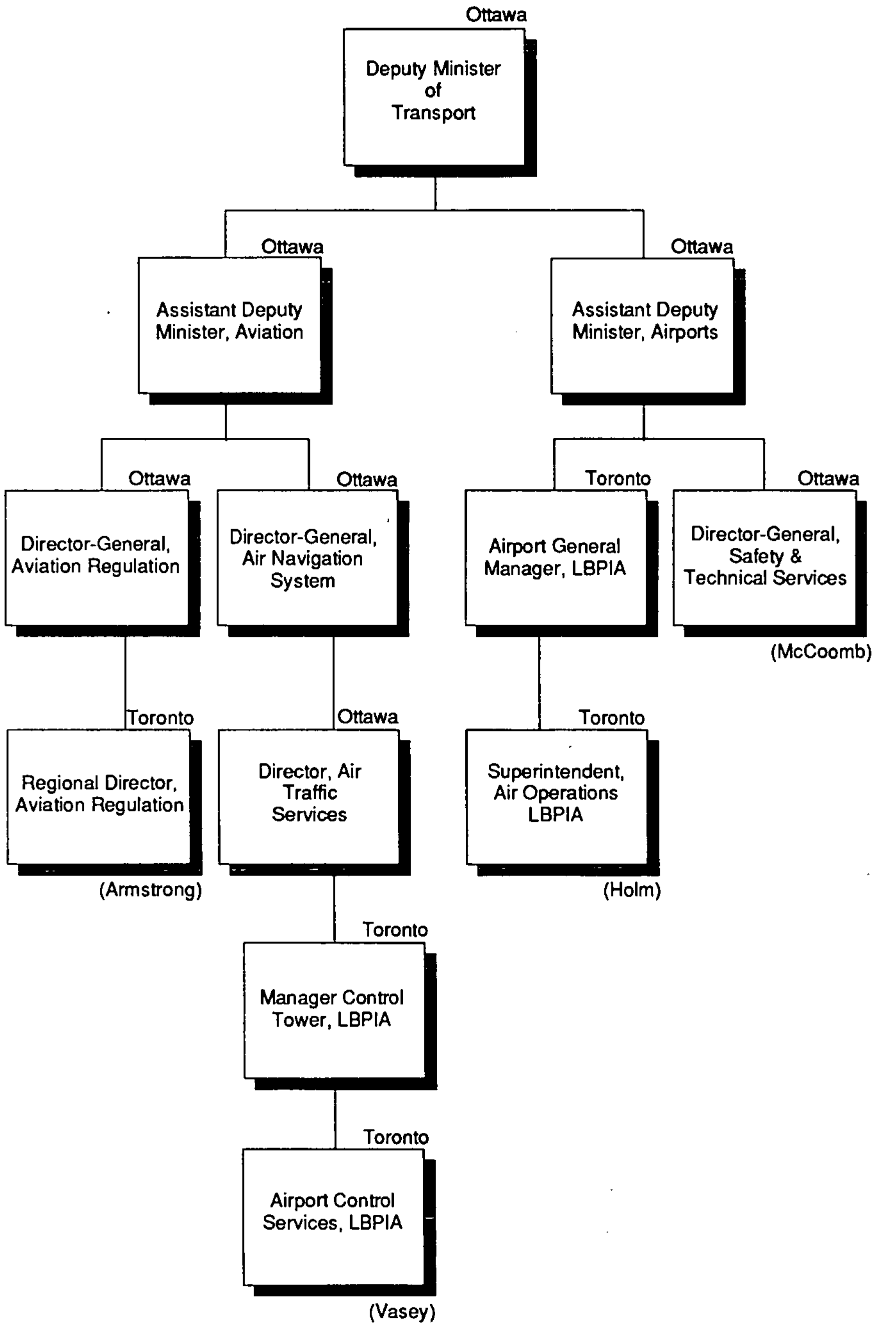
Mr Vasey described in detail the problems of ensuring that aircraft were capable of departing Pearson within a reasonable period of time after being de-iced. Mr Holm reiterated Mr Vasey's concerns about the safety aspects of lengthy takeoff delays after de-icing and testified that he had expressed them to the Transport Canada airport management at Pearson. Dr McCoomb gave the opinion that the safety aspects of aircraft de-icing are the responsibility of the air carrier in the first instance and that Transport Canada's Aviation Regulation Directorate has the responsibility of monitoring airline operations to ensure that aircraft do not depart in an unsafe condition. Mr Ronald Armstrong, Ontario Region's director of aviation regulation, later testified that he had not been made aware of any problems of aviation safety associated with such conditions at Pearson.

The evidence reflects the views of these four witnesses on a specific aviation safety-related problem as well as the differences of opinion as to whether in fact a problem existed and, if it did exist, how it should have been addressed. The fact that the problem was not universally recognized and addressed demonstrates a serious lack of communication and direction at appropriate levels of management in Transport Canada. Mr Holm made reference to two on-site committees he chaired at Pearson, the Civil Aeronautics Committee and the Airside Committee, before which some concerns on the subject were raised. The facts indicate, however, that these committees were ineffective either in gaining full recognition of the problems or in pursuing resolution to the necessary level.

The Problem Resolution Chain

It is not difficult to understand how such lack of communication and direction occurs when the reporting relationship of the four witnesses in question is examined. Figure 37-1 is designed to show that reporting relationship; it is not presented as an official organization chart. It demonstrates, however, that each of the witnesses reported through different channels and that there was no coordinating authority in the region.

Figure 37-1 Transport Canada: Reporting Relationships*



* Depicts selected relationships

Figure 37-1 illustrates the following significant points:

- Mr Vasey was aware of the operational problems at Pearson International Airport in conditions of adverse winter weather. His line reporting chain was to his superior, who in turn reported directly to the Ottawa office of the director, air traffic services, which reported to the assistant deputy minister, aviation, who reported to the deputy minister. Air Traffic Services, however, was not responsible for regulation of flight operations.
- Mr Holm recognized the problems. He reported them to his superior, who said they were airline problems. The airport general manager was responsible to the assistant deputy minister, airports, in Ottawa, who in turn reported to the deputy minister.
- Dr McCoomb, who was located in Ottawa, was responsible as director-general, safety and technical services, for policy regarding certain safety aspects at airports. He reported to the assistant deputy minister, airports, but was not in the line reporting relationship with the airport general manager at Pearson. He was not aware of the problems.
- Mr Armstrong, who was located in Toronto, was responsible for aviation regulation monitoring and enforcement in the Ontario Region. He stated that he was not aware of the problems.

Even if each of the four witnesses had been fully aware of the problem at Pearson and had sought direction for a resolution, the first level of authority at which Mr Armstrong's and Mr Vasey's views would have come together would have been that of the assistant deputy minister, aviation, in Ottawa. The first level at which Mr Holm's and Dr McCoomb's concerns would have been heard together would have been that of the assistant deputy minister, airports. The first level at which authority over all four of these areas of responsibility existed would have been that of the deputy minister.

It is in my view unacceptable and not in the interest of aviation safety that Transport Canada allowed such a segregated organizational approach to management of the aviation system to exist.

Background

The Canadian Air Transportation Administration (CATA) after 1982

The report of the Dubin Commission of Inquiry on Aviation Safety was published in 1981–82 following an exhaustive investigation spread over two years. The report was critical of CATA's inability to enforce regulations and of its organizational mix of responsibilities for aviation regulation and air navigation services. The recommendations of that inquiry resulted in the consolidation of air navigation services under a single directorate in CATA headquarters and the establishment of an enforcement branch. Similar changes were made in the organization of each of CATA's six regions in that each region was directed by a regional administrator to whom the three major operational directors – air navigation services, aviation regulation (including enforcement branch), and airports – reported. That organizational structure provided a central authority in each region responsible for coordinating the activities of the three major functions, including safety-related problems, particularly those that cut across the areas of responsibility of the three functions. Similarly, aviation safety problems of a national or international nature could be dealt with by direction from the CATA headquarters administrator.

The Present Organization (1985–April 1, 1991)

In 1985–86 a major reorganization took place in which CATA was disbanded and separate Airports and Aviation groups were formed. The positions of the CATA administrator and those of the six regional administrators disappeared. The regional directors of air navigation services, aviation regulation, and airports now reported directly and separately to the individual Ottawa headquarters office responsible for their particular function.

This organizational change facilitated centralization of authority and the elimination of some managerial levels. The change, however, also eliminated the regional structure that had previously provided a common Transport Canada aviation response to aviation industry concerns and to safety-related aviation problems. The most significant result of this 1985–86 organizational change was that the office of the deputy minister of transport at that time became the first level at which there was overall authority over the activities of the three groups.

Problems Inherent in the Present Organization

The Management Consulting Services Branch of Transport Canada in 1990 prepared an organizational change proposal for the Aviation Group (Project Number 1682-342 dated January 1991). A copy of that document, provided to this Inquiry, outlines organizational problems within Transport Canada caused by centralization and as perceived by its staff and client groups:

ORGANIZATIONAL CHANGE PROPOSAL AVIATION GROUP

B. BACKGROUND.

...

Management of the Aviation Group has become highly centralized. The objectives of centralization included achieving economies of scale, and overcoming an autonomous approach to regional management which was evident in the previous CATA organization. That approach had resulted in inconsistent application of national standards, policies and procedures. However, management centralization brought its own set of problems.

C. CURRENT PROBLEMS IN THE AVIATION GROUP.

MEMBERS OF THE AVIATION COMMUNITY HAVE OBSERVED THAT IT APPEARS THE DEPARTMENT IS ORGANIZED TO MEET ITS INTERNAL NEEDS RATHER THAN THE NEEDS OF ITS CLIENTS. Two problems most frequently cited were:

- clients are forced to coordinate participation of several TC branches to resolve aviation (ANS), IFR, airports problems, and

- clients encounter delays in the delivery of the regional regulatory program because of procedural problems and the requirements for HQ approvals.

A number of regional managers and staff expressed concern regarding the increasing tendency for the aviation community to bypass regions and deal directly with HQ, to resolve problems or obtain approvals, undermining the credibility and sense of commitment of regional officials.

The Aviation community suggests that improvements are needed in the Aviation Group's approach to consultation: the process should be structured, and undertaken in the problem definition phase, rather than after the solution has been developed.

THE FOLLOWING PROBLEMS WERE IDENTIFIED BY MANAGERS AND STAFF IN THE AVIATION GROUP:

- The Aviation Group does not operate as a team. Problems requiring system-wide solutions are not resolved in a timely manner (eg, de-icing, noise abatement, environmental issues).

- The compartmentalized structure of Aviation in HQ and regions discourages a Group approach to establishing priorities and leveraging resources.

- The senior management forum in the Aviation Group comprises only HQ managers representing both functional and operational issues. The Regional Managers, who actually deliver aviation services, have no direct input to decisions in the Assistant Deputy Minister, Aviation's (ADMA) management forum.

- The [Air Navigation Services] ANS directorate, comprising 80% of Group resources, has not been successful in managing within its resource envelope. Part of this problem is due to the political difficulty of changing levels of service; a management culture that historically viewed additional resources as the sole solution to all problems also has made cost containment difficult.

- The Executive Director of Technical Services, with a span-of-control of 15, manages a capital program of nearly $250 million, which includes three MCPs [major crown projects]. Management layers in the ANS directorate do not permit compliance with Chapter 545 of the Treasury Board (TB) Administration Policy Manual (APM) which states that MCP project managers should be no more than two management layers below the Deputy Head.

- The Aviation Safety Programs activity has undergone an extensive review recently, and there is a need to clarify its external and internal responsibilities.

- There are as many as seven layers of management between the point of service delivery and ADMA. Layers are not only expensive, but they dilute accountability and filter information. Layers diminish ADMA's influence on service delivery.

The problems identified in the organizational change proposal are those that led to what I view as a fragmented approach to resolution of safety issues. The centralization of control at headquarters effectively reduced regional capability to deal with safety issues in a direct and coordinated manner. The many layers of management between regional branches, where the real work of inspection is done, and senior headquarters management created a gap in communications and a lack of understanding of existing problems.

Safety Assurance Issues

Although the de-icing situation at Pearson International Airport discussed above is the issue most relevant to conditions existing at the time of the Dryden accident, there is other evidence as to the inappropriateness of the present organization to the provision of thorough aviation safety assurance.

Audit Organization

The effectiveness of air carrier audits in assuring aviation safety is addressed in chapters 32 and 33 of this Report. Although various opinions were expressed in evidence by Transport Canada witnesses as to the safety effectiveness of audits relative to other types of monitoring and surveillance, it is evident that there is a requirement for thorough and timely audits. However, Transport Canada has no established organizational structure that provides dedicated resources for the conduct of audits. The 1988 audit of Air Ontario is an example of the inadequacies of the present Transport Canada organization to provide that service. The convening authority who was located in headquarters in Ottawa appointed the audit manager, also from headquarters in Ottawa. Members of the audit teams, including the team leaders, were solicited from various regions. The audit manager did not have full control over the inspection staff provided for the audit. As a consequence, it was conducted in a poorly organized, incomplete, and ineffective manner.

If the convening authority, the audit manager, and the team leaders do not have dedicated personnel under their full control and authority, they cannot be expected to conduct a high quality audit.

Resource Allocation Process

Chapter 31, Aviation Regulation: Resourcing Process, deals at length with the inadequacies of the Transport Canada resource identification and allocation process. The cumbersome system of challenge and re-challenge for justification of requirements described by numerous witnesses was an example of the unwieldiness of the process and the organization itself. The evidence showed that the managers were unduly burdened with the extra justification paperwork, even though they already suffered from insufficient resources.

The staffing standard provided to the Aviation Regulation organization was particularly important to the inspector staff of the sections responsible for air carrier inspection both in the Airworthiness and Air Operations sectors. The estimation of the times required to perform their tasks and the frequency with which those tasks were to be performed was derived through an exhaustive challenge system, as described by Mr Armstrong in his testimony. The estimates of those frequencies and times were challenged again at each level of management, finally receiving the approval of the assistant deputy minister, review. The resulting staffing standards were verified by a non-partisan review conducted by McGill University. The regional headquarters and Ottawa headquarters managers responsible for inspection services rightfully believed that the figures they put forward using such formulae represented the minimum numbers of persons required on their inspection staff to conduct the vital aviation safety inspection services required of them. Yet throughout this Inquiry, many witnesses testified that those recommended levels had never been provided.

The failure of Transport Canada to provide the number of persons that the aviation regulation program clearly required in the absence of any program modification is an anomaly that is patently unacceptable. In the earlier CATA organization, the regional administrator and the headquarters administrator had a one-on-one relationship, with regional perspectives and concerns being communicated directly to the administrator. The organization that came into effect in 1985–86 separated the assistant deputy minister from his regional directors, interjected resource management review levels, and deprived regions of direct access to plead their case and impress on the assistant deputy minister the serious implications of the lack of resources. As a result, the senior management levels within Transport Canada became unrealistically separated from the problems in the regions and the seriousness of the failure to deliver an aviation safety-related program.

Management Hindrance: Line-Manager Levels

The reorganization that took place in 1985–86 resulted in the allocation of person-years being made by the headquarters directors-general to individual directors and in the removal of all flexibility from regions in the disposition of the allotted resources. Under the previous CATA organization, regional administrators controlled and were accountable for all person-years relative to air navigation services, aviation regulations, and airports, and the financial resources provided to their region. If in their wisdom there was a requirement to direct utilization of resources temporarily to an area where aviation safety or other urgent demand required, the regional administrators had the power to do so. Within a reasonable length of time they were expected to correct that situation through the routine administrative process. In the meantime, the urgent situation could be managed by reallocating resources within the region. The system facilitated responsible and accountable management at the appropriate level.

The Management Consultant Services study mentioned above stated that one of the purposes of the 1985–86 reorganization was "overcoming an autonomous approach to regional management which was evident in the previous CATA organization. That approach had resulted in inconsistent application of national standards, policies and procedures." Surely correction of ineffective or inconsistent management should have been pursued through counselling and direction rather than through a reorganization that centralized authority and discouraged managerial accountability at the program delivery level.

This lack of regionally centralized management authority resulted in underutilization of person-years in some branches, while other branches that could have used the excess person-years were not authorized to do so. Mr Fernand Mousseau, Aviation Group's director-general of the Policy Planning and Resource Development Directorate, during his testimony illustrated the misinterpretation that could be taken from such under-utilization. He maintained that the Aviation Regulation Directorate could not recruit the people to fill their allotment. The implication was that the lack of inspectors was not affected by allocation levels but by availability of qualified candidates. The evidence indicates, however, that managers were restricted in their pursuit of candidates because of limits on allocation levels. It is my view from the evidence that they were further restricted in their ability to staff their organization because of lack of managerial flexibility and by bureaucratic misunderstanding or obstinacy at the resource management and allocation levels.

Management Hindrance: Senior Levels

Within the Aviation Group, the assistant deputy minister, aviation, was responsible for putting forward the fully justified requirements for person-years for the Air Navigation and Aviation Regulation directorates. Problems in this area were outlined by Mr David Wightman, assistant deputy minister, aviation, Mr Claude LaFrance, former assistant deputy minister, aviation, and Mr Weldon Newton, director-general, Aviation Regulation Directorate. The assistant deputy minister, aviation, having been assigned a specific allotment of person-years, had some flexibility in assigning those person-years to these two major directorates. He was not entirely free, however, to allocate them to the most safety-effective groups. For example, Mr LaFrance testified that he was of the opinion there were certain navigational facilities that could be closed without affecting the safety of the system. The savings in person-years from those facilities could have been allocated to aviation regulation, thereby increasing their surveillance and monitoring capability. When such proposals were put forward they were frequently rejected: the political influences that come to bear on such decisions will be understood. The result, however, was an inability to direct resources to the most safety-critical areas.

It is difficult to understand how a reorganization of this nature could have been allowed to come into effect in 1986 considering that the implementation of the recommendations of the Dubin Inquiry were only being completed about that time. The very principles of organization that had been recommended by that inquiry appear to have been violated in the attempts to centralize the organization with more control at headquarters. It was counterproductive for the senior management of Transport Canada to have approved an organization so ill-designed to ensure accountability for the taking of immediate and appropriate action to address serious aviation safety issues.

Transport Canada Safety Awareness

On July 5, 1970, an accident involving an Air Canada DC-8 occurred at Toronto International Airport, Malton, Ontario. One hundred and nine lives were lost in the crash of that aircraft. Mr Justice H.F. Gibson was subsequently appointed to conduct an inquiry to determine the causes of the accident.

Mr Justice Gibson determined that the captain had adopted a procedure concerning the operation of the aircraft spoilers that was contrary to that specified in the Air Canada DC-8 operating manual. Confusion arising out of this noncompliance with the manual resulted in the first officer inadvertently deploying the spoilers while the aircraft was about 60 feet above the runway during the landing flare. This premature deployment of the spoilers set in motion a sequence of events that led to the crash. Evidence presented to the Gibson Inquiry indicated that it was common practice among certain Air Canada pilots to follow a procedure concerning the arming and deployment of the spoilers that was contrary to the Air Canada DC-8 operating manual. Further evidence indicated that some Air Canada check pilots did not insist that certain Air Canada pilots adhere strictly to the operating procedures prescribed in Air Canada's DC-8 operating manual. It appears that one recommendation made by Mr Justice Gibson was designed to prevent such unauthorized practice from developing in future. That recommendation reads as follows: "Consideration should be given by the Ministry of Transport to strengthening its capability of monitoring flight procedures of Canadian air passengers carriers."[1] It is noteworthy that this recommendation is one of only eight made by Mr Justice Gibson and that the report is dated January 1971.

The director (now director-general) of aviation safety is assigned a role of promoting aviation safety through, among other things, participation in the organization of aviation safety education. I believe there is a clear

[1] "Report of the Board of Inquiry into the Accident at Toronto International Airport, Malton, Ontario, to Air Canada DC8-CF-TIW Aircraft on July 5, 1970," p. 111

need for such an educational program to be conducted within the senior offices of the groups responsible for aviation within Transport Canada.

Various reports on aviation accidents, inquiries, and investigations have produced findings and recommendations that have, over the years, been aimed at the adoption of policies designed to improve aviation safety. The Gibson and Dubin reports are but two examples. It seems logical that the Aviation Safety Directorate should be charged with the responsibility to review these reports and documents, to consolidate the findings and recommendations, to track the implementation of such recommendations, and to design and conduct an aviation safety course for all senior managers of Transport Canada aviation programs to familiarize them with respect thereto.

Overall Safety Management

The assistant deputy minister, aviation, Mr Wightman, stated emphatically in his testimony that it was his office that was responsible for overall aviation safety. I find his "buck stops here" attitude most admirable. The question remains, however, on what basis can Mr Wightman make this assertion. The evidence indicates that his concept of singular responsibility for aviation safety management is not held by all management members of Transport Canada, nor is it clearly stated in the policy documents or position descriptions. Questions remain as to the aviation safety responsibilities of the Aviation and Airports groups, the extent to which aviation safety levels can be assured through the regulatory process, and how safety effectiveness can be measured.

Responsibility for Safety

Although the *Aeronautics Act* is not specific in its assignment to the minister of responsibility for aviation safety, the role statements for the Airports and Aviation groups clearly include such responsibility. Indeed, most of the position descriptions of witnesses who appeared before this Commission, whether senior public servants, line managers, or inspectors, included definite statements of responsibility to participate in the assurance of aviation safety. The evidence of these witnesses when they were questioned indicated that each was quite conscious of such responsibility.

At the practical level at Transport Canada, however, there is no organization responsible for overall aviation safety and management of the department, and each organization at Transport Canada pursues its individual safety goals. Many of the witnesses expressed a preference for a separate office or agency responsible for the identification of aviation safety issues, and with the authority to direct the actions of the relevant groups to resolve such issues.

The Inspector-General, Transportation Safety

The title of this position would seem to indicate that the appointed incumbent would hold the responsibility for and the authority to address the overall safety issues of Transport Canada. Such is not the case, however.

In the course of the hearings, Mr Ronald Armstrong, Ontario Region's director of aviation regulation, was questioned about the role of the inspector-general, transportation safety. A copy of the job description indicated, as did Mr Armstrong in his evidence, that the position would be responsible to investigate and advise the deputy minister regarding safety issues on a case-by-case basis for all three transportation modes: air, surface, and marine. It is obvious that the position could not be held accountable for overall aviation safety management of the department, particularly since the staff of the inspector-general consisted of a total of only five people to address all three modes of transportation.

I have been made aware that, as of October 1, 1990, the position of inspector-general, transportation safety, no longer reports directly to the deputy minister of transport but has been incorporated into the organization of the assistant deputy minister, review. There is no indication that the change in reporting relationship entails additional responsibilities or authority that will contribute to the improvement in coordination and direction of response to safety-related issues. In fact, the lowering in reporting level would seem to indicate the reverse.

Aviation Safety Programs: Transport Canada

The Aviation Safety Programs Branch of the Transport Canada Aviation Group reports directly to the assistant deputy minister, aviation. The title of that branch may give the impression that this organization is responsible for overall safety assurance in the Aviation Group. Such is not the case. The primary function of the branch is to enhance aviation safety through the promotion of safety education programs and to analyse aviation safety data for the information and action of the assistant deputy minister, aviation. The organizational change proposal mentioned above (Project 1682-342) proposes an extension of the responsibilities of the branch to include monitoring the overall Transport Canada Aviation Group system, including regulatory and air navigation branch activities related to safety. It also proposes the retitling of the organization to System Safety.

Although this organization change is an attempt to address a missing systems approach to safety through a clear assignment of such responsibility to a particular directorate, it still does not address or include any safety issues that might affect airports or the Airports Group.

In summary, it appears that the various directorates are cognizant of their safety responsibilities. The Airports organization recognizes its responsibility to ensure that airport facilities meet reasonable safety standards; the Air Navigation organization is consciously responsible for providing safe services in the form of navigational aids, en route and terminal facilities, and air traffic control; the regulatory organization contributes to safety through ensuring compliance by the industry with the regulations and orders. It appears that all the functions and activities necessary to address aviation safety have been considered and assigned to these agencies. Missing, however, is an organizational structure with the positive control and authority necessary to direct a coordinated and practical aviation safety management program.

Transportation Safety Board of Canada

The mandate of the Transportation Safety Board is broad in scope. However, it does not extend to participation in the internal review or monitoring of Transport Canada in its role of providing assurance of aviation safety.

Enforcement and Education

In the latter stages of the hearings there was considerable discussion on the virtues of education as an effective means to enhance aviation safety. The report prepared by the consultant firm James F. Hickling in 1990 on aviation regulation and safety programs was critical of Transport Canada for spending too much energy on minor violations that were of little safety consequence, while not enough effort was being put into overall education and safety promotion.

Mr Wightman, assistant deputy minister, aviation, supports the need for increased emphasis on safety promotion and education and, accordingly, has increased both the stature and resources of his safety promotion organization. In his testimony before this Inquiry on January 22, 1991, he indicated that, in his view, there was good safety value to be obtained from such an investment. He also expressed a conviction that these initiatives would not be achieved at the expense of the surveillance and compliance/enforcement organization:

> A. ... I just wanted to conclude by saying that in increasing the emphasis on safety programs, safety educational programs and promotional activities, we are not going to take those resources from the Enforcement group to do that. We will find them

> elsewhere and the Enforcement activity will continue.
> (Transcript, vol. 166, p. 74)

I fully support the notion that safety promotion and education is an effective way to enhance aviation safety. I believe little benefit can be obtained from enforcing minor first-occurrence documentary and administrative violations to the full extent of the law. The imposition of licence suspensions and fines for these kinds of occurrences in all probability detracts from the promotion of a positive compliance attitude. Having so stated, I would urge the government to provide sufficient resources to Transport Canada's Aviation Group to ensure that the aviation community, and in particular the air carrier industry, is effectively monitored to comply with essential safety regulations and standards. Where noncompliance is detected, effective action must be taken by an appropriately staffed and trained enforcement organization. Aviation education and safety promotion should most definitely not be enhanced at the expense of surveillance and enforcement.

Safety Assurance Effectiveness

Safety Assurance Effectiveness of Aviation Regulation

Evidence before this Inquiry with regard to assessment of the effectiveness of aviation regulation in achieving aviation safety does not provide any conclusive and quantitative result. There is agreement that the monitoring of the industry for conformance with aviation regulations and orders does have a positive effect on assuring some degree of safety. The inspection, approvals, and licensing activities of aviation regulation assure minimum standards that contribute to an overall acceptable level of safety. There are, however, no sound detailed data and analysis available that will quantitatively demonstrate the effectiveness of regulatory activity in the prevention of accidents and incidents. The absence of such a formula leads to subjective analysis based on the experience and judgement of the senior review personnel such as those participating in the challenge procedure associated with the resource acquisition process as outlined in chapter 31, Aviation Regulation: Resourcing Process. The evidence indicates there is a significant gap in perception between incumbents of these senior positions and the operating regulators as to the safety effectiveness to be achieved by performance of various types and frequencies of regulatory activity. The result, of course, is the continual denial or return of resource submissions by the senior review committees, as described by Mr Claude LaFrance (see chapter 31).

The evidence indicates that a staffing formula known as ARASS, a refinement of the A-base review outlined in chapter 28, Conditions at Transport Canada, Early 1980s, was based initially on the considered input of the inspectors who conduct the actual inspection. Following detailed examination and dialogue at that level, the system was further reviewed by, and received the approval of, their supervisors, the relevant branch managers, directors, and directors-general of aviation regulation, as well as the assistant deputy minister of aviation. Development of that standard yielded agreement on the various tasks to be performed by aviation regulation and the frequencies at which they should be conducted in order to monitor adequately the safe performance of the aviation industry.

It would, of course, be of great value and convenience to have a clear-cut formula based on sound data and scientific analysis that would indicate conclusively the exact effect to be expected on aviation safety with each additional person-year assigned to the aviation regulation program. Such a system would be of particular value to departmental reviewing officers with little or no knowledge or experience of aviation on which to base their judgement.

The evidence indicates that the aviation regulation organization has given serious and sound consideration to development of the tasks and their appropriate frequencies necessary to achieve its stated regulatory objectives. These considerations appear to have been based on the best available data. Until more suitable and practical measurement systems evolve, it can be assumed that the methods adopted by the aviation regulation organization will assure an acceptable contribution to the overall level of safety, provided the program is properly directed, supported with the necessary resources, and monitored appropriately.

Safety Assurance Effectiveness Measurement Methods

The foregoing section of this chapter recognizes an ongoing need for improved methods of assessing the effective influence of various regulatory activities on aviation safety. Such improved methods should continually be sought in attempts to obtain the best results with available resources and in the establishment of task priorities. In order to achieve those aims, it is necessary to examine the factors influencing the achievement of aviation safety and to identify and define indicators to be used in measuring the effectiveness of those factors.

Numerous studies have been conducted by Transport Canada, by various consulting agencies, and by the United States Federal Aviation Administration (FAA) in attempts to identify and define such safety measurement indicators. One of the more recent studies was conducted by Sypher-Mueller International Ltd, as part of an evaluation of the contribution of aviation safety regulation and aviation safety programs to aviation safety in Canada (Exhibit 1316). That study was successful in identifying a list of optimal indicators and proposed a model that could be developed to provide improved methods of analysing and assessing acceptable safety levels. The report also concluded, however, that deficiencies exist in the data-gathering process and that these deficiencies must be overcome prior to realization of significant progress in such analysis and assessments.

The FAA has expended considerable effort in the development and use of aviation safety measurement indicators, and the Aviation Safety Programs Branch of Transport Canada is cooperating with that agency towards further development in that regard. Although research and development of such safety measurement indicators and data collection process systems are expensive and onerous, the eventual values would appear to be significant.

During this Inquiry we have seen examples of the variations in opinion as to the effectiveness of different types of surveillance and regulatory activity in achieving aviation safety assurance. The advances and changes to be anticipated in the dynamic aviation industry dictate use of scientific and practical methods of assuring that scarce resources are directed to the most safety-effective issues and activities. It is encouraging to note that Transport Canada is now cooperating with authorities in the United States in such a worthwhile effort.

Future Management and Organizational Structure

Following the hearings, the Inquiry was provided with a copy of a Transport Canada news release announcing organizational changes within the Aviation Group effective April 1, 1991. A copy of that news release is reprinted below. The information provided in that news release consists of a simple outline and is not intended to describe fully the change in organization. Nevertheless, some comments are warranted regarding the proposed organizational structure's ability to resolve the type of safety issues discussed in Part Five of this Report.

With the changes indicated by that announcement, it appears that Mr Wightman, as the current assistant deputy minister, aviation, has attempted to rectify the situation to some degree. Each of the regions will now have a director-general, aviation, who will have overall control of both the air navigation services and aviation regulation in their region. The reorganization also provides a direct reporting relationship for those directors-general to Mr Wightman. The revised organization will facilitate better communication between the air navigation and regulatory directorates and will provide a structure suited to prompt resolution of safety problems affecting those two areas of responsibility.

The Airports Authority Group (Airports Group), however, is not included in the reorganization. I have seen no evidence of an attempt to put Airports Group under a similar organizational umbrella, thereby assuring con-solidated response to aviation industry concerns and needs, nor any evidence that indicates there are measures to address the safety issues affecting the activities of both the Airports and the Aviation groups of Transport Canada. The measures taken, therefore, seem to be incomplete: they reflect Mr Wightman's enthusiasm within his specific areas of jurisdiction, but do not address cross-group issues such as the de-icing concerns addressed in my *Second Interim Report*.

This new organization will provide the regional directors-general with better access to the assistant deputy minister, aviation. It can be assumed that they will therefore have a better opportunity to express their concerns and provide direct communication regarding the need for resources and the establishment of priorities in the conduct of their duties associated with program delivery.

This reorganization applies to the Aviation Group only and does not, therefore, entail any changes outside this group such as the resource allocation process. I have concern that these important aspects have not been considered and that such organizational change was directed to only one group, Aviation Group, when the department's area of aviation responsibility in fact includes the current Airports Group. Accordingly, the reorganization should be re-examined, but at the departmental level rather than the Aviation Group level.

Transport Canada News Release

Annex A to Section H
(H.5.4)
Part 12
No. 53/91 For release
April 5, 1991

NEW REGIONAL DIRECTORS GENERAL NAMED TO TRANSPORT CANADA AVIATION

OTTAWA – Six Transport Canada directors have been promoted by the Public Service Commission to the position of regional director general in Transport Canada Aviation.

Robert W. M. Corbett of Moncton, N.B., is the Atlantic regional director general, aviation; André D. Perez of Montreal is the Quebec regional director general; and Ronald I. Coulas of Toronto is the Ontario regional director general.

Frank M. Murphy of Winnipeg is the Central regional director general; Donald J. Douglas of Vancouver moves to Edmonton to become the Western regional director general; and David J.R. Larrigan of Vancouver is the Pacific regional director general.

Corbett, Perez, Murphy and Larrigan are former regional directors, aviation regulation; Coulas and Douglas are former regional directors, air navigation services.

The appointments are the result of a recent reorganization which calls for directors general to administer the department's aviation programs in each of the six regions across the country.

The reorganization has eliminated the positions of regional director, aviation regulation and air navigation system, and has assigned these functions to the new regional directors general. Each new director general has increased authority and responsibilities for air traffic control and the monitoring and evaluation of system safety.

All Instrument Flight Rules air traffic control staff now report to the regional director general instead of Transport Canada Aviation headquarters in Ottawa. This decentralization move is in keeping with the federal government's Public Service 2000 policies which encourage the delegation of authority to managers who are closer to the clients they serve.

The six regional directors general also have additional responsibilities for system safety. New resources are being allocated in Transport Canada Aviation to improve the way safety deficiencies in the national civil air transportation system are identified, analyzed and evaluated.

Aviation safety-education programs will be continued but with more emphasis on the acquisition and evaluation of "safety-deficiency data" as well as monitoring and consultation with the aviation industry.

Transport Canada Aviation is the new name for Transport Canada's Aviation Group.

Contact: Ron Armstrong
Aviation, Ottawa

Findings

- The *Aeronautics Act* itself is not specific in its delineation of aviation safety responsibility. Nevertheless, the raison d'être of the Transport Canada organization is to provide an aviation safety net.

- Throughout the Transport Canada phase of the Inquiry, I was, for the most part, impressed by the dedication of Transport Canada witnesses at all levels, from the inspectors involved in day-to-day regulatory activity through to very senior managers. The critical conclusions that can be drawn relate to a lack of mutual understanding of the restrictions placed on various levels of management through enforced economies and the unprecedented increase in aviation-related activity in the latter half of the 1980s.

- Because of resource constraints, an inadequate regulatory framework, and organizational deficiencies, the present Transport Canada organization is ill-equipped to provide in an efficient manner a uniform level of safety. The existence of distinctly separated line reporting relationships to the top of the organization appears to foster rather than discourage fragmentation of management philosophy and activity. The apparent inability of the Air Navigation, Aviation Regulation, and Airports groups to work together in identifying and addressing aviation safety issues is troublesome.

- The segregated organizational structure within Transport Canada Aviation Group precludes any direct contact between regions and the assistant deputy ministers, and provides little opportunity for regional managers to influence the decisions of senior management and agencies such as Management Review Board in order to ensure that regional resource requirements are properly addressed.

- The evidence provided graphic examples of the problems faced by those charged with the responsibility of completing audits, inspections, certification programs, and other regulatory and surveillance functions, but who were not provided the resources so to do.

- The inability of lower and middle management to relay emphatically the safety concerns caused by such resource shortages to the most senior management of Transport Canada is, in my view, an abrogation of responsibility attributable to lack of effective organization and the inaccessibility of senior management. This basic problem hinders all aspects of the Aviation Group safety program.

- Compared with the system that existed under the CATA organization, managers in the regions now have little control over the allocation of resources to high-priority safety items. They are now restricted to specific allotments and are limited by staffing restrictions such as freezes and inflexibility of policy.

- The Aviation Group conducts audits on the industry to assure conformance with the *Aeronautics Act* and its regulations and orders.

- Although the Transport Canada organization has been studied and restudied, there seems to be an absence of will to review such studies and to implement programs that will effectively address genuine safety concerns.

- Considering all of the evidence, I find it difficult to understand why the April 1, 1991, reorganization left the Airports Group separated from the Aviation Group in the area of safety responsibility. The news release announcing these changes indicates that the new directors-general of aviation in each region will have "increased authority and responsibility for air traffic control and the monitoring and evaluation of system safety." The authority and responsibility do not extend to the positive action that is required to address safety problems identified and analysed in the "monitoring and evaluation process."

- The absence of such authority limits the ability of the regional directors-general to address such safety aspects unless they fall entirely within the purview of Air Navigation systems and/or Aviation Regulation; they have no authority over the Airports program.

- The evidence, particularly as it related to aircraft de-icing, demonstrated the weakness in an organization that does not provide clearly stated overall authority and responsibility for coordination of safety activities. Accountability cannot be expected unless it is supported by the necessary authority and responsibility.

- It would be erroneous to conclude that the organizational change of April 1991 will address the shortcomings which this Inquiry has uncovered regarding inattention to aviation safety management issues that cross both the Airports and Aviation groups' lines of responsibility. That will in all probability not occur unless a senior position in each region is made responsible for the functions of both of those groups and, similarly, unless a senior aviation position becomes responsible for the headquarters aspects of those functions as well as for line authority over the six regional senior positions. It appears that such an arrangement could be achieved with a reduction rather than an increase in numbers of senior positions.

- It is time that Transport Canada address lack of coordination of safety activities among its various aviation groups rather than proposing reorganizational attempts that go halfway towards proper safety supervision and responsibility.

- There is ample evidence before this Commission to show that Transport Canada, because of a variety of inadequacies in its organization, has fallen short of meeting its safety assurance responsibilities. Much of the evidence indicates that competition for scarce resources, both within the department itself and with other departments, has been a basic contributing factor to such inadequacy.

RECOMMENDATIONS

It is recommended:

MCR 161 That Transport Canada proffer for enactment an amendment to the *Aeronautics Act* to delineate clearly the minister's responsibility for aviation safety. Such amendment should emphasize the minister's responsibility to ensure that the department is organized in a manner to keep the minister accurately informed of the ability of Transport Canada to deliver its mandated aviation safety programs effectively.

MCR 162 That Transport Canada be organized in a manner to provide the managerial structure necessary to keep the minister and deputy minister fully and accurately informed of all matters having an impact on aviation safety, and to ensure that appropriate and timely action is taken to address aviation safety concerns.

MCR 163 That Transport Canada state clearly the goals that aviation safety–related programs are expected to achieve, and that it identify the extent of inspection, surveillance, and enforcement activities that must be conducted within a given time frame. Such program goals should be designed in consultation with the Aviation Group's operationally and technically qualified staff.

MCR 164 That Transport Canada create a single position in each region (e.g., a director-general) responsible and accountable for the delivery of the aviation programs assigned to the present Airports Authority Group and the Aviation Group. This position should report directly to a senior administrator or assistant deputy minister at headquarters, who is responsible for the overall delivery of such aviation programs on a national basis.

MCR 165 That the regional directors-general (proposed in MCR 164 above) be authorized to manage their resources in a responsible and flexible manner. Such authority should be accompanied by firm insistence on accountability and a monitoring activity that will ensure responsible management.

MCR 166 That Transport Canada create the position of a headquarters' operational aviation safety officer with an appropriate support staff. This aviation safety officer should report directly to the most senior aviation position in the department and should be responsible for auditing the safety performance of both the Airports Authority Group and the Aviation Group.

MCR 167 That Transport Canada actively participate in the research and development necessary to establish safety effectiveness measurement systems that will lead to the most efficient use of resources in assuring safety. Cooperation with the United States Federal Aviation Administration and other international groups should be encouraged and resourced to obtain the maximum and most expedient benefits from such programs.

MCR 168 That Transport Canada aviation safety committees, with access directly to the headquarters' operational aviation safety officer, be established in regions and headquarters.

MCR 169 That Transport Canada establish a mandatory education program to ensure that senior managers and officials of the department who are responsible for or associated with aviation programs are aware of the basis for and requirement to support policies that affect aviation safety.

PART SEVEN

HUMAN FACTORS

38 CREW INFORMATION

Flight Crew

Captain George Morwood

George John Morwood: captain, C-FONF
Age: 52
Date of birth: March 27, 1936
Pilot licence: Airline Transport Pilot Licence YZA-001128
Pilot medical expiry: September 1, 1989
Total flying time: 24,100.00 hours
Total flying time F-28: 82 hours
Total jet experience: 673 hours (591 hours on Gulfstream II)
Total flying time last 90 days: 130 hours
Total flying time on aircraft type last 90 days: 80 hours
On duty March 10, 1989, prior to occurrence: 5.4 hours (approximate)
Off duty prior to March 10, 1989, work period: 14.5 hours (approximate)

Flying Background

Captain Morwood began flight training in Toronto in September 1953 with Central Airways, located on Toronto Island, and obtained a private pilot licence in January 1954. He then enrolled in a course for commercial pilots and received his licence in January 1955. After training, he achieved a flight instructor rating in May 1955 and commenced work for Central Airways as an instructor. He obtained an instrument rating in 1961 and continued to instruct and to fly charters for Central Airways until 1967. He accumulated over 12,000 hours flying for this company. Of this total, approximately 550 hours were on multi-engine aircraft. He then took a similar position with Millardair based at Lester B. Pearson

International Airport and flew there for about one year, accumulating a further 500 hours multi-engine experience on larger aircraft.

Captain Morwood joined Transport Canada as an air carrier inspector, conducting instrument rides and pilot proficiency checks on pilots located in the Ontario Region. He continued in this position until September 1970, when he joined Denison Mines as a pilot on a Grumman Gulfstream GII turbojet aircraft. This aircraft is similar in appearance to an F-28, and each is equipped with Rolls-Royce RB183 Mark 555-15 engines, more commonly known as Rolls-Royce Spey. Although the Grumman Gulfstream GII aircraft is lighter than the F-28, it has similar operational speeds and design characteristics, such as a hard wing, that is, a wing with no movable lift-generating device on the leading edge. Captain Morwood did his recurrent flight training on a GII flight simulator with Flight Safety Inc., and the records of his instrument rides indicate that his performance was consistently above average on this jet aircraft.

Captain Morwood joined Great Lakes Airlines, the forerunner to Air Ontario, in 1973. He was trained on a Convair 440 aircraft and upgraded to a Convair 580 turboprop aircraft in 1974. By 1988 he was an experienced airline transport pilot, having accumulated over 9000 hours on the Convair 580. Further, he had acquired management experience, having served as a company check pilot on the CV580 as well as chief pilot from 1978 to 1980.

In January and February 1988 Captain Morwood successfully completed the Piedmont Airlines F-28 ground school and simulator training. He completed his pilot proficiency check, and his licence was endorsed for the F-28 aircraft on February 26, 1988. After this training Captain Morwood went back to flying a Convair 580 aircraft for the remainder of 1988.

The company received its second F-28 aircraft in December 1988, and thereafter Captain Morwood attended a Piedmont F-28 Pilot's Recurrent Ground School, which consisted of 16 hours of classroom instruction and a written examination that he passed with 99 points out of a possible 100. Captain Morwood completed eight hours of recurrent F-28 simulator training and thereafter passed a proficiency check on January 9, 1989. He carried out his line indoctrination training and route check between January 18 and January 25, 1989, accumulating a total of 27.5 hours of line flying.

Captain Morwood's work schedule for the four months prior to the crash was examined and was not considered arduous. In the month of March he had worked six days and had three days off prior to the accident. All of Captain Morwood's flight schedules met the requirements for duty time limitations set out in the Air Navigation Orders.

Captain Morwood filed 40 company incident reports that the Commission is aware of during his employment with Air Ontario Inc. and Great Lakes Airlines. The reports were recovered in part from Air Ontario Inc., with the remainder coming from Captain Morwood's personal files. Many of the reports as filed involve occurrences that could affect the safe continued operation of an aircraft and provide an insight into the extent of his professional experience and knowledge.

A review of several representative incident reports demonstrates clearly that Captain Morwood had an established record of making sound decisions concerning the operation of an aircraft. He viewed these reports as a valuable source of information that could be used by company management and fellow employees to enhance the efficiency and safety of the operation. He was willing to file incident reports, even when not required to do so, and was able to accept full responsibility for any errors or omissions on his part.

A number of documents that belonged to Captain Morwood were recovered in the wreckage of the aircraft on March 10, 1989. It is curious that some of these documents dated back to 1979. Of particular interest was a letter of January 11, 1983, to Captain Morwood from Captain Robert Murray, director of flight operations at the time, on the subject of de-icing.

Aviation Management Experience

A compilation of 373 bulletins concerning a wide range of operational and administrative matters and primarily authored by Captain Morwood in the period 1977–80 was reviewed. A sample listing of some of the bulletins he produced during this period shows that he was providing both guidance and authoritative direction to the Great Lakes Airlines flight crews under his direction.

After reviewing these bulletins and other evidence, Mr David Rohrer testified before the Commission:

> A. A review of Captain Morwood's Air Ontario personal file, training file, and Department of Transport file indicate Captain Morwood consistently maintained a high standard during his pilot proficiency checks on various aircraft.
>
> Captain Morwood was generally described by many pilots who flew with him as an assertive Captain who was safety conscious and cautious. The company flight safety incident reports filed by Captain Morwood generally support this description of him.
>
> (Transcript, vol. 87, p. 110)

Captain Erik Hansen, an Air Ontario pilot, added to this description, based on his long association with Captain Morwood that began more than 20 years before the accident:

Q. What was your overall impression of Morwood as a pilot?
A. He was a proverbial instructor. He never shut up. And ... to him, there was no other way but to teach. He was just checking and checking and checking.
   That's why I think a lot of the first officers we had – and captains too, for that matter – really didn't like flying with George too much. It was not because of his – it was just that you always felt you were on a check ride.
   It took the, shall we say, the fun out of flying or the enjoyment out of doing a trip, because George was always on your case, asking you questions and crossing all the T's, dotting all the I's and all that good stuff in the log book. That was George.
...
   But, other than that, like I say, I've known George for twenty-some odd years.
Q. From the way you knew Morwood, sir, can you see a first officer getting under his skin by telling him what to do?
A. No.
Q. How would he react to that?
A. Well, George would tolerate it to a certain extent, but I don't think George would ... let them get under his skin, as such. George would put him in his place. You wouldn't be in doubt as to who was in charge when you were flying with George.
Q. He was the boss?
A. He was the boss.

(Transcript, vol. 94, pp. 101–103)

A. He would always be concerned about the people in the back, are the people getting a nice ride or if it gets bumpy.
   He would always be on the chimes, again George on the chimes, get the girls up front, tell everybody to buckle down. He may see a cloud 25 or 50 miles ahead and he says, maybe get a little bumpy, he says, you better get everybody strapped down and you get the coffee out of the way and pick up all the cups. And that would be George, concerned with passengers.
   Whereas, you know, other pilots might be saying, well, you know, it may get bumpy, it may not.
   Let's wait for the first bump before we do anything, kind of thing.
Q. That was not his style?
A. No, not George.

(Transcript, vol. 94, pp. 143–44)

Q .... Really, I want to come to my final area of questioning now, Captain. Everything we've heard about George Morwood is that ... he was a very careful, cautious pilot, maybe a little condescending from time to time to first officers, he was a born teacher, but he was a by-the-book kind of guy, and he was – he erred on the side of being a conservatively safe pilot.

Does that synopsis of George Morwood coincide with your own impression of the man?

A. That is correct, pretty well.

(Transcript, vol. 94, pp. 166–67)

Captain Morwood's Takeoff Limits

In order to determine Captain Morwood's takeoff visibility limit for the Dryden airport, it is necessary to refer to the Air Ontario Flight Operations Manual (FOM), the Canada Air Pilot (CAP), and the Air Regulations.

The Air Ontario FOM stipulates that:

> a) Standard Take-Off Weather Minima
> All take-offs must be carried out in weather conditions that are at, or better than, those published in the Canada Air Pilot, Jeppeson [sic], US National Oceanic and Atmospheric Administration, Company Approach Procedures manuals or Operations Specifications amendments as applicable.
>
> (Air Ontario Flight Operations Manual, p. 6-5, s. 6.5.2 IFR Flights)

Operating specifications are contained in the operating certificate of an air carrier. A copy of the operating certificate with amendments is contained in the air carrier's FOM. Amendment No. 8 to Air Ontario Operations Specifications allows F-28 takeoffs where the reported visibility is RVR (runway visual range) 1200 feet (one-quarter mile) or more. One of the conditions for applicability is that the pilot-in-command (PIC) have at least 100 hours of PIC experience on the aircraft type.

The Air Ontario FOM continues:

> Exception
> If the take-off limits are lower than the published landing limits for the landing runway(s) at that airport, the take-off may be made provided that you have a take-off alternate meeting the requirements of ANO V, No. 8 within 60 minutes flying time on one engine in still air.
>
> (Ibid. p. 6-5)

The FOM specifies the takeoff and landing limits that apply for new pilots-in-command as follows:

> a) <u>New Pilots-in-Command (Captains)</u>
> Until the Captain has achieved 100 hours on type, the ceiling and visibility will be increased one hundred (100) feet and one-half (½) mile respectively, above the limits published in the Canada Air Pilot/Jeppeson, Foreign Approach Manual, or approved Company approach procedures manual.
>
> (Ibid., p. 6-9, s.6.6 Specific Limits)

This requirement is in accordance with a Transport Canada policy.

According to the airport chart page in the Canada Air Pilot, the takeoff visibility minima for the Dryden Municipal Airport effective March 9, 1989, were one-half mile for both runway 29 and runway 11.

The lowest published landing ceiling and visibility data for the Dryden airport, effective December 15, 1988, and in effect on March 10, 1989, are for the instrument landing system (ILS) approach to runway 11. Although technically these data are not limiting, they are treated as limits by Air Ontario (FOM, p. 6-9, s.6.6). The limits are a decision height of 1554 feet above sea level, which equates to a cloud ceiling of 200 feet above ground level, and three-quarters of a mile visibility.

Air Regulation 554 reads in part as follows:

> (1) The Minister may establish standard procedures for air operations at specific aerodromes, which procedures may be published in a document entitled the *Canada Air Pilot*.
> (2) The instrument approach procedures established under subsection (1) shall specify and authorize
> (a) the minimum altitudes to which a pilot-in-command may descend during an approach to a landing;
> (b) the minimum visibility in which any pilot-in-command may conduct a landing or a take-off.

Air Regulation 555 defines the takeoff visibility for a runway as

> (a) the RVR [runway visual range] of the runway, unless the RVR is
> (i) fluctuating ...
> (ii) ... a localized phenomenon
> (iii) not reported ...
> (b) the ground visibility of the aerodrome for the runway, if
> (i) the RVR is as described in subparagraph (a) ... and

(ii) the ground visibility of the aerodrome is reported as set out in the definition "ground visibility";[1] or

(c) the visibility for the runway as observed by the pilot-in-command, if

(i) the RVR is as described in subparagraph (a) ... and

(ii) the ground visibility of the aerodrome is not reported as described in subparagraph (b)(ii).

The RVR was not reported at Dryden on March 10, 1989, and since the ground visibility of the airport was reported, paragraph (b) above applies. As stated in chapter 4 of this Report, the reported ground visibility for the Dryden airport at 12:00 noon CST was two-and-a-half miles and at 12:06 p.m. it was three-eighths of a mile. Because the ground visibility is reported at Dryden airport, a pilot-in-command must use the reported ground visibility as the takeoff visibility.

On March 10, 1989, Captain Morwood had fewer than 100 hours as pilot-in-command on the F-28 aircraft. Accordingly, he was governed by the limits as published in the Canada Air Pilot and not by the takeoff visibility as in Amendment No. 8 to Air Ontario Operations Specifications, and he had to add 100 feet and one-half of a mile to the applicable published takeoff and landing limits.

The published takeoff visibility limit for Dryden is one-half of a mile, which is less than the lowest landing visibility limit of three-quarters of a mile; therefore, three-quarters of a mile applies. Because he was required to add one-half of a mile to the published limit, Captain Morwood's visibility limit for takeoff from Dryden was one-and-one-quarter miles unless he filed a takeoff alternate.

If Captain Morwood had filed a takeoff alternate, the Exception referred to above would have applied and his takeoff visibility limit

---

1 "Ground visibility," in respect of an aerodrome, means the visibility at that aerodrome as contained in a weather observation reported by

(a) an air traffic control unit,
(b) a flight service station,
(c) a community aerodrome radio station operated under the control and supervision of the territorial government of the Northwest Territories or the Yukon Territory,
(d) a COMMET station, or
(e) a radio station that is ground based and operated by an air carrier.

(Air Regulations, p. 7)

The weather facility at the Dryden Municipal Airport was operated under contract with the minister of the environment. The weather observations made at Dryden were available through normal Environment Canada weather services to any of the above agencies.

would have been one mile. There is no evidence, however, that a takeoff alternate was filed.

Personal Profile

Captain Morwood was in good health. He was approachable, friendly, and well liked by his fellow workers. He was regarded within the company as somewhat of a father figure. He was a conservative, religious, and fastidious person and was generally viewed as being part of the "old school." It was the fastidious side of his nature that led to the only potentially negative comments that were made about him. He was a punctual man who disliked being late and who felt almost an exaggerated sense of contractual obligation to his passengers. In an interview, Mr Kothbauer, duty manager of Air Ontario's system operations control, stated: "If he [Captain Morwood] thinks you're going to inconvenience his passengers, you know, it's almost like a personal insult to him."

Captain Morwood was not a man who was easily intimidated. In one incident, he submitted a letter to Air Ontario management pointing out what he believed to be a safety deficiency in a particular aircraft. When Air Ontario management did not respond to his concerns, he sent a copy of his letter to the regional director of aviation regulation of Transport Canada. In general, however, Captain Morwood was reported as being happy with Air Ontario, happy with the F-28, and not contemplating any change in employment.

Approximately 14 months prior to the accident, Captain Morwood separated from his wife of 29 years. He was not initially happy with the separation, but, in time, he met someone else and was engaged to be married. In the six months prior to the accident he was described by everyone interviewed as being happier than they had seen him of late. His relationship with his wife was amicable and their financial separation was complete. Captain Morwood maintained a good relationship with his children and was, in fact, sharing an apartment with one of his daughters. He was financially secure, and he and his fiancée had purchased a block of land and were in the process of planning to build a house. Captain Morwood did not smoke and drank alcohol very moderately.

First Officer Keith Mills

Keith Benjamin Mills: first officer, C-FONF
Age: 35
Date of birth: February 24, 1954
Pilot licence: Airline Transport Pilot Licence YZA-143579
Pilot medical expiry: July 1, 1989
Total flying time: 10,000 hours plus
Total flying time F-28: 66 hours
Total jet experience: 3500 hours Cessna Citation (estimated)
Total flying time last 90 days: 93 hours
Total flying time on aircraft type last 90 days: 66 hours
On duty March 10, 1989, prior to occurrence: 5.4 hours (approximate)
Off duty prior to March 10, 1989, work period: 14.5 hours (approximate)

Flying Background
First Officer Mills began flying in 1973 and obtained a private pilot licence in 1974 from Peninsula Air Service in Hamilton. He enrolled in the commercial pilot course and obtained that licence in 1975 from the same company. He flew commercially for various companies, and was also a flying instructor for a parachuting school in Toronto.

In May 1979 First Officer Mills was employed by Austin Airways Ltd as a Twin Otter co-pilot for its northern operations. He became a captain in the Twin Otter aircraft and flew in this capacity until 1982. He moved to the air ambulance division of the company, where he flew the Cessna Citation aircraft, a light twin-engine jet with a gross takeoff weight of less than 12,500 pounds. He also flew the Cessna 402 aircraft and other small twin-engine piston-powered aircraft. After he qualified for Transport Canada's "A" and "B" authority as a company check pilot, he was authorized to conduct pilot proficiency checks and instrument rating renewals, as well as to carry out company line indoctrination and pilot route checks on both aircraft types. The air ambulance operation was administered through a contract with the Ontario government and often required short-notice flights under less-than-favourable weather conditions into remote settlements throughout the province.

First Officer Mills moved to Thunder Bay in February 1987 and flew a Twin Otter on an Air Ontario subcontract for Bell Canada, but the contract was cancelled in January 1988. He then trained on the Hawker

Siddeley HS-748 turboprop aircraft. He attended the Canadian Airlines International Limited initial pilot ground school on the HS-748 turboprop aircraft from January 11 to 22, 1988, and obtained a 96 per cent average. He successfully completed his initial company aircraft training and initial Transport Canada pilot proficiency check as a captain between January 25, 1988, and February 1, 1988. In February 1988 he was promoted captain on the HS-748. Between February 5 and February 29, 1988, Captain Mills was successful in completing his initial line indoctrination, accumulating 57.5 hours of line flying before assuming line flying duties as a captain. The base in Thunder Bay was subsequently closed and Air Ontario sold the HS-748 aircraft to another carrier. In late 1988 he applied to be first officer on the F-28, based in Toronto, and was awarded that position. In January 1989 he attended the F-28 ground school in Winston-Salem, North Carolina, conducted by USAir. His flight training on the F-28 aircraft began in February 1989, and he successfully completed a pilot proficiency check ride on February 10, 1989, exactly one month before the Dryden crash. First Officer Mills did not take any F-28 simulator training because time on the simulator was fully booked. He received his flight training in the F-28 aircraft. His instructor was Captain Joseph Deluce and the training was carried out in four flights from Winnipeg airport. All of these training flights were carried out late at night, when the aircraft were not being used in revenue flights.

First Officer Mills flew for Austin Airways and then Air Ontario for a total of 10 years. He was known as an assertive pilot who could be abrasive at times. His schedule in the four-month period preceding the accident was not unusual and all schedules were within the duty time limitations contained in the Air Navigation Orders.

First Officer Mills's flying abilities, as documented by his initial training, his recurrent training, and proficiency checks carried out by Transport Canada and company check pilots, were satisfactory. However, in reviewing his records, it was apparent he had from time to time experienced some difficulties, as set out hereunder.

In his first attempt to obtain a class I instrument rating, the inspector terminated the ride and provided the following reasons:

> Applicant experienced difficulty right from start, YYZ VOR off the air so he set up for V361 using London VOR – Flying erratic – x-[cross] check poor – holding at KF poor – no wind assessment – ADF approach barely acceptable – Timed turns poor – ILS entry and procedures OK up to Marker then Localizer steering became poor – Back Crs [course] again OK until Final then Localizer steering became very poor – <u>ride terminated</u>!
>
> (Exhibit 690)

First Officer Mills passed a reride test a short time later.

During and following his HS-748 training, First Officer Mills was involved in three reported incidents involving the HS-748 aircraft. On February 23, 1988, during the course of his initial line indoctrination with Captain Ross Woods, an engine overtemperature occurred in the aircraft during a takeoff from Thunder Bay. The takeoff attempt was aborted and the aircraft remained in Thunder Bay. An inspection of the aircraft revealed that the left engine plug covers had not been removed prior to the flight, resulting in an engine overtemperature condition that required the engine to be replaced. Captain Woods had carried out the walkaround and evidently neglected to remove the left engine plugs. Since First Officer Mills had not completed his training, Captain Woods would have been captain of this flight.

The second incident involving Captain Mills occurred on May 15, 1988, at Marathon, Ontario. The investigation of this incident by the Canadian Aviation Safety Board (CASB) determined that the aircraft was high on final approach and did not touch down until it was a considerable distance down the runway. The aircraft could not be stopped on the runway and it ran off the end to a distance of approximately 300 feet. The incident occurred when Captain Mills had 150 hours on type and while the first officer was flying the aircraft. In this occurrence, Captain Mills apparently failed to recognize that a go-around should have been initiated before touchdown and failed to take appropriate action.

As a result of the company investigation of this overrun on landing, Captain Mills was required to undergo a flight check. When this flight check was conducted, Captain Mills's performance proved to be unsatisfactory. He was then required to undergo an additional 50 hours of line indoctrination with a company check pilot. Captain Ross Woods, who was the captain mentioned in the first HS-748 incident referred to above, was assigned as the pilot to carry out this extra flying training with Captain Mills. Captain Mills demonstrated a lack of proficiency in handling the aircraft on approaches and landings. These difficulties, explained in notes taken by Captain Woods at the time, indicated problems that I find somewhat surprising in a pilot who appeared to have had no serious problems on his initial line training and who had already flown 150 hours as captain on the HS-748. In any event, Captain Woods recommended and the company required an additional 50 hours of line indoctrination, the latter portion of which was conducted by Captain Peter Hill.

Captain Mills's flying performance indicated considerable improvement after the second 50 hours and a check ride was carried out by Captain Larry Raymond on a three-day trip on July 20, 21, and 22, 1988. Captain Raymond considered the ride to be satisfactory and his report stated: "He had just completed an additional 100+ hours line indoc with

Captains Hill and Woods and appears to have absorbed and learned much from this extra training."

Mr David Rohrer, the CASB operations group chairman, commented as follows:

Q. And you've noted here that the accident occurred when he had 150 hours on type, and while the First Officer was flying the aircraft.
 Could you explain the next sentence:
 "Captain Mills failed to recognize that a go-around should have been initiated before touchdown. As a result he was returned to the line for further indoctrination. He completed another 100 hours of line indoctrination with company check pilots and was again released as a Captain on the HS748."
 Just explain to us what that means?
A. Well, as a result of this occurrence, the company reviewed Captain Mills' performance and elected, at that time, to give him further line indoctrination in the amount of 100 hours.
 This is basically flying the airplane in his role as Captain under supervision of a check pilot.
Q. From your experience, sir, would the 100 hours that he did, is that high or low or is that average when you put a pilot back on further training?
A. Well, I suppose as a sense of comparison, the line indoctrination Captain Morwood did as a captain on the F-28 was 25 hours. The line indoctrination that First Officer Mills did was 20.
 Now –
Q. That's on the F-28?
A. On the F-28. Now, Captain Mills on the HS748s had already been line indoctrinated once and this was an additional 100 hours, which was about four times more than what a normal captain would receive.
Q. In your opinion, is that high?
A. Yes.
Q. In your opinion, is that demonstrative of anything?
A. Well, it indicates that he had some difficulties transitioning to that aircraft.

(Transcript, vol. 87, pp. 117–19)

The third incident involving Captain Mills occurred at Detour Lake on November 17, 1988. While he was taxiing the aircraft onto the runway in preparation for takeoff the right main landing gear settled in a soft spot off the prepared area. During the initial attempt to free the aircraft using its own power, the propeller was damaged by rocks that were thrown up by the propeller itself. Shortly after this incident the company sold the HS-748 aircraft fleet. Captain Mills applied to be first officer on the F-28 aircraft, and he commenced his training in January 1989.

With regard to these three incidents, it should be noted that they all occurred on the largest aircraft First Officer Mills had flown up to that date and in a relatively short span of time before he had acquired a significant amount of experience on the aircraft.

The record of pilot proficiency checks flown by First Officer Mills indicated some recurring problems with stall recovery on various aircraft types. Mr Randy Pitcher, civil aviation inspector in Transport Canada's Ontario Region, noted on one occasion when First Officer Mills was flying, the F-28: "Lost 200 feet because he allowed the nose to drop a little during recovery."

Personal Profile

First Officer Mills was 35 years old, married, and had one child. He had worked for Austin Airways Ltd and Air Ontario Inc. for 10 years. Interviews with company personnel portrayed him as an assertive individual who could be abrasive at times.

It is reported that First Officer Mills drank very little and did not smoke. He was in excellent physical condition, he worked out at the local gymnasium, and he played golf. In his youth he had been a successful athlete and had been drafted to play professional hockey.

First Officer Mills was apparently happy with Air Ontario and had no plans for changing employment. He was also happy with the F-28, but, according to his wife, he felt that his F-28 training had been a "little rushed."

Cabin Crew

Cabin Attendant Katherine Say

Katherine Lea Say: purser
Age: 31
Date of birth: November 30, 1957
Initial F-28 emergency procedures training completed: December 1, 1988
First-aid training completed: July 1, 1987
Fire-fighting training completed: November 1, 1988

Cabin attendant Say's work schedule for the four-month period preceding the accident complied with all crew rest restrictions in place on March 10, 1989.

Although Mrs Say had not originally been scheduled to fly on the F-28 aircraft between March 6 and 10, 1989, the manager of in-flight services, Mrs Ruthe-Anne Conyngham, assigned her to these flights to review and organize the F-28 trolley carts and cabin service. Mrs Say was given these duties in her supervisory capacity as an in-flight coordinator.

Cabin Crew Training

Air Navigation Order Series VII, No. 2, part V, section 42(5), requires an air carrier to "submit to the Director for approval, a detailed training syllabus for each crew member classification." Mrs Say was properly qualified and trained to perform her assigned duties as the purser cabin attendant on Air Ontario F-28 aircraft in accordance with existing company requirements as approved by Transport Canada. She had successfully completed her mandatory initial F-28 training in December 1988 and had obtained both current and valid first-aid and fire-fighting training prior to her assigned duties on the F-28. She was considered to be a qualified and experienced cabin attendant and was deemed competent by both her superiors and her peers.

Cabin Attendant Sonia Hartwick

Sonia Victoria Hartwick: cabin attendant
Age: 26 (on March 10, 1989)
Date of birth: January 24, 1963
Initial F-28 emergency procedures training completed: October 14, 1988
First-aid training completed: September 1, 1986
Fire-fighting training completed: October 1, 1988

Cabin attendant Hartwick's work schedule for the four-month period preceding the accident complied with all crew rest restrictions.

Cabin Crew Training
Mrs Hartwick was properly qualified and trained to perform her assigned duties as a cabin attendant on the Air Ontario F-28 aircraft in accordance with existing company requirements as approved by Transport Canada. She had successfully completed her mandatory initial F-28 training in October 1988 and had completed both first-aid and fire-fighting training prior to her assignment on the F-28 aircraft.

Mrs Hartwick had been employed by Air Ontario Inc. and one of its corporate predecessors, Air Ontario Limited, for two years and six months prior to the accident. She was considered to be a capable employee and was well liked by her superiors and peers. Although she was generally pleased with her duties as a cabin attendant, she had previously expressed reservations about the level of training she had received on other aircraft types in the company fleet. She had raised this concern in a memorandum to the manager of in-flight services, Mrs Conyngham, who, in response, assured her that she was a capable and dedicated cabin attendant who had been adequately trained for her position. Mrs Hartwick enjoyed her duties on the F-28 aircraft and had a good working relationship with Mrs Say. Mrs Hartwick's observations on her training at Air Ontario are further elaborated in chapter 20, F-28 Program: Flight Operations Training.

Crew Flight and Duty Times

ANO Series VII, No. 2, Part IV, sections 38 to 41, specify a number of crew-member requirements, including those that are common to both flight crew and cabin crew. A perusal of Part IV discloses an anomaly in the regulations regarding crew flight duty times. Section 41.1 requires an air carrier to set up a system that "establishes a maximum flight time, maximum flight duty time and a minimum rest period" for the air carrier's flight crew members for each 24-hour period. Section 41.1 also establishes a maximum flight duty time for a flight crew member of "15 hours in any period of 24 consecutive hours."[2] While maximum flight times and maximum flight duty times as well as minimum rest periods are specified in this section for flight crew members, there are no similar requirements in the ANOs for cabin crew members. The reasons for this distinction are not obvious.

Crew fatigue is one issue that must be addressed from the human performance perspective of aircraft accident investigation. Evidence as to the flight times and flight duty times worked by the air crew prior to an accident is relevant to this issue. The flight time and flight duty time

---

2 Exhibit 308, ANO Series VII, No. 2, Standards and Procedures for Air Carriers Using Large Aeroplanes, section 41.1(1)(5), pp. 12 and 12-A.

records of all of the aircraft crew members of C-FONF were examined by the human performance investigators for this Commission.

The Commission investigators determined that the maximum flight times and maximum flight duty times of the flight crew of C-FONF on March 10, 1989, were in fact well within the limits set for flight crew in Part IV of ANO Series VII, No. 2. In the case of the cabin attendants of C-FONF, because there are no similar flight time and flight duty time limitations prescribed for cabin crew in ANO Series VII, No. 2, it is not possible to make such a comparison.

However, it can be said that the flight time and the flight duty time records of both of the cabin attendants on C-FONF in the week prior to the March 10, 1989, crash did not exceed the total times recorded by the flight crew members of C-FONF.

Findings

- The maximum flight times and maximum flight duty times of the flight crew of C-FONF on March 10, 1989, were within the limits set for flight crew in Part IV of ANO Series VII, No. 2.

- There are no maximum flight time and maximum flight duty time limitations prescribed for cabin crew in ANO Series VII, No. 2.

- The flight times and flight duty times of the cabin attendants on C-FONF on March 10, 1989, did not exceed the total times recorded by the flight crew members of C-FONF.

RECOMMENDATION

It is recommended:

MCR 170 That Transport Canada address the anomaly existing in Air Navigation Order Series VII, No. 2, with respect to the lack of maximum flight times and maximum flight duty times prescribed for cabin crew members.

39 CREW COORDINATION AND THE COMMUNICATION OF SAFETY CONCERNS BY PASSENGERS

A number of individuals aboard flight 1363 were aware of an increasing buildup of contamination on the wings of the F-28 as it sat on the ramp at Dryden and as it taxied out in preparation for its fateful takeoff. Included in this group were the two flight attendants for flight 1363, Mrs Katherine Say and Mrs Sonia Hartwick, and two highly experienced professional pilots, Captain Murray Haines, an Air Canada DC-9 captain with 12,000 flying hours, and Captain David Berezuk, an Air Ontario de Havilland Dash-8 captain with 10,000 flying hours. Both of these pilots were travelling as passengers aboard the F-28, together with their families.

The question that was asked repeatedly during the Commission hearings, when it became clear that many of the passengers were concerned about the buildup of snow on the wings and recognized the potential for catastrophic results if a takeoff was attempted, was why did someone not bring this concern to Captain Morwood's attention. Yet, except for unsuccessful efforts by a Royal Canadian Mounted Police special constable, no one aboard flight 1363 made any attempt to check with the captain to see if he was aware of the contaminated condition of the aircraft wings.

The reasons for this apparent reluctance to bring to Captain Morwood's attention the condition of the wings, in the face of perceived danger, can be culled from the testimony of some of the survivors. Expert evidence was called in an attempt to rationalize the hesitance of Mrs Say, Mrs Hartwick, Captain Haines, and Captain Berezuk to speak to Captain Morwood regarding the wing contamination. Mr David Adams, chairman of the Commission's human factors group, and Dr Robert L. Helmreich, professor of psychology at the University of Texas and a social psychologist employed by NASA in the selection program for astronaut candidates, gave evidence relative to the human factors and human performance aspects of the Dryden accident that may have had a bearing on the events of March 10, 1989.

The Evidence

Mrs Hartwick felt some concern about the presence of snow on the wings immediately after the passenger door to the aircraft was closed in preparation for departure. She testified she observed snow while the aircraft was in front of the terminal building and explained how she believed at the time that the aircraft would possibly be de-iced. Mrs Hartwick further testified that while walking through the cabin of the aircraft, after the door had been closed, she overheard passengers' concerns about the snow on the wings, some indicating they hoped it would blow off.

After the pre-takeoff cabin check was completed by the two flight attendants, they stood at the back of the aircraft as it taxied away from the ramp, only to be delayed short of the active runway while waiting for the Cessna 150 to land. Mrs Hartwick testified that thoughts of the Gander crash came to her mind and she was, at this time, becoming more apprehensive over the snow-covered condition of the wings. The snow was now starting to build up and a concern about the contaminated condition of the wings, and what the crew intended to do about it, was raised directly with the flight attendants by a passenger seated at the back of the aircraft. The passenger was Special Constable Dennis Swift of the RCMP, who was seated in aisle seat 13C.

Both Constable Swift and Mrs Hartwick testified before me in relation to this conversation about Constable Swift's concerns. He was a seasoned air traveller who had some knowledge of the theory of flight. He had an understanding that contamination adhering to a wing was capable of disrupting the lift-generating properties of the wing. Mrs Hartwick's evidence about that conversation is illuminating:

A. He looked at Katherine, and he said, "At what stage do you de-ice?" And, at that time, Katherine looked at him, and she said, "Well, we have automatic de-icers, sir." And then, at that time, he looked at her, and he said, "Yeah, but only on the leading edges."

And, at that time, Katherine just went like – she just shrugged her shoulders with this type of look, and she looked at me and –

Q. She shrugged her shoulders and looked at you?

A. Yes.

Q. What did you feel at that point in time?

A. Uncomfortable.
Q. Why?
A. Because I was thinking of that Gander incident about the possibility of ice on the wings, and it just worried me seeing that white, fluffy snow on the wings. And then I thought, My goodness, if she's – you know, it just seemed so strange that – I just felt very uncomfortable with the snow on the wings, and Katherine, being a very experienced flight attendant.

(Transcript, vol. 10, pp. 229–30)

Constable Swift's recollection of the conversation corroborated Mrs Hartwick's version. He recalled being advised by Mrs Say that the snow on the wings would blow off on the takeoff roll and that the aircraft was equipped with a built-in de-icing device that would take care of the problem. Constable Swift testified he was sceptical of these claims:

Q. Would you tell the Commissioner about the substance of that conversation, Sir?
A. Well, Sir, I had indicated that I felt the aircraft should have been de-iced. In fact, I questioned, asking that, are they not going to de-ice the airplane prior to takeoff?

At that point, a reply came back, and I can't be certain who said that – I believe it may have been Katherine Say – said that it is light, fluffy snow and it will blow off on rollout.

I still found that a little hard to accept myself, and I may or may not have indicated, I don't think so, I don't believe it would.

And I believe it was told to me that not to worry, this aircraft has a built-in device and – thinking that that would take care of the problem.

Once again, I was skeptical in that remark. I didn't think that this particular aircraft had a built-in de-icer. It may have had an inflatable boot or ice boot at the leading edge of the wing, but I didn't think that it had a built-in de-icer, as the way it was – I was interpreting it.

(Transcript, vol. 18, pp. 79–80)

Mrs Say may have believed that the F-28 was equipped with some sort of ground de-icers, when in fact it was not. This apparent misapprehension on her part graphically demonstrates the need for air carriers to involve the cabin crew, jointly with the cockpit crew, in an education program related to the ground de-icing of aircraft and stressing the dangers of takeoff with contaminated wings. She might not then have entertained the belief that the snow would blow off or that a self-de-icing wing existed. More importantly, she would have been confident enough to communicate Constable Swift's valid concerns to the captain.

The evidence shows that both Constable Swift and Mrs Hartwick were of the view that the snow was not going to blow off the wings during takeoff. Mrs Hartwick was very clear in her recollection that the snow was wet and sticky. Being a resident of Northern Ontario, at Sudbury, she easily differentiated between dry, flaky snow that blows away and wet, sticky snow that adheres to objects on which it falls. She testified it was the latter type of snow she observed on the F-28 wings at Dryden.

It was clear to me that both Mrs Hartwick and Constable Swift were uncomfortable with the fact that the F-28 was not going to be de-iced. Both testified they did not believe that the snow would blow off. However, neither one of them pressed the issue with the in-charge flight attendant, Mrs Say, or with a member of the flight crew. Although Constable Swift and Mrs Hartwick possessed elementary knowledge of the effects of wing contamination and were sceptical of the reassurance offered by Mrs Say, neither one of them pursued their concerns any further.

Constable Swift testified that on March 10 he was experiencing pain in one of his ears because of altitude changes during flight. He was preoccupied with this pain and, although he was concerned about the contaminated wing condition, he resigned himself to the fact that the crew were "professional people" whose judgement he would respect:

> A. ... these are professional people, they make a living by flying these things and I don't. I make my living by riding on them.
>
> I had accepted the fact that this aircraft – perhaps someone had made the decision it was safe to fly.
>
> (Transcript, vol. 18, p. 81)

Constable Swift's eventual and understandable decision to rely on the professionalism of the flight crew reflects the attitude of the general air-travelling public. It does not explain, however, why the cabin crew and the two off-duty airline pilot passengers did not take some positive action in the circumstances described.

Mrs Hartwick, by virtue of her limited training, was not well versed in the theory of flight or in the technical aspects of the effect of contamination on the ability of the aircraft to fly. A number of prior experiences as a flight attendant had a bearing on her reactions to the pre-takeoff situation, however, and, in all probability, had a similar impact on Mrs Say.

The presence of snow on the wings of an aircraft was not a new experience for Mrs Hartwick. She testified that while she was working as an Air Ontario flight attendant on the Convair 580 aircraft, she had experienced a takeoff when the aircraft had snow on its wings. The snow on that occasion was dry and powdery, and it blew off during takeoff. She also recalled having observed pilots of the Convair 580 and Dash-8 aircraft check the snow on the aircraft fuselage with their hands before entering the aircraft. Mrs Hartwick testified that before March 10, 1989, she had never been in an aircraft that attempted a takeoff with wet, sticky snow on its wings.

There appear to have been a number of factors that mitigated against Mrs Hartwick or Mrs Say going to the cockpit and conferring with Captain Morwood about the contaminated condition of the wings. Mrs Hartwick testified that there was a feeling among flight attendants that pilots did not accept them as part of the crew in an operational context. She described what I regard as a serious dichotomy between the cockpit crew and the cabin crew:

> A. Well, we have – the pilots and the flight attendants have respect amongst one another as friends but when it comes to working as a crew, we don't work as a crew. We work as two crews. You have a front-end crew and a back-end crew and we are looked upon as serving coffee and lunch and things like that.
>
> (Transcript, vol. 11, p. 117)

Mrs Hartwick recalled instances where she had, on previous flights, gone forward to the cockpit with safety concerns, only to be told by the pilots not to worry, even though the pilots had conducted no visual checks to verify or dispel the concerns she had raised. In one instance she related, she saw what appeared to be a rivet sticking out of the wing and, in another case, she noticed some oil on the wing. Both of these incidents occurred on the Convair 580, when she was a relatively new flight attendant, and she was left with the impression that, by reporting such matters, she had appeared stupid inasmuch as the pilots did not seem to be interested in or concerned with her report to them.

There were other instances, Mrs Hartwick recalled, where the pilots had shown interest in her concern and had taken the time to make checks and to keep her informed. She observed that the attitude and cooperation of the pilots varied, depending on the character and disposition of the individual:

> Q. ... The kind of reactions that you would get from a pilot when you had a concern ... would it vary from pilot to pilot?
>
> A. Yes, it would. There's some pilots that took more of an interest to explain to you what something was.
>
> (Transcript, vol. 11, p. 118)

There was no doubt in Mrs Hartwick's mind that certain captains were not disposed to consider information from flight attendants seriously. Moreover, the evidence also shows that Air Ontario flight operations management, despite a history of previous incidents involving takeoffs with contaminated wings, did not seem to grasp or understand the reluctance on the part of flight attendants to approach a captain with their safety-related observations and concerns. This lack of understanding by senior management was highlighted by two post-crash telephone conversations between Mrs Hartwick and Mrs Ruthe-Anne Conyngham, Air Ontario manager of in-flight services.

In view of Mrs Hartwick's expressed concerns about snow on the wings before the takeoff at Dryden, Mrs Conyngham was curious why Mrs Hartwick did not do something to satisfy her concerns, such as speaking to the captain. Mrs Hartwick testified as follows regarding her conversations with Mrs Conyngham after the Dryden crash:

> A. There was a specific question at that time that she mentioned to me. It was only in mentioning. She mentioned, well, the guys upstairs – and I don't know who she meant, who were these guys upstairs. I only figured out to myself they must be some sort of officials in upper management; brought the question, well, if Sonia had such a gut feeling about the snow on the wings, well, why didn't she say anything.
>
> And I said – and then Ruthe-Anne mentioned that she, in turn, explained to them that it was not my position to make such a decision or my position or job to actually go up and tell the captain that he required de-icing at that time.
>
> I have been asked this question twice on two different telephone conversations and during the second telephone conversation I mentioned to her that if she would like to do a little bit of investigating herself – because I felt very horrible that these people were trying to put this back on my lap, I said, well, there is an incident that occurred in December of 1987 out of Toronto. It was a Hawker 748 which took off from Toronto Airport.
>
> (Transcript, vol. 11, pp. 109–10)

The December 1987 incident referred to by Mrs Hartwick in her conversation with Mrs Conyngham concerned an HS-748 aircraft under the command of Captain Joseph Deluce, who later became chief pilot for Air Ontario's F-28 and Convair 580 aircraft and the project manager of the F-28 program. It is reviewed in detail in chapter 24, Flight Safety, and is referred to in this Report as the "December 15, 1987, incident."

The evidence showed that the December 15, 1987, incident involving Captain Joseph Deluce was a subject of discussion throughout the company. It involved a takeoff in inclement weather conditions with a snow accumulation on the aircraft surfaces, resulting in violent vibration on climb-out and the need to execute an emergency landing. The flight attendant on that flight, Ms Alana Labelle-Hellmann, who was called as a witness before this Inquiry, testified that she had expressed her own concerns about the snow accumulation as well as those of passengers aboard the flight directly to Captain Deluce, but was told to take her seat. Captain Deluce, for his part, testified he had no recollection of this conversation with Ms Labelle-Hellmann. The first officer, Mr Scott Jensen, testified he could not remember whether Ms Labelle-Hellmann had come to the cockpit on this occasion. I found Ms Labelle-Hellmann to be a very credible witness, and I accept her evidence.

Mrs Hartwick's knowledge of this incident and the manner in which Captain Joseph Deluce was reported to have responded to the concerns expressed by the flight attendant and passengers on the flight clearly had a profound impact on her. Undoubtedly this incident influenced her conduct on March 10, 1989.

When asked why she had mentioned the December 1987 incident, Mrs Hartwick stated:

> A. Because it dawned on me after the incident, I thought, well – it seems that people were trying to push the blame on me and I feel guilty as it is but I thought of this incident [the December 15, 1987, incident] and it was a very specific incident that where a flight attendant actually went up to the flight deck to inform a captain of the snow on the wings and what his response was to that.
>
> (Transcript, vol. 11, pp. 111–12)

Regardless of the facts of the December 15, 1987, incident, I believe it crystallized the understanding of the respective roles of pilots and flight attendants at Air Ontario, as perceived and described by Mrs Hartwick. Even if the day-to-day pilot/flight attendant crew relationships varied, depending on the personnel involved, the perceptions created by the December 15, 1987, incident were to have a lasting effect at Air Ontario.

The testimony of Ms Labelle-Hellmann about the perceptions of flight attendants with respect to operational concerns on board aircraft corroborated that of Mrs Hartwick. I was struck by the similarity of the events experienced by Ms Labelle-Hellmann and the passengers involved in the December 15, 1987, incident to those at Dryden on March 10, 1989.

Ms Labelle-Hellmann's evidence was of considerable assistance in attempting to arrive at a rationale for, and an understanding of, the conduct of Mrs Say and Mrs Hartwick on March 10, 1989. Ms Labelle-Hellmann testified that, during her initial flight attendant training in 1985, she had been instructed that, with respect to safety-related matters, she had the "authority to go up there [the cockpit] and insist that it be taken care of" (Transcript, vol. 106, p. 60). However, following this initial training and up to the time of the December 15, 1987, incident, the practical aspects of being a flight attendant somewhat altered her views. She testified:

A. I just got to know basically a pilot's role and a flight attendant's role. We ... were there for safety ... and serving and taking care of passengers, but ... for de-icing incidents and things like that, I wouldn't make a call like that. I would try to have enough faith in the pilots and hope.

(Transcript, vol. 106, p. 60)

There was a further practical concern that may have influenced Ms Labelle-Hellmann not to be more forceful with Captain Joseph Deluce on December 15, 1987:

A. Well, you could – you would probably be attached with – it was a smaller company ... it would become known and ... it would just be hard and you could get a bad schedule and different things like that could happen.

(Transcript, vol. 106, p. 61)

Ms Labelle-Hellmann had experienced other HS-748 takeoffs when there was snow on the wings. Like Mrs Hartwick, she testified that such takeoffs did not involve wet, sticky snow, but dry snow that blew off on takeoff.

Having heard the testimony of Mrs Hartwick and Ms Labelle-Hellmann, it is not difficult to understand why flight attendants at Air Ontario may have come to the conclusion that management, as well as at least some pilots, were not interested in the opinions or observations of flight attendants on operational matters.

In addition to the factors enumerated, I am of the view that Mrs Hartwick's expressed fundamental respect for and trust in the professionalism of both Captain Morwood and Mrs Say was a compelling factor influencing her not to go to the cockpit to voice her own concerns. She testified as follows:

Q. ... maybe you can tell the Commissioner in your own words why you didn't go up to the cockpit to tell Captain Morwood about what you observed on the wings. Why didn't you go up?

A. Well, on March 10th it was not only obvious to myself and the passengers on board flight 1363 that it was snowing in Dryden, but it was something that the captain was aware of as well. It wasn't just snowing over the wings, it was snowing throughout Dryden, Ontario, at the time.

And not only is the captain an expert and a professional with these types of things, the captain has in his possession the temperatures, the winds, the weather conditions, and at that time he is the expert to make the decision such as de-icing.

Also, after conversation with Katherine Say, I looked upon her as a very professional person and I still do. She had ten years of experience and she was a very conscientious person and

> at that time I did not feel it was my place to overstep her as I respected her very much so as I did Captain George Morwood. He was a very special pilot.
>
> (Transcript, vol. 11, pp. 112–13)

As professional pilots, Captain Berezuk and Captain Haines had an in-depth understanding of the danger of wing contamination. In the context of the prevention of similar accidents in future, the reasons given by these two pilots for not bringing the wing contamination to Captain Morwood's attention before takeoff are equally as important, in my view, to those given by Mrs Hartwick.

The lack of affirmative action by Captain Berezuk and Captain Haines was most unfortunate in this instance since any indication of concern on their part would in all probability have been considered seriously by either flight attendant and by Captain Morwood. Knowing that a professional pilot was concerned would likely have convinced one of the flight attendants to relay such concern to Captain Morwood. If this had occurred, Captain Morwood would in all probability have been encouraged to assess the condition of the aircraft wings and to reconsider his injudicious decision to take off. Failing this outcome, both off-duty pilot passengers had the right, as did any passenger on board, to demand to be let off the aircraft when it appeared that the danger posed by the contaminated wings would not be rectified. In the case of flight 1363, it was obvious that the rectification required was de-icing of the aircraft.

The evidence of Captain Berezuk and Captain Haines differs somewhat on the particular reasons why they did not raise their concerns directly with the flight attendants, but there are two points on which they both agree. They had both assumed, prior to takeoff, that the pilots of the F-28 were aware of the condition of the wings and Captains Berezuk and Haines both believed that the aircraft was going to be de-iced. Captain Berezuk knew that the de-icing equipment at Dryden was at the ramp, so he expected they were going to return to the ramp. If the aircraft was not de-iced, he felt that takeoff would be aborted should the snow not come off the wings during the takeoff roll, a highly dangerous practice in itself (see chapter 24, Flight Safety).

Captain Berezuk stated:

> A. ... when we were waiting for the small airplane to [land], that we were sitting at that point for approximately five minutes, and at that point I told my wife that at that point we'd probably be delayed even further because we probably would have to go back for de-icing.
>
> Q. So you thought at that time the aircraft was going to go back or might go back and de-ice?

A. That is correct.
Q. Now, having seen – having seen the snow on the ice and you saw the – or snow on the wing as it was taxiing down the runway, and you had a concern, would you as a captain had you seen the snow on the wing gone back and de-iced?
A. Yes.
Q. Now, if you would have gone back and de-iced the aircraft had you seen as a captain the snow on the wings, can you tell me why you did not communicate your concern to the crew of the aircraft?
A. Up until the final point or final second before takeoff, I was not aware of the pilot's judgment or decision about regarding de-icing.
Q. Now, can you explain that to me. Why were you not aware of his decision or the crew's decision?
A. As making decisions as a captain of an aircraft, at any time you can stop the proceedings up until the point of power application.
Even after the point of power application if you deem necessary in order of safety or if something doesn't seem right, at any time you can stop the process.
Q. So when the aircraft was taxiing down backtracking to commence its takeoff, are you saying that you thought that the captain or the crew might go back and de-ice the aircraft?
A. Yes.
Q. And when was the first time – when did you realize that the – that the crew, the captain, was not going to de-ice that aircraft?
A. When the aircraft was rolling down the runway.

(Transcript, vol. 14, pp. 186–88)

As an Air Canada DC-9 pilot, Captain Haines did not operate into Dryden. However, he was quite familiar with the airport since he resided near Dryden and regularly commuted to work at Winnipeg by flying out of Dryden. He testified that he thought, during the initial taxiing away from the ramp and the backtracking on the runway, that the aircraft was proceeding to a remote de-icing area at the Ministry of Natural Resources (MNR). This was a natural assumption for him to have made, since Air Canada often de-ices its DC-9 aircraft at locations remote from the gate. There was no doubt in his mind that the aircraft had to be de-iced and he was convinced that the F-28 would be de-iced before takeoff:

Q. You fully expected de-icing?
A. They had to de-ice. I knew that.

(Transcript, vol. 19, p. 35)

Q. And there's no doubt in your mind that that aircraft had to be de-iced?
A. Absolutely none. It had to be de-iced. I just talked myself into it.
Q. Did you personally think it could fly with that amount of contamination on its wings?
A. Oh, I knew it couldn't.
Q. You knew it couldn't?
A. Yes.

(Transcript, vol. 19, p. 37)

Captain Haines offered a further surprising explanation for his lack of assertive action on board the aircraft. He stated in his evidence that he had assumed the wings had some fluid in them, or that there existed "some automatic de-icing system" he did not know about "built into the airplane to take care of the ice on the wings" (Transcript, vol. 19, pp. 36–37). He testified that had he known there was no such on-board deicing system, he would have prevented the takeoff:

Q. Captain Haines, if you would have known that there was no on-board-the-aircraft system to de-ice, what would you have done?
A. I would have prevented the aircraft from taking off.
Q. As a matter of fact, you used a little more graphic term when speaking to me.
A. I would have broken down the cockpit door, I would have done anything, had I known that the wing was not going to de-ice itself.
Q. Now, in hindsight, which is always great –
A. Yes.
Q. – I guess you were wrong in the assumption you made during those maximum 30 seconds?
A. Very wrong.
Q. And how do you feel about that today, Captain?
A. Terrible.

(Transcript, vol. 19, p. 38)

The evidence before this Inquiry leaves no doubt whatsoever that no built-in automatic de-icing system exists for the ground de-icing of aircraft. I view Captain Haines's explanation based on an imagined built-in automatic wing de-icing system in a 17-year-old aircraft as completely implausible. It likely constitutes an afterthought in his obviously sincere efforts to rationalize his reasons for not taking any action to prevent the takeoff.

In his testimony, Captain Berezuk offered a further and cogent explanation for his passivity in not communicating his concerns to any crew members on March 10. In so doing he identified what I perceive to be an absence of guidelines to off-duty air crew members travelling as airline passengers in circumstances such as occurred at Dryden. Captain Berezuk stated:

> A. If I was an outside observer looking at an aircraft, there is no written-down procedure or set of rules that I could refer to on how to and when I should express my concern or state my observation to a crew member of that aircraft. There is nothing concrete.
>
> (Transcript, vol. 16, p. 74)

Captain Berezuk also adverted to a so-called "pilot professional courtesy" or "pilot-respect" theory within the professional pilot community, which purports to preclude an off-duty airline pilot, flying on board as a passenger, from drawing to the attention of the cockpit crew an observed safety concern. Because of the serious potential consequences of such a theory finding acceptance among professional pilots, relevant portions of Captain Berezuk's testimony are set out hereunder:

> Q. Now when questioning you about the crew of an aircraft, you stated in your evidence as follows, and I will just summarize it, but you – whether you knew the pilots in the front of the aircraft or not, it could have been one – it could have been one of 10,000 pilots, you wouldn't have changed your mind about not going up front, is that correct?
> A. Correct.
> Q. And you further stated that you were a pilot and they were pilots and you trusted them with your life and the life of the family and the passengers?
> A. Yes.
> Q. And you further stated you expected the same courtesy, respect and authority given to you as a pilot in command of your aircraft as you owed to the other pilots in the profession of aviation?
> A. Correct.
> Q. Now, am I correct in saying then that it was out of professional courtesy that you did not go forward or advise a flight attendant of your concern about the snow on the wings?
> A. Not as a fact of courtesy but, again, respect.
> Q. Out of respect for the competency and capability of that front-end crew?
> A. Yes.
> Q. So, is it fair to say that in your mind on March 10, 1989, this courtesy and respect, that imputed or regarded in the crew, outweighed your concerns for the amount of snow on the wings?

A. Yes.
Q. Now, is it fair to say then that you were placing this courtesy and respect for the crew before the safety of the aircraft and your safety on March 10, 1989?
A. Can you repeat the question?
Q. Is it fair to say that you place this courtesy and this professional respect before your safety and the safety of the aircraft when you saw the snow on the wings.
A. Yes.

(Transcript, vol. 15, pp. 9–11)

The most obvious inference that could be drawn from this evidence is that professional courtesy and respect among pilots are more important than safety. If true, this would represent a dangerous attitude and one that common sense would demand be expunged in no uncertain terms. However, later in cross-examination, Captain Berezuk displayed obvious discomfort with this statement. What he really meant, he indicated, was that he trusted Captain Morwood and that, as a pilot, he had a reluctance to interfere and to offer advice to another pilot who was actually flying the aircraft. He admitted his view of "professional respect" to be his own, and that he was not speaking for other pilots. As a captain, he personally favoured an open flight-deck environment and welcomed information from other crew members, including flight attendants:

Q. Now, I take it, Captain, that, in your mind, as one goes through the training to become even a basic pilot, you go through a rite of passage at the point in time at which you become licensed as a pilot in Canada, and you're something different at that point than you are before; is that right?
A. I guess it is a feeling that I had, yes.
...
Q. ... Even if you're a nervous passenger in a plane, because you're a pilot and because you know the person flying the plane is a pilot, you're reluctant to interfere and offer him advice about flying the airplane –
A. Yes.
Q. – generally? And that's kind of, in your mind, an ethic that pilots have?
A. I don't know if any other pilot feels that, but I guess I do.
Q. Now, on the one hand, you feel reluctant to offer advice to another pilot, correct?
A. Correct.
Q. On the other hand, you told my friend Mr Wells that you personally encourage an open-cockpit – I should say an open-flight-deck environment; is that right?
A. That's right.

Q. You welcome the flow of information from other members of your flight crew, including flight attendants, about matters of safety; is that right?
A. Yes.

(Transcript, vol. 15, pp. 113–14)

Captain Haines expressed the opinion that pilot respect or professional courtesy should not prevent a professional pilot passenger from drawing the attention of the cockpit crew to a safety problem. In his view there is no unwritten code of pilot respect or courtesy that prevents one pilot from communicating information to another pilot in matters affecting flight safety. He stated:

Q. And I believe you said the professional courtesy would be to tell the pilot what you know that could affect the safety of this flight?
A. Yes.
Q. Do you feel that most pilots would be of the same mind?
A. I hope so.

(Transcript, vol. 19, p. 143)

Given his stated belief that it was appropriate to do so, the obvious question is why Captain Haines himself did not do anything to draw Captain Morwood's attention to his professional opinion, unequivocally expressed in his testimony, that there was no way the F-28 would successfully take off with the wings contaminated as they were.

The common thread in the evidence of Constable Swift, Mrs Hartwick, Captain Berezuk, and Captain Haines was their expression of reliance on the professionalism of the pilots in the face of perceived danger. There was an assumption by each of them that the cockpit crew was aware of the condition of the wings and that they were dealing with the situation in a proper and safe manner. There is, however, a curious difference between the actions of Constable Swift and those of Captain Berezuk and Captain Haines. Constable Swift, who was not a professional pilot, did not hesitate to make his concerns known to both of the cabin crew members. In contrast, neither Captain Berezuk nor Captain Haines, the professional pilot passengers, made mention of their concerns to either of the flight attendants. Post crash, however, both of these captains testified that, in similar circumstances in future, they would take a different course of action. This is suggestive, in my view, of the validity of Captain Berezuk's notion of an unwritten code of professional courtesy or respect among at least some pilots that militates against the communication of even a perceived life-threatening safety concern to the cockpit crew. There are, however, at least four other factors that could influence an off-duty airline pilot on board an aircraft from making known to the captain his perceived safety concerns: a simple act of faith in the professionalism of the captain; the fear of offending the captain and possible rebuke for unsolicited advice; the fear of embarrassment in the event that the concern expressed proved groundless; and a reluctance to interfere in the obviously busy cockpit routine prior to takeoff.

Whatever the reason, the evidence before this Inquiry points unerringly to the existence of a general reluctance on the part of the cabin crew and the off-duty airline pilot passengers on flight 1363 to intervene in any way with the conduct of the operation of the aircraft by the operating pilots, even in the face of apprehended danger.

Evidence was also heard with respect to several other unrelated occurrences in which there was a reluctance to communicate information to the cockpit crew. In other incidents, the operating pilots viewed information communicated to them with great scepticism or chose not to act upon it.

Mr David Adams recounted his personal experience on board an aircraft shortly after he had participated in the Canadian Aviation Safety Board (CASB) investigation at the crash site at Dryden. Mr Adams, who was en route from Thunder Bay to Toronto, boarded an Air Canada 727 aircraft that had been sitting at the gate overnight. On looking out a window prior to takeoff he noted that the wings had approximately a half inch of wet snow on them. He was extremely disturbed by this observation, but was initially hesitant to raise the issue with either of the flight attendants or the pilots. Finally, he spoke to a flight attendant, requesting her to ask the captain when de-icing would occur. The flight attendant complied with his request and, approximately one and a half minutes later, an announcement was made that the aircraft would be delayed while de-icing took place. It is of some significance that an experienced aircraft accident investigator felt an initial reluctance to deal quickly and assertively with what he perceived to be a dangerous situation.

To amplify the point further, Mr Adams referred in his evidence to the crash of a Boeing 737-400 on January 8, 1989, at Kegworth in the United Kingdom. The aircraft had developed an engine vibration and the pilots inadvertently shut down the wrong engine. The aircraft was, as a result, left flying on the engine that was actually experiencing a malfunction. The cabin attendants and a number of passengers on board the aircraft watched sparks, flames, and pieces of the engine being spewed out the rear of the malfunctioning engine, yet no one took the initiative to notify the captain. The aircraft crashed and a number of passengers were killed.

Mr Adams aptly summed up a problem that has been identified in several aviation accidents, including that at Dryden: "[I]t's one of those issues where ... the information to correct the situation is perceived accurately by somebody on board the aircraft, but is not brought to the attention of the people who can do something about it" (Transcript, vol. 157, p. 43).

In order to remove any possible vestige of doubt about the matter, I believe the time has come for air carriers to counsel their pilots that it is appropriate for off-duty airline pilots on board an aircraft as passengers to draw any perceived safety concern to the attention of the captain. In fact, the time has come for all components of the aviation industry, be they regulators, carriers, or industry associations, to support the notion that it is not only acceptable but expected that off-duty airline pilots on board an aircraft as passengers communicate perceived safety concerns without fear of rebuke.

Later in the hearings, Captain Charles Simpson, vice-president of flight operations for Air Canada, was asked whether an ethic existed that might inhibit a pilot from expressing a concern. He responded in the negative, and expressed the view that a pilot was obliged, as part of his responsibility as a citizen, to report his concern:

> A. No, I think that – I think in fact, I think it's an obligation of a pilot to do that. It's a little like what is the responsibility of a citizen. I think there is a definite responsibility there.
>
> (Transcript, vol. 123, p. 164)

It was refreshing to hear a respected senior officer of a major airline make such a clear and unequivocal statement of principle on a subject I consider to be of great importance to the advancement of aviation safety. Based on the evidence I have heard, and considering the complexity and the size of jet aircraft flying today, there can be little doubt that the cockpit crew can benefit from the eyes and ears of all aboard an aircraft, but especially from those possessing special skills.

I will now outline what I perceive to be the most effective solution to the basic flight crew communications problem identified during the hearings of this Inquiry.

According to the evidence, an environment of near-complete separation of cabin crew and cockpit crew responsibility appears to have been fostered by Air Ontario management and by some Air Ontario pilots. As a result, flight attendants were discouraged from becoming involved in operational matters and were led to believe they should simply trust the pilots to deal with any operational problems that arose in flight. Mr Adams offered some insight into this ill-advised and short-sighted attitude:

> A. If you look at almost any company, you will usually find that the cabin attendants and the flight crew are very very clearly separated. They work for different branches of the company in most cases. The culture is one of almost complete separation. Yet

> the fact of the matter is, in a safety situation, these two sections of the company have to work together. And the consequences of not efficiently working together quite often means a bunch of people get killed.
>
> (Transcript, vol. 157, p. 50)

At Air Ontario, prior to the March 10, 1989, crash, the evidence shows that new flight attendants were taught simply to have confidence in the pilots. The report of the human factors and survivability group, introduced into evidence by Mr David Adams, refers to an interview with and a statement given by Mrs Ruthe-Anne Conyngham, manager of in-flight services for Air Ontario, who was responsible for flight attendant training. Mrs Conyngham was asked the following question: "There's been a lot of reports about the contamination on the wings of this aircraft. Would that be something that the flight attendants would look at?" Her reply is telling and sets out what I believe to be the reason for the lack of assertive action by Mrs Say and Mrs Hartwick with regard to the pre-takeoff concern about wing contamination. Both flight attendants, in the view of Mrs Conyngham, conducted themselves in precisely the manner expected of them, based on their training:

> ... It's just not the mind set that I would be in. I can't believe there would be many flight attendants that would be in the mind set where they would be looking at something like that ... I think it would be a very unusual thing for somebody to look out the window and say gee, I think there is too much something on this wing. It would be remarkable if somebody did that. Extremely exceptional ... I have a lot of confidence in these pilot[s] and the whole safety system in Canada, particularly in Canada. And I think that's instilled in, I instill it certainly in new flight attendants and you have to have, to have confidence in the team and that would be my second reason. That it would sort of be out of character unless something is tremendously blatant, for the flight attendant to question that confidence ...
>
> Statements such as those made by Mrs. Conyngham indicate that Kathy Say and Sonia Hartwick did exactly what the system expected them to do. It also helps explain CA Hartwick's interpretation of Kathy Say's gesture to Officer Swift:
> "I don't know what that meant. I know what it meant in a way, but again, **ITS NOT UP TO US.**"
>
> (Exhibit 1258, pp. 91–92)

The Need for Crew Cooperation

Having heard the testimony of flight attendants Hartwick and Labelle-Hellmann, and having reviewed the detailed expert testimony presented before this Inquiry pertaining to the human factors elements of this crash, I find that the reluctance of Mrs Say and Mrs Hartwick to convey their own valid concerns, and those of passengers, to the cockpit crew was the product of a mind-set ingrained in them by virtue of their training, or lack thereof, and the failure of Air Ontario management to coordinate properly the activities and responsibilities of their cabin and flight crews.

A basic problem on board flight 1363 clearly appears to have been one of lack of crew coordination. While it would not be difficult specifically to direct flight attendants to raise operational safety concerns with the pilots and also to direct the pilots to treat such intervention seriously, in practical terms mere directives are not sufficient. Closer cooperation, or crew coordination, between pilots and flight attendants in operational safety matters is clearly desirable in the interests of aviation safety. Such crew coordination must, however, be structured and developed through appropriate training, with limits imposed that are realistic, practical, and understood by all concerned. A careful balance must be struck between ensuring that pilots are aware of all operational problems and discouraging flight attendants from intruding into the cockpit at random.

As a result of previous accident investigations, where interruptions and non-relevant conversations were found to be distractions that detracted from the pilots' concentration, the Federal Aviation Administration (FAA) of the United States implemented what is commonly referred to as the sterile cockpit rule. This rule, referred to by Dr Robert Helmreich in his evidence, is, in fact, Federal Aviation Regulation (FAR) 121.542, part of which states:

> (b) No flight crewmember may engage in, nor may any pilot in command permit, any activity during a critical phase of flight which could distract any flight crewmember from the performance of his or her duties or which could interfere in any way with the proper conduct of those duties. Activities such as eating meals, engaging in nonessential conversations within the cockpit and nonessential communications between the cabin and cockpit crews ... are not required for the safe operation of the aircraft.
>
> (c) For the purposes of this section, critical phases of flight includes all ground operations involving taxi, takeoff and landing, and all other flight operations conducted below 10,000 feet, except cruise flight.

Dr Helmreich and his colleagues conducted extensive research in an attempt to establish how stressful situations impact on the dynamics of crew interaction. Analysis of conversations from cockpit voice recorders recovered from accidents were used for this purpose. In his testimony before me, he referred to two aviation accident investigations he had examined in some detail, both of which had on impact on the issue of pilot and flight attendant cooperation.

The first accident involved a Boeing 727 that crashed on takeoff at Dallas, Texas. The National Transportation Safety Board found that the crew failed to extend the flaps for takeoff. Dr Helmreich testified that the three pilots and one flight attendant were involved in social conversation that was dominated by the first officer. Just before the aircraft departed from the ramp, when a final check of the aircraft configuration should have been conducted, there was a flurry of social communications among the four crew members.

The second accident referred to by Dr Helmreich involved an MD-80 aircraft taking off at Detroit, Michigan, when the crew again failed to extend the flaps and slats prior to takeoff. The relevant taxi checklist was not completed. The crew was engaged in extensive social communications involving the two pilots and a flight attendant who was in the cockpit at the time.

The cases alluded to by Dr Helmreich demonstrated that whatever is ultimately done to ensure that flight attendants become part of a more effective flight safety team, it is critical that a delicate balance be struck and maintained whereby, on the one hand, pertinent information is exchanged between pilots and flight attendants, and on the other, an unnecessary intrusion into the cockpit is restricted at critical times. Mr Adams identified the nature of the on-board communications problems and outlined three elements essential to a solution:

> The real heart of the communications problem and therefore the potential coordination problem, is not that Cabin Attendants are universally discouraged from talking to the flight crew, but rather, they are discouraged from talking to the flight crew about specific subjects. For example, if a Cabin Attendant goes forward to the Flight Crew to point out that some emergency cabin equipment is not functioning, this would be almost universally accepted by both the flight crew and the cabin crew as a legitimate and acceptable communication. However, if a Cabin Attendant goes forward to the flight crew to point out to the Captain that he or she believes there is too much snow on the wings, this would in general not be considered by most flight crew and many cabin attendants as a legitimate or acceptable communication.
>
> In this type of scenario, the Cabin Attendant seems to have only three allies. They are: a clear and well-promoted company policy; a Captain who will consider any information from any source; or an individual Cabin Attendant characteristic of assertiveness.

> Air Ontario seemed to lack many of the elements that would be seen as providing clear and unreserved promotion of efficient operational communications between its flight and cabin crews.
> (Exhibit 1258, pp. 90–91)

The resolution to this communications problem would appear to be founded in well-planned and structured crew coordination or crew resource management[1] (CRM) training of both the pilots and the flight attendants. Dr Helmreich was firmly of the view that had the four crew members of flight 1363 completed extended CRM training and accepted its concepts, there may have been an exchange of information that would have prevented the attempted takeoff in the circumstances described.

It became very clear from the testimony of Dr Helmreich, Dr C.O. (Chuck) Miller, and Mr Adams that the effectiveness of any type of CRM training is contingent upon the commitment of the employer and the employees involved. The attainment of such a commitment is not easily achieved. Without a dedicated commitment by the employer to introduce, facilitate, and stand behind CRM training, such training is likely to have little or no impact on its primary goal of safety enhancement. Dr Helmreich stated:

> A. ... the organization has to sanction the new norms that you adopt. And that goes back to our issues about, if you will, about C.E.O.s and management and all of that.
>
> Because, you can provide that training from hell to breakfast, but if the organization doesn't sanction it, the training will have no impact. So, it requires organizational commitment.
>
> It also requires the establishment of norms through role models, and consistent reinforcement of it ...
>
> ...
>
> So the answer is, you have to have an organizational commitment to believe in what's important, you have to provide the mechanisms to train people, provide the opportunities, and

---

1 The application of human factors concepts in the flight deck environment was initially known as cockpit resource management. More recently, as human factors programs have come to include other participants in the aviation system, such as cabin crews and maintenance personnel, the phrase crew resource management (CRM) has come into wide use. CRM refers to the effective use of all available resources – human, hardware, and informational. It encompasses optimizing both the person-machine interface and interpersonal activities, including effective team formation and maintenance, information transfer, problem solving, decision making, maintaining situational awareness, and dealing with automated systems. Training in CRM thus involves basic indoctrination and recurrent training of crews in human factors concepts as they relate to the aviation system.

> ultimately, you have to be willing to say, this behaviour is not only expected, it is required.
>
> (Transcript, vol. 158, pp. 139–40)

The kind of commitment described by Dr Helmreich will not be realized by simply mandating that CRM training be undertaken. The three expert witnesses who testified in the area of human factors, Dr Helmreich, Dr Miller, and Mr Adams, were firmly convinced that there needs to be a certain degree of economic trade-off between the regulator and the airlines in order to ensure that an appropriate program of CRM training is undertaken and conducted. There was no disagreement among them that, in the case of major airlines, CRM training should be mandatory. What was discussed, and merits further consideration, is a regulatory trade-off system whereby a major airline with a well-developed CRM training program in place is given leeway with respect to certain regulatory matters that are required in the absence of a CRM training program.

Dr Helmreich testified as follows regarding the FAA experience on the issue of trade-off or economic incentives:

> A. ... what the FAA has tried to do with the AQP [Advanced Qualification Program] is provide some very important incentives, aside from the true safety benefits which they recognize, but some economic incentives in terms of checking and standards that make it extremely desirable to implement training that they feel is important anyway.
>
> I think that does good things. It makes the organizations and it makes the people feel like they're not getting the program rammed down their throat.
>
> (Transcript, vol. 158, pp. 143–44)

Having considered the testimony of the human performance experts who appeared before this Inquiry, and the evidence of Mrs Conyngham, Ms Labelle-Hellmann, and Mrs Hartwick, I am convinced that had the crew of flight 1363 been exposed to extended CRM training, there is every likelihood that a full and complete exchange of information would have occurred between the flight attendants and the pilots of flight 1363, with the result the aircraft may not have attempted its fateful takeoff.

The issue to be addressed by CRM training, specifically in the context of contaminated wings, is relatively simple. Following the recommendation made in my first *Interim Report,* Canada has now adopted the clean wing concept and, by so doing, has removed the discretionary aspect of whether a takeoff may be attempted with a degree of contamination adhering to the wings.

Apart from the primary responsibility on the cockpit crew to ensure that the aircraft wings are free of contamination prior to takeoff, an additional safety factor, related to crew resource management, can be introduced at no cost. The implementation of a simple mandatory crew procedure, prior to departure from the gate, in adverse winter weather conditions would introduce a double-check against the possibility of takeoff with contaminated aircraft wings. Further to the relevant recommendations contained in my first and second interim reports regarding joint cockpit crew–cabin crew training related to wing contamination, it appears desirable to adopt the following procedures:

- That the captain of an aircraft operating in adverse winter weather conditions be required formally to advise the in-charge flight attendant, prior to departure from the gate, whether ground de-icing of the aircraft is to take place and, in order to eliminate potential apprehension on the part of the passengers, that they be advised of such intention on the public address system of the aircraft.

- That, at any time prior to commencement of the takeoff roll, in the absence of advice by the captain that ground de-icing of the aircraft in adverse winter weather conditions is to be conducted, the in-charge cabin crew member be required to report to the captain his or her own concerns, or any concerns conveyed to him or her by any cabin crew member or any passenger on board the aircraft, relating to wing contamination.

It is important, however, not to lose sight of the fact that CRM training is concerned not only with contaminated wings. The exchange of information between the aircraft pilots and flight attendants covers a multitude of areas I do not consider necessary to canvass in this report. The entire spectrum of cabin crew–cockpit crew communication can best be addressed by well-trained crews having an appreciation and understanding of their respective roles and operating as a team. Because the issue of information exchange between pilots and flight attendants involves many historical and, in some cases, institutionalized behavioural norms, only a serious commitment by all segments of the industry and the regulator to provide CRM training for both pilots and flight attendants will produce the necessary operational environment and standard operating procedures needed to enable the aircraft crew to operate safely as a team.

Air Canada introduced cockpit resource management training for its pilots in January 1989, and over half of its pilots have completed the course to date. All Air Canada pilots are expected to complete this training by late 1992. Mr William Deluce, Air Ontario president, testified that Air Ontario has taken a corporate decision to introduce cockpit resource management training commencing in "the early part of 1991" (Transcript, vol. 153, p. 66). While clearly laudable in themselves, these initiatives must, in the interests of aviation safety, be expanded to involve the cabin crew jointly with the cockpit crew in a program of crew resource management training.

RECOMMENDATIONS

It is recommended:

MCR 171 That Transport Canada implement regulations requiring air carriers to provide approved crew resource management training and standard operating procedures for all Canadian air carrier flight crews and cabin crews. This training should be designed to coordinate the flight activities and information exchange of the entire air crew team, including the following particulars:

(a) As part of such crew resource management training, joint training should be carried out involving all captains and in-charge cabin crew members in order that each fully understand the duties and responsibilities of the other.

(b) All cabin crew members should be given sufficient training to enable them to recognize potentially unsafe situations both in the cabin and outside the aircraft. If it is necessary to prioritize such training, it should first be provided to all in-charge cabin attendants.

(c) As part of normal pre-flight announcements over the aircraft public address system, passengers should be advised that they may draw any concerns to the attention of the cabin crew members.

(d) All cabin crew members should be trained and instructed to communicate all on-board safety concerns they may have or that may be communicated to them by any passenger to the captain through the in-charge cabin crew member, unless time or other circumstances do not permit following this chain of command.

(e) All in-charge cabin crew members, after appropriate training, should be encouraged in adverse winter weather conditions to monitor the condition of the surface of the aircraft wings as part of the pre-takeoff cabin routine, in order to check for contamination, as a supplement to the captain's primary responsibility in that regard.

(f) Pilots should be made aware that concerns raised by cabin crew members should be taken seriously and investigated, where appropriate.

(g) Pilots should be instructed that when travelling as passengers on board an aircraft they should never assume that the operating crew is aware of any situation that they themselves perceive to be a safety concern. Such pilot passengers should be encouraged to raise such concerns with a cabin crew member and request that the information be given to the captain.

MCR 172 That, in order to dispel any possible notion of "professional courtesy" or "respect" precluding the communication of any dangerous situation, specifically addressing the case of off-duty airline pilots, all Canadian air carriers and the Canadian Air Line Pilots Association provide to each of their pilots a clear statement disavowing any notion that professional courtesy or respect precludes an off-duty airline pilot on board an aircraft as a passenger from drawing a perceived safety concern to the attention of the captain. The statement should indicate that, while it is not mandatory for them to do so, it is appropriate for off-duty pilots who are on board an aircraft as passengers to communicate to the captain, through the intervention of a cabin crew member, any safety-related concerns perceived on board the aircraft.

MCR 173 That the captain of an aircraft operating in adverse winter weather conditions be required formally to advise the in-charge cabin crew member, prior to departure from the gate, whether ground de-icing of the aircraft is to take place and, in order to eliminate potential apprehension on the part of passengers, that they be advised accordingly on the public address system of the aircraft.

MCR 174 That Transport Canada implement a regulation requiring that, at any time prior to commencement of the takeoff roll, in the absence of prior advice by the captain that ground de-icing of the aircraft in adverse winter weather conditions is to be conducted, the in-charge cabin crew member be required to report to the captain his or her own concerns, or any concerns conveyed to him or to her by any cabin crew member or any passenger on board the aircraft, relating to wing contamination.

40 HUMAN PERFORMANCE: A SYSTEM ANALYSIS

In the first *Interim Report* of this Commission, issued in November 1989, I found that on the basis of the overwhelming evidence of the surviving passengers and other eyewitnesses, the upper surfaces of the aircraft C-FONF were severely contaminated with heavy, wet snow prior to its attempted takeoff and that such contamination was at least a contributing factor to the crash.[1] Although further investigative and expert testimony had yet to be heard, the evidence available to me at that time convinced me that steps had to be taken prior to the 1989–90 winter flying season to heighten the awareness of the aviation community to the dangers of wing contamination. Accordingly, I made three recommendations directed at implementing a "clean wing" policy in Canadian aviation.

Subsequent to issuing my first *Interim Report*, I heard expert evidence regarding the performance and flight dynamics of the Fokker F-28 Mk1000 in studying the crash of flight 1363. The essential task of these experts was to assess the physical "flight dynamic" causes of the crash by examining aircraft systems, structures, and engine performance.

Without the information from the flight data recorder (FDR) and the cockpit voice recorder (CVR), this technical analysis was more difficult than it might otherwise have been. The technical analysis of the accident was necessarily based upon wreckage examination, eyewitness and expert testimony, and computer reconstruction of the takeoff and flight path.

The performance, investigative, and flight dynamic evidence, considered at length in chapters 10–12, has satisfied me that:

- there were no discernible defects in the aircraft's structures, systems, or engines that directly affected the performance of the aircraft; and
- the immediate cause of the crash is attributable to the contamination of the aircraft lifting surfaces at the time of takeoff.

---

1 *Interim Report*, p. 25

The Fundamental Question

The implication of the findings of the technical and performance aspects of this investigation is that the flight crew, in particular Captain Morwood as the pilot-in-command, erred in commencing the takeoff with contamination on the wings.

The flight crew represents one component in the air transportation system which must be evaluated in the investigation like any other component, such as aircraft engines or aircraft structures. If a failure of a component is identified, there must be an examination of both the causes of the failure and the backup systems or redundancies that are expected to prevent or mitigate the component failure. In the present case, having identified that there was a failure on the part of the flight crew of flight 1363, the following fundamental question must be addressed:

- Why did the pilot-in-command attempt to take off with contamination on the wings?

In keeping with the system analysis, two further questions are suggested:

- What caused or prompted the pilot-in-command to make the decision to take off?
- What system safeguards should have prevented or altered the decision to take off?

These questions, which relate to a failing of the human component of the air transportation system, are the subject of investigation and analysis by experts in the field of human factors.

Human Factors

Aviation occurrence investigations have historically involved inquiry into the human aspects of the occurrence. These may be divided into two broad categories:

- an inquiry into causes of injury and death among passengers and crew;
- an inquiry into the human error that was the immediate cause of the accident or incident and into other human involvement that could have, but did not, intervene to prevent the occurrence.

Internationally accepted conventions call for this investigative approach into the human factors of aviation occurrences.[2] The Transportation Safety Board of Canada also inquires into the human factors of any aviation occurrence.[3]

Cause of Injury and Death

The first inquiry is concerned with physical injury and death. The investigators are interested in matters such as the toxicity of combusted cabin interiors, the propagation of crash fires, the structural integrity of the aircraft, and the functioning of emergency exit and crash survival equipment. This aspect of the investigation was discussed in chapter 11, Aircraft Crash Survivability.

Human Performance

The second part of human factors investigation is that concerned with the human components directly and indirectly connected to the operation of the aircraft. It includes an examination of the flight and cabin crew to determine if there is anything in their recent history that could have influenced the circumstances surrounding the occurrence, either in a positive or in a negative way. Some of the investigative areas are training, experience, medical considerations, lifestyles, and personal circumstances. This area of investigation, referred to as the human performance investigation, is the focus of this part of the Report.[4]

Mr Gerard Bruggink, a former deputy director of the National Transportation Safety Board (NTSB) in the United States, describes a human performance investigation as follows:

---

[2] Exhibit 429, International Civil Aviation Organization (ICAO), *Manual of Aircraft Accident Investigation, 4th ed.* (Montreal: ICAO 1970; amended February 1972), chap. 9, "Human Factors"

[3] Exhibit 428, CASB Manual of Investigation; Exhibit 1256, CASB Human Factors Preliminary Investigation Checklist (PIP); and *Transportation Safety Board Manual of Investigation Operations*, vol. 2, part 4: "Investigation Standards and Procedures – Air" (June 1, 1991)

[4] It should be noted that the terms "human factors" and "human performance" are often used interchangeably to describe the study of the interaction among "man, machine, and the environment" – particularly in the context of examining pilot behaviour. Because there are both crash survival and human operational aspects to human factors investigations, the operational aspect is more properly referred to as "human performance." This is the usage adopted here. Human performance is one aspect of a human factors investigation. See C.O. Miller, "Human Factors in Accident Investigation," *ISASI Forum*, spring 1980 (Exhibit 1243).

> The systematic search for the probable reasons why personnel directly involved in the operation of a flight did not, or could not, interrupt the event sequence that terminated in the accident or incident.[5]

While I concur with the above definition, I note that it refers only to personnel directly involved. My investigation went further, to include corporate and regulatory management levels that, although not directly involved in the operation of the flight, may well have had a significant influence on events and circumstances surrounding the flight.

The study of human performance has been applied to the aviation industry, and a body of data has been established that enables researchers in this field to improve their understanding of the decision-making processes of flight crews and the extent to which their decisions are influenced by other components of the air transportation system. These components are as follows:

- the regulatory component: Air Regulations, Air Navigation Orders, surveillance, and monitoring;
- the organizational component: the culture and behaviourial norms of the organization as influenced by morale, policies, standards, organizational stability, change, and resources;
- the physical component: weather, operating conditions, and the aircraft, including its condition and capabilities; and
- the crew component: interpersonal coordination and communication among and between flight crew, cabin crew, and support personnel; and the individual characteristics of the aircraft crew members, including training, experience, motivation, personality, attitudes, fatigue, and stress.

The Commission was fortunate to have as witnesses some of the leading experts in the field of human performance investigation to assist in the interpretation of the evidence as it applied to the actions of Captain George Morwood and First Officer Keith Mills. In particular, I was greatly assisted by Mr Gerard Bruggink, who was mentioned above, and Dr C.O. (Chuck) Miller, former director of the United States Bureau of Aviation Safety, NTSB. Dr Robert L. Helmreich, professor of psychology at the University of Texas in Austin, Texas, assisted this Commission by preparing an analysis of the human factors aspect of the crash. The analysis has been used in part in writing this section. Dr Helmreich's

---

[5] Gerard M. Bruggink, "Assessing the Role of Human Performance in Aircraft Accidents," *ISASI Forum*, winter 1978

report, "Human Factors Aspects of the Air Ontario Crash at Dryden, Ontario: Analysis and Recommendations to the Commission of Inquiry," is included as number 7 in the Technical Appendices volume of my Report. In addition, I had the benefit of the investigative evidence of the chairman of the human factors and survivability group, Mr David Adams, in 1992 the acting director of the Australian Bureau of Aviation Safety in Canberra, who coordinated the Commission's investigation into the human factors aspects of the crash of flight 1363. Much of what follows in this chapter is based upon the work of these four experts.

By way of illustrating how human performance fits into a systems analytical model, Dr Miller, in one of his publications, provided the following explanation:

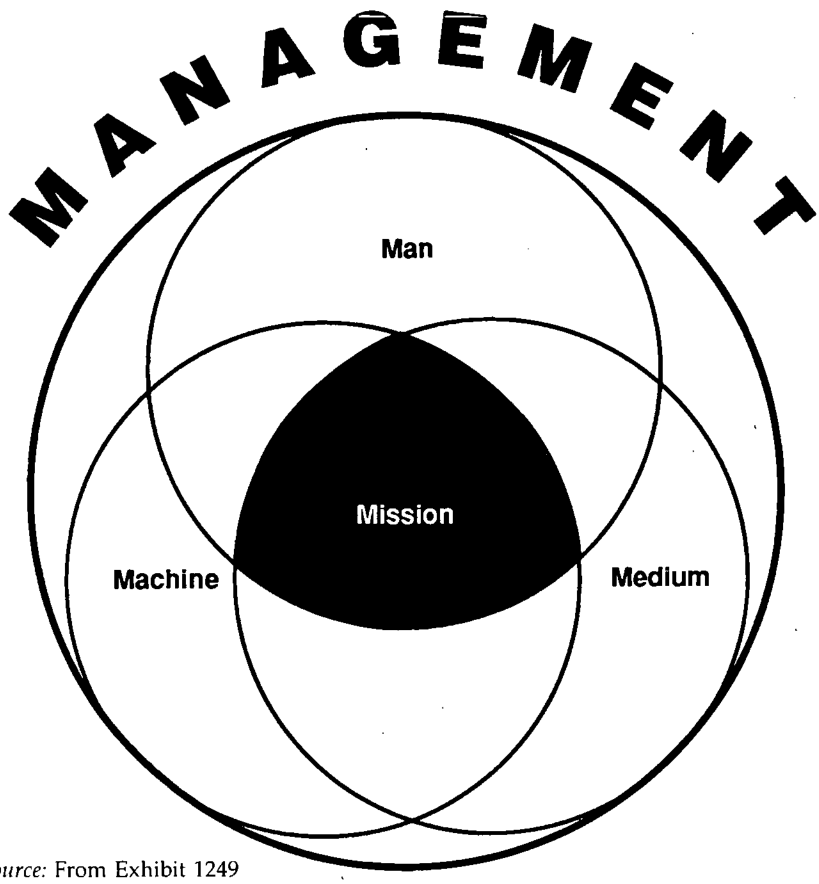
> Figure [40-1] identifies the traditional man-machine-medium (environment) factors for either accident causation or prevention in a framework of system safety principles identified in the very definition of the term, namely, the influence of the mission and overall management in system safety. It shows not only the significance of an individual factor, for example, man, but also that factor's mutual subset relationship to other factors. In practical terms, it suggests a problem has not been analyzed completely until the investigator or analyst asks whether the case has really been examined from all key points in the diagram.
>
> For example, take the infamous 14th Street Bridge air carrier accident near Washington National Airport, January 13, 1982 (NTSB 1982).[6] The accident occurred under icing conditions. The aircraft struck a bridge less than two miles from start of takeoff roll. The machine came into question because of the aircraft's aerodynamic characteristics with ice-contaminated wings. The captain had quite limited experience in winter flying weather – the man factor. The weather was very snowy with severe visibility restrictions, and another part of the medium (environment) was the airport's relatively short runway.
>
> The man and machine came together at the cockpit instruments where, indeed, the influence of the medium was felt because of ice formation on critical engine thrust–sensing probes, which resulted in a false engine pressure ratio gauge readings (used to set takeoff thrust). The mission came into the equation based on recent airline deregulation, placing economic pressures on the airline and the crew. Management of the situation by the airline in terms of crew assignments, dissemination of icing-effects information, coordination of

---

6 National Transportation Safety Board, *Aircraft Accident Report, Air Florida Inc. Boeing 737-222 ... Near Washington National Airport January 13, 1982* (NTSB AAR-82-8) (Washington, DC 1982)

ground servicing, and the like, was involved throughout the case. So was cockpit management, including the interpersonal relationships between the captain and the first officer. The first officer seemed to sense something was wrong during the take-off roll but never did challenge the judgement of the captain. Even FAA management involvement in the situation was a factor meriting close attention. Their oversight of the airline was minimal, and even the air traffic control procedures the night [evening] of the accident came into question. Most, but not all of these factors were addressed by the NTSB in the study of the accident.[7]

Figure 40-1 System Safety Factors



Source: From Exhibit 1249

[7] C.O. Miller, "System Safety," in E.L. Wiener and D.C. Nagel, eds., *Human Factors in Aviation* (San Diego: Academic Press 1988), pp. 63–64

While there are some similarities between the 1982 Air Florida crash and the Air Ontario crash of March 10, 1989, it must be stressed that the example is offered only by way of explanation of the investigative and analytical approach that I adopted with this Inquiry.

The pilot-in-command of flight 1363 made a flawed decision, but that decision was not made in isolation. It was made in the context of an integrated air transportation system that, if it had been functioning properly, should have prevented the decision to take off. Instead, it was revealed that there were significant failures, most of them far beyond Captain Morwood's control, that had an operational impact on the events in Dryden. In this chapter, the regulatory, organizational, physical, and crew components of the air transportation system are examined to determine how each may have influenced the captain's decision. Each of these system components is analysed from the perspective of the two previously cited fundamental questions:

- What caused or prompted the pilot-in-command to make the decision to take off?
- What system safeguards should have prevented or altered the decision to take off?

Much of the work in the field of human factors dealing with flight crew performance in operational situations is founded upon the interpretation of data recovered from cockpit voice recorders (CVR) and flight data recorders (FDR). Because neither the CVR nor the FDR information was available after this accident, analysis of flight crew interaction and actions during the station stop in Dryden, and particularly in the final minutes before the crash, is necessarily limited. Nevertheless, the expert witnesses were able to integrate historical data and their wealth of experience with the results of the investigation into the accident to provide possible scenarios of flight crew conduct.

Flight History: Summary

The crew of C-FONF reported in at Winnipeg at approximately 6:30 a.m. Central Standard Time (CST) Monday, March 6, for a five-day block in the F-28 aircraft, involving six flight legs per day ending at 3:30 p.m. CST each day. Captain George Morwood had flown with the two flight attendants before, but none of them had previously flown with First Officer Keith Mills. After flying on Monday, March 6, Captain Morwood was displaced on Tuesday by Captain Robert Nyman and on Wednesday by Captain Alfred Reichenbacher. Captain Morwood rejoined the crew on Thursday and Friday.

On March 10, the crew checked in at Winnipeg at approximately 6:40 a.m. CST and discovered that the auxiliary power unit (APU) was unserviceable. The flight pushed back off the gate at 7:35 a.m., 10 minutes late, and took a further 8-minute delay because Captain Morwood had the aircraft de-iced. The flight was airborne for Dryden at 7:49 a.m. It was further delayed at Dryden by poor weather at Thunder Bay. At Thunder Bay the flight was delayed because of a lack of communication and effective procedures for handling the extra passengers and the resultant need to defuel the aircraft after it had been refuelled. Prior to departure from Thunder Bay, two weather forecasts called for light freezing rain at Dryden. The aircraft departed 64 minutes late, arriving at Dryden at 11:39 a.m. CST. It was refuelled at Dryden with an engine running and with the passengers on board.

During the stop at Dryden, snow was falling and accumulating on the wings. First Officer Mills commented on the aircraft's radio to Kenora Flight Service Station (FSS) at 12:00 noon, "quite puffy, snow, looks like it's going to be a heavy one" (Exhibit 7A, p. 29). Shortly after the aircraft began to taxi, a passenger asked flight attendant Katherine Say when the aircraft was going to be de-iced. The flight attendants did not inform the flight crew of these expressed concerns about the need to de-ice.

The flight was delayed for approximately three minutes while a light aircraft in distress landed. At 12:07 p.m. CST the flight was cleared to Winnipeg, and at 12:09 p.m. First Officer Mills transmitted that the flight was about to take off. The aircraft crashed about one kilometre from the end of the runway.

The Regulatory Component

On March 10, 1989, the crew of Air Ontario flight 1363 was governed by the *Aeronautics Act*, the Air Regulations, and the Air Navigation Orders (ANOs) administered by Transport Canada. Several aspects of the regulations and orders that existed at that time provided an indirect, deleterious influence on the crew's operational environment. Certain regulatory requirements did not ensure the existence of safeguards that might have influenced Captain Morwood's decision to take off at Dryden, given the weather conditions and the aircraft's mechanical defect (the unserviceable APU) and the Air Ontario policy to shut main engines down during de-icing. The following issues are relevant to the regulatory environment:

- Transport Canada did not provide clear guidance for carriers and crews regarding the need for de-icing.

The regulatory requirement that existed at the time of the accident, ANO Series VII, No. 2, section 25(3), prohibited aircraft from commencing a flight "when the amount of snow, frost or ice adhering to the wings, control surfaces or propellers may adversely affect the safety of the flight." (Based on my first *Interim Report*, ANO Series VII, No. 2, has since been amended to remove a judgemental element in the original order.)

There were no regulatory requirements for training on the effects of aircraft contamination and associated phenomena such as cold soaking. Such requirements are now being considered by Transport Canada.

The information on aircraft icing contained in the A.I.P. Canada: Aeronautical Information Publication, produced by Transport Canada as an aviation reference manual, was very limited. The A.I.P. has since been amended to provide more comprehensive information; however, it contains no information about the cold-soaking phenomenon.

- Transport Canada did not rigorously monitor Air Ontario Inc. for regulatory compliance following its merger and during its initiation of jet service.

  Air Ontario operated the F-28 aircraft for a number of months without an approved minimum equipment list (MEL), yet deferred aircraft unserviceabilities to an MEL. Pilots used two different F-28 operating manuals on the flight deck. Neither Piedmont nor USAir authorized the use of these manuals for other than training, and an amendment service was not provided for either manual. These discrepancies were not discovered by Transport Canada, although Transport Canada reviewed and approved the F-28 flight-training program.

- A Transport Canada audit of Air Ontario was delayed and incomplete. It did not address the F-28 operation.

  A national audit of Air Ontario was scheduled by Transport Canada for February 1988. While the airworthiness, passenger safety, and dangerous goods portions of the audit were completed as scheduled, the flight operations portion of the audit was deferred and not completed until November 1988. In light of the recent and major changes that had occurred within the company, a thorough examination of flight operations was warranted. It is noteworthy that the audit that was eventually conducted failed to review the most significant operational change within the company, the initiation of jet service with the introduction of the F-28.

- Transport Canada regulations did not require licensing or effective training of flight dispatchers.

  Air Ontario operated with what it called a pilot self-dispatch system but employed flight dispatchers in that system to provide flight watch and assistance to flight crew as in a full-dispatch system. Since flight dispatchers were used in the system, it was important that they be properly trained. They were not. Transport Canada had no formal requirements for training and licensing of flight dispatchers.

- The Air Navigation Orders did not contain clear and definitive criteria for the qualification of persons in positions governed by regulations, that is, directors of flight operations, chief pilots, and company check pilots.

- Transport Canada did not have a comprehensive policy for the training and operational priorities of air carrier inspectors.

  The rate of turnover within the air carrier inspector ranks resulted in relatively inexperienced personnel being quickly pressed into service with little training for the task. Line checks, which may have revealed anomalies in Air Ontario line operations, were not routinely performed.

- Transport Canada did not have a clear definition as to what constituted an essential airworthiness item. Consequently, this left flight crews and management uncertain at times as to when and under what conditions an aircraft should, or should not, be dispatched.

  The evidence revealed that the Minimum Equipment List Order, ANO Series II, No. 20, provided little, if any, guidance to pilots as to what an essential airworthiness item was. Management interpretations of deferred snags or defects were therefore seldom challenged on the basis of stringent regulatory requirements.

In summary, the safety net that should have been provided through safety regulation, air carrier certification, inspection, and ongoing surveillance was lacking in a number of areas on March 10, 1989.

The Organizational Component

A number of Air Ontario's flight operations and overall management practices increased the potential for operational error. At the highest level, Air Canada, despite owning a controlling interest in the company, did not require Air Ontario to operate to Air Canada's operational standards, nor did it monitor Air Ontario operations or provide resources to achieve these standards. Some significant safety-related deficiencies developed at Air Ontario that may have been prevented or discovered by Air Canada had it taken a more active role in the operational management of its feeder. The focus of discussion in this chapter is not on faulting Air Ontario or Air Canada for not going beyond regulatory requirements; rather, it is to discuss the impact of the organizational setting and practices that were present at the time.

Lack of Operational Support from Air Canada

During the introduction of F-28 service, Air Canada owned a 75 per cent controlling interest in Air Ontario, which was operating under shared (AC) flight designators. Air Canada has had long experience in jet transport operations and in stringent requirements for dispatch and flight following. The resources of this organization would have been valuable in facilitating the merger of Austin Airways and Air Ontario Limited and in initiating the F-28 jet service. According to testimony, there were financial and labour relations reasons for maintaining a separation between the two carriers, and there was no regulatory requirement that obliged the parent company to share resources and impose its standards on Air Ontario.

The Potential Disruptive Impact of Mergers and Strikes

According to Dr Helmreich, research pertaining to crew attitudes and behaviour has been conducted in several airlines that were the result of mergers. As part of the research, crew member attitudes towards flight-deck management were assessed. The data show significant differences in attitudes as a function of previous organizational membership, in one case nearly a decade after a merger. The results clearly indicate the existence of enduring subcultures within organizations. When cultural factors support the maintenance of differing attitudes about the appropriate conduct of flight operations, the effectiveness of flight crew performance is likely to be compromised.

The process of combining seniority lists from merging organizations frequently results in poor relations among crew members from different airlines. The research also indicates that pejorative nicknames are sometimes employed to label crew members from the opposite side of mergers, as indeed occurred within Air Ontario.[8]

[8] Former Air Ontario Limited pilots referred to their Austin Airways colleagues as "bush pilots," while former Austin Airways pilots referred to their Air Ontario Limited counterparts as "401 pilots" – an allusion to the major highway running from Windsor to Toronto to Montreal.

The data indicate that labour-management strife can have a detrimental effect on crew members' morale and attitudes towards their organizations. There is no doubt that the negative climate fostered by poor pilot-management relations is not conducive to effective team performance. According to Dr Helmreich, relations among pilots and between pilots and management remain poor in some airlines for years after a strike.

In the course of the Air Ontario Limited–Austin Airways merger and in the period leading up to the pilot strike, there was apprehension among and a certain degree of animosity between the flight crews of the two companies. Several witnesses, however, testified that the strike served in some ways as a catalyst in bringing the two pilot groups together in a united front in their approach to management.

Although Captain Morwood and First Officer Mills came from different pre-merger companies and were involved with the strike, the evidence is that their relationship appeared to be normal. There is no evidence before the Commission that the pre-merger corporate subcultures or the pilot strike had any effect on the relationship of the two pilots of flight 1363.

High Personnel Turnover Following the Merger

The period between the merger of the two carriers and the accident saw substantial changes made in personnel. Part of the operation was sold, and the number of personnel in the combined organization was reduced from eight hundred to approximately six hundred. There was also turnover in two critical areas of management, the positions of vice-president of flight operations and director of flight operations. Similarly, the position of safety officer was filled, became vacant because of a resignation, and, after considerable delay, was subsequently refilled. The lack of continuity in management impeded needed supervision of operational issues, including the introduction of the F-28 aircraft and the standardization of operations following the merger.

Lack of Organizational Experience in Jet Operations

Air Ontario as an organization did not have experience in jet transport operations. At the time of the introduction of the F-28, efforts were made to acquire outside expertise in management, and representations to this effect were made to Transport Canada. Ultimately, Captain Claude Castonguay, who had substantial jet transport operational experience (including the F-28), was hired; but he resigned after one month, stating in his letter of resignation: "So much as I would like to keep working to establish your F-28 program, I have concluded that I cannot function in my duties as a check pilot when I do not get the support I need" (Exhibit 805). His only further involvement with Air Ontario was six months later, when he was called back to conduct line indoctrination training for a very short period of time. No one was subsequently hired from outside the organization to fill this role. Air Ontario elected to manage the F-28 program with internal pilot resources, consisting of pilots with minimal F-28 experience and no previous experience on large jet aircraft.

Deficiencies in System Operations Control Practices

Air Ontario operated with a dispatch and operational control system that consisted partly of full co-authority dispatch and partly of pilot self-dispatch. Although this system was permitted by current Transport Canada regulations, it failed to provide crews with the same level of support and resources as in the parent organization, Air Canada.

In the absence of regulations mandating formal training and licensing for dispatchers, Air Ontario primarily employed on-the-job training for dispatch personnel. For the introduction of the F-28, brief training in the operation of this type of aircraft was provided only for duty managers. In contrast, Air Canada provided its dispatchers with formal training and operational guidelines, including rules that would forbid dispatching an aircraft with an inoperative APU into any station with no ground-start capabilities. That the Air Ontario system was deficient is indicated by errors in flight releases, including erroneous fuel load calculations. Indeed, the flight release for C-FONF contained such errors on the day of the accident. Further, the failure to accommodate for forecast freezing rain in Dryden on March 10, 1989, represented another deficiency within Air Ontario system operations control (SOC).

Lack of Standard Operating Procedures and Manuals for the F-28

Revenue passenger service was initiated without a specific Air Ontario operating manual for the F-28. There was also no approved minimum equipment list for some months after passenger service began. There were inconsistencies between cockpit manuals and between cockpit and cabin manuals provided to crew members. For example, the flight attendant manual required passenger disembarkation for refuelling with an engine running, but there was no parallel rule in the flight operations manual or the aircraft operating manual. Crews thus lacked standardized operational guidelines either from manuals available on the flight deck or from SOC.

Inconsistencies/Deficiencies in Training F-28 Flight Crew Members

Initial training of F-28 flight crew members, including both ground school and simulator training, was contracted with Piedmont Airlines. Piedmont itself was involved in a merger with USAir, which decided to achieve standardization of the merged operation by shifting all former Piedmont personnel to USAir procedures and manuals. There were several implications of this merger for Air Ontario flight crews. Some crew members received training from the Piedmont F-28 manual, and those training later worked with the USAir manual. Since Air Ontario had not developed its own manuals, some individuals returned from their training sessions with the Piedmont manual and others with that of USAir. Although Air Ontario management witnesses stated that the Piedmont manual was its standard, this was not clearly communicated to crews, and no efforts were made to provide all crews with the same manual. Air Ontario also failed to arrange an amendment service for the manuals it was using. Although the Fokker F-28 Flight Handbook was carried in the aircraft, there was limited training in the use of this manual; and there were variances between the Fokker and Piedmont manuals – for example, in computing corrections for runway contamination.

Another result of the Piedmont/USAir merger was that the Piedmont F-28 flight simulator was not available for the training of Air Ontario flight crews. Because of this, a number of Air Ontario F-28 pilots were trained in the aircraft itself, by newly qualified Air Ontario F-28 training pilots, rather than in the Piedmont simulator. There is consensus in the industry that a flight simulator provides broader and more effective flight crew training.

Fight crew members surveyed by the Air Ontario safety officer following the accident generally reported their line indoctrination at Air Ontario to be "fair" in quality. One deficiency noted was a failure to define clearly the duties of the pilot flying and the pilot-not-flying, indicating a weakness in training and in flight-deck operating procedures.

Leadership of the F-28 Program

Captain Joseph Deluce was simultaneously the F-28 project manager and the chief pilot for both the F-28 and the Convair 580 aircraft. Captain Deluce had numerous responsibilities, including line flying during the strike that preceded delivery of the F-28 aircraft and conducting flight training and line indoctrination in the F-28 for new crew members. Captain Deluce, in addition to being overloaded with responsibilities, had limited operational experience on both the F-28 and the Convair 580 aircraft.

One incident that may have had a significant impact on the attitudes of crew members was the removal of an F-28 flight crew from a line trip to meet with the chief pilot, Captain Joseph Deluce, for allegedly writing up too many maintenance discrepancies in the aircraft journey logbook. One can easily understand how other F-28 pilots might interpret this event as a lack of leader support for optimal operating conditions and as strong pressure to operate at all costs.

The Informal Culture at Air Ontario

During the period of initiation of F-28 service at Air Ontario there was lax regulatory supervision, high management turnover, a self-dispatch system with SOC personnel who lacked knowledge of the F-28 and were generally inexperienced, and a lack of clearly specified and enforced standard operating procedures. Some crews, instead of entering mechanical problems or snags in the aircraft journey logbook, wrote them on loose pieces of paper and passed them on to relieving crews, thus permitting deferral of maintenance and avoiding the grounding of aircraft.

Another non-standard procedure was the "80-knot check," a visual examination of the wing surfaces during takeoff to ensure that contamination had blown off prior to rotation. Captain Deluce, who had been involved in at least two earlier reported incidents involving take offs with snow- or ice-contaminated surfaces that resulted in emergency landings, contributed to this lax attitude at Air Ontario. These examples suggest that crews may have been allowed considerable leeway in making decisions about whether to take off with surface contamination, a practice that, unfortunately, was not unequivocally proscribed by the then current Transport Canada regulations.

Former Austin Airways pilots, including Captain Joseph Deluce, who formed a large part of the leadership in Air Ontario flight operations management, were branded as "bush pilots" by former Air Ontario Limited pilots. No doubt the name refers to the roots of Austin Airways in charter and cargo operations in Northern Ontario and Quebec. The term is not necessarily pejorative. Some former Austin Airways pilots, for example Captain David Berezuk, were quite proud to describe themselves as bush pilots; in fact, the term can connote ability to fly safely in particularly harsh operating environments with a certain independence and self-reliance and with a willingness to make every effort to complete a flight.

I read with great interest a special study of the National Transportation Safety Board (NTSB) on air taxi safety in Alaska, in which "bush pilot syndrome" was described:

> [S]tatements from operators, pilots, and regulatory personnel in the Alaskan aviation community suggest that the "bush pilot syndrome" may be an integral factor not only in high pilot involvement but also in the high accident rate in Alaska.
>
> Descriptions of the "bush pilot syndrome" range from a pilot's casual acceptance of the unique hazards of flying in Alaska to a pilot's willingness to take unwarranted risks to complete a flight. In Alaska it is not uncommon for pilots to fly in extremely poor weather or to attempt to land on runways that are in bad condition or off the airport on snow-covered strips or frozen lakes marginally suited for landing. Stories abound about pilots who have been involved in numerous accidents and have survived. These pilots have become near legends and are spoken of almost reverently by some young pilots ... Taking chances is considered a part of flying in Alaska by many Alaskans – not just the pilots, but also the passengers. Passengers affected by the "bush syndrome" demand to fly even in hazardous weather conditions, and if one pilot or operator will not fly, the passengers will go to another operator; occasionally they find one who will fly in hazardous weather conditions.
>
> The "bush syndrome" goes beyond the realm of poor judgment compounded by pressures and into the area of unreasonable risk-taking. Although the "bush syndrome" apparently exists, it cannot be unequivocally demonstrated by statistical data. However, it is clear that most operators, pilots, and others associated with Alaskan aviation believe that it does exist. The review of accident cases further supports the contention.
>
> ...
>
> Although the pilot is cited in a higher percentage of air taxi accidents in Alaska, that statistic does not tell the entire story and may even be misleading. The Safety Board determinations of detailed cause/factors in air taxi accidents in Alaska were compared with the determinations for accidents in the rest of the United States. This comparison indicated that when the pilot was cited as the broad cause/factor, several detailed cause/factors pointing to two general problem areas frequently appeared. These problem areas are: (1) inadequate airfield facilities and inadequate communications of

> airfield conditions, and (2) inadequate weather observations, inadequate communications of the weather information, and insufficient navaids.[9]

These NTSB observations were echoed by Mr Martin Brayman of Transport Canada, when he testified about the northern environment within which Austin Airways operated. Mr Brayman was shown the accident statistics for a number of carriers, including Austin Airways, that operated in northern and remote regions. In discussing the accident rates of these carriers, he stated that there is "a direct relationship between the number of accidents or incidents that a carrier has and the condition under which the carrier operates" (Transcript, vol. 131, p. 63). He pointed out that in northern Canada, in mountainous areas like British Columbia, in northern Quebec, and in the Arctic there are a number of factors that have to be taken into account with respect to operations.

Mr Brayman expressed his opinion with respect to the element of risk involved in the hostile environment of northern operations:

> A. ... there is no question that in remote areas where the population demands a reasonably high level of air service, and in Canada, our native peoples surely do that, the carriers are hard-pressed often to meet those demands.
>
> You are working in areas of bad weather, poor runways, little in the way of runway markings or approach aids, weak beacons often covered with ice. So ... it is a hostile environment.
>
> And if you take it even further to operations that extend out onto the sea ice, for instance, a lot of the northern operators land and take off from frozen lakes, from frozen sea ice, they touch down on frozen cracks in the sea ice. There is no question there's an element of risk.
>
> (Transcript, vol. 131, pp. 63–64)

He elaborated on the difficult conditions habitually faced by pilots in northern operations:

> A. You are getting in an area that has a paucity of aids to the pilot. You are dealing with basic single runway strips. You are dealing with heavy snowfalls, high snowbanks, drifting snow,

9 National Transportation Safety Board, *Special Study: Air Taxi Safety in Alaska* (Washington, D.C.: September 16, 1980), pp. 19–20

> white-outs. It's a very difficult area to fly in successfully. Extremely cold temperatures, heavy icing during transitional periods, spring and fall. Yes, it's a very, very difficult area to fly in.
>
> (Transcript, vol. 131, p. 65)

One can easily imagine how the message communicated during training, and in the Fokker manual for the F-28, that no snow, ice, or frost should be present on wings, may have been discounted to some extent by crews who had successfully operated (albeit in different types of aircraft) with some degree of contamination. Combined with a "bush culture" which was attributed to much of the operational management of Air Ontario, this tendency would not have been properly checked by the F-28 chief pilot or the director of flight operations. In all likelihood, the permissive management environment at Air Ontario probably exacerbated such non-standard operational practices.

Additionally, the Transport Canada air carrier inspector appointed for the F-28 fleet, who was relatively inexperienced in the aircraft, may not have been in a strong position to impose appropriate standards.

Maintenance Problems with the F-28

A number of maintenance problems were encountered with the F-28. These were exacerbated by a lack of familiarity with the aircraft on the part of maintenance personnel and a shortage of spare parts. The journey log for the accident aircraft, C-FONF, listed a number of problems between June and December 1988, many of which were deferred for extended periods. These included earlier problems with the auxiliary power unit (APU) in August and October 1988. On several occasions in 1989 the cabin filled with smoke while passengers were aboard, and, in the week of the crash, the aircraft experienced cabin pressurization problems.

On the day of the accident, C-FONF was dispatched with an unserviceable APU and had three other deferred maintenance items, including roll and yaw in the autopilot and a fuel gauge that read intermittently. Other discrepancies that were brought to the attention of the flight crew by the cabin crew prior to the first flight on March 10 were inoperative exit lights, dim cabin emergency floor lighting, missing oxygen masks, and problems securing the main door handle because of a missing clip. Though these items, with the exception of the APU, do not have an appreciable safety significance, they reflect a haphazard maintenance philosophy that can result in accidents.

Flight Attendant Training

Flight attendant training at Air Ontario did not encourage flight attendants to bring operational issues to the attention of the flight deck or to question matters pertaining to flight operations. Training stressed the competence of pilots and fostered a position of total reliance on the flight crew. Two examples that demonstrate a separation of cabin and flight deck can be seen on the day of the accident: the hot refuelling of the aircraft in Dryden that was at variance with the flight attendant manual, and the failure of the flight attendants to relay passenger concerns about de-icing to the flight deck. In contrast to this lack of crew communication, the concepts taught in crew resource management stress the importance of complete information exchange between the flight deck and the cabin.

The Physical Component

A number of negative factors were present in the physical environment facing the crew on March 10. These included an aircraft with mechanical problems, no F-28 ground-start equipment in Dryden, poor weather with snow and freezing precipitation throughout the area of the flight, and a change in the passenger load in Thunder Bay that required an unplanned defuelling of the aircraft.

The Aircraft, C-FONF

The operations officers in Air Ontario SOC and the flight crew knew that the APU of aircraft C-FONF was unserviceable on the day of the crash. Mr Martin Kothbauer, the SOC duty manager, had even sent a message to Winnipeg, Thunder Bay, Dryden, and Sault Ste Marie to advise that C-FONF was operating without a serviceable APU and to ensure that the agents had the F-28 ground power and air start equipment ready. The message also stated that if air starts could not be provided, SOC was to be advised so it could set up hot refuelling. It was not determined what steps SOC would have taken to set up hot refuelling, if it was required, but Dryden had no F-28 start equipment, and there is no evidence that anything was done by SOC with regard to hot refuelling in Dryden.

There were other minor unserviceabilities on the aircraft that day, but none of them in isolation would pose a concern for any of the air crew. The accumulation of the unserviceabilities probably were frustrating for them.

The Weather

The weather conditions throughout the scheduled routing area of Air Ontario flights 1362 and 1363 were poor during March 10, 1989, and created complications for Captain Morwood. At Winnipeg he had the aircraft de-iced because it had frost on it, thereby causing the first delay of the day. Subsequently, because the weather at Thunder Bay was below published landing minima, flight 1362 was delayed on the ground in Dryden while it waited for the weather in Thunder Bay to improve. The alternate airport for all of the flight legs was Sault Ste Marie, rather than the normal closer alternates, which meant that more fuel had to be carried and that more attention had to be paid by the flight crew to the weather en route, at each destination and alternate airport, and to aircraft takeoff and landing weights. There was freezing precipitation, occasional freezing precipitation, or the risk of freezing precipitation forecast for all of the terminals in question, but the flight crew's knowledge of the implications of this forecast is not known. With regard to the operation of flights 1362 and 1363, there is no evidence that the forecast of freezing precipitation altered or otherwise played a part in Captain Morwood's decisions or in any of the decisions of the SOC personnel.

The weather in Dryden during the stopover of flight 1363 deteriorated from a VFR day with a ceiling of 4000 feet and visibility of 12 miles at landing to a low IFR day with the weather report at 12:06 p.m. CST, three minutes before the start of the takeoff roll, indicating a ceiling of 300 feet and visibility of three-eighths of a mile in snow. The lowest condition forecast for Dryden for the period of the flights was occasional ceiling 700 feet broken and visibility two miles in light rain and fog. The lowest condition forecast for Dryden in the forecast issued at 1630Z (10:30 a.m. CST and 11:30 a.m. EST), and available to the flight crew in Thunder Bay before takeoff for Dryden, was a broken ceiling at 3000 feet and visibility five miles in light rain, light freezing rain, and fog. This was the latest and last forecast issued for Dryden prior to the crash. There is evidence that SOC did not note the mention of freezing precipitation and that SOC did not pass the forecast to the crew of flight 1363.

The low ceilings and visibility encountered by the flight crew when they were preparing for the takeoff from Dryden may have surprised them somewhat. However, Canadian commercial pilots encounter poor weather conditions many times in their careers, and, for the most part, they accept poor weather as part of their job. Inevitably, though, poor weather conditions put extra pressures and workload on pilots both in flight planning and in flying the aircraft.

Activities in Thunder Bay

A number of decisions imposed by SOC resulted in flight 1363 falling further behind schedule. The decision to defuel in Thunder Bay after the aircraft had been refuelled, in order to take on board eight extra passengers, had an impact on the flight crew in many ways. The defuelling caused a further delay of 35 minutes in the departure, and Captain Morwood particularly disliked being late. Captain Morwood and First Officer Mills had to recalculate the takeoff and landing data to accommodate the increased passenger load and reduced fuel load. Captain Morwood's authority as the pilot-in-command, within Air Ontario's hybrid pilot self-dispatch and full co-authority dispatch system, to operate the flight as he deemed necessary with regard to fuel and passenger loads was effectively usurped by SOC in London, in that the SOC solution to the aircraft overweight condition (to defuel, rather than to off-load passengers) prevailed.

After the decision had been made to defuel the aircraft, both Captain Morwood and First Officer Mills got off the aircraft. Captain Morwood spoke to Mr Gary Linger, the owner of ESSO Flight Refuelling at the Thunder Bay airport and the person who defuelled the aircraft, and they discussed the amount of fuel to be taken off. During his testimony, Mr Linger described Captain Morwood in words such as "calm," "very professional," and "apologetic," in that Captain Morwood said to him: "Sorry to bring you down here again" (Transcript, vol. 56, pp. 82–89).

Flight attendant Sonia Hartwick testified that during the Thunder Bay station stop the crew were "becoming very frustrated." This frustration was expressed verbally and, in Mrs Hartwick's opinion, resulted from a combination of things that had happened earlier in the week and were happening to them in Thunder Bay. In testimony she stated:

A. They were ... becoming very frustrated. They felt like we were all being ignored. No one was coming to our rescue. We sat there and we were actually delayed one hour in Thunder Bay.
Q. As a matter of fact, did the captain to the best of your recollection make a bit of a comment that you recall?
A. Well, he was very upset. He may have swore and said God damn it like this but ...
Q. He felt ignored, didn't he?
A. We all felt ignored. Passengers had connections to make in Winnipeg and we were delayed a total of an hour in Thunder Bay. So, we were worried about them as well.
Q. Did you find that First Officer Mills felt slightly ignored and annoyed as well?
A. Yes, they both –

Q. They both were?
A. Yes, they were.

(Transcript, vol. 10, pp. 191–92)

While Captain Morwood's frustration may not have been evident to Mr Linger, it was certainly evident to flight attendant Hartwick during discussions among the crew members. Although it is not conclusive from the evidence whether Captain Morwood's frustration influenced his decision making at Thunder Bay, it may well have manifested itself as a factor both in any consideration that should have been given to the option of overflying Dryden on the return leg to Winnipeg, having regard to the forecast freezing rain, and in the decision not to de-ice the aircraft with no operable APU and no ground-start facilities at Dryden.

The Crew Component

A number of factors present among the crew of the accident flight have been identified through research in other organizations as significant stressors that can serve to reduce flight crew effectiveness. These include situational factors surrounding the operation of the flight as well as characteristics of individual crew members.

Situational Factors

Crew Members' Knowledge and Training

Captain Morwood and First Officer Mills each had fewer than 100 hours of flight time on the F-28 aircraft. After completion of ground and simulator training at Piedmont, Captain Morwood returned to flying the Convair 580. His line transition to the F-28 was further delayed by the Air Ontario pilots' strike. The delay in reinforcing Captain Morwood's training on the line could have rendered him less effective initially. First Officer Mills received all of his training in the aircraft rather than the simulator. The lack of opportunity to use the simulator to acquire F-28 skills and confidence, particularly with respect to practising abnormal or emergency situations, could have affected First Officer Mills's ability with regard to abnormal and emergency situations on the F-28.

There is growing concern in the industry, based on several recent accidents in the United States, about the safety implications of pairing crew members new to an aircraft soon after completion of line indoctrination. It takes a significant amount of flight time to become comfortable with a new aircraft, particularly one substantially different from prior equipment. One of the basic premises of the crew concept of flight operations is that crew members support each other in safe and effective flight management. When both crew members are still becoming familiar with the aircraft, the margin of safety is reduced. Efforts are under way in the United States to require newly qualified crew members to be scheduled with more experienced crew members for some time following completion of their initial operating experience (a mandated period after initial training of flying with a company check pilot while gaining familiarity with the aircraft in line operations). In that regard, the evidence of Captain Gert Andersson, a highly experienced pilot with Linjeflyg, a Swedish carrier flying F-28 aircraft in Europe, is worth noting. According to Captain Andersson, the Linjeflyg computerized crew-scheduling program precludes the scheduling of an inexperienced captain with an inexperienced first officer (Transcript, vol. 83, pp. 158–60). The crew-pairing problem caused by the introduction of a new aircraft type is, in my view, best addressed by bringing in outside expertise, as Air Ontario initially represented it was doing by hiring Captain Claude Castonguay, to support training, line indoctrination, and general flight operations until such time as company pilots have obtained the requisite experience levels to be paired together. Captain Castonguay, however, resigned after one month, citing lack of support by Air Ontario management.

Organizational Background and Experience Working Together

Several additional issues made the pairing of Captain Morwood and First Officer Mills potentially stressful. One was the fact that Captain Morwood came from Air Ontario Limited while First Officer Mills came from Austin Airways. Additionally, both men had been operating as captains in their prior aircraft. Individuals accustomed to acting as pilot-in-command have been noted to function less effectively when paired with one another, in that a captain wants to be a captain. A concern in that regard was expressed in evidence by Captain Erik Hansen, an Air Ontario F-28 pilot. He had no difficulty with the competence of First Officer Mills, but found that First Officer Mills had a tendency to make decisions that were not his to make (Transcript, vol. 94, p. 87). These factors, combined with the lack within Air Ontario of enforced standard operating procedures, including the noted failure to specify pilot-flying/pilot-not-flying duties in flight-training line indoctrination, could well have reduced the effectiveness of this crew as a team (Exhibit 744).

The week of March 6 to March 10, 1989, was the first time that Captain Morwood and First Officer Mills had flown together, and Captain Morwood was displaced by other captains for two days. At the time of the accident, their total time flying as a crew was just over two days. According to Dr Helmreich, experimental simulation research conducted by NASA-Ames Research Center found that crew coordination and effectiveness are significantly increased by the simple fact of working together as a team.

Delays and Stresses Imposed by the Operating Environment

The initial flight segment on March 10 was delayed because the aircraft was de-iced in Winnipeg. As noted, there were also deferred APU unserviceability and minor mechanical problems with C-FONF. In a radio communication shortly after takeoff from Winnipeg, Captain Morwood commented, "everything else seems to be going wrong today" (Exhibit 375). Upon arrival at Dryden, flight 1362 was held on the ground for some 20 minutes while it waited for Thunder Bay weather to improve. Because of defuelling in Thunder Bay, departure from Thunder Bay was more than an hour behind schedule.

At Dryden, it was necessary to refuel flight 1363 with an engine running. It is not known why the passengers were not disembarked at Dryden during the hot refuelling. During the refuelling, snow was falling. As Captain Morwood had fewer than 100 hours in the aircraft type, he was required by Air Ontario policy to have higher takeoff weather limits than a more experienced pilot on type would have had. He may have been concerned that the visibility would be below his limits prior to departure. The flight was already running late, and a number of passengers had tight connections in Winnipeg. After the aircraft taxied for departure, a final delay of approximately three minutes was incurred waiting for the arrival of a Cessna 150 that was experiencing difficulties because of the poor weather. There is little doubt that the continual delays and problems encountered throughout the day added frustration and stress to the overall operation of flight 1363.

Personal Factors

Fatigue and Mood

The term acute fatigue is used to indicate short-term fatigue, such as the result of losing a night's sleep, while the term chronic fatigue is used to indicate long-term fatigue, such as the result of working long hours for an extended period of time. Acute fatigue is considered less serious because it can be relieved relatively easily, whereas chronic fatigue cannot. Further, acute fatigue is usually recognized by the person experiencing it, whereas chronic fatigue can be insidious because of a failure of the person involved to recognize it.

A review of the work schedules for Captain Morwood, First Officer Mills, and flight attendants Say and Hartwick for the period January 1, 1989, to March 10, 1989, indicates that none of them, based solely on their work schedules, should have been suffering from chronic fatigue. They had days on duty and days off duty as follows: Morwood 31/38, Mills 39/30, Say 35/34, and Hartwick 33/36. Their flying schedule for the week of March 6 to 10 started each day at 7:30 a.m. and ended at 3:30 p.m.

The days on and days off, and the duty period each day are well within all of the maximum duty times for the flight crew (pilots) as specified in ANO Series VII, No. 2, section 41.1. While the flight attendants were also within the maximum duty times for flight crew, there are no regulatory requirements in the ANOs or elsewhere regarding maximum duty times for flight attendants. There was no evidence to indicate that any of the crew members were experiencing the effects of chronic fatigue.

There is some evidence that Captain Morwood, First Officer Mills, and flight attendant Say may have been experiencing mild acute fatigue. Flight attendant Hartwick stated in testimony that Captain Morwood had said in conversation that he had tossed and turned all week and was getting phone calls that interrupted his sleep. She also stated that Mrs Say had complained about her lack of sleep. First Officer Mills had complained that he had too much coffee, presumably a reference to his inability to get a good night's sleep (Transcript, vol. 10, pp. 156–58). Mrs Hartwick had had no difficulty sleeping and was not tired. "I was sleeping like a log. I got to bed really early that whole week, and I just bugged them [other crew members] about that" (Transcript, vol. 10, p. 158).

Mr David Adams, in testimony, discussed the investigation into possible fatigue of the crew:

> A. We collected as much information as was reasonably available in terms of what their duty times were, flight times, what their personal activities were in the week preceding the accident. We tried to determine where they had meals, what time they went to sleep, how many interruptions they went through during the evening, so on and so forth.
>
> And basically ... it's my opinion, that we exhausted all of those avenues of information.
>
> The information basically told me that Katherine Say, First Officer Mills and Captain Morwood were all probably suffering some degree of mild acute fatigue.
>
> The next step was to try and relate that condition, if it did probably exist, to the sequence of events leading to the accident. And I was not able to do that, other than to make the observation that one of the empirical findings of fatigue is an increased reporting of their subjective feelings of irritability by people who are fatigued.

> And I made the comment that if, in fact, this was the case, it may have contributed to Captain Morwood's feelings of frustration.
>
> But as far as I'm concerned, we exhausted the issue with the available information in this accident.
>
> (Transcript, vol. 159, pp. 184–85)

Dr Helmreich commented on Mr Adams's testimony as follows:

> A. I think Mr Adams put it perfectly. I certainly feel that the issue of fatigue is an important current research topic and it's one that's being investigated in a number of places. But I simply don't see it as having relevance to the scope of this Inquiry.
>
> (Transcript, vol. 159, p. 185)

The crew, according to flight attendant Hartwick, were in good humour throughout the week they flew together. When asked during her testimony about the mood of the crew members on March 6, the first day of their week's flying, she said, "They were in a very good mood ... They were happy, in fact, because they would be starting holidays the following week, so they were very happy" (Transcript, vol. 10, p. 134). Mrs Hartwick used the same type of words to describe the mood of the crew members each day that week. However, she did state that they were frustrated at times because of the defects on the aircraft and, particularly during the stop in Thunder Bay on March 10, 1989, with the delay and confusion regarding the extra passengers and defuelling.

Toxicology Results

Toxicological testing was completed on all of the deceased passengers and crew. The results for the crew members showed no evidence of alcohol or drugs. The results for flight attendant Say showed an elevated level of hydrogen cyanide in her blood. This finding is considered to be the result of inhalation of toxic gases that may be generated during the combustion of aircraft materials.

Captain George Morwood

Captain Morwood received 22 hours of F-28 simulator training following his initial ground school in 1988 and a further 8 hours 20 minutes during his recurrent training in 1989. At the time he commenced flying the F-28 as a line captain he had accumulated a total of 29 hours aircraft time, which included 27.5 hours of line indoctrination and 1.6 hours aircraft training. All of his check rides during training were well flown, and he received nothing but satisfactory comments on his training and check ride reports. At the time of the crash, Captain Morwood had 81 hours on the F-28. I conclude that Captain Morwood was properly trained to fly the aircraft.

According to his record and the evidence of his peers, Captain Morwood was considered above average as a professional pilot. He had shown not only a concern, but a dogged determination in his pursuit of safety issues in his prior management positions. Captain Morwood during his F-28 training at Piedmont Airlines had been exposed to and was aware of the effects of icing on the F-28, including those caused by differential temperatures of fuel and ambient air. It should be noted, however, that, despite the best efforts of Commission staff, no direct evidence was found that either Captain Morwood or First Officer Mills was fully conversant with the cold-soaking phenomenon and its potential effect with respect to aircraft contamination.

The evidence of another senior Air Ontario captain, Mr Erik Hansen, who attended both the initial and the recurrent F-28 ground school with Captain Morwood, was that the sensitivity of the F-28 wing to contaminants was covered very thoroughly by Piedmont instructors. These same instructors, in response to Captain Morwood's questioning, insisted that the wings not only be clean for takeoff, but that they be "super clean" (Transcript, vol. 94, pp. 70–74).

Captain Hansen's evidence suggests that some Air Ontario Convair 580 pilots were not particularly concerned about wing contamination on that aircraft and that they had previously taken off with some contamination adhering to the aircraft. Captain Morwood may well have been one such pilot. He was reported by his colleagues to be a by-the-book pilot and, by Captain Hansen, "a proverbial instructor" when flying on the line (Transcript, vol. 94, p. 101). Another colleague described him as being "a little condescending," as coming from "the old school where the captain is the captain and the first officer is the first officer," and that he "wasn't quite as tied into the modern concept of the team concept" (Transcript, vol. 92, p. 61). In theory, this characteristic could have been an annoyance to highly experienced junior crew members such as First Officer Mills, who had considerable experience flying as a captain. Evidence from the surviving flight attendant and a company employee who occupied the flight-deck jump seat during the previous leg indicates, however, that the two pilots were getting along well together and were both in good moods.

Evidence from several witnesses shows that Captain Morwood had a strong commitment to on-time operations and a high level of concern for his passengers. A number of passengers had connecting flights in Winnipeg on March 10. Some of these passengers had expressed their concerns about missing their connections to the flight attendants, who in turn passed the concerns to the flight crew. In addition, Captain Morwood had a personal trip scheduled for the following day out of

Toronto. These factors could have heightened his motivation to complete the scheduled flying as near as possible to the schedule.

First Officer Keith Mills

First Officer Mills completed 8.3 hours of training and a 1.2-hour pilot proficiency check on the F-28 aircraft in February 1989; he did not have the opportunity to train in the simulator. He flew 20 hours of line indoctrination and then, with 29.5 hours on the aircraft, began duties as an F-28 first officer. His F-28 training and check ride reports, although incomplete, indicated that his training was satisfactory, although there were some elements of the training that were considered satisfactory only after debriefing.

First Officer Mills had a record of some difficulties with the aircraft-handling aspects of flying, but he met all regulatory requirements for competence. The fact that he did not receive simulator training in the F-28, along with Captain Morwood's long experience and reputation as a perpetual instructor, may have made First Officer Mills somewhat reluctant to practise optimal crew resource management concepts and to provide operational suggestions to Captain Morwood. First Officer Mills also had scheduled personal plans for the next day.

Flight Attendants Katherine Say and Sonia Hartwick

There was only one flight attendant activity that could have had a bearing on the captain's decision to take off: the flight attendants' going to the flight deck and expressing their concerns and those of the passengers regarding the accumulation of snow on the wings of the aircraft. Flight attendant Hartwick testified that she had heard passengers expressing their concerns about the accumulating snow, and she heard Special Constable Dennis Swift discussing the subject with flight attendant Say. Special Constable Swift, in testimony, corroborated Mrs Hartwick's testimony. Flight attendant Hartwick did not talk to the flight crew about the snow on the wings, and the evidence is overwhelming that flight attendant Say did not do so either. Cabin crew members are often reluctant to discuss operational problems with flight crew, as discussed in detail in chapter 39, Crew Coordination and Passengers' Safety Concerns.

Passengers and Ground Crew

There were two professional pilots on the flight as passengers, Captain David Berezuk and Captain Murray Haines. Although during their testimony they both stated they were very concerned about the buildup of contamination on the wings, neither of them, for their own reasons as discussed in chapter 39, passed his concerns to the cabin crew or the flight crew. Two ground personnel, Mr Jerry Fillier and Mr Vaughan Cochrane, could have had an influence on the captain's decision to take off, although the accumulation of snow on the aircraft was not as great while the aircraft was at the ramp as it was later while the aircraft waited to take off. Mr Cochrane talked to the flight crew when he went to the flight deck to pass on information about the baggage, again when he passed the information about the fuel upload, and when he was asked by the captain about the availability of de-icing. There was some evidence that ground personnel are also reluctant to approach flight crew with operational concerns because of the fear of a rebuff, a cause for embarrassment.

The Situation on March 10, 1989

The picture that emerges from examination of the regulatory and organizational environments in which this crew was operating is one of an array of factors that served to undermine crew effectiveness and to increase their level of stress. I believe that none of these factors in isolation is likely to cause an accident – as evidenced by the fact that the F-28 was operated without an accident for several months prior to March 10. However, when these seemingly unrelated factors were combined with the particular conditions of the physical environment, the margin of safety was clearly reduced. Factors in the crew environment such as the operational unfamiliarity of the crew with each other and the aircraft, combined with absence of clear understandings with respect to communication within the crew, no doubt exacerbated the situation.

Operational Stressors

In considering the crew's actions on March 10, the operational factors that may have caused them stress should be reviewed. According to research in the field of human performance, psychological stress can serve to reduce individual and team effectiveness, especially in the areas of interpersonal communications and coordination and in decision making. Relevant classes of stressors include time pressure and frustrations associated with inadequate resources and suboptimal operating conditions. Captain Morwood and First Officer Mills faced a number of these conditions during March 10. It may provide a useful context for the situation at Dryden to summarize them.

- On accepting the aircraft in Winnipeg, the flight crew found the APU to be unserviceable. As noted previously, there were three more deferred maintenance items, as well as other items in the cabin that were reported by the flight attendants.

- The weather conditions throughout the region forced an initial delay for de-icing and the adoption of a more distant alternate, with a consequent requirement to carry additional fuel. Conditions also required the crew to be continually concerned about the weather.
- It was necessary to hot refuel during the stop in Dryden.
- The necessity to keep an engine running may have triggered concerns because of company policy, and a stated requirement in the Fokker Publication on Cold Weather Operation, that the aircraft could not be de-iced with the engines running.
- SOC dispatched the flight with a clearly erroneous flight release. It may have been a source of concern for the crew to have been dispatched with no explicit accommodation for the unserviceable APU under conditions of freezing rain.
- Both crew members had fewer than 100 hours in the F-28. In addition to the stress imposed by lack of familiarity with the aircraft, Captain Morwood had more restrictive company takeoff and landing weather limits because he had less than 100 hours on the aircraft type.
- The flight was delayed on its initial stop in Dryden because Thunder Bay weather was below Air Ontario landing limits.
- A major delay occurred in the departure of flight 1363 from Thunder Bay.
- There was considerable confusion surrounding the loading of additional passengers in Thunder Bay, and, after the aircraft had been refuelled, the need then to defuel the aircraft to meet weight restrictions. The defuelling added a further delay of 35 minutes to the already delayed flight.
- The crew had difficulty in Thunder Bay in obtaining assistance from Air Canada during the station stop.
- As the flight landed in Dryden, snow began to fall, with the intensity of the fall increasing during the stop. At the time of takeoff, the actual visibility was below the captain's takeoff minima.
- The date of the accident was the beginning of the March school break, and the aircraft was full. A number of passengers had flight connections to make in Winnipeg. If the connections were to be made, further delays, such as would have been necessitated by de-icing of the aircraft, could not likely be tolerated.
- Flight 1363 left the ramp at Dryden just over an hour behind schedule, only to be further delayed by the Cessna 150 that was caught in the snow storm.

While none of these issues alone can be considered an overwhelming stressor, taken together they indicate a taxing operational environment.

From the perspective of hindsight, it is likely that a change in any one of a number of conditions might have interrupted the sequence of events that led to the accident. The following four examples illustrate the point:

- A more stringently regulated and managed dispatch system should have precluded operations into Dryden on March 10, or at least on the return from Thunder Bay.
- A more stringent regulatory requirement and a mandatory training program on the effects of contamination, including the cold-soaking phenomenon, may well have created a greater sensitivity on the part of the flight crew to the potential for degraded airfoil performance.
- An effective training program in crew resource management could have resulted in a review of the operational situation involving both pilots and led to a critical evaluation of the appropriateness of the decision to take off without de-icing.
- Similarly, training that encouraged cabin crew members and ground support personnel to share operational concerns with flight crews and encouraged pilots to listen to such concerns might also have triggered further consideration of the implications of contamination on the aircraft.

The issues discussed in preceding sections have an empirical basis as significant influences on flight crew behaviour, but a weighting of each issue as a determinant of the outcome of flight 1363 cannot be made from the available record. Nor can the decision processes surrounding the takeoff from Dryden be specified in the absence of cockpit voice recorder evidence. However, considering the four components affecting crew behaviour, the regulatory, organizational, physical, and crew components, it is possible to construct a likely scenario for the crew's actions. It must be stressed that this scenario represents an after-the-fact reconstruction from the available evidence.

A Scenario for Crew Decision Making in Dryden

In retrospect, the operation into Dryden on the return from Thunder Bay, without a functioning APU and already behind schedule, is questionable. Certainly, making the stop would minimize passenger disruption. An alternative was to leave the extra passengers in Thunder Bay, carry additional fuel, and proceed directly to Winnipeg. The evidence of Captain Erik Hansen, an Air Ontario F-28 captain, is revealing:

> A. And the only thing I don't understand is why George decided to defuel in Thunder Bay to accommodate more passengers, because he was already late, I understand.

> And what I would have done differently was I would have told these passengers that just the space wasn't available. There are weight penalties, obviously. He had fuel to go all the way through to Winnipeg.

Later in the same discussion:

> Q. Supposing the decision in Thunder Bay to take on these passengers was not his but someone else's?
> A. It's still George's decision if he wants them or not. If he can give a good reason why he doesn't want them ...
> Q. Suppose he was told by SOC to take them on.
> A. I don't think George would be intimidated by SOC.
>
> (Transcript, vol. 94, pp. 172–76)

Although the latest forecast for the Dryden terminal available to the flight crew while they were in Thunder Bay forecast occasional light freezing rain, the forecast was not passed to the crew by SOC. There is no evidence to indicate whether the flight crew obtained the new Dryden forecast during the station stop in Thunder Bay. It is not known whether Captain Morwood considered the option of overflying Dryden; however, the option existed and would have been justified in light of the status of the aircraft, the fact that they were already behind schedule, and the forecast for freezing rain at Dryden.

The actual weather conditions on approach to Dryden were VFR. However, once the aircraft was on the ground in Dryden, the weather and the operational situation deteriorated. It should be noted that the crew was conducting a day of flying that must be considered stressful because of the mechanical problems with C-FONF, increasing delays, the frustrations experienced at Thunder Bay, the poor weather conditions, and the flight crew's relative inexperience in F-28 operations. While the aircraft was on the ground in Dryden, the following issues faced the crew:

- refuelling with an engine running;
- passenger connections at Winnipeg;
- de-icing with an engine running;
- the need to import ground-start equipment if both engines were to be shut down;
- the inconvenience and cost of stranding passengers in Dryden;
- snowfall during the stop, causing both aircraft and runway contamination;
- the implications of contamination on the aircraft;
- the implications of contamination on the runway;

- variance among Fokker, Piedmont, and USAir manuals regarding correction charts for takeoff from contaminated runways;
- deteriorating visibility that may have prevented the takeoff;
- the delay caused by the arrival of the Cessna 150; and
- personal plans of the crew for the next day.

According to Dr Helmreich, one of the effects of psychological stress, including that imposed by time pressure, is an inability to process multiple sources of information as effectively as under more relaxed conditions. As outlined in the previous section, a strong case can be made for a finding that the crew, and especially Captain Morwood as pilot-in-command, was under considerable stress by the time the flight stopped for the second time in Dryden. There is the evidence of Captain Morwood's demonstrated frustration during his telephone calls at the Air Ontario counter at Dryden. The aircraft load sheet containing aircraft weight and balance data was normally left with the station attendant immediately prior to departure from the ramp. According to the evidence of Mr Cochrane, the flight crew did not pass this document to him. In fact, after the aircraft was closed up and the second engine started, "First Officer Mills held the weight and balance up in the window to indicate that he had it in his possession" (Transcript, vol. 53, p. 163).

In addition, there was the evidence of Ms Jill Brannan, a Dryden Flight Centre employee on duty at the time of the accident, and of Mr Christopher Pike, who was near Ms Brannan at the time, that after flight 1363 taxied away from the ramp, there were two radio transmissions from the aircraft to the Dryden Flight Centre. Their evidence was that, during the radio transmissions, the pilot "seemed upset," "mad," "impatient," and "pissed off" at the prospect of yet a further delay caused by the Cessna 150 (Transcript, vol. 20, pp. 174–75; vol. 28, p. 22). The mood of the flight crew, combined with the lack of Air Ontario operational support and safety-oriented operating policies, may have precluded a rigorous crew evaluation of the operational situation.

The decision to take off raises several critical questions. One is whether the crew was fully aware of the safety implications of the accumulating snow. As noted, Captain Morwood had a history of concern and awareness of icing risks. He had delayed the initial flight of the day for de-icing. Testimony by a representative of Transport Canada described an incident when Captain Morwood insisted on going back to the gate in a Convair 580 for de-icing even though the Transport Canada inspector had remarked that the snow seemed dry and the propellers were blowing it off the wings. Also, a 1983 letter from Air

Ontario management endorsing a captain's authority to de-ice when circumstances require was found in Captain Morwood's flight bag at the accident scene.

Perhaps the most revealing incident of Captain Morwood's normally cautious attitude is an experience cited in evidence by a former first officer previously paired with Captain Morwood on the F-28, Captain Keith Fox. Captain Fox stated that while their aircraft was being de-iced in Toronto on February 26, 1989, both generators flickered on and off after engine start. He said it appeared obvious to them that the engines had ingested some de-icing spray:

> A. We shut the ... engines down and George, Captain Morwood said, well, it's probably something minor but, you know, we do not have bags of time on this aircraft. Let's get it checked out.
> (Transcript, vol. 51, p. 85)

This evidence reflects Captain Morwood's normally conservative approach, and it also serves to indicate that there was a concern for the possible consequences of ingestion of de-icing fluid should de-icing take place with an engine running.

A second question is whether the flight crew was aware of the accumulation of snow on the wings at Dryden. The captain walked across the ramp to the terminal and back in his shirtsleeves during the stop and would have been aware of snow falling. During a telephone conversation with Ms Mary Ward at SOC in London during the stop, he commented to her that the weather at Dryden was "going down." At 12 noon, First Officer Mills advised Kenora Flight Service Station to the following effect: "We're down to about a mile and a half in Dryden in snow right now, quite puffy, snow, looks like it's going to be a heavy one" (Exhibit 7A, p. 29).

The flight crew also had the ability to observe the outer portion of the wings from the cockpit, and the testimony of informed passengers indicated that snow was accumulating there. The fact that Captain Morwood inquired of the station manager at Dryden about de-icing suggests an awareness of the problem. It is, in my view, inconceivable that the flight crew would have been unaware of snow on the wings.

It seems most likely that Captain Morwood weighed costs and benefits surrounding the issues referred to above and concluded that the best course of action would be to leave Dryden as soon as possible. Several factors may have influenced this decision. The multiple stressors involved in the situation, along with Captain Morwood's focus on completing the trip, may have caused him to concentrate on the benefits rather than the risks of taking off. The ambiguity of the Air Ontario procedures for de-icing with an engine running, combined with his earlier experience with Captain Fox in Toronto, could also have influenced his decision not to de-ice the aircraft in Dryden.

The role of First Officer Mills in Captain Morwood's decision-making process could not be determined. However, based on considerations of Captain Morwood's history, it is not likely that he would have heavily involved First Officer Mills in the decision-making process.

It is probable that, with wet snow falling, the flight crew did not consider the effects of the phenomenon of cold soaking. Air Ontario pilots who gave evidence during the hearings demonstrated that they were not fully aware of the concept or the implications of cold soaking, particularly as it related to weather conditions such as existed in Dryden on March 10. The Piedmont F-28 Operations Manual, which was used by Air Ontario pilots, addresses the cold-soaking phenomenon in its Cold Weather Operations section. It states as follows:

> When the tanks contain sufficient fuel of sub zero temperatures as may be the case after long flights at very low ambient temperature, water condensation or rain will freeze on the wing upper surfaces during the ground stop forming a smooth, hardly visible ice coating.
>
> During takeoff this ice may break awaõ¼y and at the moment of rotation enter the engine causing compressor stall and/or engine damage.
>
> (Exhibit 307, Piedmont F-28 Manual, 3A-24-1)

The caution relates to potential engine damage on takeoff rather than to the aerodynamic consequences of electing to take off with ice on the wing. Notwithstanding, the above information, combined with the other cautionary notes listed in the Piedmont and USAir manuals and the Fokker F-28 Flight Handbook, should have served to alert the flight crew of the need to inspect the wings prior to takeoff.

Given the large fluffy flakes coming down and the lack of accumulation on the tarmac surrounding the aircraft, the decision may well have been reached by the crew that the snow was melting and, therefore, would not adhere to the wing during the takeoff roll. The possibility that rough granular ice was developing under the snow on the upper surfaces of the wings because of the cold soaking was not likely considered by either Captain Morwood or First Officer Mills.

Once the aircraft was on the ground in Dryden, the implications of a long delay probably had an influence on the captain's decision to take off. Captain Morwood was clearly concerned about holiday passengers who were anxious to make connecting flights in Winnipeg, and both he and First Officer Mills had personal plans for the next day. Had the flight been cancelled in Dryden, it would have been necessary to fly in ground-start equipment, causing a lengthy delay and disruption of crew and passenger plans.

A last chance to re-evaluate the situation was probably missed when the flight took its final delay for the landing of the Cessna 150. It should be noted that a radio transmission from First Officer Mills to Kenora FSS in response to a request to hold for the Cessna 150 indicated that "we're down to about half a mile," referring to the visibility restriction caused by the snowfall. However, the accumulation of stress and frustration surrounding the day's operations had probably reduced the crew's effectiveness and decision-making capabilities by this time, as evidenced by the fact that the poor visibility did not affect the captain's decision to take off.

It is my considered opinion, after a thorough review of all the evidence, that the captain's decision to take off was made with the knowledge that snow was accumulating on the aircraft but with the mistaken perception and confidence that the snow was not adhering to the wings and would blow off during the takeoff roll. I do not believe that either Captain Morwood or First Officer Mills recognized the possibility that the cold-soaking effect could cause the wet snow to freeze to the upper surfaces of the wings; otherwise, based on his past performance, Captain Morwood would not have attempted to take off without first verifying his perception or having the aircraft de-iced.

Captain Morwood, as the pilot-in-command, must bear responsibility for the decision to land and to take off in Dryden on the day in question. However, it is equally clear that the air transportation system failed him by allowing him to be placed in a situation where he did not have all the necessary tools that should have supported him in making the proper decision.

Commercial and Operational Risk: Management Factors

Having examined the issues that most directly confronted the crew of flight 1363, I was particularly struck by certain evidence provided during the examination of Mr William Deluce, chief executive officer of Air Ontario Inc. The evidence related to the apparent difference in operating policy between Air Canada and Air Ontario regarding the dispatch of an aircraft with an unserviceable APU into a station with no appropriate ground-start facilities. The evidence is as follows:

> Q. Air Canada when it takes a jet like a 727 will not bring it into a place like Fredericton because there are no ground-start facilities in Fredericton, okay, that is a given.
>
> Bill Deluce and Air Ontario acquire a new fleet of jets and they require APUs. My question to you, sir, is: Would Air

Ontario take your jet fleet that you could acquire tomorrow or next week and fly your jets into a place like Fredericton when there are no ground-start facilities available in Fredericton?

A. Again, under those circumstances, we would make an assessment because ... the fact that you have or do not have an APU affects at the end of the day the reliability of that service, and ... I can only reiterate that there is nothing unsafe about flying into a place with no APU.

Air Canada – and can't speak for Air Canada ... may have a policy like that .... I don't know why they have their policies the way they are. I can tell you that each company has – looks at ways – the commercial – we will call it the commercial risk differently and different companies may come to different conclusions about what level of commercial risk they are prepared to take.

(Transcript, vol. 154, pp. 175–76)

Mr Deluce's evidence, when considered in isolation, appears quite innocuous. Certainly, different companies accept different levels of commercial risk as they see fit. There is nothing wrong with that; there is no flight safety consequence to the commercial risk that an airline is prepared to assume, provided that the commercial risk is not somehow translated into operational risk.

I interpret Mr Deluce to be saying in the cited quotation that Air Ontario was prepared to accept the commercial risk of grounding an aircraft at an outlying base that has no ground-start facility. Such commercial risk would include a consideration of:

- the inconvenience to stranded and downstream passengers, and resulting loss of goodwill;
- the cost of accommodating the stranded passengers; and
- the cost of replacement aircraft and crew.

Air Canada, apparently, is not prepared to accept such risk.

Mr Deluce also testified "there is nothing unsafe about flying into a place with no APU." Indeed, this is true if the operational personnel in a company clearly understand that the company is willing to accept the commercial risk of grounding an aircraft. I am of the view that, in such circumstances, the acceptance of commercial risk has no flight safety implication only if a documented operational policy exists reflecting the fact that conservatism and safety must prevail, and that such policy is clearly understood by flight crews, operational managers, dispatchers, and maintenance personnel.

If the prevalent operational management attitude in an airline was one where personnel are encouraged, either implicitly or explicitly, to push the limits of what is legal and sound operational practice, then the commercial risk spoken of by Mr Deluce may be translated into operational risk. This is clearly not acceptable. For instance, when a pilot faced with the Dryden scenario clearly understands from published company policy that the company is willing to accept in such circumstances aircraft groundings or extended delays, then Mr Deluce may be right in saying that there is no flight safety implication to his company's policy regarding commercial risk.

In order to make an assessment as to whether Air Ontario was in fact willing to incur such delays and disruptions of schedules, with associated costs, it was necessary to review evidence that was indicative of the operational attitude of its management.

The following facts are representative of the Air Ontario operational management attitude in the months leading up to the accident on March 10.

- In an undated status report written by Captain Joseph Deluce, the F-28 project manager, in late June or July 1988, he pointed to reliability as the single most important problem with the F-28 program at that early stage. Inexperienced flight crews, low levels of expertise among maintenance personnel, and insufficient spares availability were identified as the causes of the reliability problems. To overcome the problems of inexperience and lack of expertise, Captain Deluce suggested in his report that aircraft utilization be significantly increased. Captain Deluce also suggested that if they did not fly the F-28 more, then their profit projections would not be realized.

  I find the suggestions of Captain Deluce to be very troublesome. In the normal course one would expect, and rely upon, operational management to advocate conservative operational practice in the face of production pressures coming from the financial side of the organization. Instead, the opposite was true, and I find that was a significant problem in the management of the F-28 program. In fact, in this case, the more conservative judgement of Mr Thomas Syme, who had no operational experience, carried the day and the more restrictive F-28 utilization continued.
- It was demonstrated throughout chapter 25 of this Report, Management Performance, that when Captain Joseph Deluce was unchecked in his supervision of the F-28 program, pilots were left to determine their own standards and operational practices; often prudence and conservatism were lost in the pilots' collective enthusiasm to see their first jet operation succeed.
- F-28 pilots, including the chief pilot, Joseph Deluce, passed along reports of aircraft defects on pieces of paper in order to avoid grounding the aircraft (apparent violation of ANO Series VIII, No. 2).

- Captain Christian Maybury, when questioned about the practice of passing such messages on pieces of paper, testified: "As pilots, we wanted this operation to be successful. And I think that's what influenced our thinking in a lot of ways and why we tolerated a lot of this stuff for as long as we did" (Transcript, vol. 92, p. 115).
- For a period of six months after F-28 service was introduced, maintenance of essential aircraft equipment was deferred, though there was no approved MEL against which deferrals could be made (apparent violation of ANO Series II, No. 20).
- When asked about his own maintenance deferral practices, the director of flight operations, Captain Robert Nyman, testified that they were against "the legal letter of the law."
- On April 5, 1989, Captain Perkins operated the F-28 aircraft on a revenue flight from Winnipeg to Toronto without a serviceable master warning light, an item that he agreed, in evidence before this Inquiry, was an essential airworthiness item. The item was improperly deferred in the aircraft journey log. In a memorandum to Mr James Morrison, then Air Ontario's vice-president of flight operations, Captain Joseph Deluce defended Captain Perkins's decision on the basis that Captain Perkins was "comfortable with the warnings that were available" and "comfortable with Maintenance's decision to defer this item." Captain Deluce then stated that "with hindsight and questions being asked," he questioned whether the item should have been deferred and that he would attempt to get a better interpretation from Transport Canada on "what and how items can be deferred and when they can not" (Exhibit 337). The incident was but another indication of a tendency to keep the operation on schedule and sort out the details later.
- Captain Alfred Reichenbacher and First Officer Monty Allan, surprised one day at the general state of unserviceability of their F-28 aircraft, recorded a large number of snags in the aircraft journey log, effectively grounding the aircraft until they could be rectified. For this they were taken to task and threatened with suspension by the chief pilot.

If the actions and attitudes of the Air Ontario F-28 chief pilot and of the vice-president of flight operations are an indication of the standards of operation that were permitted, if not encouraged, then it is apparent how Mr William Deluce's commercial risk of a grounded aircraft in a Dryden scenario could turn into an operational risk of an attempted takeoff. A pilot would want to avoid the grounding of an aircraft because there is a possibility that he would have to answer to the company for having put the aircraft in the position of being grounded.

Given this state of mind, in a "bending the letter of the law" operational environment, where less restrictive operational practices are preferred, a pilot may be encouraged to encroach upon the margin of safety and attempt a takeoff with contaminated wings.

Flight Safety: The Air Ontario Corporate Business Plan

From a corporate perspective, the 1988 Air Ontario Inc. business plan (Exhibit 936) contained a mission statement that referred in part to "the creation of a safe and reliable diversified regional airline system." Yet, I could find no evidence of a company safety policy that, at the corporate level, reflected an overriding commitment to safety other than the above-noted general statement. Since the statement was contained in the company's business plan, it is unlikely that it received company-wide distribution.

The position of flight safety officer within the company appeared to have an "on again–off again" history. The original flight safety officer, Captain Ronald Stewart, resigned in 1987 after two years in the position, largely because of a lack of management support. Captain James Byers turned the position down because of a lack of a documented job description. Captain Stewart accepted the position for the second time approximately six weeks before the March 10, 1989, Dryden accident. A review of Air Ontario's investigation into three Air Ontario incidents, all involving Captain Joseph Deluce and two of which were takeoffs with a contaminated aircraft requiring an immediate return to the airport, have convinced me that whatever flight safety organization might have existed had little if any management support and was largely ineffective.

It is clear from the evidence that flight safety management within Air Ontario was left to operational managers and their appointees. From a corporate perspective, the commitment to safety management was, in the years preceding the Dryden accident, largely cosmetic. In light of the corporate and operational management attitudes discussed in this chapter of the Report, combined with the lack of an effective regulatory safety net, I can readily understand how commercial risk would become operational risk.

Safety Management

In light of the preceding discussion regarding the cause-and-effect relationship between commercial risk and operational risk, I refer to the writings of Dr C.O. Miller. In a paper entitled "Investigating the Management Factors in an Airline Accident" presented in 1990 to the

Brazilian Congress of Flight Safety (Exhibit 1251), Dr Miller made some observations that are, in my view, highly relevant. In the interests of brevity, key points are summarized as follows:

- There is a general lack of understanding of what constitutes safety/accident-prevention management throughout many parts of the aviation community.
- Airline and other management must become more attentive to accident prevention management for reasons of potential liability personally, let alone corporate liability in the event of an accident.
- Airline executives should make a corporate commitment to vigorous, viable, and visible proactive flight safety programs.
- Investigation of accidents in civil aviation does not have a procedure or protocol that will encourage examination of management failures in a causal sense. As a result, the management system leading to the failure often goes unchallenged. In that regard, International Civil Aviation Organization Annex 13 has yet to address management failures. I would observe that the most recent Transportation Safety Board accident investigation manual addresses the issue, but in a peripheral rather than a comprehensive manner. Nor is there any requirement in Canadian aviation regulations for a Canadian air carrier to have in place a comprehensive safety management plan.
- Safety policy that simply says "safety is our total priority," but is unsupported by a meaningful safety plan, is unacceptable.

On January 30, 1989, the International Air Transport Association issued a policy item to its member air carriers entitled "Airline Safety Manager." The policy states:

> 1. All airlines should establish a professional Safety Manager.
> 2. All airlines should support the following Flight Safety functions:
>   a. Organisation of Accident Prevention Programmes
>   b. Collection/Analysis/Communication of Safety Information
>   c. Technical and Safety Coordination
>   d. Corporate Emergency Response Procedures

The reason stated for adoption of the policy is quoted as follows:

> Governments charge the airlines with the responsibility of satisfying the public need for safety and reliable air transport. This responsibility cannot be discharged without provision of adequate professional review of all safety related activities of each airline. To do this

> effectively and efficiently, it is imperative that a professional Flight Safety Management post be established and adequate safety management functions supported.
>
> (IHTA Technical Policy – Flight Safety Management)

I find the observations summarized by Dr Miller as well as the essence of the IATA policy document most appropriate to the evidence before me as they relate to the management aspects of this accident. I would go further and observe that they are not only relevant to air carrier management, but also to the management of regulatory bodies responsible for aviation safety.

Findings

- All of the air crew of Air Ontario flight 1363 on March 10, 1989, were certified and qualified for the flight in accordance with existing regulations.

- There was no evidence found that physical or psychological factors affected the air crew's performance.

- The facts derived from the Inquiry into the crash of Air Ontario flight 1363 are indicative of an operational environment that allowed an experienced captain to reach a flawed decision regarding the safety of takeoff during a heavy snowfall with accumulating contamination on the aircraft's wings.

- Neither Transport Canada in general nor Air Ontario in particular provided adequate information to pilots regarding the cold-soaking phenomenon and its effects on aircraft contamination after flight in conditions conducive to cold soaking.

- The preponderance of evidence indicates, and I find, that the fuel in the aircraft wing tanks of C-FONF was exposed to subzero temperatures in flight resulting in the manifestation of the cold-soaking phenomenon on the ground at Dryden.

- Captain Morwood was not sufficiently aware of or knowledgeable about the cold-soaking phenomenon to alert him to the possibility that fuel of subfreezing temperature in the aircraft wing fuel tanks could cause wet snow to freeze to the aircraft wings.

- The Air Ontario accident at Dryden, like similar aircraft wing contamination accidents, was preventable and should not have occurred.

- Had the required effective and adequate resources, regulations, procedures, training, and policies identified throughout this Inquiry been in place on March 10, 1989, it is possible, and indeed likely, that the event sequence that resulted in the accident would have been interrupted.

- A lack of understanding existed within the aviation industry in general and within Air Ontario in particular with respect to both safety and accident-prevention management, with a resultant lack of Air Ontario management attention and commitment to these important areas prior to the Dryden accident.

- The regulatory environment allowed decisions to be made that led to the lack of a complete safety net for the flight crew of flight 1363. I cite only two examples: the use of different aircraft operating manuals on the flight deck of the F-28, and the lack of a definitive regulation regarding aircraft contamination.

- The senior management of Air Ontario failed to ensure that commercial risk did not translate into operational risk. For example, C-FONF was allowed to land at Dryden in weather conditions that could have required that the aircraft be de-iced while the aircraft's APU was unserviceable and there was no F-28 ground-start equipment at Dryden.

- Air Ontario's efforts in the area of safety management in the critical months of the company's restructuring prior to the accident received little or no priority and can best be described as cosmetic.

- The Air Ontario policy that did not allow an F-28 aircraft to be de-iced while one of its main engines was running may have influenced Captain Morwood's decision not to de-ice the aircraft at Dryden. It is not known to what extent Captain Morwood was aware of this policy or what he thought of it.

- The weather conditions on March 10 were such that the flight crew of flight 1363 had to be concerned about the weather, but Air Ontario SOC personnel did nothing to assist the crew in operational decisions involving the weather, other than to delay the flight in Dryden on its first stop.

- The slush accumulation on the eastern end of the runway at Dryden contributed to a longer than usual takeoff roll by flight 1363.
- Air Ontario did not provide to its F-28 flight crews, nor did Transport Canada require, runway slush-correction charts that were readily usable in the aircraft cockpit.
- The aircraft C-FONF was not in a completely serviceable state, thereby putting additional pressure on the crew.
- The weather conditions on March 10, 1989, required that the flight crew of C-FONF use a more distant alternate airport, a situation that resulted in the crew's having to pay more attention to fuel and aircraft weight.
- Many of the events that occurred on March 10, 1989, served to increase the frustration levels of the crew members of flight 1363. Frustration can lead to hasty or ill-conceived decisions.
- In the investigation of accidents in civil aviation, there is no procedure or protocol that encourages examination of management failures relating to the cause of an aircraft accident. The most recent accident investigation manual of the Transportation Safety Board of Canada, while it addresses management failures peripherally, does not do so in a comprehensive manner.

RECOMMENDATIONS

The Human Performance chapter of this Report is, in many ways, a synthesis of all the issues that the crew faced on March 10, 1989, and recommendations on such issues have already been set out elsewhere. It is not my intent to repeat these recommendations in detail in this chapter, but, in the interests of continuity, a synopsis of the principal recommendations already addressed and relevant to Human Performance includes:

- A renewed air carrier certification and inspection program incorporating improved safety regulations, adequate resources, and properly qualified and trained personnel be implemented by Transport Canada on a priority basis.
- Formal training of all air carrier crew members in crew resource management be made mandatory by regulation.

- Crew-oriented training and evaluation be actively pursued jointly by Canadian air carriers and Transport Canada as a more effective means of training and evaluating air carrier flight crews.
- The appointment of an air carrier flight safety officer, approved by Transport Canada, and the establishment of an approved flight safety program by all Canadian air carriers be made a regulatory requirement.
- A systematic and comprehensive discussion regarding cold soaking, based on research such as was conducted for and on behalf of this Commission of Inquiry, be inserted in air carriers' flight operations manuals and/or aircraft operating manuals and in government publications such as the Aeronautical Information Publication in order to make all pilots and aviation operational personnel aware of the various factors that may cause contamination to adhere to lifting surfaces.

Recommendations not previously addressed and specific to this chapter are as follows:

MCR 175 That the Transportation Safety Board of Canada further develop its human factors investigation procedures into human factors aspects of aviation accidents to include a comprehensive section addressing the role of air carrier management in the area of flight safety management; and that the board encourage examination of management failures in a causal sense as part of its accident investigation procedures.

MCR 176 In conjunction with MCR 175 above, that the Transportation Safety Board of Canada actively pursue the amendment of appropriate International Civil Aviation Organization documents to address in a similar manner the role of air carrier management in the area of flight safety management.

PART EIGHT

LEGAL AND OTHER ISSUES BEFORE THE COMMISSION

41 THE AVIATION ACCIDENT INVESTIGATION PROCESS IN CANADA

As a result of the work undertaken by this Commission, several flaws were identified in the aviation accident investigation process in Canada.

In my first *Interim Report* of November 30, 1989, I pointed out that this Commission was born out of the public controversy surrounding the investigation by the Canadian Aviation Safety Board (CASB) of the Arrow Air DC-8 crash at Gander, Newfoundland, on December 15, 1985. Having recognized, early in the process, that an important objective of my Commission was to endeavour to re-establish public confidence in the accident investigation process in this country, I made the following commitment at the formal hearings of the Commission on June 16, 1989:

> If during the course of this investigation fundamental flaws were found in this process, then appropriate recommendations will be made by me.
>
> (*Interim Report*, p. 9)

This chapter of my report is written in response to that commitment.

At the outset it should be noted that the field phase of the Dryden crash investigation had already been completed by the CASB investigating team by the time that this Commission was constituted on March 29, 1989. Thus, I was not involved in the conduct of the initial phase of the investigation.

However, during the remainder of the investigation, conducted under the auspices of my Commission, I have had an opportunity to observe first hand the effectiveness of CASB's organizational structure, investigative methodology, and practices. I can state that I was generally favourably impressed with the calibre of individual CASB staff members who were seconded to this Commission to assist in the investigation of the Dryden crash. In particular, I must single out Mr Joseph Jackson, the investigator in charge, Mr David Rohrer, the chairman of the operations group, and Mr David Adams, the human factors expert working for CASB on secondment from the Bureau of Air Safety Investigation in Australia, all of whom were seconded on a full-time basis to my Commission from CASB. Each epitomizes consummate professionalism in his work and each has made an invaluable contribution to this process.

A prerequisite for an evaluation of the Canadian aviation accident investigation process is a review of some of the basic principles laid down in the *Canadian Transportation Accident Investigation and Safety Board (CTAISB) Act*, S.C. 1989, c.3. The Act established the multi-modal Canadian Transportation Accident Investigation and Safety Board (CTAISB), which replaced CASB, as the aviation accident investigating authority in Canada. Subsequently the federal identity program formally changed the short title to the Transportation Safety Board of Canada (TSB).

As a result of observations that I have made in the course of the proceedings of this Inquiry, the briefs and investigators' reports received, and consultations with Commission of Inquiry investigators, counsel, and technical advisers, I have concluded that the *CTAISB Act* contains several provisions, as did its predecessor *CASB Act*, which impair the investigative process and compromise the independence of the Canadian investigating authority. Of particular concern are the Act's provisions dealing with:

- the granting of observer status to interested parties;
- the privileged status of certain factual evidence, including witness statements, on-board recordings, and air traffic control communications;
- the requirement for the TSB's draft report to be reviewed by interested parties.

In addition, six other areas of concern have come to my attention on which I feel obliged to report:

- the training of investigators;
- the taping and transcription of interviews;
- the lack of use of outside experts by the investigating authority;
- the lack of forensic training for TSB scientists;
- the need for greater emphasis by the board of the TSB on human factors in aviation accidents;
- the monitoring of TSB recommendations.

I will now deal with each of these concerns affecting the investigative process and comment upon them. I have confined my comments and the recommendations which follow to the matter of aviation occurrences.

The Granting of Observer Status to Interested Parties

It should be pointed out that in the case of a major aviation occurrence, such as the Dryden crash, the investigation is conducted by a team of investigators led by the investigator in charge (IIC). Investigators are generally assigned to specific investigating groups within the team in accordance with their area of expertise and under the leadership of a group chairman.

A party having a direct interest in the investigation of an aviation occurrence in Canada has no legal right whatsoever to attend at that investigation, even as an observer, unless invited by the board to so attend under the provisions of section 23(2)(*d*) of the *CTAISB Act*. Section 23(2) reads as follows:

> Subject to any conditions that the Board may impose, a person may attend as an observer at an investigation of a transportation occurrence conducted by the Board if the person
> (*a*) is designated as an observer by the Minister of Transport in order to obtain timely information relevant to the responsibilities of that Minister;
> (*b*) is designated as an observer by the Minister responsible for a department having a direct interest in the subject-matter of the investigation;
> (*c*) has observer status or is an accredited representative or an adviser to an accredited representative, pursuant to an international agreement or convention relating to transportation to which Canada is a party; or
> (*d*) is invited by the Board to attend as an observer because, in the opinion of the Board, the person has a direct interest in the subject-matter of the investigation and will contribute to achieving the Board's object.

Section 23(3) of the Act contains a provision for the removal of an observer from an investigation:

> The Board may remove an observer from an investigation if the observer contravenes a condition imposed by the Board on the observer's presence or if, in the Board's opinion, the observer has a conflict of interest that impedes the conduct of the investigation.

The investigation of a major air carrier accident is a formidable task under the best of circumstances. Since such an accident is a manifestation of failure in a complex system that is designed to operate accident-free, it would be logical to assume that the system's designers are in a good position to identify and correct the flaws that underlie the accident. This, however, would mean that the investigation of an air carrier accident would be left in the hands of manufacturers, air carriers, regulators, and others responsible for the system's daily functioning. Although such an investigation would benefit from the expertise available, it would probably lack objectivity when one of these parties inevitably assumed a dominant role. After all, each of these parties has at risk a reputation or a financial stake, or both, depending on the outcome of the investigation.

To avoid the possibility of relying on any of the interested parties involved, most countries have established independent aviation accident investigating authorities in accordance with International Civil Aviation Organization (ICAO) guidelines. Canada has done so with the creation of CTAISB in 1990 and its predecessor CASB in 1984. Given proper staffing, training, and procedures, these authorities develop specialized skills in investigation management. It should be pointed out, however, that, unless investigators within such organizations have an opportunity to keep abreast of technological advances, there is a drawback inherent in the investigating authority's relying only upon a permanent staff of investigators. While gaining the necessary investigative skills, aviation accident investigators, over time, may lose some of their currency in the field of expertise that brought them to the authority in the first place. Periodic refresher courses do not necessarily give assurance that the investigators are fully familiar with the aviation system's current technological advances, peculiarities, and pitfalls.

I make these observations to emphasize the need to keep abreast of new technologies in the industry. It is wise for the investigating authority to avail itself of the expertise within the aviation industry by seeking, on an ad hoc basis, the services of persons with special expertise from within the aviation industry on investigative teams controlled by government investigators, as was in fact done by this Commission.

Practical experience has shown that a coordinated investigative effort is best achieved by using the group system of investigation, as recommended and explained in the ICAO Manual of Aircraft Accident Investigation. In my view the functioning of the group system is enhanced by granting to appropriate representatives of the interested parties, who possess special expertise, status as participants in the accident investigation. It is on this point that I find the Act fundamentally flawed in that it does not guarantee status for interested parties.

The only status for qualified representatives of the interested parties on aviation accident investigation teams, recognized by section 23 of the Act, is that of observer-invitee. By definition, the observer role is a limited role, and its limitations are exacerbated by the Act's prohibition against the exchange of certain information as explained in the discussion of witness statements that follows.

Inasmuch as this Commission of Inquiry derives from the provisions of the *Inquiries Act* and was not bound by either the provisions of the *CTAISB Act* or the predecessor *CASB Act* in the conduct of its investigation, and seeking to benefit from the best expertise available, I granted to interested parties, on an experimental basis, the right to second persons with particular expertise from among their ranks as full-fledged participants in specific investigation groups (see pages 10–14, 17, and appendix D of my first *Interim Report*). This experiment provided to the investigating teams expertise that was not otherwise available and proved to be highly successful.

It is my recommendation that the Act be amended to provide to interested parties the right to full participant status on CTAISB investigating team groups, by secondment to those groups of individuals from among the interested parties who, in the opinion of the board, possess expertise enabling them to contribute to the investigation.

I am indebted to the parties who made the expertise available, to the participants themselves, and to the CASB investigators seconded to my Commission, under whose leadership the technical investigation of the Dryden accident was successfully completed.

The Privileged Status of Certain Factual Evidence

Sections 28 and 29 of the Act, respectively, provide, inter alia, that onboard recordings made on the flight deck of an aircraft, and a communications record relating to air traffic control or related matters, are privileged. Section 30 of the Act provides that statements relating to a transportation occurrence and the identity of the author are privileged.

Sections 28(5), 29(5), and 30(4), respectively, provide that such onboard recordings, communications records, and statements shall be made available to the following persons only:

(*a*) a peace officer authorized by law to gain access thereto;
(*b*) a coroner who requests access thereto for the purpose of an investigation that the coroner is conducting; or
(*c*) any person carrying out a coordinated investigation under section 18 or designated as an observer by the Minister of Transport under subsection 23(2).

It is obvious from a reading of these sections that even those persons invited by the board itself to attend as observers, pursuant to section

23(2)(*d*), are effectively excluded, by virtue of these provisions, from examining the material in question.

It will also be seen that there is no specific provision in these sections of the Act by which any of this material could be made available to individuals who would be granted, pursuant to my previous recommendation, participant status on investigation team groups, as representatives of parties who have a direct interest in an aviation occurrence.

The analysis of the evidence begins well before the fact-gathering phase of an aviation accident investigation is completed. There cannot be a meaningful fact-finding process unless the potential importance of each new piece of evidence is analysed and used to determine the scope and direction of the investigative effort. A theorizing process is essential to a thorough investigation since it leads to the exploration of every possible avenue in the search for all of the facts.

To ensure that the collective expertise of the investigation team is brought to bear on the development and testing of theories, incoming factual information should be freely shared with all team members, including experts seconded from the participating parties. Unencumbered by the provisions of the *CASB Act* (now the *CTAISB Act*), and, after due consideration, I decided to direct that all participants on specific investigating team groups operating under my Commission of Inquiry would share in all factual material from the investigation, in return for an undertaking of confidentiality. I can report that there was a very satisfactory result and a clear benefit, in terms of the additional expertise provided, from this decision. The truth is that certain provisions of the Act hamstring the board in the application of this concept. In addition to permitting interested parties to participate at an investigation only as invited observers, sections 28, 29, and 30 of the Act list various items of evidentiary material, such as air traffic control tapes, cockpit voice recordings, and witness statements, that cannot be released to observers representing interested parties on the investigation team.

It is of interest to note that ICAO Aircraft Accident Investigation, Annex 13 to the Convention on International Civil Aviation (7th ed., May 1988), recognizes participants, not observers. Section 5.26 of ICAO Annex 13 recommends:

> Participation in the investigation should confer entitlement to:
> (a) visit the scene of the accident;
> (b) examine the wreckage;
> (c) question witnesses;
> (d) have full access to all relevant evidence;
> (e) receive copies of all pertinent documents; and
> (f) make submissions in respect of the various elements of the investigation.
>
> (Exhibit 430)

By legislating privileged status for witness and survivor statements, section 30 of the Act detracts from the effectiveness of the theorizing process, and raises two further possible problems:

1 Witnesses who are assured of the confidentiality of their statements and identities may be tempted to stretch their recollections to accommodate their preconceived notions or biases, as well as those of the investigator/interviewer, knowing that they will be unchallenged.
2 The withholding of such information from the individuals representing the parties as either observer or participants on investigating teams implies that the parties – and the public – have to accept the board's interpretation of that information on blind faith. The resultant appearance of lack of openness in the investigative process does not instil confidence in its outcome.

With regard to section 29, I fail to see the justification for giving air traffic control transcripts privileged status when any person on the same frequency had access to the transmissions involved. I firmly believe that, under properly controlled conditions, the sharing of pertinent portions of the cockpit voice recorder and flight data recorder information with the parties will contribute greatly to the timely and effective completion of the investigative process.

I recommend that the provisions of sections 28, 29, and 30 be amended to provide that statements and the other material referred to shall be made available on a confidential basis to individuals granted full participant status as representatives of parties having a direct interest in the accident investigation.

In order to avoid any misunderstanding, I re-emphasize that I fully endorse the confidentiality of statements made under the provisions of the board's confidential aviation safety reporting system. The subject of privilege with respect to pilot incident reports made on a confidential basis in connection with an air carrier's flight safety and accident prevention program is dealt with in detail in chapter 42 of this Report, Incident and Accident Reporting and Pilot Confidentiality.

Review of the Board's Draft Report

The stated object of the Transportation Safety Board is to advance transportation safety. Section 7(1) of the *CTAISB Act* lists five means by which this objective is to be achieved. That section reads as follows:

> The object of the Board is to advance transportation safety
> (*a*) by conducting independent investigations and, if necessary, public inquiries into transportation occurrences in order to make findings as to their causes and contributing factors;
> (*b*) by reporting publicly on its investigations and public inquiries and on the findings in relation thereto;
> (*c*) by identifying safety deficiencies as evidenced by transportation occurrences;
> (*d*) by making recommendations designed to eliminate or reduce any such safety deficiencies; and
> (*e*) by initiating and conducting special studies and special investigations on matters pertaining to safety in transportation.

Section 7(1)(a) charges the board to conduct "*independent* investigations and, if necessary, public inquiries into transportation occurrences." The obvious objective is to assure the public that the investigating authority will not hesitate to identify safety deficiencies, regardless of which government agency, corporate entity, or private individual played a role in the accident sequence.

With this objective in mind, the authority's formulation of its findings, conclusions, and recommendations for its final report is critical. It is essential for the authority to avoid even the appearance of influence from organizations or persons with a vested interest in the outcome of the authority's deliberations. Unfortunately, there is a provision in the Act that may well give the public reason to question the board's independence. Section 24(2) of the Act requires that the board, before making public an occurrence report, circulate its draft report to parties and ministers deemed by the board to have a direct interest in the board's findings and to permit representations with respect thereto:

> Before making public a report under subsection (1), the Board shall, on a confidential basis, send a copy of the draft report on its findings and any safety deficiencies that it has identified to each Minister and any other persons who, in the opinion of the Board, has a direct interest in the findings of the Board, and shall give that Minister or other person a reasonable opportunity to make representations to the Board with respect to the draft report before the final report is prepared.

Requiring the board to submit its draft report to interested parties, be they ministers or other persons having a direct interest in the board's findings, so they can make representations to the board, strikes me as being somewhat analogous to requiring a judge, after hearing the evidence at trial, to submit his or her draft judgement for review and comment by the litigants, before it is formally entered into the record. The board's conclusions, like the judgement of a court, should not be subject to what on the face of it is a process which can only be described as demeaning to the integrity and independence of the board.

The public, including persons in the industry, has the full right to expect the board to reach its conclusions from the evidence before it, independently and free from outside influence. Section 4 of the Act requires that board members be knowledgeable in transportation matters. The chairman of the board has the responsibility to maintain a staff with the professional qualifications needed to conduct investigations that fully satisfy the public's and the industry's safety concerns. If properly followed, these requirements should bolster the public's trust in the board's integrity and competence. There is simply no logic to undermining this trust by legislation which gives the appearance that the board is to seek an imprimatur from interested parties for its final report.

The provision in the Act that charges the board to solicit representations on its draft report from interested parties probably finds its rationale in the desire to avoid shortcomings in the final report. However, this provision hardly represents a vote of confidence by the Government of Canada in the board it has created. The damage that this review by interested parties does to the credibility of the board and its reports is in my view too high a price to pay. If interested parties were granted full participant status with the right to assign experts to be full-fledged participants in the investigative process, as I have recommended, rather than being observers as is the case at present, their views on the facts would be made known at the investigative stage. This would then avoid the unseemly practice legislated by section 24(2) of the Act of inviting representations by the interested parties on the contents of a draft report formulated by the board after its review of the evidence.

Section 24(2) of the Act, which entitles interested parties to review and make representations regarding the board's draft report, should be replaced with a provision that gives to participants the right to make their own submissions to the board following completion of the investigation and prior to the preparation by the board of its final report. The logical time for those interested parties who have been granted participant status to exercise this privilege would be at the completion of the fact-gathering phase of the investigation or upon completion of a public inquiry conducted by the board. The changes to the Act that I advocate here would render superfluous the review by participating parties of the board's draft report. In such a case, the board, after completing its investigation, need only concern itself with the production of a final report in respect to a transportation occurrence.

Sections 26(1) and (2) of the Act empower the board to reconsider its findings and recommendations when, in its opinion, new evidence becomes available. Lacking in this section is a specific provision entitling a party with a direct interest in an investigation or public inquiry to petition the board for reconsideration of its conclusions where it is shown that new and material evidence has been discovered that might reasonably affect such conclusions or where the board's factual conclusions are shown to be erroneous. I am of the view that the incorporation of such a provision in section 26 of the Act, together with my recommendation for giving parties the right to make formal submissions prior to the board's drafting of its final report, should ameliorate any concern by the interested parties over the loss of their present right to review and make representations with regard to the board's draft report.

The Training of Investigators

During the course of this Inquiry, I and my staff have read and reviewed the records of hundreds of witness interviews conducted by investigators on behalf of CASB, and later on behalf of this Commission. As is the case with every investigation, witness interviews provided the basis for virtually all of the Commission's investigative activity. There were large variances in the ability of individual CASB investigators to conduct witness interviews, as is evidenced by the interview transcripts and records. Many initial interviews were in fact well conducted. Numerous others, because of the investigator's lack of forethought and interviewing skill, did little to enhance the investigative process. As a result, numerous witnesses had to be re-interviewed by Commission staff.

In order to provide the direction required in the investigative process, an interview must be conducted in a manner that will, it is hoped, extract from each witness his or her best recollection of the events observed by that witness. To accomplish this task is by no means easy. The interviewer must be trained and well prepared for the interview, there must be a purpose to every question, and every answer must be immediately analysed to determine if follow-up questions are required.

A number of the interview records clearly demonstrated that some of the CASB investigators were not well trained or well prepared to conduct interviews. Interviewing of potential witnesses is a skill which is gained by practical training and experience. An interview is not conducted for the purpose of projecting the views and opinions of the interviewer to the witness, as indeed occurred in some of the initial interviews done under the auspices of CASB. It is of utmost importance to an ongoing investigation that witness interviews conducted shortly after an air carrier accident be carried out in the most professional manner possible. One of my most vivid impressions from the investigative stage of the Inquiry is that there is a dire need for investigators trained in witness-interviewing techniques.

My concerns relating to the witness-interviewing skills of some of the accident investigators seconded to this Commission by CASB were made known to Mr Joseph Jackson, the investigator in charge, and to CASB, in the summer of 1989, while the Dryden accident investigation under the auspices of this Commission was still ongoing. It had been my intention in this Report to make a recommendation that the CTAISB should develop a mandatory training program whereby all its investigators undertake and complete initial and recurrent professional training in witness-interview techniques and report writing, as well as accident investigation generally, such training to be provided through recognized professional learning institutions specializing in the training of accident investigators or a senior police force. However, during the month of May 1991, it came to my attention that, following my expressions of concern and, commencing in the autumn of 1989, the TSB began discussions with professional consultants and in October 1989 contracted with the Public Service Commission's Training Programs Branch to develop a witness-interview training course structured specifically for TSB investigators. I have been advised that, as of March 1991, 77 TSB investigators have participated in newly developed courses in witness-interviewing techniques. I am further advised that such training is now mandatory. It has also been brought to my attention that TSB investigators will receive recurrent interviewing-technique training on a regular basis and that investigators are being encouraged to request additional training if they feel it will enhance their interviewing skills.

I am encouraged by the fact that the TSB has initiated what I consider to be an essential training program in response to the concerns identified by this Commission of Inquiry. I would commend the TSB for so doing and I am hopeful that the training program undertaken will improve the quality of aviation accident investigation. Only the passage of time will reveal whether the quality of this training program is sufficient to meet the challenge presented.

The Taping and Transcription of Interviews

While conducting pre-hearing interviews with knowledgeable persons and potential witnesses, my Commission staff, with the exception of a few occasions early in the process, endeavoured to record the witness interviews on tape. This was done not only to ensure accuracy, but also to expedite the interview process by ensuring an orderly flow of questions and answers and to achieve a timely process by not having to write down everything that was spoken. Persons interviewed were, without exception, offered a transcription of their interview once completed, as well as access to the interview tape.

The Canadian Air Line Pilots Association (CALPA) initially objected to the recording of witness interviews and insisted that many of the interviews of pilots who were CALPA members not be taped. In such cases all questions posed by counsel and the answers given by CALPA members had to be transcribed by hand, a time-consuming process to say the least. In addition to increasing the work of Commission staff, this process did not add to the assurance of accuracy of the interview record.

Being fully aware of the frustrations experienced by my investigators and counsel who helped interview hundreds of witnesses during this Inquiry, I am of the firm view that all interviews conducted in connection with an air carrier accident should be tape recorded and transcribed, and I would recommend an amendment to the Act to so require. Such a procedure would not only be in the interest of the investigating agency, but also would protect those being interviewed. There is, in my view, no rational basis upon which a person being interviewed in connection with an air carrier accident investigation should be able to insist on handwritten notes of the interview being made, in place of accurate electronic tape recording.

The Use of Outside Experts

The success of an investigation depends on the logical and methodical gathering of all pertinent evidence. The quality of the evidence so assembled will, to some extent, reflect the skill and knowledge of the persons gathering and assimilating the evidence. The value of such evidence will largely depend upon the skill and ability of those analysing and interpreting it.

This Commission of Inquiry, in addition to utilizing CASB staff experts, relied extensively upon independent experts. Experts in aircraft ground de-icing, engines, aircraft performance, aerodynamics, meteorology, human factors and human performance, and aeronautical engineering were retained to assist with the investigation and in some instances to testify before the Commission. Such experts were retained partly because there was a lack of particular expertise within CASB, from which the majority of the Commission's investigators came, and partly because, as I stated in my first *Interim Report*, "I considered it important for my Commission to have the benefit of totally independent expert advice" (p. 6).

Having observed many witnesses testify before the Commission on complex technical matters, I am of the opinion that the TSB, the agency responsible for the investigation of aircraft accidents in Canada, would benefit from the assistance, on an ad hoc basis, of highly qualified professional experts from outside its ranks. It would be unrealistic to expect the TSB to maintain on staff all manner of expertise required in the investigation of an aircraft accident. Accordingly, I recommend that an expert witness roster be developed by the TSB, in consultation with the aviation industry, consisting of persons willing to be called upon to assist in any given investigation, upon very short notice. I would strongly recommend that the TSB establish close liaison with the National Aeronautical Establishment and the National Research Council Canada and utilize fully their facilities and staff experts in various disciplines, as this Commission has in fact done. Such lists of experts, when established, should be updated from time to time to reflect the highest degree of knowledge and expertise available. As a direct result of my experience on this Commission, I am of the firm belief that the utilization by the TSB of its own in-house experts as well as outside experts from such a list on an ad hoc basis is both a desirable and a practical way to enhance the quality of aircraft accident investigation in Canada.

Forensic Training for TSB Scientists

The TSB (previously CASB) employs a number of forensic scientists. The word forensic means "of or in relation to courts of law." Forensic scientists must, by definition, possess expertise beyond their scientific field in that they must be able to attend at a court, inquiry, or inquest and properly present their evidence with clarity. They must be able to explain, support, and extemporaneously defend their conclusions in the crucible of the witness box. To do so requires special training.

During the hearings of this Commission of Inquiry, I formed the impression that some CASB scientists who appeared as witnesses, although obviously experts in their respective scientific fields, were, through no fault of their own, ill-equipped to present their evidence adequately in a public forum. Some of the shortcomings I observed in the presentation of evidence by some of the TSB forensic scientific witnesses included:

- venturing an opinion clearly outside the area of expertise
- CASB did not understand fully the significance of protecting the continuity of an important piece of evidentiary material

- CASB did not appreciate the importance of requiring the designated CASB engine expert to attend personally at the initial post-crash disassembly by the manufacturer of the aircraft engines
- the attachment as an appendix to a scientist's report of a report from a manufacturer, when such report was not clearly understood
- obvious discomfort or unease on the witness stand, particularly during cross-examination.

These observations led me to direct inquiries to be made of Mr Doug Lucas, director of the highly regarded Centre of Forensic Sciences in Toronto. Mr Lucas has indicated that, when interviewing potential candidates for the position of forensic scientist at the centre, focus is exclusively on whether the scientist can cope with the demands of the witness box. Academic qualifications are taken as a given. Only one in ten otherwise qualified scientists meets this criterion. Thereafter, the successful candidate embarks on a two-year training program. At the end of the first year, the scientist's continued employment is contingent upon the successful handling of a mock court exercise where the candidate is the witness. Only rarely are candidates allowed to testify in court prior to completing the two-year training program. They are never allowed to testify prior to the completion of one year's training.

The training syllabus followed by the Centre of Forensic Sciences includes having candidates observe the testimony of others to familiarize them with different styles of examination and cross-examination. Mock exercises are videotaped and reviewed as a training tool. The candidate must complete a course of reading covering such topics as the rules of evidence, the structure of various tribunals and the functions of the associated officials, preserving continuity, note-taking, and the pitfalls associated with being an expert witness. All of this is in addition to continuing scientific training within the candidate's area of specialty.

By contrast, I have been informed that CASB scientists received a half-day lecture from CASB counsel devoted primarily to explaining the provisions of the *CASB Act*. It is therefore not surprising that some of the CASB scientists who testified encountered difficulty on the witness stand.

In order to advance the image of the TSB as a world-class investigative body, I am convinced it is essential that forensic training be provided to TSB scientists and that the TSB call upon such outside resources as are necessary to assist them in this endeavour.

Human Factors in the Investigation of Aviation Occurrences

From the beginning of the work of this Commission, I resolved that, if human error was a basic cause of the Dryden crash, as indeed has turned out to be the case, it would not be acceptable simply to identify pilot error as a cause without a thorough investigation of all factors which may have influenced the actions of the pilots. Although it was not difficult to identify pilot error as one of the factors in the Dryden crash, it was by no means the only factor, as can be seen from the body of this Report.

It is internationally recognized that human performance issues are major contributing factors in approximately 80 per cent of all aircraft occurrences. The ICAO clearly views human factors as a legitimate investigative pursuit. In its Manual of Aircraft Accident Investigation (4th ed.), ICAO postulates the following basic criteria for aircraft accident investigation:

> Reduced to simple terms, the investigator has to determine what happened, how it happened, and why it happened, applying these questions not only to basic cause but to all aspects relating to safety ...
>
> ... Similarly, if human error appears as a possible cause of the accident all factors which may have influenced the actions should be examined ... Experience has shown that the majority of aircraft accidents have been caused or compounded by human error, often by circumstances which were conducive to human error; this applies to design, manufacture, testing, maintenance, inspection and operational procedures both ground and air. Identification of this element is frequently difficult but it may be revealed by careful, skilful and persistent investigative methods.
>
> Some aircraft accidents have resulted from organizational defects or weaknesses in management; for example, an operator may have prescribed or condoned procedures not commensurate with safe operating conditions in practice. Similarly, ambiguous instructions, and those capable of dual interpretation may also have existed; these factors may well have stemmed in the first instance from uncritical scrutiny by regulating authorities. It may therefore be necessary to inquire closely into other organizations or agencies not immediately or directly concerned with the circumstances of the accident but where action, or lack of it, may have permitted or even caused the accident to happen.
>
> (Exhibit 429)

This broad approach to the search for all possible factors which may have influenced an aircraft accident, advocated by ICAO, represents the investigative methodology adopted by this Commission of Inquiry. In my view this is the only acceptable way to conduct a full and proper investigation of an aviation occurrence. The subject of human factors or human performance in the context of aviation accidents was canvassed in depth during the hearings of this Commission and is covered at length in Part Seven of this Report, Human Factors.

The 1981 Report of the Commission of Inquiry into Aviation Safety, which recommended the establishment of the Canadian Aviation Safety Board (CASB, now the TSB), also suggested that the Canadian investigative authorities should improve human performance investigations.

Although the TSB now has a human factors unit and a number of human factors specialist researchers and investigators, it would appear that the board has not yet fully perceived human factors as a legitimate pursuit. This conclusion is reached in part on the basis of an analysis of board decisions which indicate an approach predicated on the view that, if something cannot be quantified as a fact, then it is not used in statements of cause. This approach certainly does not work for human factors considerations. Any reticence to draw inferences, or conclusions, on the basis of a preponderance of evidence is in my opinion detrimental to the conduct of a full investigation of an aviation occurrence and is totally counterproductive to an investigation of human factors issues. I am strongly of the view that the board should adopt a policy recognizing that the investigation of human factors is a legitimate pursuit in the investigation of and reporting on an aviation occurrence.

The Monitoring of TSB Recommendations: One Example

The proceedings before me revealed that, from time to time, the TSB, and its predecessor, CASB, have made recommendations for consideration and action in the interest of aviation safety to the minister of transport. The evidence before me further revealed that on some fundamental safety issues an inordinate amount of time passes between the date of a TSB (or CASB) safety recommendation and consequent action by the minister. This unsatisfactory state of affairs can be illustrated by describing what has occurred, and is continuing to occur, in relation to the issue of carry-on baggage.

Civil Aviation Inspector Randy Pitcher, in his testimony before the Commission, described the problem of carry-on baggage in the following terms:

> A. I appreciate the fact that it doesn't appear that the carry-on baggage may have been a factor in the number of people that unfortunately lost their lives at Dryden, but I do understand that the overhead rack was, to some extent, limiting in terms of people being able to escape the aircraft.
>
> But specifically, the problem that exists today primarily is a situation where you have passengers deplaning or changing from a large airplane, for example, a 767, off of Air Canada or Canadian, and joining an Air Ontario Dash 8, F-28, or indeed a Canadian ATR 42. They may have very, very bulky carry-on baggage, and it's been my experience, sir, that flight attendants are forced to deal with this difficult problem right on board the airplane. It creates unnecessary stress for the flight attendant. It certainly is not a pleasant situation for the passenger.
>
> And my recommendation would be that flight attendants, first of all, should not have to deal with these problems on the airplane, that carriers must take measures to screen this kind of carry-on baggage, that overhead bins often times, although they are designed for hats and coats, often times passengers do load very, very heavy pieces of luggage which become projectiles, which become very dangerous in an accident situation.
>
> (Transcript vol. 128, pp. 6–7)

The problem described by Mr Pitcher is not new. In fact, it was known to Transport Canada at least as far back as October 24, 1985, when Mr Donald Douglas, then director of Transport Canada's Licensing and Certification Branch, noted in a memorandum that the director general of air regulations "has been advised that Donna Richard will be taking on the carry-on baggage project" (Exhibit 1174).

By correspondence dated January 28, 1986, Mr William Tucker of CASB wrote to Mr William Slaughter, then director of Transport Canada's Aviation Safety Programs Branch, expressing concern about the amount of cabin baggage being brought aboard aircraft:

> Three confidential aviation safety reports have been received from flight attendants employed by different airlines expressing concerns about the amount of cabin baggage being brought aboard aircraft.
>
> (Exhibit 1175)

Mr Tucker noted in his correspondence that the carry-on baggage issue had been discussed with Air Canada, CP Air, Nordair, and PWA, and that there was common agreement that the issue could only be resolved on an industry-wide basis. Mr Tucker's letter described the safety concern in the following terms: "The resultant situation could lead to unnecessary injury and perhaps even obstruct evacuation routes in the event of a serious occurrence involving a large passenger aircraft."

The evidence indicates that Mr Slaughter transmitted these concerns to Mr Douglas, the Transport Canada officer responsible for air carrier passenger safety standards. On February 27, 1986, Mr Douglas communicated with Mr Slaughter, stating in part: "if consultation with the carriers does not prove beneficial, or at the completion of the survey it is evident there is no improvement, consideration will be given to developing more stringent legislation" (Exhibit 1176).

Ms V.M. Doll, the acting manager, passenger safety, made a note on her file, dated December 11, 1986, indicating that amendments to Air Navigation Order Series VII, No. 4, Carry-On Baggage Order, were prepared and that air carriers had been consulted. However, the fact is that no amendments to the ANO were passed to restrict carry-on baggage.

Almost four years later, on July 25, 1990, the TSB drew attention to a potentially serious aviation safety deficiency and released four safety recommendations, based on more than 60 incident reports, relating to the lack of clear guidelines concerning carry-on baggage. The TSB recommendations state in part:

> It appears that this potentially serious aviation safety deficiency is the result of air carriers failing to comply with existing legislation, a lack of clear definition as to the size, weight and amount of carry-on baggage that is permitted, and a lack of understanding on the part of passengers of the safety implications of this issue.
>
> (Exhibit 1179)

Pursuant to the *CTAISB Act*, the minister of transport had 90 days in which to reply to the recommendations. Accordingly, the ministerial response was, by law, required by October 25, 1990.

As of the date of writing this section of my Report (June 28, 1991), there have been at least five consecutive years of documented, legitimate expressions of concern by CASB or the TSB on the issue of carry-on baggage, with no meaningful action on the part of Transport Canada. Surely it is totally unacceptable that, within a five-year period, there has been no regulatory change enacted to eliminate a serious and legitimate aviation safety concern.

Despite repeated warnings and recommendations from CASB (and the TSB) to Transport Canada, the issue of carry-on baggage remains unresolved, largely, based on the evidence before this Inquiry, because of the lobbying of the Air Transportation Association of Canada (ATAC).

In my view, the TSB's responsibility for safety recommendations should extend beyond merely notifying the minister of transport of a safety concern. The TSB should have the responsibility under law for tracking and following up on the action taken by the minister of transport on a safety recommendation, and if no action is taken within a specified time frame, it should have the authority to require an explanation from the minister. Any legislation conferring upon the TSB the power to follow up its safety recommendations should include a legislated mode of procedure which causes Transport Canada to commit itself to a resolution date rather than allowing the regulator simply to indicate that a matter is being studied or considered.

RECOMMENDATIONS

It is recommended:

MCR 177 That the *Canadian Transportation Accident Investigation and Safety Board Act* be amended and regulations be passed to provide that, at any major aircraft accident investigation, parties having a direct interest in the investigation have the right to nominate, in consultation with the investigator in charge, individuals with specific expertise from among their ranks to be involved in the investigation as participants (as opposed to observers) on specific investigation team groups, such as operations, human factors, records, systems, engines, or site survey.

The terms and conditions of such participant involvement should be determined by the Transportation Safety Board of Canada and ought to include provisions placing participants under the authority of and responsible to the investigator in charge, as well as provisions to ensure the absolute confidentiality of all information and documentation gathered relating to the investigation.

MCR 178 That sections 28, 29, and 30 of the *Canadian Transportation Accident Investigation and Safety Board (CTAISB) Act* be amended to provide that witness statements, on-board recordings, and communications records referred to in those sections be made available on a confidential basis to those individuals who have been granted full participant status as representatives of parties having a direct interest in the accident investigation; and that all other provisions of sections 28, 29, and 30 of the *CTAISB Act* be amended accordingly in order to give full meaning and effect to the recommended amendments.

MCR 179 That section 24(2) of the *Canadian Transportation Accident Investigation and Safety Board (CTAISB) Act* be repealed. The Transportation Safety Board of Canada, in order to preserve its independence, should not be required to send a copy of any draft report on its findings and safety deficiencies that it has identified to each minister, or to any other person with a direct interest in the findings of the board, to provide them with an opportunity to make representations to the board with respect to the draft report, before the final report is prepared.

The other provisions of section 24 of the *CTAISB Act* should be amended accordingly in order to give full meaning and effect to the recommended repeal of section 24(2).

MCR 180 That a section be added to the *Canadian Transportation Accident Investigation and Safety Board Act* to provide to each minister and to each party having a direct interest in the findings of the board an opportunity, after completion of the aviation occurrence investigation and the gathering of the evidence, to make formal submissions within a time frame to be prescribed by the board, for consideration by the board in its deliberations.

MCR 181 That section 26 of the *Canadian Transportation Accident Investigation and Safety Board Act* be amended to incorporate a specific provision entitling a party with a direct interest in an investigation or public inquiry to petition the board for reconsideration of the conclusions of its final report where it is shown that new and material evidence has been discovered subsequent to the conclusion of the investigative process and which might reasonably affect such conclusions or where it is shown that the board's factual conclusions are erroneous.

MCR 182 That the *Canadian Transportation Accident Investigation and Safety Board Act* be amended to provide that all witness interviews conducted by investigators in connection with an aviation occurrence shall be tape recorded and transcribed.

MCR 183 That the Transportation Safety Board of Canada add to its roster the names, addresses, and telephone numbers of highly qualified Canadian and international professional experts, learned in the various disciplines, who are willing to be called upon to assist in any given aviation occurrence investigation. Such a roster should be maintained and updated in consultation with the Canadian aviation community.

MCR 184 That the Transportation Safety Board of Canada, as a matter of policy, establish a closer liaison with the National Aeronautical Research Establishment and the National Research Council Canada and, on an ad hoc basis, utilize to the fullest their facilities and staff experts in various applicable disciplines, to assist in the investigation of aviation accidents.

MCR 185 That sections 24(5) and 24(6) of the *Canadian Transportation Accident Investigation and Safety Board (CTAISB) Act* be amended to empower the board with the responsibility and authority under law to track and follow up on an ongoing basis the action taken by the minister of transport with respect to each board safety recommendation and, if no action is taken by the minister within a specified time frame, to require an explanation in writing by the minister therefor. There should be a legislated mode of procedure that causes Transport Canada to commit itself to a resolution date, within a specified time frame, with respect to all board recommendations that are accepted by the minister, with an explanation for the time frame contemplated. In the event that the minister's action varies from the board recommendation, or if the minister proposes to take no action with respect to a recommendation of the board, then written reasons therefor should be provided to the board, and such reasons should be made available to the public.

The other provisions of section 24 of the *CTAISB Act* should be amended accordingly in order to give full meaning and effect to the noted recommended amendments.

MCR 186 That the annual report of the Transportation Safety Board of Canada continue to set out, as it now does, all of the recommendations, whether interim or final, that have been made by the board to the minister in the preceding year, but that it add comment regarding the actions taken by the minister in regard thereto.

MCR 187 That the Transportation Safety Board of Canada provide forensic training to all its scientists and that the board call upon such outside resources as are necessary to assist them with such training.

MCR 188 That the Transportation Safety Board of Canada formally adopt a policy recognizing that the investigation of human factors involved in an aviation occurrence is a legitimate pursuit and an important element of the investigatory process.

MCR 189 That the Transportation Safety Board of Canada formally adopt a policy recognizing that it is appropriate for the board to draw inferences of fact based on a preponderance of evidence and to refer to such inferences in its decision-making process.

42 AVIATION INCIDENT AND OCCURRENCE REPORTING AND THE ISSUE OF PILOT CONFIDENTIALITY

The issue of whether statements and reports made by pilots with respect to aviation occurrences or incidents are entitled to privilege on the basis of confidentiality, and therefore inadmissible as evidence, arose during the course of the hearings of this Commission. Counsel for Air Ontario and for the Canadian Air Line Pilots Association (CALPA) asserted a claim of entitlement to privilege on the basis of confidentiality and objection to their production with respect to the following documents:

- The questionnaires and contemporaneous notes completed by Captain Ronald Stewart, the Air Ontario flight safety officer, in relation to his telephone interviews with five Air Ontario F-28 pilots about the F-28 operations, following the March 10, 1989, crash at Dryden.
- All incident reports relating to Air Ontario F-28 aircraft C-FONF and the sister aircraft C-FONG.
- The incident and occurrence reports that had been filed by Captain George Morwood and First Officer Keith Mills while they were in the employ of Air Ontario Inc. or its predecessor companies.

Counsel for Air Ontario and for CALPA argued that air carrier pilots submit incident reports in the belief they are confidential. They suggested that if such confidentiality is breached, pilots will be less forthcoming and frank in disclosing information about incidents, and the circumstances in which they occurred, to airline management. They predicted a potential chilling effect on the reporting of incidents, and argued that the release of incident reports and questionnaires would compromise rather than facilitate improvements in aviation safety.

Counsel for CALPA further argued that if the identity of pilots making incident reports were disclosed, this source of information would dry up. In contrast, counsel for the chief coroner of the Province of Ontario, for the surviving passengers and the families of victims, and for the *Toronto Star* and the Canadian Press, all of whom were granted intervenor status with respect to this issue, argued in favour of the disclosure of the material in question and the identity of its authors. They argued that disclosure was in the public interest and that the value flowing from disclosure far outweighed any negative impact such disclosure might have on the candour and willingness of pilots to make such reports in the future. Counsel for the Government of Canada, although in favour of disclosure of the material in question, argued that the identity of pilots should be kept confidential.

The issue was ultimately resolved to the satisfaction of counsel for all parties. Captain Stewart and the pilots waived any possible privilege based on confidentiality and agreed to the production of the documents in question. They also agreed to testify voluntarily before this Inquiry.

Notwithstanding this result, I deem it appropriate to comment on this issue because of the widespread interest in the subject of pilot confidentiality within the aviation community. I want to explain the objectives of the Commission in pursuing this evidence and hope to clarify, to the extent possible, the pilots' confidential incident-reporting system.

Background

Captain Ronald Stewart was the Air Ontario Inc. flight safety officer at the time of the crash of flight 1363 and in the months following. While conducting an internal investigation into the crash, he interviewed five Air Ontario F-28 pilots by telephone on various aspects of the Air Ontario F-28 operation. In the course of each of the interviews, Captain Stewart completed a questionnaire he had prepared and made notes of the pilots' responses. He told the pilots that their interviews with him were confidential.

Captain Stewart was himself interviewed by Commission of Inquiry staff in the course of the investigation of the March 10, 1989, crash. He informed the Commission interviewers of the nature of the responses he had received from the five pilots, without divulging their names. On the advice of Air Ontario counsel, Captain Stewart withheld his contemporaneous notes of the five pilot interviews, the completed questionnaires, and the names of the pilots.

Correspondence subsequently passed between counsel on behalf of the Commission and counsel to Air Ontario in which the Commission sought production of the completed questionnaires, the contemporaneous notes, the names of the five pilots, and reports and other materials prepared or received by Air Ontario in connection with incidents involving the F-28 aircraft. Counsel for Air Ontario, supported by counsel to CALPA, refused to produce the information requested, claiming that any such action "would have a chilling effect on the reporting of incidents generally and a detrimental effect on the flight safety program" (Exhibit 576, appendix 3).

Despite considerable discussion between Commission counsel and counsel to Air Ontario and CALPA whether all the information and documentation relating to the crash of flight 1363 should be produced to the Inquiry, counsel for Air Ontario, supported by counsel to CALPA, continued to refuse such production. When no resolution appeared to be forthcoming on a consensual basis among counsel, I issued a subpoena *duces tecum* on February 22, 1990, to be served on Captain Stewart requiring his attendance before the Commission and requiring him to produce the documentation in question.

On April 23, 1990, during the course of the hearings of this Commission to which Captain Stewart was summoned as a witness, a claim of privilege, based on confidentiality, was asserted by counsel representing Air Ontario and CALPA. This claim was made with respect to the proposed introduction into evidence by Commission counsel of the questionnaires completed by Captain Stewart. In addition, objection was taken to the identification and proposed calling of the five pilots as witnesses, and to the introduction of evidence of incident reports involving the F-28 aircraft as well as incident reports specifically involving Captain George Morwood and First Officer Keith Mills. It was proposed, in the alternative, that I receive the documents in a sealed envelope and that I consider them privately, without public disclosure of the contents or revelation of the identity of the pilots. I summarily dismissed this proposal as inappropriate, particularly in the case of a public inquiry.

The proposal by Commission counsel to put forward this evidence was strongly supported by counsel for the chief coroner of the Province of Ontario; by counsel for the victims' families and the survivors; and by counsel for the *Toronto Star* and the Canadian Press, who were granted intervenor status in this regard. An adjournment with respect to this issue was granted to May 22, 1990, to allow counsel to prepare written submissions in support of their respective positions.

Detailed written arguments were in fact produced by counsel for all of the concerned parties. On May 22, 1990, the hearing into the issue of pilot confidentiality resumed. Commission counsel proposed to begin by calling Captain Stewart and the five pilots to give evidence regarding the circumstances under which the statements by the pilots were made.

At this time, counsel for both Air Ontario and CALPA indicated they had no objection to Captain Stewart's being called as a witness or to his disclosing the nature of the information obtained from the five pilots. However, they strenuously objected to his being required to identify the pilots, and they remained totally opposed to the pilots being called as witnesses.

After I had heard considerable argument by counsel I was of the view that a two-stage process was involved in deciding the issue. The first stage was to determine the circumstances on which the claim for privilege based on confidentiality was founded. Obviously, if no offer had been made by Captain Stewart to give rise to the cloak of confidentiality, that would end the matter. If, however, it was found from the evidence that an offer of confidentiality had been made to the five pilots, then it would be necessary to go on to the second step to determine whether the pilots' statements to Captain Stewart were in fact privileged in law.

In my view, the best possible evidence of whether a statement was made in confidence was that of the person who actually made the statement. Counsel for Air Ontario and CALPA urged that only Captain Stewart be called in this regard and that the five pilots neither be identified nor called as witnesses at this stage of the proceedings. This position was tantamount to hearing only one-half of the story and was clearly unacceptable in a public forum.

In addition, counsel for the provincial coroner of Ontario moved for an order excluding witnesses during Captain Stewart's testimony. In opposing this motion, counsel for Air Ontario and CALPA argued that the five pilots occupied a position analogous to that of an accused in a criminal matter or a party to a civil proceeding and that they ought not to be excluded. Following all of the argument, I made the ruling set out hereunder.

Ruling of the Commissioner Made on May 22, 1990

> It strikes me that there is really no analogy between the position of these pilots and a party accused in a criminal matter and a party in a civil action. I don't think I can come to the conclusion that you suggest, Mr Keenan, with respect to the pilots.
>
> In this matter, it is not in dispute that five Air Ontario F-28 pilots gave certain information to their safety officer, Captain Stewart, after the March 10th crash at Dryden and that Captain Stewart recorded this information.
>
> Commission Counsel proposes to call Captain Stewart and the five pilots in order to establish the circumstances under which the information was given to Captain Stewart by these pilots, and he argues that those circumstances are relevant to the larger issue of privilege based on confidentiality which is being asserted on behalf of those pilots with respect to that information.
>
> This is a two-stage issue. The first stage involves the circumstances out of which a claim for privilege based on confidentiality

arises. The second stage involves examining the issue of whether or not a claim for privilege can be sustained on the basis of confidentiality. At this point, we are concerned only with the first stage.

Counsel for Air Ontario and for the Canadian Airline Pilots Association representing the five pilots argue that the pilots who gave statements to Captain Stewart should not be called as witnesses at this stage, nor should their identities be made public prior to a decision being made on the larger issue of privilege itself. It is suggested that I hear only the evidence of Captain Stewart on this point. However, to hear the evidence of Captain Stewart alone would be to only hear one side of the story.

The question is not so much one of whether an offer of confidentiality was made but whether that information which was received by Captain Stewart would not have been given to him by the pilots in question in the absence of an undertaking as to confidentiality.

The available jurisprudence on the subject indicates that a tribunal faced with a claim of privilege on the basis of confidentiality must hear evidence as to the circumstances giving rise to such claim. In this case, I can think of no evidence more germane to the issue of such circumstances than that of the five individuals with respect to whom a claim for privilege is being asserted on the basis of confidentiality.

The circumstances under which the statements in question were given go to the very heart of the matter. That evidence can only be given by the pilots themselves. Position statements made by counsel on their behalf is not evidence.

In short, in order to intelligently adjudicate on the main issue, I feel that I have to hear those who claim privilege and their evidence must be subject to the tests of cross-examination.

At this stage, no reference to the content of the actual statements given by each of the pilots will be made. It is already public knowledge that certain statements were made.

In my view, it cannot reasonably be inferred that any injury will accrue to these pilots or to the general pilot group by merely hearing the evidence of the five pilots as to the circumstances under which their individual statements were made to Captain Stewart.

I therefore conclude in all the circumstances of this case that it is appropriate that Captain Stewart and the five pilots be called as witnesses in this stage of the process of ultimately determining the efficacy of the claim for privilege.

Counsel for the Provincial Coroner of Ontario has moved that there be exclusion of witnesses during this phase of the inquiry. This is routinely done in courts at all levels.

Because of the delicate nature of this matter, I deem it to be in the best interests of all concerned including the said pilots themselves that an order for exclusion be made.

I accordingly make the following order:

> First, all witnesses who are to be called to testify in this phase of the inquiry shall be excluded from the hearing room while other witnesses testify.
>
> Second, witnesses who are yet to be called to testify are hereby directed not to watch the television monitor at Commission premises during the hearings.
>
> Third, witnesses who are to be called shall not discuss their evidence or the evidence of any other witness with any other person excluding counsel for those persons.
>
> Witnesses who are yet to be called to testify are directed not to read the transcripts of evidence given by other witnesses who have testified ahead of them during this phase of the inquiry.
>
> (Transcript, vol. 74, pp. 72–76)

Shortly thereafter that same day, May 22, 1990, I was told that all counsel had arrived at an agreement on the issue of privilege based on a claim of confidentiality, which precluded the necessity of a protracted hearing before me. The position arrived at by counsel was essentially the following:

- The five questionnaires completed by Captain Stewart during his telephone interviews with the F-28 pilots would be produced to the Commission.
- The contemporaneous notes of the interviews with the five F-28 pilots made by Captain Stewart would be produced to the Commission.
- All incident and occurrence reports relating to the F-28 aircraft would be produced to the Commission.
- All incident and occurrence reports in the possession of Air Ontario, or from other sources, pertaining to Captain Morwood and First Officer Mills would be produced to the Commission.
- The names of the five pilots would be made available to the Commission, and the pilots would all appear as witnesses before me waiving whatever alleged privilege may have attached to the questionnaires completed by Captain Stewart. The pilots in question were Christian Maybury, Deborah Stoger, Angus Moncrieff (Monty) Allan, William Wilcox, and Erik Hansen.

The Five F-28 Pilot Questionnaires and Contemporaneous Interview Notes

Captain Stewart was called to testify on May 23 and 24, 1990. In response to questions by counsel for Air Ontario, he gave the following explanation for his personal decision, as the Air Ontario flight safety officer, to conduct the pilot surveys after the F-28 crash:

Q. ... tell me, sir, why you drafted this survey.
A. Rumours. They're prevalent in every industry, I'm sure. They are very much so in the airline. After the accident, there was many rumours of – surrounding the F-28 operation and what was wrong with it, and I wanted to get to the bottom of it to see if there was any basis for fact.
Also, I had some specific questions, some concerns that had been raised during the investigation, during the on-site investigation out in Dryden, with respect to icing with – or, excuse me, de-icing on aircraft with an engine running and also with respect to, in quotation marks, "hot refuelling," and I wanted to learn what the pilot viewpoints were on those two issues as well.
Q. Now, what use was going to be made of this survey by you once you had it completed?
A. Well, what I intended to use this for was simply to assess whether or not the rumours were true and, assuming the worst, make recommendations to the president with respect to the operation.
Q. So this would be in line with your major responsibilities as you've outlined it on the –
A. Yes, very much so.

(Transcript, vol. 74, p. 98)

Captain Stewart testified that he originally planned to survey all F-28 pilots with Air Ontario but abandoned this plan after the vice-president of flight operations, Mr James Morrison, took great exception to the survey and angrily queried Captain Stewart whether he was conducting a "witch hunt." In his evidence, Mr Morrison conceded he had referred to the pilot survey as a witch hunt:

A. ... And he said, well, what do you mean, Jim, and I said, well, basically, Ron, are you on a witch hunt or are we trying to develop something here?

(Transcript, vol. 115, p. 160)

Q. When you talked to him, did you use the word "witch hunt" in talking to him? Do you recall?
A. I believe I did.
Q. Do you think that choice of terminology on your part may have transmitted your dissatisfaction with the survey to him?
A. In retrospect, yes, I would say that it would, certainly.

(Transcript, vol. 115, pp. 166–67)

The company discontinued the F-28 operation six weeks later, citing commercial reasons for the cancellation of the program.

The contents of the questionnaires and the contemporaneous notes of the pilot interviews made by Captain Stewart were of considerable probative value to the inquiry into the Air Ontario F-28 operations and flight safety program. The principal criticisms cited by the five pilots regarding the F-28 operations concerned a lack of technical direction in the F-28 program and the fact that there was no one in the organization experienced enough to lead the F-28 project. The competence of Captain Joseph Deluce in his role as F-28 chief pilot was also the subject of pilot criticism. Captain Stewart in fact recommended to Air Ontario management that Air Canada be brought in to lead the program. This recommendation was not acted upon.

Other pilot criticisms centred on the lack of Air Ontario F-28 standard operating procedures (SOPs), confusion among pilots as to which of three different flight manuals should be used, poor coordination within the Air Ontario system operations control (SOC) centre, and lack of ground-support facilities at various stations. These matters are explored in greater detail in other chapters of this Report.

Clearly, the information contained in the pilot questionnaires and in Captain Stewart's interview notes was relevant to the issues being considered by this Inquiry and it was, in my view, in the public interest that it be disclosed. I would emphasize that the Commission was duty-bound to pursue all relevant evidence pertaining to the Air Ontario F-28 operation in its search for the contributing factors and causes of the March 10, 1989, crash. All steps taken towards this end, including the introduction into evidence of the five F-28 pilot questionnaires and Captain Stewart's interview notes, were, in my view, consistent with the laws of Canada.

I propose now to outline and comment on the powers of a Commission under the *Inquiries Act*; the applicable Canadian statutory provisions; the position of the International Civil Aviation Organization (ICAO); the provisions of Air Ontario corporate manuals and forms; and the common law that evolved with respect to privilege and confidentiality in relation to the production of the documents in issue.

Powers of the Commissioner with Respect to the Conduct of the Inquiry

The Order in Council: Procedures

The Order in Council establishing this Commission, dated March 29, 1989, provides that "the Commissioner be authorized to adopt such procedures and methods as he may from time to time deem expedient for the proper conduct of the inquiry."

The Inquiries Act: Summoning Witnesses and Production of Documents

Section 4 of the *Inquiries Act*, R.S.C. 1985, c.I-11, provides:

> The commissioners have the power of summoning before them any witnesses, and of requiring them to
> (*a*) give evidence, orally or in writing, and on oath or, if they are persons entitled to affirm in civil matters on solemn affirmation; and
> (*b*) produce such documents and things as the commissioners deem requisite to the full investigation of the matters into which they are appointed to examine.

The Order in Council, when read in conjunction with and subject to the terms of the *Inquiries Act* and the common law, suggests that the commissioner is entitled to conduct the inquiry in such a way as to further the objects of his commission and that, to the extent that legal rights are not contravened, is "the master of [his] own procedure." (See *F. Irvine v. Canada* (Restrictive Trade Practices Commission), [1987] 1 S.C.R. 181.)

Canadian Statutory Provisions

There are no statutory provisions to assist a commissioner in determining whether the documents in issue should be produced. However, some mention should be made of the Air Navigation Order (ANO) Series VII, No. 2; the *Canada Evidence Act*, R.S.C. 1985, c.C-5, as amended; the *Canadian Aviation Safety Board Act*, R.S.C. 1985, c.C-12, and the Regulations thereunder; and the now proclaimed *Canadian Transportation Accident Investigation and Safety Board Act*, S.C. 1989, c.3.

ANO Series VII, No. 2

ANO Series VII, No. 2, which establishes the Standards and Procedures for air carriers using large aircraft, is silent with respect to the aviation occurrence reporting system.

The Canada Evidence Act

Section 37 of the *Canada Evidence Act*, R.S.C. 1985, c.C-5, as amended, permits a minister of the Crown or "other person interested" to object to the disclosure of information on the basis of a specified public interest. The court may examine or hear the information and order its disclosure subject to restrictions or conditions it deems appropriate, if it concludes that the public interest for disclosure outweighs the specified public interest. For the purposes of the Act, "other person interested" contemplates a person in authority in relation to the public interest specified. (*R. v. Lines* (1986) 27 C.C.C. (3d), 377 (N.W.T.C.A.)). One would be hard pressed indeed to find that either Air Ontario or CALPA would be persons interested within the meaning of the Act and, therefore, entitled to invoke section 37 to their benefit. Certainly I cannot come to such a conclusion.

The Canadian Aviation Safety Board Act

The *Canadian Aviation Safety Board Act*, R.S.C. 1985, c.C-12, created the now defunct Canadian Aviation Safety Board (CASB), a statutorily mandated board with broad powers to, *inter alia*, search and seize property, compel individuals to attend and give evidence under oath, compel the production of medical records, and conduct public inquiries into aviation occurrences.

The provisions of the *Canadian Aviation Safety Board Act* are of no assistance to Air Ontario or to CALPA in this matter. While the legislation creates a privilege for specifically defined statements, the privilege clearly attaches only to statements obtained by the board or an investigator for the board. Notwithstanding this, where the production of a statement is contested on the grounds that it is privileged, the court (defined to include a commission under the *Inquiries Act*) is to review the statement in camera and may order production if it concludes that "the public interest in the proper administration of justice outweighs in importance, the privilege attached to the statement by virtue of section 38."

There are no provisions in the *Canadian Aviation Safety Board Act* that afford any individual (such as Captain Stewart and each of the five F-28 pilots), corporation (such as Air Ontario), or association (such as the Canadian Air Line Pilots Association) any privilege, degree of protection, or confidentiality in the gathering of occurrence or incident reports or any other documents or information pertaining to the safety of the operation of an air carrier.

Canadian Aviation Safety Board Regulations

The Canadian Aviation Safety Board Regulations established a mechanism for anonymous and confidential reporting of aviation-related concerns to the board. Section 6 of the Regulations provides as follows:

Voluntary Reporting

6.(1) Any person having knowledge of an aviation occurrence who is not required to report the occurrence pursuant to section 3, 4 and 5 may report to the Board any information that the person wishes to report.

(2) Where a person reports to the Board pursuant to subsection (1), the person may, by using the form set out in the schedule, request that his identity and any information that could reasonably be expected to reveal his identity not be released.

(3) Where a report is made to the Board by using the form set out in the schedule,

(*a*) the report shall be examined exclusively by officers of the Board specifically designated by the Board to examine the report; and

(*b*) the Board shall return the removable identification strip on the form to the address appearing on the strip within 10 clear days from its receipt of the report.

(4) Where a person reports to the Board pursuant to subsection (1) by using the form set out in the schedule, no person shall release, or cause to be released, the identity of the person making the report or any information that could reasonably be expected to reveal his identity, unless the person making the report authorizes, in writing, such release.

The confidential aviation safety reporting system provided for by section 6 is the only method provided by statute or regulation whereby aviation occurrences may be reported in a confidential manner.

A brochure published by the Canadian Aviation Safety Board (CASB) entitled *Reporting in Confidence* describes the system in the following terms: "A new mechanism, using a reporting form provided by the Board, is available for those wishing to protect their identity when voluntarily reporting aviation occurrences. The program is designed to gather information not provided under the other systems." The "other systems" referred to are the mandatory and voluntary reporting systems:

Mandatory – Existing regulations require that all civil aircraft accidents and missing aircraft as well as certain types of incidents be reported to the CASB. The mandatory reporting of incidents presently applies only to aircraft weighing more than 5,700 kg and covers specified types of incidents such as engine failure, smoke or fire in the aircraft and near collisions ...

Voluntary – The voluntary system is concerned with incidents, situations or conditions involving aircraft weighing more than 5,700

> kg that are outside mandatory reporting requirements, and all those involving aircraft weighing less than 5,700 kg.
> (Exhibit 577, Document 4)

Thus, there are no provisions in the Canadian Aviation Safety Board Regulations that afford any individual, corporation, or association any degree of protection or confidentiality in the gathering of occurrence or incident reports or any other documents pertaining to the operation of an aircraft, except to the extent provided for an individual who avails himself or herself of the mechanism provided for in section 6 of the CASB Regulations. In fact, it is mandatory to report certain specified incidents involving aircraft weighing more than 5700 kg. No confidentiality whatsoever attaches to such reporting.

The Canadian Transportation Accident Investigation and Safety Board Act

An aviation occurrence is defined in section 2 of the Act as follows:

> (*a*) any accident or incident associated with the operation of an aircraft, and
> (*b*) any situation or condition that the Board has reasonable grounds to believe could, if left unattended, induce an accident or incident described in paragraph (*a*).

This Act effects the replacement on June 29, 1989, of the Canadian Aviation Safety Board (CASB) by the new Canadian Transportation Accident Investigation and Safety Board (CTAISB). There are no provisions in the *Canadian Transportation Accident Investigation and Safety Board Act* for any reporting systems that are different from those in place pursuant to the predecessor *Canadian Aviation Safety Board Act*. As of the date of this Final Report, no new regulations had been passed pursuant to the *CTAISB Act*.

Section 30 of the Act broadens the non-disclosure provisions in the predecessor legislation. Moreover, it includes in subsection (5) a provision allowing for a court to determine issues relating to the production and discovery of a statement made under the Act, where a claim to privilege is asserted, by balancing public interest with the importance of the privilege. Subsection (6) deems a "court" to include an inquiry under the *Inquiries Act*.

Subsections (5) and (6) provide as follows:

> (5) Notwithstanding anything in this section, where, in any proceedings before a court or coroner, a request for the production and

discovery of a statement is contested on the ground that it is privileged, the court or coroner shall
(*a*) *in camera*, examine the statement; and
(*b*) if the court or coroner concludes in the circumstances of the case that the public interest in the proper administration of justice outweighs in importance the privilege attached to the statement by virtue of this section, order the production and discovery of the statement, subject to such restrictions or conditions as the court or coroner deems appropriate, and may require any person to give evidence that relates to the statement.
(6) For the purposes of subsection (5), "court" includes a person or persons appointed or designated to conduct a public inquiry into a transportation occurrence pursuant to this Act or the *Inquiries Act*.

Clearly, even confidential statements made under the statutory protection of section 30 of the *CTAISB Act* are, at the instance of a court, in a proper case, subject to disclosure.

Position of the International Civil Aviation Organization

The position of ICAO with respect to disclosure of any records, including the statements of pilots made in the course of an accident or incident investigation, is unequivocal. Such records or information enjoy no legal privilege.

Paragraph 5.12 of Annex 13 to the Convention on International Civil Aviation relating to international standards and recommended practices, aircraft accident investigation, states as follows:

Disclosure of Records

5.12 When the State conducting the investigation of an accident or incident, wherever it occurred, considers that disclosure of any of the records, described below, might have an adverse effect on the availability of information in that or any future investigation then such records shall not be made available for purposes other than accident or incident investigation:
a) statements from persons responsible for the safe operation of the aircraft;
b) communications between persons having responsibility for the safe operation of the aircraft;
c) medical or private information regarding persons involved in the accident or incident;

d) cockpit voice recordings and transcripts from such recordings;
e) opinions expressed in the analysis of information, including flight recorder information.

(Exhibit 577, Document 11)

Attachment D to Annex 13

Attachment D to Annex 13 provides guidance to the interpretation of paragraph 5.12. It appears to modify the provisions of paragraph 5.12 to the extent that the appropriate authority must determine whether in the use of records, including pilot statements given in confidence, the proper administration of justice outweighs any adverse impact such use may have in future investigations. It provides:

ATTACHMENT D. DISCLOSURE OF RECORDS

Practical applications of 5.12

...

[4] a) in the spirit of 5.12, the records specified therein should not be made available to civil, administrative or judicial proceedings unless the appropriate authority determines that the proper administration of justice outweighs the adverse domestic and international impact such action may have on that or any future investigations;

(Exhibit 577, Document 11)

The standards and recommended practices of Annex 13 have no legally binding power. Furthermore, any member states that are signatory to Annex 13 and find it impractical or impossible to comply with a given standard or practice may at any time notify a "difference" and opt out. As of January 15, 1989, Canada and 14 other states had notified ICAO of differences with respect to paragraph 5.12 of Annex 13. The "difference" filed by Canada simply states:

5.12 Present Canadian legislation precludes the possibility to guarantee that the documents outlined could be afforded any protection from disclosure.

It is readily apparent that no degree of protection from disclosure or confidentiality can be invoked by any individual, corporation, or association pursuant to Annex 13. The Government of Canada, by filing a "difference," has made it abundantly clear that no protection from disclosure based on ICAO standards and recommended practices can be assumed or relied upon.

Applicability of Air Ontario Manuals and Forms

The Air Ontario Flight Operations Manual contains specific sections pertaining to aviation occurrences, accidents, and reportable incidents as well as the circumstances, by whom and to whom, under which reports are to be made. There are no provisions whatsoever in the manual which state or even remotely suggest that any information contained in aviation occurrence reports, accident reports, or incident reports, including the names of the operating crew members, will be treated as being confidential, privileged, or in some other manner protected. Furthermore, the various forms that were to be used by crews to record incidents were intended for a fairly wide distribution. Only one Air Ontario incident report form had three options to be checked off under the headings "Operational," "Flight Safety," or "Anonymous." A number of Air Ontario pilots who testified before me were uncertain as to the use and meaning of the "anonymous" option.

It became quite clear from the evidence of Air Ontario pilots and managers, and from the manuals and forms they used, that there were no corporate directives or individual expectations that Air Ontario had some type of formal confidential reporting system. This simply was not the case.

Past Practices of Commissions of Inquiry

The confidentiality of accident investigation procedures was discussed by Mr Justice Dubin in his *Report of the Commission of Inquiry on Aviation Safety* (vol. 1, May 1981). While the Dubin Commission did not deal with privilege issues in relation to pilot incident reports and questionnaires, there was controversy with respect to disclosure of material gathered by aviation safety investigators.

Mr Justice Dubin reviewed several case studies in the report, including the crash of a Pacific Western Boeing 737 at Cranbrook, British Columbia. Litigation was commenced against the Department of Transport by Pacific Western Airlines as a result of this crash. The Department of Justice began to collect documents relating to the crash for the purposes of production on discovery, but members of the aviation safety investigation division who inquired into the Cranbrook crash refused to produce certain documents relating to their examination. They maintained that it would frustrate their efforts to obtain full and frank disclosure from individuals if those communications did not remain strictly confidential.

In his comments, Mr Justice Dubin concluded that no privilege attached to the materials gathered by the investigators. He suggested in his report, however, that it might be appropriate to introduce legislation that would provide for confidentiality of the type sought by the aviation safety investigation division (pp. 210–13). Such provisions subsequently surfaced in the Regulations to the *CASB Act*.

In his Report, Mr Justice Dubin referred to the United States experience:

> The main ground advanced by those asserting that a privilege should be attached to all statements obtained by the investigators in the course of their investigations is that witnesses would refuse to provide information to accident investigators if these statements could become admissible in legal proceedings. Those who advanced this position opined that this would happen. These opinions were equally matched with the opinions of others that no such result would flow. It has not been the experience of the National Transportation Safety Board in the United States, where witnesses' statements enjoy no privilege, that their sources of information have dried up. Conversely, there is a danger that witnesses who are assured that their information will not be challenged, nor come under public scrutiny, may take liberties with the facts. This may impair public confidence in the reliability of accident reports.
>
> The practice of accident investigators of assuring confidentiality to those being interviewed should not be encouraged since the investigator cannot in all circumstances carry out his pledge of confidentiality.
>
> In my opinion no satisfactory arguments have been advanced which would warrant any rule of absolute privilege to be attached to witnesses' statements.
>
> (*Report of the Commission of Inquiry on Aviation Safety*, vol. 1, pp. 239–40)

While the documents sought from the aviation safety investigators in the Cranbrook crash were ordered produced, it should be pointed out that the documents and pilot information in issue before this Commission were different in the sense that they were internal to Air Ontario and were not prepared or produced for the purposes of assisting aviation safety investigators in their efforts to determine the cause of the Dryden crash. For this reason, it is my view that both Air Ontario and CALPA are in a much more tenuous position in asserting a claim to privilege with respect to those documents and pilot information than was the case in the Cranbrook crash investigation.

The Documents in Issue: The Common Law

Taking into consideration the broadly stated objectives of the Order in Council and the absence of statutory direction with respect to the receipt and admissibility of the documents in issue, I conclude that I should be guided in my decision by the common law principles on privilege and confidentiality.

Evidentiary exclusion on the grounds of privilege is an exception to the presumed rule that all relevant evidence is to be placed before the trier of the fact. Wigmore addressed this fundamental principle of law in the following terms:

> For more than three centuries it has now been recognized as a fundamental maxim that the public (in the words sanctioned by Lord Hardwicke) has a right to every man's evidence. When we come to examine the various claims of exemption, we start with the primary assumption that there is a general duty to give what testimony one is capable of giving and that any exemptions which may exist are distinctly exceptional, being so many derogations from a positive general rule.
>
> (John Henry Wigmore, *Evidence in Trials at Common Law*, vol. 8, revised by John T. McNaughton [Boston: Little, Brown 1961], p. 70)

This fundamental principle was noted by authors Sopinka and Lederman, who stated there is an onus on a party asserting a privilege to establish why an exemption should be recognized:

> The extension of the doctrine of privilege consequentially obstructs the truth-finding process, and, accordingly, the law has been reluctant to proliferate the areas of privilege unless an external social policy is demonstrated to be of such unequivocal importance that it demands protection.
>
> (John Sopinka and Sidney N. Lederman, *The Law of Evidence in Civil Cases* [Toronto: Butterworths 1974], p. 157)

Prior to 1975, common law privileges were generally restricted to communications between solicitor and client, spouses, national security (state secrets), and to briefing assembled in the course of litigation. Inasmuch as the documents in issue do not fall into any of these categories, they clearly would have been subject to production.

In 1975 the Supreme Court of Canada in *Slavutych v. Baker* (1976) 1 S.C.R. 254 appears to have extended the common law to recognize privilege for confidential communications in narrow circumstances. Mr Justice Spence, adopting a test previously advanced by Wigmore, was prepared to grant a qualified privilege to confidential communications if four conditions were met:

1. The communications must originate in a confidence that they will not be disclosed.
2. The element of confidentiality must be essential to the full and satisfactory maintenance of the relation between the parties.
3. The relation must be one which in the opinion of the community ought to be sedulously fostered.
4. The injury that would inure to the relation by the disclosure of the communications must be greater than the benefit thereby gained for the correct disposal of the litigation.

The four conditions set forth in *Slavutych v. Baker* have been judicially interpreted in a number of decisions. One author commented that the Slavutych decision is capable of an equitable and evidentiary interpretation:

> If the equitable interpretation is the correct one then the case simply stands for the proposition that a party who makes a promise of confidentiality in return for information may not subsequently make use of that information as evidence against the promisee. The equitable principle of confidentiality does not prevent the court from compelling the disclosure of some confidential information at the instance of some third party.
>
> (Peter Sim, "Privilege and Confidentiality: The Impact of Slavutych v. Baker on the Canadian Law of Evidence," *Advocates Quarterly* 5 (1984–85): 360)

If one adopts the evidentiary approach, "a privilege could be granted in respect of a confidential communication even if both parties to the communication were strangers to the action" (ibid.).

The issue of qualified privilege of confidential communications was more recently canvassed by the Supreme Court of Canada in *Moysa v. Alberta* (Labour Relations Board) (1989), 60 D.L.R. (4th) 1 (S.C.C.). In this case the Supreme Court considered the decision of the Alberta Labour Relations Board, which ordered a journalist to give evidence with respect to her sources. The board applied Wigmore's test as adopted in the Slavutych decision and determined that the journalist did not fall within the scope of a "qualified testimonial privilege" either under common law or the Charter. Interestingly, Mr Justice Sopinka qualified his remarks relative to Slavutych by stating: "Even if a such qualified testimonial privilege exists in Canada this appeal must be dismissed as the appellant here does not fall within any of the possible tests which have been proposed as establishing the conditions necessary to justify a refusal to testify" (p. 1578).

In light of these comments, it could be argued that it is still not clear whether the Wigmore test is part of the law of Canada. If one takes the position that Mr Justice Spence's adoption of the Wigmore test is obiter, then production of the documents in issue should clearly not be refused since there is no common law or statutory prohibition that Air Ontario or CALPA could properly rely on in support of exclusion.

On the assumption that the Wigmore test is to be the appropriate test in the circumstances, however, the question is whether the applicants have met the four criteria enunciated by Wigmore.

In the case of *Re: Abel et al. and Director, Penetanguishene Mental Health Centre* (1979) 24 O.R. (2d) 279, the court in dealing with the question of the admissibility of confidential information stated that the courts have generally shown great sensitivity to the need for investigating bodies to rely to some extent on confidential information.

In the present case a balance had to be struck between the need of the community to know the full details and circumstances surrounding the crash and a potential risk that pilots might not be so forthcoming in the future in the completion of reports related to the carrying out of their duties. Although counsel did not present oral argument on their respective positions because the issue was eventually disposed of by agreement, they did, prepare and present to me very full and comprehensive written arguments, which I have considered at length.

Dealing with the first condition of the Wigmore test, although it is questionable whether the information in issue here can be said to have been given "in a confidence that [it] will not be disclosed," for the purposes of this exercise I will assume that this was in fact the case and that the first branch of the test has been met.

I did not hear a great deal of evidence from pilots on the second condition of the Wigmore test – whether confidentiality is essential to the satisfactory maintenance of the relationship – but I did hear some. Based on the evidence I heard and the arguments of counsel, I am of the view that, in the case of aviation safety and accident prevention programs, the assurance to pilots of confidentiality with respect to incident reporting is not only highly desirable but also essential to the satisfactory maintenance of the relation, subject only to a caveat in the case of aviation accident investigation, a matter with which I will deal in my comments regarding the fourth Wigmore condition. I will therefore assume for the purposes of this discourse that the second condition of the Wigmore test has been met.

The third Wigmore condition requires that the relationship be one that the community believes should be fostered. While it may be the view of the community that relations such as solicitor/client, husband/wife, patient/physician should be fostered, it is doubtful that the general community has an overwhelming sense that the management, flight safety officer(employer)/pilot (employee) confidence relationship must be maintained in the case of the investigation of an air accident.

Finally, it is my view that, even if the first three conditions were met, Air Ontario and CALPA could not meet the fourth Wigmore condition that the injury to the relation by the disclosure must be greater than the benefit thereby gained. The potential of injury to the management, flight safety officer (employer)/pilot (employee) relation because of disclosure in the course of an air carrier accident investigation of pilot incident or occurrence reports made in confidence is an extremely remote possibility, given the fact that air carrier accidents are a relatively rare occurrence. In my view the remoteness of the possibility of disclosure ever occurring is a factor to be considered in the balancing of interests.

It is certainly questionable whether pilots or other employees of an airline realistically expect that incident and safety reports given by them, in confidence, and in the context of an air carrier's flight safety or accident prevention program will not be disclosed during the investigation of the uncommon event of an air crash. In fact, some pilots have so indicated in their testimony. It is clearly in the best interests of the pilots themselves, as well as the public, that aviation safety be enhanced by the lessons to be learned from thorough and complete aviation accident investigations.

Having regard to all of the circumstances, I have no difficulty whatsoever in concluding that the injury that might or would inure to the relation is far outweighed by the public benefit realized through the full investigation of air disasters and the remedial actions that may follow to prevent future accidents. The balance, with respect to the question of privilege regarding the documents and information in issue, must, in the case of an aviation accident investigation, surely be tilted in favour of full access, recognizing the general public good.

Conclusion

Having reviewed the legal principles that govern the privilege or confidentiality of statements and reports made by pilots, it seems appropriate to comment generally on the application of such principles to the aviation community.

The evidence shows there are two distinctly different situations in which the issue of privilege/confidentiality arises. The first is in the context of accident prevention, and the second is in the context of accident investigation. The difference is fundamental.

It is clearly in the interest of accident prevention that pilots be able to author incident reports and complete flight safety–related surveys on a confidential basis, in order to avoid the possibility of harassment or adverse reactions from their employers. Such a regime deserves the fullest support since it obviously promotes candour and honesty. It is for this reason that some air carrier employers use anonymous or non-attributable incident-reporting systems. When such systems are established, however, it ought to be clearly understood they are for the purpose of accident prevention and intended for the furtherance of aviation safety practices. Fortunately, major airline accidents are a relatively rare occurrence, and the occasions on which the confidence of pilot incident reports are likely to be breached in the public interest are rare.

Captain Stewart, the Air Ontario flight safety officer, set up an informal, confidential incident-reporting system for pilots at Air Ontario as part of a safety and accident prevention program, without direction or authority from his employer. Under this system, pilots could report aviation incidents to the flight safety officer, in order to further the safety and accident prevention program of the carrier, with Captain Stewart's assurance that their identity would not be disclosed. Well intentioned as it was, Captain Stewart's offer of confidentiality to the five F-28 pilots, in return for their candour and cooperation in reporting on the F-28 program following the Dryden crash, can only have application in the context of Air Ontario's accident prevention program. It cannot be seen to defeat the introduction of evidence relevant to the aircraft accident investigation itself.

It is an obvious fact that Air Ontario was not charged with the responsibility of the accident investigation into the Dryden crash. Initially that was, by law, the responsibility of the Canadian Aviation Safety Board (CASB) and, subsequently, the responsibility of this Commission of Inquiry. When an aviation accident occurs and an accident investigation begins, the question of privilege for documents or statements previously given by pilots in confidence in the cause of accident prevention becomes an issue for determination by the authority investigating the aviation accident. This cannot be otherwise.

Aircraft accident investigation requires a thorough and detailed analysis of every conceivable element that may have had a bearing on an accident. It is inconceivable that the tribunal charged with the investigation of the Air Ontario crash of flight 1363 would not look at all prior incident reports filed by Captain Morwood or First Officer Mills, such reports being highly relevant to the human performance aspects of the crash investigation.

It is further inconceivable that a proper and thorough investigation of the crash of flight 1363 would not include a detailed review of all Air Ontario corporate practices relating to the F-28 program, including the five pilot questionnaires and interview notes completed specifically with respect to that operation. For a public inquiry to conduct an aviation accident investigation without the examination of such evidence in public would be a contradiction in terms. Unless information such as that contained in the pilot questionnaires, the interview notes, the names of the five F-28 pilots, and all applicable incident reports was made public, the credibility of the Commission of Inquiry as the investigative body, and its findings, would be compromised. The reassurance of the public that all possible factors influencing an aviation accident have been thoroughly investigated would, in my view, be seriously undermined if the information in question were to be treated as privileged, on the basis of confidentiality, and beyond the bounds of public scrutiny.

Although I am totally supportive of a confidential pilot incident-reporting system from the perspective of accident prevention, there can be no doubt whatsoever that the greater public interest must prevail and any privilege attaching to pilot incident reports made in confidence must yield in the case of an aircraft accident investigation. Frankly, I doubt that professional pilots would want it otherwise.

43 OBJECTION TO PRODUCTION OF DOCUMENTS, BASED ON A CONFIDENCE OF THE QUEEN'S PRIVY COUNCIL, SECTION 39, CANADA EVIDENCE ACT, R.S.C. 1985, c.C-5

During the summers of 1989 and 1990, counsel and technical advisers to the Commission, as part of a system approach to accident investigation of the Dryden crash, conducted extensive interviews with many persons involved with Transport Canada. Such interviews resulted in the review and assessment by officials of this Commission of hundreds of documents and files totalling thousands of pages.

The management of Transport Canada was generally cooperative and helpful in locating and reproducing documents for the Commission. However, as the in-depth examination of Transport Canada records progressed, the senior general counsel from the Department of Justice, who represented Transport Canada at the hearings of this Commission, wrote to Commission counsel on August 30, 1990, objecting to the production of certain documents and information, pursuant to the provisions of section 39 of the *Canada Evidence Act*, and advising, inter alia, as follows:

> Finally, in case we cannot reach agreement on this issue, I have to tell you that the Government of Canada objects to produce to the Commission documents or information that disclose the contents of submissions by Transport Canada to Treasury Board, on the ground that these are confidences of the Queen's Privy Council for Canada. If the Commission takes steps to compel production of such documents or information, the Government will produce a certificate as contemplated by s. 39 of the Canada Evidence Act.
>
> (Exhibit 1329, pp. 2–3)

The provisions of section 39 of the *Canada Evidence Act* are as follows:

> (1) Where a minister of the Crown or the Clerk of the Privy Council objects to the disclosure of information before a court, person or body with jurisdiction to compel the production of information by certifying in writing that the information constitutes a confidence of the Queen's Privy Council for Canada, disclosure of the information shall be refused without examination or hearing of the information by the court, person or body.
>
> (2) For the purpose of subsection (1), "a confidence of the Queen's Privy Council for Canada" includes, without restricting the generality thereof, information contained in
> (*a*) a memorandum the purpose of which is to present proposals or recommendations to Council;
> (*b*) a discussion paper the purpose of which is to present background explanations, analyses of problems or policy options to Council for consideration by Council in making decisions;
> (*c*) an agendum of Council or a record recording deliberations or decisions of Council;
> (*d*) a record used for or reflecting communications or discussions between ministers of the Crown on matters relating to the making of government decisions or the formulation of government policy;
> (*e*) a record the purpose of which is to brief ministers of the Crown in relation to matters that are brought before, or are proposed to be brought before, Council or that are the subject of communications or discussions referred to in paragraph (d); and
> (*f*) draft legislation.
>
> (3) For the purposes of subsection (2), "Council" means the Queen's Privy Council for Canada, committees of the Queen's Privy Council for Canada, Cabinet and committees of Cabinet.
>
> (4) Subsection (1) does not apply in respect of
> (*a*) a confidence of the Queen's Privy Council for Canada that has been in existence for more than twenty years; or
> (*b*) a discussion paper described in paragraph (2)(b)
> (i) if the decisions to which the discussion paper relates have been made public, or
> (ii) where the decisions have not been made public, if four years have passed since the decisions were made. 1980-81-82-83, c.111, s. 4.

A total of 24 documents were withheld by Transport Canada and sheltered from review by Commission staff, and from consideration by me, on the basis of the provisions of section 39 of the *Canada Evidence Act*. More specifically, section 39, subsections (2) (a), (c), (d), and (e), were relied upon in order to deny the Commission access to those documents in issue.

A certificate was issued by the clerk of the Privy Council on January 8, 1991, pursuant to section 39 of the *Canada Evidence Act*, certifying that the 24 documents in question contained information constituting confidences of the Queen's Privy Council for Canada.

It is noteworthy that such a certificate does not include the following information: a description of the document, including the date of the document; from whom and to whom it was sent; and the general subject matter of the document. The utterly barren nature of the information contained in the certificate with respect to all 24 documents is illustrated by the vague and virtually unintelligible description of document number one:

> Document #1 is a copy of a record which consists of information contained in a memorandum the purpose of which is to present proposals or recommendations to Council within the meaning of 39(2) (a).
>
> (Exhibit 1333, attached schedule)

The proceedings of a public inquiry are, by definition, open to the public and are designed to alleviate those concerns and considerations that led to the establishment of the inquiry in the first place. From the perspective of the public interest and the public perception, I have considerable difficulty with the efficacy of the simple expedient of invocation, through the means of a vaguely worded certificate, of section 39 of the *Canada Evidence Act* with respect to documents and information sought by a commission of inquiry established under the *Inquiries Act* by the Government of Canada. When dealing with state secrets and litigious or adversarial interests, the raison d'être of section 39, and its invocation in a proper case, can be understood. However, in the case of a public commission of inquiry, I am troubled by the existence of a possibility for arbitrary application of this section to withhold from public scrutiny, for inappropriate reasons, certain documents and information that may be of probative value in the conduct of a full inquiry and essential to satisfying the broad public interest. The claim to confidence in the case of the 24 documents in question, it is reasonable to assume, was initiated by officials within Transport Canada and advanced by counsel for the Department of Justice who represented Transport Canada at the hearings. While not alleging that this was the case in this Inquiry, it is possible to conceive of a situation in which a departmental official or manager may have inappropriate personal reasons, including the concealing of mismanagement, to assert the protection of section 39 against disclosure of incriminating documents. I am strongly of the view that a commissioner appointed under the *Inquiries Act* should be empowered to make a determination in an in camera hearing as to the appropriateness of the claim to confidence under section 39.

It is noted that certain provisions of the *Canadian Transportation Accident Investigation and Safety Board Act*, in particular section 30 thereof, allows, for example, that statements for which a privilege is claimed may be reviewed by a court or a coroner in camera.

Subsections (5)(a) and (b) of section 30 state as follows:

> (5) Notwithstanding anything in this section, where, in any proceedings before a court or coroner, a request for the production and discovery of a statement is contested on the ground that it is privileged, the court or coroner shall
> (*a*) *in camera*, examine the statement; and
> (*b*) if the court or coroner concludes in the circumstances of the case that the public interest in the proper administration of justice outweighs in importance the privilege attached to the statement by virtue of this section, order the production and discovery of the statement, subject to such restrictions or conditions as the court or coroner deems appropriate, and may require any person to give evidence that relates to the statement.

It is my opinion that the proper conduct of a public inquiry requires that an amendment be made to the provisions of section 39 of the *Canada Evidence Act* to establish a procedure for an in camera assessment, similar to that provided by section 30(5)(a) and (b) of the *Canadian Transportation Accident Investigation and Safety Board Act*, whereby the commissioner appointed under the *Inquiries Act* to conduct a public inquiry considers whether the public interest in the conduct of the inquiry outweighs in importance the confidence claimed with regard to the document in question under section 39 of the *Canada Evidence Act*. In the alternative, this result might also be achieved by an appropriate amendment to the *Inquiries Act* incorporating provisions similar to those contained in section 30, subsections (5)(a) and (b) of the *Canadian Transportation Accident Investigation and Safety Board Act*. In either event, such a provision would enable the commissioner conducting a public inquiry to determine objectively, in an in camera hearing, whether the public interest in a full and open inquiry outweighs the importance of what is now an unchallengeable and unsupported invocation of an objection under section 39 of the *Canada Evidence Act*, based on a confidence of the Queen's Privy Council.

RECOMMENDATION

It is recommended:

MCR 190 That section 39 of the *Canada Evidence Act*, R.S.C. 1985, c.C-5, be amended to empower a commissioner appointed under the *Inquiries Act* to make a determination in an in camera hearing as to the appropriateness of an objection, pursuant to the provisions of section 39 of the Act and based on a confidence of the Queen's Privy Council, to production of a document. Such determination should take into consideration the nature of the document in issue and its relevance and probative value to the subject matter of the inquiry, and should weigh the claim to confidence asserted under section 39 of the Act against the public interest in full disclosure of such document. In the alternative, the provisions of the *Inquiries Act* should be amended as required to give full meaning and effect to this recommendation.

44 INQUIRIES ACT, R.S.C. 1985, c.I-11, SECTION 13

Section 13 of the *Inquiries Act* states that:

> No report shall be made against any person until reasonable notice has been given to the person of the charge of misconduct alleged against him and the person has been allowed full opportunity to be heard in person or by counsel.

This section of the Act embodies in statute the principle of natural justice, which requires that affected persons be provided with reasonable notice and a fair opportunity to be heard. Because there is little judicial precedent interpreting the specific terms of section 13, its application has tended to vary from one Commission of Inquiry to the next. While I do not propose to conduct a detailed review of the history and jurisprudence that have evolved surrounding this section, I will review the provisions of section 13 and describe how this Commission approached their administration and dealt with their inherent difficulties.

Procedural Fairness

It was my desire and instruction that all proceedings of the Inquiry be conducted in keeping with the principles of procedural fairness and equity. To that end, the following specific procedures were adhered to throughout the course of Commission hearings to ensure that any individual adversely implicated before this Commission, in any respect, had the full right to be heard. It should be noted that all individuals who received letters of notice pursuant to section 13 testified at the hearings of this Commission and, therefore, had the benefit of these procedures.

1 All witnesses who might conceivably be adversely affected by these proceedings were advised of their right to counsel, prior to their being interviewed by Commission staff.

2 All interviews undertaken by Commission staff of potential witnesses who might be adversely affected by these proceedings were either conducted in the presence of their counsel or with the concurrence of counsel for such witnesses. In some cases such witnesses waived the right to have counsel present during their interviews. Copies of interview transcripts were always made available on request.
3 Before a witness testified, a synopsis of such witness's anticipated testimony, based on witness interviews, was forwarded to all participating parties.
4 Before a witness testified, photocopies of all exhibits proposed to be introduced through a given witness were forwarded to all participating parties.
5 All counsel appearing before me were afforded broad rights of cross-examination of all witnesses.
6 All participating parties were afforded the right to file written briefs, as they saw fit, for my consideration.
7 All hearings were conducted in such a manner so as to adhere as closely as possible to commonly accepted evidentiary rules.
8 All counsel appearing before me were afforded the opportunity to call such further evidence as they saw fit, in addition to the evidence called by Commission counsel.
9 All counsel appearing before me were afforded the opportunity to present closing arguments.

To the extent that any party perceived that there were inaccuracies or misstatements on the record, such party, directly or through counsel, was able to take steps to clarify the record – by cross-examining a witness, by adducing new evidence, or by submitting oral or written argument to me. Throughout this process all parties availed themselves of these rights from time to time as they saw fit.

The procedures adopted throughout the Inquiry with respect to the interviewing of witnesses, the adducing of evidence, and the general conduct of the Inquiry were not challenged or questioned by way of judicial review proceedings, or otherwise, by any party or person participating in the Inquiry process.

As an extension of the approach taken throughout the hearings, I have attempted to be as fair as possible in my interpretation of section 13 and in the establishment of procedures to ensure that parties affected at this stage continue to have the protection of procedural fairness, including the right to be heard.

After the hearings of the Commission were concluded on January 24, 1991, I commenced the lengthy process of reviewing transcripts, exhibits, and background informational papers prepared at my request by my staff. By the end of July 1991 the basic direction to be taken was in place for assessing evidence, making findings, and determining recommendations. From a practical perspective, this was the first time that I was in a position to assess the applicability of section 13 and the procedure to be adopted in that regard.

The Meaning of "Misconduct"

Section 13 states that notice is to be given to persons against whom a "charge of misconduct" is alleged. The *Inquiries Act* does not define the term "charge of misconduct." This is a basic weakness in the Act.

One of the meanings ascribed to the word "charge" in the Oxford English Dictionary is to "accuse." By definition, a charge of criminal misconduct is accusatory, as opposed to the civil misconduct with respect to which an "allegation" is normally made.

I therefore have taken the view that the term "charge of misconduct," as it appears in section 13, *prima facie* encompasses wrongdoing or misconduct of such a nature as to attract a criminal charge. The evidence before this Inquiry, while in some cases disclosing situations that could be seen to be breaches of the provisions of the Air Navigation Orders and/or the Air Regulations, would not in any case support a charge under the criminal law.

On the basis of this interpretation of the meaning of the term "charge of misconduct," there was in fact no necessity to give any person notice under section 13. However, given that the term is not defined in the *Inquiries Act*, I decided out of an abundance of caution to instruct Commission counsel to give notice to all persons against whom comment might be made in my Final Report which could be perceived to be adverse in nature.

This point was reflected in the following paragraph, which was contained in all the letters of notice that Commission counsel sent to affected parties:

> This letter shall constitute notice that the Commissioner will hear and consider any submissions that you or your counsel may wish to make in relation to adverse findings made against you. Although the Inquiries Act addresses a "charge of misconduct", in the interest of fairness, Commissioner Moshansky has directed that notice be afforded to all persons against whom he may make adverse findings. The Commissioner has advised me that he does not view the findings enumerated below as constituting "misconduct" within the meaning of Section 13 of the Inquiries Act.

Attached as appendix L is a sample of the correspondence forwarded by Commission counsel to persons affected.

The Meaning of "Reasonable Notice"

Section 13 requires that affected persons be given reasonable notice of the charge of misconduct alleged against them. In addition to the lack of definition in the *Inquiries Act* of the term "misconduct," a further basic difficulty in administering this section is founded in the lack of direction in that section as to when such notice is to be given. Letters of notice pursuant to section 13 were sent to affected parties by Commission counsel on August 19, 1991, after I was in a position to determine my intended findings.

As previously noted, all individuals who received letters of notice pursuant to section 13 had testified at the hearings of this Commission. It may have been desirable, from the perspective of the affected parties, to serve such notice upon them early in the proceedings of the Commission. However, since the section 13 process is based upon intended findings, from a practical point of view it would have been impossible to extend notice before I had reviewed all of the evidence and the arguments of counsel, and had settled upon the direction that my Report would take.

For example, I considered but rejected the possibility of giving notice to a person before that person's testimony was heard. This approach seems attractive in that it presents the affected party with the opportunity to respond to allegations at the time of his or her testimony, thereby limiting that person's involvement with the Commission process to one appearance. In all other respects, however, I found this to be an untenable procedure. To give notice of an intended finding of alleged misconduct before a person has testified under oath is, in my view, premature and presumptuous. Furthermore, because subsequent evidence often affects the matters in issue, it would be inappropriate, if not impossible, to give notice of an intended finding before all the evidence has been heard and considered as a whole.

The only course of conduct that struck me as plausible was to provide notice to affected parties only after I had considered all of the evidence, had developed the basic outline of my Report, and had come to conclusions as to my intended findings. The proceedings of a commission of inquiry are complex and often protracted, with many witnesses being called and a voluminous record being established. Findings made in this Report are based on the record of this Inquiry. Until the basic drafting of the Report is completed it is unrealistic to expect, and virtually impossible to finalize in a meaningful way, findings of misconduct.

The term "reasonable notice" implies that both the time period afforded to an affected party to respond to notice under section 13 and the substance itself of the notice are adequate such that the "full opportunity to be heard" is meaningful.

The *Inquiries Act* provides no indication that the term "person" is limited in its meaning to individuals. Therefore, I instructed Commission counsel to extend notice under section 13 to corporations and government bodies as well as to individuals.

Parties who received notice pursuant to section 13 were offered the opportunity to submit written submissions, or to attend in camera before me, personally or by counsel, and make oral submissions. In keeping with my strongly held view that all proceedings of this Commission were to be conducted in public, submissions received pursuant to section 13 were made part of this Commission's record.[1]

Section 13 Procedure

Once a first draft of this quite substantial Report was completed, the parties against whom I was considering making adverse comments were identified. Letters of notice such as the model appended to my Report as appendix L were forwarded in confidence to all affected parties and their counsel.

The recipients of letters of notice issued pursuant to section 13 responded to the Commission in a variety of ways. A number of affected parties submitted written submissions, others communicated with Commission counsel, either personally or through counsel by telephoning their comments and observations directly to him, and others appeared before me at in camera hearings. The Commission did not respond in any way, nor did it take counter-positions to these submissions.

As noted above, every individual who received a letter of notice pursuant to section 13 had previously testified at the public hearings of this Commission on the very issues that became the subject of my intended findings. All such testimony given at the public hearings was subject to challenge or clarification under cross-examination by participating counsel, including counsel for each affected party. Also, such counsel had the opportunity to call any witness as well as to make final submissions at the close of the public hearings.

---

[1] Oral submissions received in camera in relation to section 13 notices were transcribed by a court reporter.

Section 13 exists above and beyond these procedural safeguards, and it entitles affected parties yet another opportunity to make submissions on their own behalf. The difference is that submissions made pursuant to section 13 are intended as a direct response to a "charge of misconduct."

The rather complex problems resulting from the provisions of section 13 are very well analysed in a textbook entitled *Commissions of Inquiry* (edited by A.P. Pross, Innis Christie, and J.A. Yogis (Toronto, Calgary, Vancouver: Carswell 1990) at pp. 144–45:

> The difficulty with section 13 relates to its administration. How can a commission fairly and at the same time procedurally comply with this provision? If reasonable notice is given during the inquiry, either by specifics in its terms of reference or by allegations during its course, then if the persons affected responded and met the allegations during the course of the inquiry, no special notice need be given under section 13 thereafter. However, if no such notice of allegations of misconduct was given before or during the course of the inquiry, then section 13 must specifically be complied with before the commission's report is delivered. If notice is given literally before the report is released, the opportunity to be heard would be somewhat illusory because the commission would have identified allegations of misconduct in the course of arriving at its conclusion and thus might be said to have effectively made up its mind before notice was given. In such circumstances, one might be forgiven for concluding that the opportunity to be heard was somewhat of a sham. If the commission gives notice after hearing the argument of counsel, the same sort of problem may arise. In any event, in an ideal environment the commission itself should not give notice because the obvious implication is that it may have drawn conclusions in order to draw the indictment. If a formal notice under section 13 is required, it should probably be given privately by commission counsel anticipating all possible findings of misconduct which the commission might make. Further notice can be given if the draft report suggests additional findings of misconduct.
>
> A solution currently in use is to comply with the notice requirement by way of commission counsel's argument. If argument is delivered in writing to all parties and they are given an opportunity to be heard under section 13 thereafter as long as commission counsel's argument is cast broadly enough to include all possible conclusions as to misconduct, then the requisite notice has surely been given. In any event, there is a universal plea for amendment to this clumsy statutory arrangement.

Legal Proceedings Instituted on Behalf of Air Ontario and Certain Named Individuals

Upon receipt of letters of notice pursuant to section 13 on August 19, 1991, Air Ontario and certain affected individuals (hereinafter referred to as the "affected individuals") raised a number of objections, culminating in an application to the Federal Court of Appeal. By virtue of their employment or other association with Air Ontario at the time of the crash, the affected individuals were represented throughout the hearings of this Commission by the same counsel who appeared on behalf of Air Ontario (Paterson, MacDougall).

In general terms, the primary objection raised was that the naming in the Report of affected individuals, that is, those against whom I intended to make comment and findings which could be perceived to be adverse in nature, would violate their rights as guaranteed under section 7 of the *Canadian Charter of Rights and Freedoms*. On October 9, 1991, counsel on behalf of Air Ontario and the affected individuals appeared before me to make submissions.

In a ruling released on October 11, 1991, I rejected the arguments of Air Ontario and the affected individuals and stated, in part:

> I am obligated to report to the Governor in Council on my observations and findings based on the evidentiary record before me. To discharge this mandate and to make meaningful recommendations in the interests of aviation safety, it is necessary that such findings and recommendations be supported by an analysis of specific evidence before me. In my view, a proper analysis of the "contributing factors and causes of the crash of Air Ontario Flight 363" requires observations and findings adverse to some organizations and individuals to be made.
>
> In my view, I would be remiss in carrying out my mandated duties as specified in the Order in Council dated March 29, 1989, if I did not specifically name organizations or individuals, where appropriate, to lend clarity to the narrative of events and to identify clearly and without ambiguity the particular events that in my view contributed to the crash, or that give rise to my specific recommendations concerning aviation safety.
>
> To refer only to nameless and unspecified individuals could do an injustice by casting a cloak of doubt over the conduct of other individuals, who are blameless, and others who did not have the opportunity to appear before me and be heard. This I am not prepared to do.
>
> In my view there is no conflict between the way in which I propose to fulfil my terms of reference and the requirements of

> natural justice, or, in *Charter* terms, the requirements of fundamental justice.

Included in appendix M, attached to this Report, is the full text of my ruling dated October 11, 1991.[2]

Air Ontario and the affected individuals (the applicants) commenced an application for judicial review in the Federal Court of Appeal seeking an order to set aside my ruling of October 11, 1991, and "prohibiting [the Commissioner] from naming individuals in the report in a manner which would causally link those individuals to the cause of the crash of Air Ontario aircraft C-FONF." [Notice of Application.]

A preliminary motion brought by the applicants before the Honourable Mr Justice Hugesson on October 28, 1991, in the Federal Court of Appeal, for an order to seal the court record was dismissed. Sealing the record would have precluded the media from reporting on the judicial review application, and particularly from reporting the names of the affected individuals. In rejecting the applicants' argument, Mr Justice Hugesson made it clear that he was not prepared to see these proceedings occur in secret.

Thereafter, Air Ontario and the affected individuals abandoned their substantive application respecting the naming of individuals in the Report, and they submitted written responses to the notice of intended findings. As was the case with all other submissions received pursuant to section 13, I considered these submissions carefully and, where warranted, incorporated changes into the Report.

This process tends to be unwieldy and cumbersome. In this case it substantially increased the work of the Commission, diverting human resources for a considerable period of time away from the task of finalizing this Report and in fact delaying its completion by approximately two months. Some recipients of letters of notice pursuant to section 13 conveyed to the Commission their surprise and concern at receiving letters of notice at a stage in the proceeding so long after their own involvement. The section 13 process is an awkward legal procedure. It requires a commissioner, after he or she has heard and considered voluminous evidence, in my case over a period in excess of two years, to disclose his or her intended findings to the affected parties and to invite further submissions in response. Thereafter, a due consideration of the submissions involves a time-consuming reassessment of relevant evidence in the context of the response received.

---

[2] The names of affected individuals have been deleted from this ruling. After the Federal Court of Appeal rejected their motion to seal the court record, none of the affected individuals chose to pursue the application, or to permit their names to be released publicly. Accordingly, the names of the affected individuals are not reprinted in this context.

The section 13 process is not unlike that facing the Transportation Safety Board of Canada (TSB, the former CASB), under the *Canadian Transportation Accident Investigation and Safety Board Act*, with respect to which I have negatively commented in chapter 41 and which comments in my view are equally applicable to section 13 in the present circumstances.

After carefully reviewing all submissions received in response to the section 13 notices, on balance I found the section 13 process to be largely unproductive. Although the submissions were generally thoughtful, I found that in most instances the matters raised in the submissions of the affected parties had already been addressed and dealt with in the draft of my Final Report. In some instances, the Final Report was amended in a minor way to reflect a valid comment. Overall, however, the responses received did not generate any substantive changes to the intended content of my Final Report. I therefore question, in the case of an Inquiry conducted as a quasi-judicial proceeding with the parties represented by counsel throughout and under the procedures already described, whether the section 13 provisions should apply at all.

RECOMMENDATION

It is recommended:

MCR 191 That the provisions of section 13 of the *Inquiries Act* be reconsidered and that, at a minimum, appropriate amendments be introduced to provide:

(a) a definition of the term "charge of misconduct," with particular focus on the meaning to be attached to the word "misconduct";

(b) more precise direction as to the point in time that notice is to be given under section 13, taking into account the various difficulties that have been pointed out herein; and

(c) an exemption from the notice provisions of section 13 in the case of Inquiries that have been conducted as quasi-judicial proceedings in the presence of counsel for the affected parties and with the attendant procedural and evidentiary safeguards discussed herein, or where it can otherwise be inferred that the person against whom the allegations are made had notice of the charges.

PART NINE

CONSOLIDATED RECOMMENDATIONS

CONSOLIDATED RECOMMENDATIONS

In the course of the hearings of this Commission of Inquiry, certain facts emerged from the evidence that, in the interests of aviation safety, I felt duty-bound to report in two interim reports. The recommendations that commence below are a consolidation of those that appear in my *Interim Report* of 1989, in my *Second Interim Report* of 1990, and in this my Final Report.

For ease of reference, the recommendations are numbered consecutively, beginning with those that appear in my *Interim Report* of 1989. They are preceded by the code "MCR," in accordance with the "short title" (Moshansky Commission) of the reports.

Interim Report, 1989

The Commission recommended that:

With respect to hot refuelling with passengers on board:

MCR 1 The Department of Transport prohibit the refuelling of an aircraft with an engine operating when passengers are on board, boarding, or deplaning.

With respect to wing contamination:

MCR 2 The Department of Transport immediately develop and promulgate an Air Navigation Order applicable to all aircraft that would prohibit take-offs when any frost, snow, or ice is adhering to the lifting surfaces of the aircraft, and the Department of Transport provide guidelines to assist aviation personnel in conforming to the amended orders.

With respect to safety awareness:

MCR 3 The Department of Transport forthwith develop and implement a mandatory and comprehensive education program for all aircrew engaged in commercial operations, including an integrated program for cockpit crew members and cabin crew members, on the adverse effects of wing contamination on aircraft performance, with provision for knowledge verification; and

The Department of Transport similarly develop and implement a mandatory safety-awareness program for all other personnel involved in flight operations, including managers, dispatchers, and support personnel, on the adverse effects of wing contamination on aircraft performance.

With respect to last-minute check for wing contamination in conditions of adverse weather:

MCR 4 The Department of Transport immediately develop and implement, in consultation with the Canadian aviation industry, a system of mandatory inspection of an aircraft to be carried out by the pilot in command or his designate, or other qualified company personnel, to ensure that the aircraft's critical surfaces are clean before take-off.

In the event that a member of the cabin crew, based on his or her observation, reports a concern regarding wing contamination to the pilot in command, it shall be the duty of the pilot in command to check the wing condition either personally or through another member of the cockpit crew before take-off.

Second Interim Report, 1990

Aircraft Ground De-icing and Related Flight Safety Issues

The problems at Pearson International Airport can be resolved by long-term and short-term solutions. Over the long term, there is an obvious need for more concrete areas at the airport, including additional ramps, runways, and taxiways to relieve congestion. Permanent runway-end de-icing facilities should also be provided for the secondary de-icing of aircraft immediately before take-off in severe weather conditions. It can be expected that these long-term measures will take approximately three to five years to implement. The carriers, for their part, should upgrade their de-icing equipment and procedures and should use type II anti-icing fluids that meet AEA type II specifications to ensure that any departure delays are within the margin of safety. It is expected that these measures can be implemented within a much shorter time frame.

In the short term, several interim measures should be put in place immediately at Pearson International Airport. ATC gate-hold procedures should be developed and implemented to ensure that departure delays are minimized. Temporary runway-end de-icing facilities for secondary de-icing of aircraft before take-off should be provided. These facilities would include the peripheral expansion of existing taxiways near the end of runways to support de-icing equipment and crews. In keeping with environmental concerns, any excess fluids at these locations should be collected and disposed of in an appropriate manner.

The Commission recommended that:

MCR 5 Transport Canada should, on a priority basis and in co-operation with major Canadian air carriers, implement interim runway-end de-icing/anti-icing facilities at Pearson International Airport. The target should be to have the first of such facilities in place on an interim basis as early as possible in the 1990–91 icing season. Subsequent permanent installations should be designed and constructed to satisfy both safety and environmental concerns.

MCR 6 Transport Canada should examine and, if feasible, implement air traffic control gate-hold procedures at Pearson International Airport as a means of reducing departure delays during conditions of freezing precipitation.

MCR 7 In addition to the already announced feasibility studies for two new runways and supporting taxiways at Pearson International Airport, Transport Canada should investigate and, if feasible, proceed to implement an expansion of existing ramp space on the airport to reduce congestion and consequent departure delays. This undertaking should be given high priority.

MCR 8 Transport Canada should strongly encourage and support the use by Canadian air carriers of type II anti-icing fluids that meet AEA specifications for turbo jet aircraft and, where applicable, for propeller-driven aircraft.

MCR 9 Transport Canada should, in the interest of employee safety and in order to facilitate reliable inspection of aircraft surfaces after de-icing/anti-icing, ensure that adequate and sufficient exterior lighting exists in all gate and ramp areas where de-icing and anti-icing operations are conducted at

Pearson International Airport and at other major airports in Canada.

MCR 10 Transport Canada should, on a priority basis, provide, where necessary, enforcement resources to ensure that the *clean aircraft* regulation is complied with, including runway-end spot checks of aircraft surfaces in adverse winter weather.

MCR 11 Transport Canada should strongly encourage Canadian air carriers to form joint entities to provide all air carrier de-icing/anti-icing services at Pearson International Airport and at other major airports in Canada, and to have available, for use when necessary, equipment capable of applying both type I and type II fluids.

MCR 12 Transport Canada should require that air carriers produce aircraft ground de-icing/anti-icing procedures and training standards for both flight and ground personnel. Implementation of such procedures and standards should be made a mandatory requirement of an air carrier's operating certificate.

MCR 13 Transport Canada's Airports Authority Group should place on the staff of each of its major airports, individuals with substantial flight operations expertise. Such individuals should report directly to the airport manager on any issue related to operational safety. Furthermore, a mandatory reporting process should be put in place to ensure that aviation safety–related issues are promptly brought to the attention of the appropriate decision-making level of senior management and to ensure that such issues are addressed within a specified period of time.

MCR 14 Transport Canada should examine, on a priority basis, Canadian airports served by air carriers to ascertain if the incompatibility between departure delays and de-icing/anti-icing fluid hold-over times, as identified at Toronto's Pearson International Airport, exists at other sites. Should such incompatibilities be found, Transport Canada should ensure that appropriate corrective measures are taken.

MCR 15 Transport Canada and/or the air carriers should, in the interests of ramp employee safety and for environmental reasons, maintain suitable equipment and develop appropriate procedures for the clean-up and disposal of de-icing/anti-icing fluids in areas utilized by air carriers.

MCR 16 Transport Canada should take an active and participatory role in the work currently underway within the international aviation community to advance aircraft ground de-icing/anti-icing technology. This should include involvement in the development of international standards, development of guidance material for remote and runway-end de-icing facilities, and development of more reliable methods of predicting de-icing/anti-icing fluid hold-over times.

MCR 17 Transport Canada should strongly encourage Canadian air carriers to provide their flight crews with de-icing/anti-icing fluid hold-over time charts that are based on the most recent technological information. These charts should be used as guidelines.

Final Report

These recommendations are a consolidation of those that appear throughout the Final Report. Although they are grouped according to the chapter they follow, recommendations may relate to more than one issue and should be considered in the context of the complete Report.

Part Two Facts Surrounding the Crash of Flight 1363

Chapter 8 Dryden Area Response

It is recommended:

MCR 18 That Transport Canada ensure that airport crash, fire-fighting, and rescue units carry out emergency response exercises as mandated in applicable Transport Canada documentation, including exercises in winter and in off-airport conditions.

MCR 19 That Transport Canada ensure that all persons involved in crash, fire-fighting, and rescue (CFR) exercises, including CFR chiefs and on-site coordinators, fully understand and carry out their duties during such exercises, as defined in applicable Transport Canada documentation and as they would in an emergency.

MCR 20 That Transport Canada ensure that airports subsidized by Transport Canada have in place at all times up-to-date crash, fire-fighting, and rescue airport emergency response plans and airport emergency procedures manuals approved by Transport Canada.

MCR 21 That Transport Canada ensure that the necessary crash, fire-fighting, and rescue emergency response to aircraft crashes that occur within the critical rescue and fire-fighting access area (CRFAA) be clearly delineated in all relevant documentation, including airport emergency response plans and airport emergency procedures manuals.

MCR 22 That Transport Canada ensure that, as part of the emergency planning process, all responding agencies designated in an airport emergency procedures manual equip themselves with radios capable of communication on a common channel.

Part Three Crash, Fire-fighting, and Rescue Services

Chapter 9 Dryden Municipal Airport Crash, Fire-fighting, and Rescue Services

It is recommended:

MCR 23 That Transport Canada ensure that airport authorities at all Canadian airports, in conjunction with crash, fire-fighting, and rescue (CFR) unit personnel, determine the best and most practical ways to deal with emergencies within each airport boundary and critical rescue and fire-fighting access area (CRFAA), having regard to available CFR personnel and equipment and to the surrounding terrain.

MCR 24 That Transport Canada ensure that all documents which describe or refer to the critical rescue and fire-fighting access area (CRFAA), be they Transport Canada documents or local airport authority documents, are informative, consistent, and unambiguous with regard to the CRFAA, and that such documents specifically define the responsibilities of a crash, fire-fighting, and rescue unit within the CRFAA both within the airport boundaries and/or beyond.

MCR 25 That Transport Canada ensure, through the fire-fighter certification program, and other programs and agreements as necessary, that all crash, fire-fighting, and rescue fire-fighters, including the fire chiefs, are adequately trained.

MCR 26 That Transport Canada proffer for enactment legislation that empowers Transport Canada to ensure that all crash, fire-fighting, and rescue (CFR) personnel, including those at non-Transport Canada–owned and non-Transport Canada–

operated airports, meet Transport Canada CFR training and operating standards.

MCR 27 That Transport Canada encourage all communities where there is an airport with fire-fighting services to include in their mutual aid/emergency response plans specific instructions regarding the duties, responsibilities, and area of authority of each organization that is expected to respond to an aircraft emergency on and/or off airport property.

MCR 28 That Transport Canada ensure that refuellers at Transport Canada–subsidized or operated airports are fully knowledgeable in and follow safe refuelling practices.

MCR 29 That Transport Canada implement a policy of having airport crash, fire-fighting, and rescue units, after appropriate training, responsible for monitoring aircraft fuelling procedures and ensuring compliance with fuelling standards and procedures.

MCR 30 That Transport Canada ensure that training programs for airport crash, fire-fighting, and rescue units include preparing fire-fighters for the realities of an air crash, so that they are not distracted from their primary responsibilities at a crash site.

MCR 31 That whenever a crash, fire-fighting, and rescue (CFR) unit responds to an aircraft crash, Transport Canada, as part of its post-crash response, objectively review and analyse the actions of the CFR unit forthwith, in order that deficiencies in the CFR response can be corrected and useful information, on both the positive and negative aspects of the response, may be passed on to other CFR units.

MCR 32 That Transport Canada ensure that local arrangements be made between airport managers and air carriers that will result in crash, fire-fighting, and rescue personnel being informed of the number of persons on board, fuel on board, and any hazardous cargo on board an aircraft in the shortest possible time following an incident or accident. These procedures should accommodate the possibility that the aircraft flight crew will not be able to provide this information.

Part Four Aircraft Investigation Process and Analysis

Chapter 10 Technical Investigation

Aircraft Crash Charts

Based on the evidence that there were no F-28 aircraft crash charts available at the crash, fire-fighting, and rescue (CFR) unit at Dryden on the day of the accident, and that the flight data and cockpit voice recorders were destroyed by fire, I had intended to make recommendations as to the availability of crash charts and their use in the training of CFR unit personnel. It appears, however, that, since the hearings of this Commission, Transport Canada has been instrumental in ensuring that all Transport Canada–owned and operated airports have aircraft crash charts readily available. These initiatives more than satisfy my concerns in relation to Transport Canada–owned and operated airports, and recommendations for such airports are, accordingly, not required. In relation to all airports in Canada that are not Transport Canada–owned or operated, I make the following recommendation:

MCR 33 That Transport Canada, in cooperation with airport operators, ensure that all Canadian airports not owned or operated by Transport Canada, which service a scheduled air carrier operation, have appropriate crash charts made available to the same degree and extent as at airports owned and operated by Transport Canada.

Survivability of Flight Data Recorders and Cockpit Voice Recorders in Aircraft Crashes

The recorders in C-FONF were destroyed by fire and were of no use to the investigators of this crash. Because recorders capture essential parameters of aircraft information and performance, and are normally the source of the best investigative information, it is vitally important that their crash survivability be enhanced. I therefore make the following recommendations:

MCR 34 That Transport Canada and the Transportation Safety Board of Canada, through national and international initiatives and committees, continue to press for the adoption of more rigorous survivability test requirements for aircraft flight data–recording systems.

MCR 35 That Transport Canada and the Transportation Safety Board of Canada undertake a research program leading to the development of the most suitable deployable or non-deployable aircraft flight data–recording systems that can reasonably be expected to survive any crash and yield usable data.

MCR 36 That Transport Canada and the Transportation Safety Board of Canada study, or cause to be studied, the location of aircraft flight data–recording systems in aircraft, with a view to assuring the survival of the recording systems in any crash.

Letter of Approval Requirement

It is not clear in the Transport Canada instructions whether the issuance of a letter of approval is a requirement. In the approval process of the maintenance control manual or any amendment thereto, in my view, the letter serves a purpose, and thus I make the following recommendation:

MCR 37 That Transport Canada make mandatory the issuance of a letter of approval to an air carrier as an integral part of the approval process of the "maintenance control manual" or any amendment thereto.

Definition of "Essential Equipment"

Testimony given at this Commission's hearings revealed that there is not a definition of the term "essential equipment" that is readily usable or useful to pilots and technicians during normal aircraft operations. It is therefore recommended:

MCR 38 That Transport Canada redefine in Air Navigation Order Series II, No. 20, the term "essential equipment," in order that it be unambiguous and easily understood by pilots and technicians who have to use or refer to the term.

Chapter 11 Aircraft Crash Survivability

It is recommended:

MCR 39 That Transport Canada press for the adoption of standards for aircraft interiors that would prevent the rapid spread of fire and the emission of toxic fumes.

Chapter 12 Fokker F-28, Mk1000, Aircraft Performance and Flight Dynamics

It is recommended:

MCR 40 That Transport Canada ensure that all operations personnel involved in air carrier operations, including managers, operations officers, maintenance personnel, and pilots, be made fully aware of the nature and the danger of wing contamination on both jet- and propeller-driven aircraft.

MCR 41 That Transport Canada ensure that all personnel involved in air carrier operations, including managers, operations officers, maintenance personnel, and pilots, have, and be able to demonstrate, a thorough understanding of all aspects of wing contamination, including its formation, removal, and prevention, and its effects on the aerodynamics of aircraft, with particular emphasis on the insidious nature of the "cold-soaking" phenomenon.

MCR 42 That pilots be informed in writing by Transport Canada how the application of non–standard handling techniques, as described in the "Flight Dynamics" report prepared for this Commission and included in the Final Report as technical appendix 4; as described in the Fokker F-28 Flight Handbook; and as described in testimony by expert witnesses, may assist a pilot to deal with an abnormal or emergency situation discovered during takeoff. It is stressed that this Commission does not advocate the use of non–standard handling techniques to operate aircraft in adverse weather conditions as an alternative to the proper preparation of the aircraft for flight.

MCR **43** That Transport Canada require that aircraft flight manuals and related aircraft operating manuals contain approved guidance material for supplementary operating procedures, including performance information for operating on wet and contaminated runways.

MCR **44** That Transport Canada, in cooperation with aircraft manufacturers and operators, expedite the search for a technically accurate means of defining runway surface conditions and their effects on aircraft performance.

MCR **45** That Transport Canada require air carriers to provide adequate training to flight crews with respect to the effects of contaminated runways on the performance of aircraft in the context of landings, takeoffs, and rejected takeoffs.

MCR **46** That Transport Canada, in cooperation with aircraft manufacturers and operators, expedite the search for an equitable and practical means of requiring operators to adhere to balanced field criteria when operating on wet or contaminated runways.

MCR **47** That Transport Canada, in cooperation with airport operators, expedite the search for more efficient methods of ensuring that runways are maintained free of contaminants that affect the takeoff performance of aircraft.

MCR **48** That Transport Canada participate in and encourage research concerning devices that can allow pilots to assess the external state of the aircraft from within the flight deck. In addition to assisting pilots in assessing possible contamination of the aircraft, such devices would assist pilots in assessing any mechanical or technical problems on the exterior of the aircraft.

Part Five The Air Carrier – Air Ontario Inc.

Chapter 16 The F-28 Program: The Auxiliary Power Unit, the Minimum Equipment List, and the Dilemma Facing the Crew of Flight 1363

It is recommended:

MCR 49 That Transport Canada proffer for enactment legislation which would require that approved minimum equipment lists be in place for all aircraft certified under United States Federal Aviation Regulation 25, predecessor regulations, or equivalent legislation, prior to the use of such aircraft in commercial service in Canada.

MCR 50 That Transport Canada not issue an operating certificate or amendment to an operating certificate to an air carrier operating aircraft certified under United States Federal Aviation Regulation 25, predecessor regulations, or equivalent legislation until required and approved minimum equipment lists are in place.

MCR 51 That Transport Canada ensure that the repair of an unserviceable aircraft auxiliary power unit be deferred only with an operational restriction requiring approved engine ground-start facilities to be available at all airports into which that commercial aircraft is expected to operate. This operational restriction should be included in the aircraft minimum equipment list.

MCR 52 That Transport Canada issue to all pilots a warning pointing out the dangers inherent in pulling circuit-breakers on board an aircraft in order to silence an alarm that may in fact be giving a valid warning.

MCR 53 That Transport Canada require that air carriers have in place appropriate policies and directives to ensure that flight crews, at the time they receive an operational flight plan, are informed of any aircraft defects that have been deferred to a minimum equipment list.

MCR 54 That Transport Canada require all air carriers that operate aircraft having minimum equipment lists (MELs) to provide approved training to all pilots, maintenance personnel, and dispatchers on the proper use of an MEL.

Chapter 17 The F-28 Program: Lack of Ground-Start Facilities at Dryden

It is recommended:

MCR 55 That Transport Canada ensure that air carriers have operational policies that require the availability of appropriate ground-support facilities at individual airports where the air carrier intends to operate.

MCR 56 That Transport Canada ensure that the operational policies referred to in Recommendation MCR 55 above be contained in the air carrier's operations manuals, such as its flight operations manual and its route manual, and/or the individual aircraft minimum equipment list.

MCR 57 That Transport Canada ensure that, when it is reviewing an air carrier application for an operating certificate or an amendment to an operating certificate, there be a scrutiny of the air carrier's intended aircraft support facilities. Transport Canada then should satisfy itself that operational policies contained in the air carrier's operations manuals adequately accommodate the air carrier's identified and existing aircraft support facilities. No operating certificate or amendment to an operating certificate should be issued unless Transport Canada is so satisfied.

Chapter 18 The F-28 Program: Spare Parts

It is recommended:

MCR 58 That Transport Canada direct its airworthiness personnel to determine themselves whether an air carrier has adequate spare parts for the proper maintenance of aircraft. Under no circumstances should this decision, in effect, be delegated to any person employed by the applicant air carrier.

MCR 59 That Transport Canada proffer for enactment an amendment to Air Navigation Order Series VII, No. 2, Part II, section 12(2), that assists Transport Canada airworthiness personnel to determine whether sufficient spare parts exist. Alternatively, an approved written departmental policy should be promulgated to assist airworthiness personnel to make this determination.

MCR 60 That Transport Canada under no circumstances issue an operating certificate or an amendment to an operating certificate until it is satisfied that all spare parts requirements established by Transport Canada are fulfilled.

Chapter 19 The F-28 Program: Flight Operations Manuals

It is recommended:

MCR 61 That Transport Canada approve a complete copy of the air carrier's operations manual prior to the granting of an operating certificate or an amendment to an operating certificate, and that it approve all amendments and insertions made to that manual.

MCR 62 That Transport Canada proffer for enactment an amendment to Air Navigation Order Series VII, No. 2, requiring Transport Canada to approve one aircraft operating manual for each type of aircraft operated by the air carrier. It is further recommended that such approval be required prior to the granting of an operating certificate or an amendment to an operating certificate by Transport Canada to the air carrier to allow the commercial use of that aircraft type by the air carrier.

MCR 63 That Transport Canada proffer for enactment an amendment to Air Navigation Order Series VII, No. 2, requiring each air carrier to provide to Transport Canada an air carrier cabin attendant manual for review and approval, either as part of the flight operations manual or as a separate manual.

MCR 64 That Transport Canada proffer for enactment an amendment to Air Navigation Order Series VII, No. 2, deleting the existing tests contained in sections 5, 6, and 33 and replacing them with tests containing the wording "high degree of safety" and "highest degree of safety." Such wording is similar to wording contained in equivalent United States Federal Aviation Regulation legislation dealing with standards and procedures for air carriers using large aircraft.

MCR 65 That Transport Canada proffer for enactment legislation requiring an air carrier to submit its operations manual as defined in Air Navigation Order Series VII, No. 2, to Transport Canada and have it approved prior to the issuance by Transport Canada of an operating certificate or any amendment thereto.

MCR 66 That Transport Canada ensure that air carriers follow and comply with those sections of the operations manuals required by Air Navigation Order Series VII, No. 2.

Chapter 20 The F-28 Program: Flight Operations Training

It is recommended:

MCR 67 That Transport Canada ensure that a systematic and comprehensive discussion of cold soaking be inserted in air carriers' flight operations manuals and/or aircraft operating manuals and in Transport Canada publications such as the Aeronautical Information Publication, to make all pilots and aviation operational personnel aware of the insidious nature of the cold-soaking phenomenon and the various factors that may cause contamination to adhere to aircraft lifting surfaces.

MCR 68 That Transport Canada ensure that all air carrier pilot flight training be conducted in aircraft flight simulators to the maximum extent possible.

MCR 69 That Transport Canada ensure that an air carrier, if it does not have pilots with the requisite and necessary flight experience on the aircraft when it introduces a new aircraft type, provide sufficient non-revenue flying time for its pilots to enable them to gain the requisite experience.

MCR 70 That Transport Canada encourage air carriers lacking pilots with sufficient experience on a new aircraft type to provide highly experienced pilots from outside the air carrier to assist in training the air carrier's pilots and to fly with them until they have gained an adequate level of flight experience on the new aircraft type.

MCR 71 That Transport Canada proffer for enactment legislation with respect to flight crew pairing, requiring that one of the flight crew members, either the pilot-in-command or the first officer, have substantial flight experience on the aircraft type.

MCR 72 That Transport Canada routinely inspect the activities of aircraft fuellers and ground-handling personnel, to ensure that they are properly performing their duties and to ensure that these personnel have received adequate training.

MCR 73 That Transport Canada ensure that all ground-handling personnel, whether employed by the air carrier or by a contract agent, receive ground-handling training on all aircraft types that they will be required to handle. If personnel are required to refuel aircraft, they should also have knowledge of proper fuelling procedures.

MCR 74 That Transport Canada proffer for enactment regulations setting the training and competency requirements for cabin attendants.

MCR 75 That Transport Canada monitor and periodically audit the cabin attendant training program of all air carriers to ensure that such training meets the standards set.

Chapter 21 The F-28 Program: Operational Practices – Hot Refuelling and Aircraft Ground De-icing

It is recommended:

MCR 76 That Transport Canada ensure that the flight operations manuals of all air carriers specify that hot refuelling is an abnormal and potentially dangerous procedure and that they outline in detail the appropriate procedures to be followed in order to conduct hot refuelling safely.

MCR 77 That Transport Canada, during the process of approval of air carrier manuals, ensure that the provisions of the proposed manuals are consistent and, specifically, that they coordinate the duties of the cabin crew with those of the flight crew concerning hot-refuelling procedures, with appropriate cross-referencing between the manuals.

MCR 78 That Transport Canada ensure that all aircraft fuellers are adequately trained to standards set by Transport Canada.

MCR 79 That Transport Canada ensure the adequate monitoring of aircraft fuelling procedures at Canadian airports.

MCR 80 That Transport Canada encourage air carriers to adjust their operational procedures and policies, where technically feasible, to permit the de-icing of an aircraft with a main engine running.

MCR 81 That Transport Canada ensure that the intention of the "clean-wing" concept, as embodied in Recommendations MCR 2 and 3 above and in recent amendments to the Air Regulations (SOR/90-757) and the Air Navigation Orders (SOR/90-758, and SOR/90-759), be incorporated into and given effect in the appropriate operational manuals of Canadian air carriers.

MCR 82 That Transport Canada ensure, during its normal certification and inspection of Canadian air carriers, that the air carriers have well-organized and effective systems in place for the coordinated distribution to all pilots and operational personnel of comprehensive operational information – including, but not limited to, information regarding aircraft ground de-icing procedures.

MCR 83 That Transport Canada give serious consideration to appointing an appropriately qualified person as a national resource specialist dedicated to all matters pertaining to aircraft surface contamination and the ground de-icing and anti-icing of aircraft in Canada, in the broadest sense, based upon a similar position in the Federal Aviation Administration of the United States and with similar objectives and responsibilities.

Chapter 22 The F-28 Program: Flight Attendant Shoulder Harness

It is recommended:

MCR 84 That Transport Canada immediately press ahead with appropriate amendments to Air Navigation Order Series II, No. 2, that would require the retrofit of shoulder harnesses and other safety-enhancing features for flight attendant seats on older aircraft types such as the F-28 aircraft.

MCR 85 That Transport Canada assess and amend, as necessary, the procedures required to enact aviation safety–related legislation so as to avoid the bureaucratic process that has delayed the enactment of flight attendant shoulder harness and other important aviation safety–related legislation for the 12-year period since similar legislation was enacted in the United States.

MCR 86 That Transport Canada ensure that individuals from aviation industry positions are not placed on Transport Canada hiring or selection committees where there is any appearance of those individuals having a conflict of interest between their industry positions and their positions on the selection committee.

Chapter 23 Operational Control

It is recommended:

MCR 87 That Transport Canada re-examine its regulatory requirements pertaining to air carrier operational control and flight watch systems, and that it consider putting into place the four-tiered scheme for such systems discussed in chapter 23, Operational Control, of my Final Report.

MCR 88 That Transport Canada proffer for enactment legislation requiring the licensing of flight dispatchers as a prerequisite to their acting as flight dispatchers and training to standards set by Transport Canada, including the passing of appropriate Transport Canada licensing examinations. I commend for Transport Canada's consideration the Federal Aviation Administration licensing regime for flight operational officers (flight dispatchers) in the United States.

MCR 89 That pending implementation of Recommendation MCR 88 above, Transport Canada direct its air carrier inspectors to be diligent in ensuring that flight dispatchers who exercise any operational control over flights meet the minimum training requirements of Air Navigation Order Series VII, No. 2.

MCR 90 That Transport Canada proffer for enactment amendments to Air Navigation Order Series VII, No. 2, that spell out minimum acceptable requirements for an operational flight plan (flight release).

MCR 91 That Transport Canada direct air carrier inspectors to be diligent during in-flight and base inspections in monitoring the accuracy of operational flight releases.

MCR 92 That Transport Canada, when approving air carrier manuals, ensure that flight dispatcher training qualifications set out in a flight dispatcher training manual are no less comprehensive than those requirements set out in the Air Navigation Orders in all cases where such dispatchers may exercise any operational control over flights.

MCR 93 That Transport Canada initiate a continuing program for the monitoring, inspection, and audit of air carrier flight dispatchers and flight dispatch and flight watch systems, with provision for spot checks and no-notice audits.

MCR 94 That Transport Canada introduce appropriate amendments to the Air Navigation Order Series VII, No. 2, Part III, so as to describe clearly and definitively where system operations control begins and terminates and where operational control begins and terminates.

MCR 95 That Transport Canada require that air carriers provide a system, automated or otherwise, for alerting dispatchers to significant changes in the weather, actual or forecast, at stations significant to flights for which a flight watch is provided.

MCR 96 That Transport Canada require that flight-planning data and procedures used by air carriers for pre-flight planning be accurate and sufficient to provide fuel reserves as stated in Air Navigation Order Series VII, No. 2, and to ensure that aircraft will be operated within the certificated weight restrictions.

MCR 97 That Transport Canada ensure that any flight watch system required under Air Navigation Order Series VII, No. 2, and approved by Transport Canada, provide for direct pilot-to-dispatch communications from the flight deck, where the necessary communications links exist.

MCR 98 That, if a pilot self-dispatch system is to be approved, both Transport Canada and the air carrier ensure that the duties and responsibilities of pilots and dispatchers are clearly and comprehensively covered in the Flight Operations Manual (FOM). It should be made clear in the FOM that no operational decisions are to be made without the captain's agreement.

MCR 99 That Transport Canada require all air carriers to have in place a system that requires ground-handling agents to inform dispatch and/or the captain of any significant change to aircraft passenger or freight loads immediately upon such a change becoming known to the ground-handling agent.

Chapter 24 Flight Safety

It is recommended:

MCR 100 That Transport Canada proffer for enactment legislation to amend Air Navigation Order Series VII, No. 2, section 5, to include the position of flight safety officer as a required air carrier managerial position.

MCR 101 That Transport Canada proffer for enactment legislation to amend Air Navigation Order Series VII, No. 2, section 5, to require the appointment by an air carrier of a person to the position of flight safety officer for the carrier, the qualifications of such person and the description of the duties and responsibilities of such position to be determined by Transport Canada after consultation with the air carrier industry, and to provide that the flight safety officer shall have direct access on a continuing basis to the chief executive officer of the air carrier in flight safety–related matters.

MCR 102 That Transport Canada initiate a program of consultation with Canadian air carriers and the Transportation Safety Board of Canada with a view to having air carriers institute, staff, and operate, on a continuing basis, an effective flight safety program that is based upon the "Flight Safety Functions," identified in the International Air Transport Association Technical Policy Manual, OPS Amendment No. 37, July 1989, referred to in chapter 24 of my Final Report, Flight Safety.

MCR 103 That Transport Canada institute a program for the monitoring of the flight safety programs of Canadian air carriers, with a view to ensuring that each air carrier has in place an effective flight safety program that is appropriate for the size and scope of the carrier's operations.

Chapter 25 Management Performance

It is recommended:

MCR 104 That Transport Canada ensure that Air Navigation Order Series VII, No. 2, section 5, be amended to provide a clear statement of the duties, responsibilities, and qualifications for all air carrier management positions set out therein.

MCR 105 That Transport Canada develop standard criteria for the qualifications of all air carrier management positions set out in Air Navigation Order Series VII, No. 2, section 5. Such criteria should include consideration of the following attributes of the respective management candidates:

- aviation and management experience;
- flying experience;
- professional licences, such as aircraft maintenance engineer or airline transport rating;
- incident and occurrence record;
- knowledge of the *Aeronautics Act*, Air Regulations, and Air Navigation Orders, including air carrier certification requirements and procedures; and
- knowledge of the appropriate air carrier manuals necessary for proper performance of duties and responsibilities.

MCR 106 That Transport Canada ensure that, once standard criteria referred to in MCR 105 are established and published, all air carrier management candidate approvals be subject to such criteria being fully satisfied.

MCR 107 That Transport Canada ensure the ongoing and adequate surveillance and monitoring of new aircraft implementation programs by Canadian air carriers.

MCR 108 That Transport Canada proffer for enactment legislation imposing upon an air carrier concurrent responsibility with the pilot-in-command for the safe and proper crewing, dispatch, and conduct of a flight over which the air carrier exercises any degree of operational control. (The adoption of the United States Federal Aviation Regulation 121 would address this area of concern.)

MCR 109 That Transport Canada ensure that the investigation of any violation of the Air Regulations or Air Navigation Orders committed by an air carrier pilot or an aircraft maintenance engineer include an examination of the air carrier's contribution to the circumstances or environment that may have led to such violation. Where such an investigation reveals that the air carrier's contribution was significant, appropriate and parallel enforcement action should be taken against the air carrier as well as against the individual.

Part Six Transport Canada

Chapter 30 The Effects of Deregulation and Downsizing on Aviation Safety

It is recommended:

MCR 110 That the Aviation Regulation Directorate focus adequate resources on surveillance and monitoring of the air carrier industry, with emphasis on in-flight inspections and unannounced spot checks.

MCR 111 That Transport Canada establish a policy that identifies surveillance of existing air carriers as a non-discretionary task.

MCR 112 That Transport Canada establish a contingency policy in order to meet unusual resource demands without jeopardizing adequate staffing of inspection and surveillance functions.

MCR 113 That Transport Canada pursue extension of the delegation of authority to industry in accordance with the recommendations of Transport Canada's Management Consultant Branch studies completed in 1990 on this subject. Where additional delegation of authority to industry can be achieved safely, such delegation should be authorized in order to allow more effective use of Transport Canada inspectors.

MCR 114 That Transport Canada establish a policy to ensure that required support staff will be provided so that inspector staff will not be misdirected from their operational safety–oriented surveillance duties in order to perform tasks more appropriately conducted by support staff.

MCR 115 That Transport Canada establish an air carrier inspector training policy to be put into force without further delay, and that the policy ensure the following:

(a) A clear statement of the requisite competencies for each inspector position in the Airworthiness and Flight Standards directorates of Transport Canada.

(b) A statement of the training courses required to be completed successfully by inspectors before they are delegated authority and before their probationary periods end.

(c) Successful completion of training to be required before air carrier inspectors are delegated their authority credentials.

(d) Establishment of a recurrent training program for each discipline of inspection to ensure continued competence.

MCR 116 That Transport Canada improve staffing and recruiting programs to enable aviation regulation requirements to be filled on a high-priority basis. The capability to fast-track such staffing requirements should be achieved as soon as reasonably possible.

MCR 117 That Transport Canada, in consultation with the air carriers, work out an arrangement to accommodate the requirement of no-notice in-flight cabin safety inspections and surveillance on charter flights.

Chapter 31 Aviation Regulation: Resourcing Process

It is recommended:

MCR 118 That Transport Canada, as an integral part of any future policy development process, ensure that thorough impact studies be carried out by experienced analysts, knowledgeable in the subject matter, as a prerequisite to government acceptance and implementation of policies that could have a bearing on aviation safety.

MCR 119 That, where a potentially adverse effect on safety is identified, appropriate measures be taken by the government to preclude the effect before the policy is implemented.

MCR 120 That all senior Transport Canada Aviation Group managers have at their disposal knowledge of the current demands being imposed on branches of the department for which they have responsibility.

MCR 121 That Transport Canada encourage all Aviation Group managers, at any level, to communicate to their superiors any significant aviation safety concern that has come to their attention and that could affect the Canadian aviation industry and public.

MCR 122 That Transport Canada put in place a policy directive that if resource levels are insufficient to support a regulatory or other program having a direct bearing on aviation safety, the resource shortfall and its impact be communicated, without delay, to successive higher levels of Transport Canada management until the problem is resolved or until it is communicated to the minister of transport.

MCR 123 That an air carrier activity reporting system providing a current and reliable picture of the industry be developed and utilized by Transport Canada to determine program resource needs, levels, and direction.

MCR 124 That the process of resource allocation, including staffing standards, be re-examined by Transport Canada with the following objectives:

(a) To establish a staffing standard based on realistic and measurable task performance and frequencies and accepted standards of time required for such tasks.
(b) To reduce the challenging levels from the present seven or more to a lower, more realistic level.
(c) To establish a resource contingency factor for aviation regulation that can, at the discretion of senior management of Transport Canada, be called upon to provide additional resources to meet exceptional safety-related circumstances.

MCR 125 That Transport Canada examine the role of the Resource Management Board, formerly the Program Control Board, with a view to attaining the following goals:

(a) To ensure that the deputy minister of transport will be informed of all aviation safety implications of any resource reductions or denials recommended by the Resource Management Board.
(b) To ensure that within the Resource Management Board and its secretariat there is an individual with aviation operational expertise who is cognizant of safety implications in resource reduction programs.
(c) To ensure that members of the Resource Management Board understand the implications of personnel reductions below the minimum level prescribed by accepted staffing standards.
(d) To ensure that the deputy minister of transport be informed of each instance in which the Resource Management Board or its secretariat returns plans to Transport Canada group heads asking for further justification of resource requirements for aviation safety–related items.

MCR 126 That Transport Canada's Aviation Regulation Directorate develop a system that focuses resources on the areas of highest risk.

Chapter 33 Audit of Air Ontario Inc., 1988

It is recommended:

MCR 127 That Transport Canada review and revise its aviation audit policy, under the direction and approval of the assistant deputy minister, aviation.

MCR 128 That Transport Canada ensure that the rationale for and the importance of the audit program be clearly enunciated to all participating departmental staff and to the aviation industry.

MCR 129 That Transport Canada ensure that the frequency of audits be based upon a formula that takes into consideration all significant factors, including safety and conformance records, changes in type of operations, mergers, introduction of new equipment, and changes in key personnel.

MCR 130 That Transport Canada policy confirm that joint air carrier airworthiness and operations audits are the accepted norm, particularly for large companies; however, other types of audits should be identified and flexibility provided to facilitate no-notice mini-audits or inspections, split airworthiness and operations audits where warranted, and audits of specific areas of urgent concern arising from safety issues that are identified from time to time.

MCR 131 That Transport Canada ensure the availability of qualified managers to manage and coordinate the audit programs.

MCR 132 That Transport Canada ensure the availability of adequate and qualified personnel to support the audit program.

MCR 133 That Transport Canada ensure that minimum training and competency requirements be established for specific positions in the audit process.

MCR 134 That Transport Canada ensure that personnel appointed to an audit have a direct reporting relationship to the audit manager from commencement until completion of the audit and the approval of the final report for that audit.

MCR 135 That Transport Canada reinforce existing policy that requires audit managers to be readily available to audit staff during the conduct of an audit.

MCR 136 That Transport Canada policy manuals provide that an air carrier document review process, including a review of prior audits, be completed prior to the commencement of an audit.

MCR 137 That Transport Canada ensure that time limitations be clearly specified and adhered to within which completion and delivery of audit reports are to be achieved.

MCR 138 That Transport Canada ensure that procedures for immediate response to critical safety issues identified during an audit be instituted and included in the appropriate Transport Canada manuals, and that such procedures be communicated to the Canadian aviation industry.

MCR 139 That Transport Canada ensure that trend analyses be produced from the results of audits and used in the formulation of decisions regarding the type, subject, and frequency of audits.

Chapter 34 Operating Rules and Legislation

It is recommended:

MCR 140 That Transport Canada ensure that managers and inspectors responsible for the application of operating rules are consulted on proposed changes to such rules.

MCR 141 That if the proposed draft operating rules currently being developed by Transport Canada do not fully address and satisfy the concerns identified by this Inquiry and expressed herein, then the entire matter of air carrier operating rules be reconsidered by Transport Canada with a view to adopting the United States Federal Aviation Regulation operating rules applying to air carriers for the Canadian regulatory scheme, amended or supplemented as necessary to accommodate Canadian conditions and purposes, on the highest possible priority basis.

MCR 142 That in the event that the United States Federal Aviation Regulation (FAR) operating rules are adopted by Transport Canada for a required Canadian regulatory scheme, Transport Canada retain an expert in the application of the FARs to assist in their transition into the Canadian regulatory regime.

MCR 143 That in the event of adoption of the United States Federal Aviation Regulation operating rules for a revised Canadian regulatory scheme, all the recommendations contained in this Final Report and in my Interim Reports proposing amendments or changes to existing Air Navigation Orders and Regulations be incorporated accordingly in order to give full meaning and effect to the subject matter under consideration.

MCR 144 That Transport Canada monitor the efforts of the United States Federal Aviation Administration and the European Joint Aviation Authorities to achieve greater commonality in aircraft design and certification requirements and in operating regulations, with a view to achieving harmonization of Canadian airworthiness and operating rules with the changing international aviation environment.

MCR **145** That Transport Canada adopt the recommendations contained in sections 5.2 and 5.3 of the May 1990 evaluation of Aviation Regulation and Safety Programs, regarding priority setting for regulatory developments and the rule-making process.

MCR **146** That a senior member of the Privy Council staff be included in the proposed senior departmental review committee for priority setting.

Chapter 35 Company Check Pilot

It is recommended:

MCR **147** That Transport Canada pursue a program that would lead to further delegation of authority to company check pilots with air carriers that have demonstrated an exemplary safety record and have in place mature programs for training and checking pilots. To such carriers, delegation of authority with respect to initial pilot proficiency checks and pilot upgrades should be considered as well.

MCR **148** That Transport Canada provide a comprehensive monitoring program of both designated company check pilots and a representative cross-section of each company's pilots to ensure that standards are being properly applied and maintained.

MCR **149** That Transport Canada conduct, and reserve the right to conduct, pilot proficiency spot checks on all air carrier pilots, including designated company check pilots, as it sees fit and without notice.

MCR **150** That Transport Canada conduct initial pilot proficiency checks and line checks with every air carrier in cases where a new aircraft type is being introduced, to ensure that the required standards are met in that air carrier's operation of the new aircraft type.

MCR 151 That Transport Canada ensure that all pilot proficiency checks on aircraft over 12,500 pounds and on all turbojet aircraft be conducted only by air carrier inspectors or company check pilots holding a current rating for the specific aircraft type on which the check is being conducted.

MCR 152 That Transport Canada ensure that pilot proficiency checks on non-turbojet aircraft and on aircraft under 12,500 pounds be conducted only by air carrier inspectors or company check pilots who are type-rated on that aircraft type or on a generically similar aircraft.

MCR 153 That Transport Canada develop a clear and unambiguous definition of "generically similar aircraft" to be placed in all applicable regulations and supporting manuals.

MCR 154 That Transport Canada, on a priority basis, rewrite the conflict of interest section of its Air Carrier Check Pilot Manual so as to include the following objectives:

(a) to provide a clear and unambiguous definition of what is meant by the term "conflict of interest" as it relates to company check pilots;
(b) to specify those areas in which a conflict of interest can arise, in addition to the area of financial interest.

MCR 155 That Transport Canada provide explicit guidelines to its air carrier inspectors on the subject of conflict of interest for use in evaluating individual candidates for the position of company check pilot.

MCR 156 That Transport Canada conduct an evaluation of potential conflict of interest with respect to each company check pilot candidate, and that a written record be kept of each such evaluation.

Chapter 36 Contracting Out, Waivers, and Spot Checks

It is recommended:

MCR 157 That Transport Canada provide appropriate regulations governing the practice whereby air carriers enter into contracts with other companies or agencies for the provision of facilities or services required under the terms of the air carrier's operating certificate.

MCR 158 That Transport Canada inspectors be provided clear and direct guidance governing their aviation-regulation responsibilities for approval of arrangements and facilities to be contracted out to other companies or agencies by Canadian air carriers.

MCR 159 That Transport Canada set out a clear and unequivocal policy for senior managers specifying the basis upon which a waiver application is to be considered, ensuring that all safety implications are fully considered and satisfied before such waiver is granted.

MCR 160 That Transport Canada take steps to increase substantially the number of no-notice inspections of air carriers, with particular emphasis on safety-sensitive or high-risk areas.

Chapter 37 Safety Management and the Transport Canada Organization

It is recommended:

MCR 161 That Transport Canada proffer for enactment an amendment to the *Aeronautics Act* to delineate clearly the minister's responsibility for aviation safety. Such amendment should emphasize the minister's responsibility to ensure that the department is organized in a manner to keep the minister accurately informed of the ability of Transport Canada to deliver its mandated aviation safety programs effectively.

MCR 162 That Transport Canada be organized in a manner to provide the managerial structure necessary to keep the minister and deputy minister fully and accurately informed of all matters having an impact on aviation safety, and to ensure that appropriate and timely action is taken to address aviation safety concerns.

MCR 163 That Transport Canada state clearly the goals that aviation safety–related programs are expected to achieve, and that it identify the extent of inspection, surveillance, and enforcement activities that must be conducted within a given time frame. Such program goals should be designed in consultation with the Aviation Group's operationally and technically qualified staff.

MCR 164 That Transport Canada create a single position in each region (e.g., a director-general) responsible and accountable for the delivery of the aviation programs assigned to the present Airports Authority Group and the Aviation Group. This position should report directly to a senior administrator or assistant deputy minister at headquarters, who is responsible for the overall delivery of such aviation programs on a national basis.

MCR 165 That the regional directors-general (proposed in MCR 164 above) be authorized to manage their resources in a responsible and flexible manner. Such authority should be accompanied by firm insistence on accountability and a monitoring activity that will ensure responsible management.

MCR 166 That Transport Canada create the position of a headquarters' operational aviation safety officer with an appropriate support staff. This aviation safety officer should report directly to the most senior aviation position in the department and should be responsible for auditing the safety performance of both the Airports Authority Group and the Aviation Group.

MCR 167 That Transport Canada actively participate in the research and development necessary to establish safety effectiveness measurement systems that will lead to the most efficient use of resources in assuring safety. Cooperation with the United States Federal Aviation Administration and other international groups should be encouraged and resourced to obtain the maximum and most expedient benefits from such programs.

MCR 168 That Transport Canada aviation safety committees, with access directly to the headquarters' operational aviation safety officer, be established in regions and headquarters.

MCR 169 That Transport Canada establish a mandatory education program to ensure that senior managers and officials of the department who are responsible for or associated with aviation programs are aware of the basis for and requirement to support policies that affect aviation safety.

Part Seven Human Factors

Chapter 38 Crew Information

It is recommended:

MCR 170 That Transport Canada address the anomaly existing in Air Navigation Order Series VII, No. 2, with respect to the lack of maximum flight times and maximum flight duty times prescribed for cabin crew members.

Chapter 39 Crew Coordination and the Communication of Safety Concerns by Passengers

It is recommended:

MCR 171 That Transport Canada implement regulations requiring air carriers to provide approved crew resource management training and standard operating procedures for all Canadian air carrier flight crews and cabin crews. This training should be designed to coordinate the flight activities and information exchange of the entire air crew team, including the following particulars:

(a) As part of such crew resource management training, joint training should be carried out involving all captains and in-charge cabin crew members in order that each fully understand the duties and responsibilities of the other.

(b) All cabin crew members should be given sufficient training to enable them to recognize potentially unsafe situations both in the cabin and outside the aircraft. If it is necessary to prioritize such training, it should first be provided to all in-charge cabin attendants.

(c) As part of normal pre-flight announcements over the aircraft public address system, passengers should be advised that they may draw any concerns to the attention of the cabin crew members.

(d) All cabin crew members should be trained and instructed to communicate all on-board safety concerns they may have or that may be communicated to them by any passenger to the captain through the in-charge cabin crew member, unless time or other circumstances do not permit following this chain of command.

(e) All in-charge cabin crew members, after appropriate training, should be encouraged in adverse winter weather conditions to monitor the condition of the surface of the aircraft wings as part of the pre-takeoff cabin routine, in order to check for contamination, as a supplement to the captain's primary responsibility in that regard.

(f) Pilots should be made aware that concerns raised by cabin crew members should be taken seriously and investigated, where appropriate.

(g) Pilots should be instructed that when travelling as passengers on board an aircraft they should never assume that the operating crew is aware of any situation that they themselves perceive to be a safety concern. Such pilot passengers should be encouraged to raise such concerns with a cabin crew member and request that the information be given to the captain.

MCR 172 That, in order to dispel any possible notion of "professional courtesy" or "respect" precluding the communication of any dangerous situation, specifically addressing the case of off-duty airline pilots, all Canadian air carriers and the Canadian Air Line Pilots Association provide to each of their pilots a clear statement disavowing any notion that professional courtesy or respect precludes an off-duty airline pilot on board an aircraft as a passenger from drawing a perceived safety concern to the attention of the captain. The statement should indicate that, while it is not mandatory for them to do so, it is appropriate for off-duty pilots who are on board an aircraft as passengers to communicate to the captain, through the intervention of a cabin crew member, any safety-related concerns perceived on board the aircraft.

MCR 173 That the captain of an aircraft operating in adverse winter weather conditions be required formally to advise the in-charge cabin crew member, prior to departure from the gate, whether ground de-icing of the aircraft is to take place and, in order to eliminate potential apprehension on the part of passengers, that they be advised accordingly on the public address system of the aircraft.

MCR 174 That Transport Canada implement a regulation requiring that, at any time prior to commencement of the takeoff roll, in the absence of prior advice by the captain that ground de-icing of the aircraft in adverse winter weather conditions is to be conducted, the in-charge cabin crew member be required to report to the captain his or her own concerns, or any concerns conveyed to him or to her by any cabin crew member or any passenger on board the aircraft, relating to wing contamination.

Chapter 40 Human Performance: A System Analysis

The Human Performance chapter of this Report is, in many ways, a synthesis of all the issues that the crew faced on March 10, 1989, and recommendations on such issues have already been set out elsewhere. It is not my intent to repeat these recommendations in detail in this chapter, but, in the interests of continuity, a synopsis of the principal recommendations already addressed and relevant to Human Performance includes:

- A renewed air carrier certification and inspection program incorporating improved safety regulations, adequate resources, and properly qualified and trained personnel be implemented by Transport Canada on a priority basis.
- Formal training of all air carrier crew members in crew resource management be made mandatory by regulation.

- Crew-oriented training and evaluation be actively pursued jointly by Canadian air carriers and Transport Canada as a more effective means of training and evaluating air carrier flight crews.
- The appointment of an air carrier flight safety officer, approved by Transport Canada, and the establishment of an approved flight safety program by all Canadian air carriers be made a regulatory requirement.
- A systematic and comprehensive discussion regarding cold soaking, based on research such as was conducted for and on behalf of this Commission of Inquiry, be inserted in air carriers' flight operations manuals and/or aircraft operating manuals and in government publications such as the Aeronautical Information Publication in order to make all pilots and aviation operational personnel aware of the various factors that may cause contamination to adhere to lifting surfaces.

Recommendations not previously addressed and specific to this chapter are as follows:

MCR 175 That the Transportation Safety Board of Canada further develop its investigation procedures into human factors aspects of aviation accidents to include a comprehensive section addressing the role of air carrier management in the area of flight safety management; and that the board encourage examination of management failures in a causal sense as part of its accident investigation procedures.

MCR 176 In conjunction with MRC 175 above, that the Transportation Safety Board of Canada actively pursue the amendment of appropriate International Civil Aviation Organization documents to address in a similar manner the role of air carrier management in the area of flight safety management.

Part Eight Legal and Other Issues before the Commission

Chapter 41 The Aviation Accident Investigation Process in Canada

It is recommended:

MCR 177 That the *Canadian Transportation Accident Investigation and Safety Board Act* be amended and regulations be passed to provide that, at any major aircraft accident investigation, parties having a direct interest in the investigation have the right to nominate, in consultation with the investigator in charge, individuals with specific expertise from among their ranks to be involved in the investigation as participants (as opposed to observers) on specific investigation team groups, such as operations, human factors, records, systems, engines, or site survey.

The terms and conditions of such participant involvement should be determined by the Transportation Safety Board of Canada and ought to include provisions placing participants under the authority of and responsible to the investigator in charge, as well as provisions to ensure the absolute confidentiality of all information and documentation gathered relating to the investigation.

MCR 178 That sections 28, 29, and 30 of the *Canadian Transportation Accident Investigation and Safety Board (CTAISB) Act* be amended to provide that witness statements, on-board recordings, and communications records referred to in those sections be made available on a confidential basis to those individuals who have been granted full participant status as representatives of parties having a direct interest in the accident investigation; and that all other provisions of sections 28, 29, and 30 of the *CTAISB Act* be amended accordingly in order to give full meaning and effect to the recommended amendments.

MCR 179 That section 24(2) of the *Canadian Transportation Accident Investigation and Safety Board (CTAISB) Act* be repealed. The Transportation Safety Board of Canada, in order to preserve its independence, should not be required to send a copy of any draft report on its findings and safety deficiencies that it has identified to each minister, or to any other person with a direct interest in the findings of the board, to provide them with an opportunity to make representations to the board with respect to the draft report, before the final report is prepared.

The other provisions of section 24 of the *CTAISB Act* should be amended accordingly in order to give full meaning and effect to the recommended repeal of section 24(2).

MCR 180 That a section be added to the *Canadian Transportation Accident Investigation and Safety Board Act* to provide to each minister and to each party having a direct interest in the findings of the board an opportunity, after completion of the aviation occurrence investigation and the gathering of the evidence, to make formal submissions within a time frame to be prescribed by the board, for consideration by the board in its deliberations.

MCR 181 That section 26 of the *Canadian Transportation Accident Investigation and Safety Board Act* be amended to incorporate a specific provision entitling a party with a direct interest in an investigation or public inquiry to petition the board for reconsideration of the conclusions of its final report where it is shown that new and material evidence has been discovered subsequent to the conclusion of the investigative process and which might reasonably affect such conclusions or where it is shown that the board's factual conclusions are erroneous.

MCR 182 That the *Canadian Transportation Accident Investigation and Safety Board Act* be amended to provide that all witness interviews conducted by investigators in connection with an aviation occurrence shall be tape recorded and transcribed.

MCR 183 That the Transportation Safety Board of Canada add to its roster the names, addresses, and telephone numbers of highly qualified Canadian and international professional experts, learned in the various disciplines, who are willing to be called upon to assist in any given aviation occurrence investigation. Such a roster should be maintained and updated in consultation with the Canadian aviation community.

MCR 184 That the Transportation Safety Board of Canada, as a matter of policy, establish a closer liaison with the National Aeronautical Research Establishment and the National Research Council Canada and, on an ad hoc basis, utilize to the fullest their facilities and staff experts in various applicable disciplines, to assist in the investigation of aviation accidents.

MCR 185 That sections 24(5) and 24(6) of the *Canadian Transportation Accident Investigation and Safety Board (CTAISB) Act* be amended to empower the board with the responsibility and authority under law to track and follow up on an ongoing basis the action taken by the minister of transport with respect to each board safety recommendation and, if no action is taken by the minister within a specified time frame, to require an explanation in writing by the minister therefor. There should be a legislated mode of procedure that causes Transport Canada to commit itself to a resolution date, within a specified time frame, with respect to all board recommendations that are accepted by the minister, with an explanation for the time frame contemplated. In the event that the minister's action varies from the board recommendation, or if the minister proposes to take no action with respect to a recommendation of the board, then written reasons therefor should be provided to the board, and such reasons should be made available to the public.

The other provisions of section 24 of the *CTAISB Act* should be amended accordingly in order to give full meaning and effect to the noted recommended amendments.

MCR 186 That the annual report of the Transportation Safety Board of Canada continue to set out, as it now does, all of the recommendations, whether interim or final, that have been made by the board to the minister in the preceding year, but that it add comment regarding the actions taken by the minister in regard thereto.

MCR 187 That the Transportation Safety Board of Canada provide forensic training to all its scientists and that the board call upon such outside resources as are necessary to assist them with such training.

MCR 188 That the Transportation Safety Board of Canada formally adopt a policy recognizing that the investigation of human factors involved in an aviation occurrence is a legitimate pursuit and an important element of the investigatory process.

MCR 189 That the Transportation Safety Board of Canada formally adopt a policy recognizing that it is appropriate for the board to draw inferences of fact based on a preponderance of evidence and to refer to such inferences in its decision-making process.

Chapter 43 Objection to Production of Documents, Based on a Confidence of the Queen's Privy Council, Section 39, Canada Evidence Act, R.S.C. 1985, c.C-5

It is recommended:

MCR 190 That section 39 of the *Canada Evidence Act*, R.S.C. 1985, c.C-5, be amended to empower a commissioner appointed under the *Inquiries Act* to make a determination in an in camera hearing as to the appropriateness of an objection, pursuant to the provisions of section 39 of the Act and based on a confidence of the Queen's Privy Council, to production of a document. Such determination should take into consideration the nature of the document in issue and its relevance and probative value to the subject matter of the inquiry, and should weigh the claim to confidence asserted under section 39 of the Act against the public interest in full disclosure of such document. In the alternative, the provisions of the *Inquiries Act* should be amended as required to give full meaning and effect to this recommendation.

Chapter 44 Inquiries Act, R.S.C. 1985, c.I-11, Section 13

It is recommended:

MCR 191 That the provisions of section 13 of the *Inquiries Act* be reconsidered and that, at a minimum, appropriate amendments be introduced to provide:

(a) a definition of the term "charge of misconduct," with particular focus on the meaning to be attached to the word "misconduct";
(b) more precise direction as to the point in time that notice is to be given under section 13, taking into account the various difficulties that have been pointed out herein; and
(c) an exemption from the notice provisions of section 13 in the case of Inquiries that have been conducted as quasi-judicial proceedings in the presence of counsel for the affected parties and with the attendant procedural and evidentiary safeguards discussed herein, or where it can otherwise be inferred that the person against whom the allegations are made had notice of the charges.

APPENDICES

Appendix A

P.C. 1989-532

CANADA

PRIVY COUNCIL

Certified to be a true copy of a Minute of a Meeting of the Committee of the Privy Council, approved by Her Excellency the Governor General on the 29th day of March, 1989.

The Committee of the Privy Council, on the recommendation of the Minister of Transport, advise that a Commission do issue under Part I of the Inquiries Act and under the Great Seal of Canada, appointing the Honourable Virgil Peter Moshansky, a Justice of the Court of Queen's Bench of Alberta, to be a Commissioner to inquire into the contributing factors and causes of the crash of Air Ontario Flight 363 Fokker F-28 at Dryden, Ontario, on March 10, 1989, and report thereon, including such recommendations as the Commissioner may deem appropriate in the interests of aviation safety; and

The Committee do further advise that

(a) the Commissioner be authorized to adopt such procedures and methods as he may from time to time deem expedient for the proper conduct of the inquiry;

(b) the Commissioner be authorized to sit at such times and in such places as he may decide;

(c) the Commissioner be authorized to rent such space and facilities as may be required for the purposes of the inquiry, in accordance with Treasury Board policies;

(d) the Commissioner be authorized to engage the services of such experts and other persons as are referred to in section 11 of the Inquiries Act, at such rates of remuneration and reimbursement as may be approved by the Treasury Board;

(e) the Commissioner be directed to advise the Governor in Council as to which, if any, of the groups or individuals that may appear before him, should receive assistance with respect to the legal costs they may incur in respect of those

...../2

P.C. 1989-532

- 2 -

appearances, and the extent of such assistance, where such assistance would, in the opinion of the Commissioner, be in the public interest;

(f) the Commissioner be directed

(i) to submit an interim report, in both official languages, to the Governor in Council not later than six months after the date of the appointment of the Commissioner and to submit any other interim reports to the Governor in Council, in both official languages, as, in the opinion of the Commissioner, may be required; and

(ii) to submit a final report, in both official languages, to the Governor in Council not later than March 30, 1990; and

(g) the Commissioner be directed to file the records and papers of the inquiry as soon as reasonably may be after the conclusion of the inquiry with the Clerk of the Privy Council.

CERTIFIED TO BE A TRUE COPY - COPIE CERTIFIÉE CONFORME

CLERK OF THE PRIVY COUNCIL - LE GREFFIER DU CONSEIL PRIVE

P.C. 1991-2591

CANADA

PRIVY COUNCIL

Certified to be a true copy of a Minute of a Meeting of the Committee of the Privy Council, approved by His Excellency the Governor General on the 30th day of December, 1991

WHEREAS the **Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario** was directed to submit a final report, in both official languages, to the Governor in Council not later than December 31, 1991;

AND WHEREAS the Commission will not be in a position to submit its final report on or prior to December 31, 1991 and the Commissioner has requested an extension until March 31, 1992 to prepare and submit his report;

THEREFORE, the Committee of the Privy Council, on the recommendation of the Prime Minister, pursuant to Part I of the Inquiries Act, advises that a Commission do issue amending the Commission issued pursuant to Order in Council P.C. 1989-532 of March 29, 1989, as amended by Orders in Council P.C. 1990-625 of March 29, 1990, P.C. 1991-1187 of June 20, 1991 and P.C. 1991-1845 of September 26, 1991, by deleting therefrom the following paragraph:

"(f) the Commissioner be directed

(ii) to submit a final report, in both official languages, to the Governor in Council not later than December 31, 1991; and"

and by substituting therefor the following paragraph:

"(f) the Commissioner be directed

(ii) to submit a final report, in both official languages, to the Governor in Council not later than March 31, 1992; and"

CERTIFIED TO BE A TRUE COPY - COPIE CERTIFIÉE CONFORME

CLERK OF THE PRIVY COUNCIL - LE GREFFIER DU CONSEIL PRIVÉ

Appendix B

Counsel and Representatives for Parties with Standing

	Counsel/Representatives
Commission Counsel	Frederick R. von Veh, QC *Commission counsel* *Stikeman, Elliott* *Toronto, Ontario* Gregory L. Wells *Associate Commission counsel* *Calgary, Alberta*
Staff Counsel	Adam S. Albright William R. Cottick Laurence C. Goldberg William M. McIntosh Douglas M. Worndl
Counsel to the Commission	W. Ian C. Binnie, QC Peter H. Griffin *McCarthy, Tétrault* *Toronto, Ontario*
Chief Coroner of Ontario	Paul A. Bailey *Crown Attorney* *Chatham, Ontario*
Air Canada	Rémi J. Lafrenière, QC *Air Canada* *Montreal, Quebec*
Aircraft Operations Groups Association (AOGA)	R.A. Peters *Aircraft Operations Groups Association* *Ottawa, Ontario*

Air Ontario Inc.	D. Bruce MacDougall, QC Gerard A. Chouest William J. Dunlop Peter M. Jacobsen Ann Bourke (student-at-law) *Paterson, MacDougall* *Toronto, Ontario*
Canadian Air Line Pilots Association (CALPA)	John T. Keenan Linda P. Thayer *Gravenor Keenan* *Montreal, Quebec*
Canadian Airlines International	Donald I. Brenner, QC Scott W. Fleming *Brenner & Company* *Vancouver, British Columbia*
Canadian Union of Public Employees (CUPE), Airline Division	Leanne M. Chahley *Caley & Wray* *Toronto, Ontario*
Fokker Aircraft B.V.	G. Robert W. Gale, QC *Blake, Cassels & Graydon* *Toronto, Ontario*
Menasco Aerospace Ltd	Berndt Weber *Technical Representative* *Product Support* *Menasco Aerospace Ltd* *Oakville, Ontario*
Rolls-Royce Ltd	Eric M. Lane Allister Ogilvie *Lane, Allen* *Toronto, Ontario*

Survivors and Estates of Victims	Kristopher H. Knutsen, QC W. Danial Newton *Carrel & Partners* *Thunder Bay, Ontario* S. Alexander Zaitzeff *Zaitzeff, Cancade* *Thunder Bay, Ontario*
Toronto Star (Torstar Corporation) and Canadian Press	J. Blair Mackenzie *Torstar Corp.* *Toronto, Ontario*
Town of Dryden and Dryden Municipal Airport	David A. Tompkins Katherine A. Auvinen *Bell, Temple* *Toronto, Ontario* Terrence A. Platana *McAuley & Partners* *Dryden, Ontario*
Transport Canada and Attorney General of Canada	Duff F. Friesen, QC *Department of Justice* *Ottawa, Ontario* J. Sanderson Graham D.M. Fiorita *Transport Canada Legal Services* *Ottawa, Ontario*

Appendix C

Parties Granted Full, Limited, and Special Participant Status and Observer Status

Full Participant Status
Air Ontario Inc.
Canadian Air Line Pilots Association
Canadian Union of Public Employees, Airline Division
Chief Coroner of Ontario
Fokker Aircraft B.V.
Her Majesty the Queen, as represented by the minister of transport and the attorney general of Canada
Town of Dryden and Dryden Municipal Airport

Limited Participant Status
Air Canada
Canadian Airlines International
Menasco Aerospace Ltd
Rolls-Royce Ltd
Toronto Star/Canadian Press

Special Participant Status
Survivors and estates of victims

Observers
Aircraft Operations Group

Appendix D

Witnesses Appearing before the Inquiry

Witness	Date and Place of Testimony
Brian Gordon Adams Survivor of the crash	September 27, 1989 Thunder Bay
David Jeffrey Adams Air safety investigator Australian Bureau of Air Safety Investigation Canberra, Australia	December 17, 1990 Toronto
Richard Irvin Adams Independent consultant on de-icing technology Newport News, Virginia, U.S.A.	June 18, 1990 Toronto
Angus Moncrieff (Monty) Allan Pilot Air Ontario (Toronto)	August 14, 1990 Toronto
Norbert Wolfgang Altmann Pilot Bearskin Air Services	November 14, 1989 Toronto
Gert Ingemar Andersson Pilot Linjeflyg Airlines Stockholm, Sweden	June 21/22, 1990 Toronto
Ronald Douglas Armstrong Regional director Aviation Regulation Directorate, Ontario Region Transport Canada	October 22/23, 1990 Toronto

Witness	Date and Place of Testimony
John Ashmore Maintenance control manager Air Ontario (London)	March 29, 1990 Toronto
Kostas J. (Gus) Athanasiou Crew chief Air Ontario (Toronto)	February 2, 1990 Toronto
Joseph P. Bajada Aircraft maintenance engineer Aircraft Analysis Section Canadian Aviation Safety Board	April 4/5, 1990 Toronto
Tara Kim Barton Customer service agent Canadian Partner and Dryden Air Services	November 17, 1989 Toronto
Diane May Beasant Owner and president Dryden Air Services	November 23, 1989 Toronto
Mark Arthur Beasant Officer, Ontario Provincial Police Part-time ramp servicer Dryden Air Services	November 23, 1989 Toronto
Lawrence Eldon Beeler President Dryden Flight Centre	November 15/16, 1989 Toronto
David John Berezuk Survivor of the crash Pilot Air Ontario (Thunder Bay)	September 25/26/27, 1989 Thunder Bay
Alfred Bertram Survivor of the crash Flight service specialist Transport Canada Rankin Inlet, Northwest Territories	September 29, 1989 Thunder Bay

Witness	Date and Place of Testimony
John Wesley Biro Survivor of the crash	October 12, 1989 Thunder Bay
Kenneth Richard Bittle Vice-president of maintenance and engineering Air Ontario	August 29/30/31, 1990 Toronto
Brian Gene Boucher Pilot Air Canada (Toronto) Part-time director of training Niagara-on-the-Lake Fire Department	April 26, 1990 Toronto
Arthur Ernest Bourre Weather observer and equipment operator Dryden Municipal Airport	November 22, 1989 Toronto
Wilson John Boynton Supervisor of engineering Air Ontario (London)	February 16, 1990 Toronto
Jill Edith Brannan Ticket and boarding agent Dryden Flight Centre	October 11, 1989 Thunder Bay
Martin Herbert Brayman Retired regional superintendent Air Carrier Inspection (Large Aeroplanes) Division Aviation Regulation Directorate Ontario Region Transport Canada	October 31/November 1, 1990 Toronto
Steven George Brezden Retired aircraft maintenance engineer Air Ontario (Winnipeg)	February 16, 1990 Toronto

Witness	Date and Place of Testimony
Craig Michael Brown Pilot Terraquest Limited	July 19, 1989 Dryden
Morgan Brown Lead station attendant Air Canada (Thunder Bay)	March 27, 1990 Toronto
Warren James Brown Dispatcher Air Ontario (London)	February 21, 1990 Toronto
Charles Thomas Bruzell Customer services manager Air Canada (Winnipeg)	February 20, 1990 Toronto
John C. Callan Chief administrative officer Town of Dryden	July 18, 1989 Dryden
Ricardo Alfonso Campbell Survivor of the crash	September 28, 1989 Thunder Bay
Claude Castonguay Pilot Air Ontario	September 10, 1990 Toronto
Peter Bonham Clay Independent expert witness for Rolls-Royce engine teardown and performance	April 5/6, 1990 Toronto
Rodney John Coates Regional manager of customer services Air Ontario (Toronto)	March 28, 1990 Toronto
Vaughan Stephen Cochrane General manager Dryden Flight Centre	March 6/7/8, 1990 Toronto

Witness	Date and Place of Testimony
Russell Wayne Copeland Dispatcher Air Ontario (London)	February 15, 1990 Toronto
Donald Leslie Crawshaw Survivor of the crash	September 28, 1989 Thunder Bay
Douglas Gary Davis Sergeant Ontario Provincial Police Dryden Detachment	July 20/24, 1989 Dryden
Charles Joseph Deluce F-28 chief pilot and project manager Air Ontario (Toronto)	September 17/18/19/20/21, 1990 December 3/4, 1990 Toronto
William Stanley Deluce President and chief executive officer Air Ontario (London)	December 10/11/12/13, 1990 Toronto
Donald James Douglas Regional director Air Navigation Directorate Pacific Region Transport Canada	November 23, 1990 Toronto
Henry Abram Dyck Superintendent Air Carrier Inspection Division Airworthiness Branch Aviation Regulation Directorate Transport Canada Headquarters	November 13/14/15/16, 1990 Toronto
James Lemar Esh Employee Dryden Flight Centre and Dryden Air Services	November 16, 1989 Toronto
Michael Andrew Ferguson Survivor of the crash	September 14, 1989 Thunder Bay

Witness	Date and Place of Testimony
Susan Mary Ferguson Survivor of the crash	September 14, 1989 Thunder Bay
Rita Figliomeni Flight attendant Air Ontario (Thunder Bay)	March 27, 1990 Toronto
Jerry Deroal Fillier Ramp attendant and refueller Dryden Flight Centre	November 17, 1989 Toronto
James Edward Foot Electrical/mechanical engineering specialist Canadian Aviation Safety Board	April 3/4, 1990 Toronto
Keith Warren Fox Pilot and flight 1363 passenger Air Ontario (Toronto)	March 5/6, 1990 Toronto
Michael Gatto Survivor of the crash	September 14, 1989 Thunder Bay
Raymond Martin Gibbs Pilot Bearskin Air Services	November 15, 1989 Toronto
Raymond Marshall Godfrey Volunteer fire-fighter Unorganized Territories of Ontario Fire Department Wainwright Township, Ontario	July 24, 1989 Dryden
Daniel Martin Godin Survivor of the crash	September 28, 1989 Thunder Bay
Arthur Edward Grenier Constable Ontario Provincial Police Sioux Lookout Detachment	March 27, 1990 Toronto

Witness	**Date and Place of Testimony**
Thomas Richard Groves Meteorological observer Dryden Municipal Airport	July 20, 1989 Dryden
Harold Murray Haines Survivor of the crash Pilot Air Canada (Sioux Lookout, Ontario)	October 10, 1989 Thunder Bay
Jeffrey Earl Hamilton Emergency services officer Airports Authority Group Central Region Transport Canada	December 7/8, 1989 Toronto
Stephen John Hanley Emergency medical care attendant and paramedic Air Ambulance Unit Ontario Ministry of Health Sioux Lookout Detachment	July 25, 1989 Dryden
Erik Bent Hansen Pilot Air Ontario (London)	August 17, 1990 Toronto
Linda Marie Harder Ticket and boarding agent Dryden Flight Centre	November 17, 1989 Toronto
Thomas James Harris Survivor of the crash	September 13, 1989 Thunder Bay
Sonia Victoria Hartwick Survivor of the crash Flight attendant Air Ontario (Thunder Bay)	September 11/12/13, 1989 Thunder Bay

Witness	Date and Place of Testimony
Allan Clifford Haw Airport mechanic and auxiliary fire-fighter Dryden Municipal Airport	November 17, 1989 Toronto
Robert Louis Helmreich Professor of Psychology University of Texas Austin, Texas, U.S.A.	December 18/19/20, 1990 Toronto
Eugene Garnett Hill Manager, Certification and configuration development Renton Division Boeing Aircraft Seattle, Washington, U.S.A.	June 19, 1990 Toronto
Roscoe Miner Carlyle Hodgins Owner and pilot General Air Spray Ltd	November 14, 1989 Toronto
Mogens Johannes (John) Holm Superintendent, Air Operations Airports Authority Group Transport Canada	June 14, 1990 Toronto
James Walrond Hutchinson Chief, Engineering Analysis Division Canadian Aviation Safety Board	April 9/10, 1990 Toronto
Allan Wesley Hymers Water bomber pilot Ministry of Natural Resources Dryden, Ontario	October 12, 1989 Thunder Bay
Gary Edward Jackson Survivor of the crash	September 27, 1989 Thunder Bay

Witness	**Date and Place of Testimony**
Joseph Edward Jackson Investigator in charge Accident Investigation Team Canadian Aviation Safety Board	February 23, 1990 March 6/8, 1990 April 3, 1990 Toronto
Bjarne Krog (Brian) Jensen Manager, airport operations and ground equipment services Air Canada (Montreal)	June 22, 1990 Toronto
Paul Scott Jensen Pilot Air Ontario	September 11/12, 1990 Toronto
John Jerabek Line maintenance supervisor Air Ontario (Toronto)	February 1, 1990 Toronto
Thomas Sidney Jones Mayor Town of Dryden	July 17, 1989 Dryden
George MacGregor Knox Acting regional director-general Airports Authority Group Central Region Transport Canada	January 25/26, 1990 Toronto
Ernest Kobelka Emergency medical care attendant Dryden District General Hospital	July 25, 1989 Dryden
Danilo (Dean) Koncan Duty manager, Operations Air Ontario (London)	February 20, 1990 Toronto
Steve Korotyszyn Aircraft maintenance engineer and lead inspector Air Ontario (Toronto)	February 2, 1990 Toronto

Witness	Date and Place of Testimony
Martin Joseph Kothbauer Duty manager System Operations Control Air Ontario (London)	February 22, 1990 Toronto
Stanley Michael Kruger Crew chief Crash Fire Rescue Unit Dryden Municipal Airport	November 20/21, 1989 Toronto
Alana Labelle-Hellmann Flight attendant Air Ontario	September 11, 1990 Toronto
Claude André LaFrance Formerly assistant deputy minister of aviation Transport Canada Headquarters	January 17, 1991 Toronto
Jack Lampe Manager, Cargo services, and de-icing commissioner United Airlines Chicago, Illinois, U.S.A.	June 20, 1990 Toronto
Daniel Keith Lavery Dispatcher Air Ontario (London)	February 21, 1990 Toronto
Paul Richard Lefebvre Station attendant and co-chairman Safety and Health Committee Air Canada (Toronto)	June 15, 1990 Toronto
Gary Donald Harvey Linger Owner ESSO Flight Refuelling Thunder Bay Airport	March 27, 1990 Toronto

Witness	**Date and Place of Testimony**
Peter Allan Louttit Airport manager Dryden Municipal Airport	July 18/19, 1989 Dryden
Lloyd Alexander McCoomb Director-general Safety and Technical Services Transport Canada Headquarters	June 26, 1990 Toronto
Gerald Hubert McCrae Volunteer fire-fighter Unorganized Territories of Ontario Fire Department Wainwright Township, Ontario	July 24, 1989 Dryden
Thomas Dickson (Dick) McDonald Chairman, Airport Commission Dryden Municipal Airport	July 25, 1989 Dryden
Bryce Neale MacGregor Acting chief Operations and Certification Division Aviation Regulation Directorate Transport Canada Headquarters	November 20/21, 1990 Toronto
Robert Carl McGogy Private pilot	November 14, 1989 Toronto
Jack Lyle McInnis Flight refueller ESSO Flight Refuelling Thunder Bay Airport	March 27, 1990 Toronto
Kelly Mackenzie Survivor of the crash	October 10, 1989 Thunder Bay
Louis John Maltais Fire chief Town of Dryden	July 18, 1989 Dryden

Witness	Date and Place of Testimony
Ronald Peter Mandich Survivor of the crash Green Bay, Wisconsin, U.S.A.	September 28, 1989 Thunder Bay
Gregory John Martin Physician and coroner Town of Dryden	July 24, 1989 Dryden
Henry Christian (Chris) Maybury Pilot Air Ontario (London)	August 15, 1990 Toronto
Charles O. (Chuck) Miller Aviation safety consultant System Safety Inc. Sedona, Arizona, U.S.A.	December 17, 1990 Toronto
Paul Orval Miller Sergeant and identification officer Technical Identification Services Unit Ontario Provincial Police Kenora Detachment	July 17, 1989 Dryden
John Arthur (Jack) Mitchell Director of flight safety Air Canada (Montreal)	October 9/10, 1990 Toronto
Henry Lucas Moore Director Airport Safety Services Branch Safety and Technical Services Directorate Transport Canada Headquarters	January 26, 1990 Toronto
John Murray Morgan Physicist Manager, In-flight simulator National Aeronautical Establishment National Research Council	May 3, 1990 Toronto

Witness	**Date and Place of Testimony**
Gregory Francis George Morrison Aircraft maintenance engineer and supervisor Air Ontario (Winnipeg)	March 9, 1990 Toronto
James Arthur Angus Morrison Pilot and vice-president of flight operations Air Ontario (London)	October 1/2/3, 1990 Toronto
Fernand Mousseau Director-general Policy Planning and Resource Development Directorate Transport Canada Headquarters	December 1, 1990 January 14, 1991 Toronto
David D. Murdoch Forensic climatologist Scientific Services Division Environment Canada	April 25, 1990 Toronto
John Leonard (Len) Murray Air carrier inspector Air Carrier Inspection (Large Aeroplanes) Division Aviation Regulation Directorate Seventh Region Transport Canada	November 2/13, 1990 Toronto
Weldon Ralph Newton Director-general Aviation Regulation Directorate Transport Canada Headquarters	January 15/16, 1991 Toronto
Jack Paul Nicholson Emergency services officer and acting superintendent Emergency Services/Crash Fire Rescue Airports Authority Group Central Region Transport Canada	December 5/6/7, 1989 Toronto

Witness	Date and Place of Testimony
Ole Tindbaek Nielsen Regional superintendent Air Carrier Maintenance Division Airworthiness Branch Aviation Regulations Directorate Ontario Region Transport Canada	October 29/30, 1990 Toronto
Roger Nordlund Fire chief Unorganized Territories of Ontario Fire Department Wainwright Township, Ontario	July 24, 1989 Dryden
Lawrence Trevor Northcott Water bomber pilot Ministry of Natural Resources Dryden, Ontario	October 12, 1989 Thunder Bay
Robert Victor Nyman Pilot and director of flight operations Air Ontario (Toronto)	September 12/13/14, 1990 September 17, 1990 Toronto
Larry Charles O'Bray Superintendent Emergency Services/Crash Fire Rescue Airports Authority Group Central Region Transport Canada	January 23/24, 1990 Toronto
William O'Connell Lead station attendant Air Canada (Winnipeg)	March 29, 1990 Toronto
Myron Morris Oleskiw Geophysicist, meteorologist, and associate research officer Low Temperature Laboratory National Research Council	April 26, 1990 Toronto

Witness	**Date and Place of Testimony**
Teoman Ozdener F-28 maintenance manager Air Ontario (Toronto)	August 28/29, 1990 Toronto
Frederick Ernest Arnold Parry Chief, Crash Fire Rescue Dryden Municipal Airport	July 20/21, 1989 July 24, 1989 Dryden
David Alan Patrick Supervising meteorologist Atmospheric Environment Services Environment Canada (Winnipeg)	February 21/22, 1990 Toronto
Robert Douglas Perkins Pilot Air Ontario (Toronto)	February 13/14, 1990 Toronto
Brian Martin Perozak Survivor of the crash	September 27, 1989 Thunder Bay
James Erwin Perry Manager, Community Airports Central Region Transport Canada (Winnipeg)	January 25, 1990 Toronto
Carol Anne Petrocovich Flight 1363 passenger Dryden, Ontario	November 20, 1989 Toronto
Kenneth Martin Pickwick Physical metallurgist Chief of Physical Analysis Canadian Aviation Safety Board	April 5, 1990 Toronto
Harold Christopher Pike Maintenance employee Dryden Municipal Airport	November 22, 1989 Toronto

Witness	Date and Place of Testimony
Earl Randy Pitcher Civil aviation inspector Air Carrier Inspection (Large Aeroplanes) Division Aviation Regulation Directorate Ontario Region Transport Canada	October 24/25/26, 1990 Toronto
Michael Roland Poole Superintendent Flight Recorders and Computers Engineering Branch Canadian Aviation Safety Board	April 9, 1990 Toronto
Channan (Ken) Ramnarine Aircraft maintenance engineer and crew chief Air Ontario (Toronto)	February 1, 1990 Toronto
Desmond James Risto Regional airports disaster planning and protective officer Airports Authority Group Central Region Transport Canada (Winnipeg)	December 4, 1989 Toronto
Gary Albert Rivard Fire-fighter Crash Fire Rescue Unit Dryden Municipal Airport	November 22, 1989 Toronto
David George Rohrer Senior aviation safety officer Canadian Aviation Safety Board	July 3/4/5/6, 1990 Toronto
Erving James Rolfe Maintenance control supervisor Air Ontario (London)	March 28, 1990 Toronto

Witness	**Date and Place of Testimony**
William John Alan Rowe Senior vice-president Western Canada & Pacific Rim Region Air Canada (Vancouver)	October 12/13, 1990 Toronto
Adrian (Sandy) Sandziuk Flight dispatcher Air Canada (Toronto)	December 14, 1990 Toronto
Brian Edward Sheppard Senior instrument meteorologist Environment Canada	April 11, 1990 Toronto
Peter Shewchuk Station agent/radio operator Air Canada (Thunder Bay)	February 23, 1990 Toronto
David John Shuel Lead attendant Air Canada (Winnipeg)	February 20, 1990 Toronto
Charles Herbert Simpson Pilot and senior vice-president of flight operations Air Canada (Montreal)	October 5, 1990 October 15, 1990 Toronto
Donald Ross Sinclair Regional manager Air Carrier Operations Branch Aviation Regulation Directorate Ontario Region Transport Canada	November 22, 1990 Toronto
Kenneth Alexander Sinclair Assistant deputy minister of policy and coordination Transport Canada Headquarters	January 21, 1991 Toronto

Witness	Date and Place of Testimony
Roderick William Slaughter Director, Flight Standards Branch Aviation Group Aviation Regulation Directorate Transport Canada Headquarters	November 27/28/29/30, 1990 Toronto
Allan Roy Slota Chairman, Emergency Services Town of Dryden Red Cross	July 25, 1989 Dryden
Reginald Harry James Smith Pilot Air Canada (Montreal)	June 12, 1990 Toronto
Ronald Bradley Somers Pilot Air Ontario (London)	January 30/31, 1990 Toronto
Ronald Cameron Stewart Flight safety officer and pilot Air Ontario (London)	May 22/23, 1990 August 20/21, 1990 Toronto
Deborah Marie Stoger Pilot Air Ontario (Toronto)	August 16, 1990 Toronto
Elaine Margaret Summers Aircraft maintenance engineer and technical investigator Canadian Aviation Safety Board	April 10/11, 1990 Toronto
Dennis Lee Swift Survivor of the crash	September 29, 1989 Thunder Bay
Thomas John Syme Executive vice-president Commercial Services Air Ontario (London)	August 22/23/24, 1990 August 27, 1990 Toronto

Witness	Date and Place of Testimony
William John Taylor Project officer and chief, Aircraft Analysis Engineering Branch Canadian Aviation Safety Board	April 6, 1990 Toronto
Uwe Ulrich Teubert Survivor of the crash	September 28, 1989 Thunder Bay
Paulette Theberge Community airports officer Airport Authority Group Central Region Transport Canada (Winnipeg)	January 24/25, 1990 Toronto
Andrew Basil Triolaire Director, Safety and Environment Canadian Airlines International Chairman, Safety Advisory Committee Air Transport Association of Canada	June 25, 1990 Toronto
Alan Ian Umbach Superintendent Air Carrier Operations Division Aviation Group Aviation Regulation Directorate Transport Canada Headquarters	November 17, 1990 November 19/20, 1990 Toronto
Jack van Hengst Chief aerodynamic analyst Fokker Aircraft B.V. Schiphol, The Netherlands	May 1/2, 1990 Toronto
Clare Rodney Vasey Unit operations specialist Airport Control Service Pearson International Airport	June 13, 1990 Toronto

Witness	Date and Place of Testimony
Gary Alan Wagner Pilot Air Canada Physicist/aeronautical engineer Adjunct professor Concordia University Montreal, Quebec	May 4, 1990 Toronto
Sandra Ruth Walker Emergency medical care attendant Dryden District General Hospital	July 25, 1989 Dryden
Richard Waller Survivor of the crash	September 29, 1989 Thunder Bay
Mary Ellen Ward Senior crew scheduler System Operations Control Air Ontario (London)	March 27, 1990 Toronto
Richard Herbert Wickens Mechanical engineer and senior research officer Low Speed Aerodynamics Laboratory National Aeronautical Establishment National Research Council	April 30, 1990 Toronto
David Philip Wightman Assistant deputy minister of aviation Transport Canada Headquarters	January 22, 1991 Toronto
William D. Wilcox Pilot Air Ontario (Toronto)	August 16/17, 1990 Toronto
Ramsey Muir Withers Formerly deputy minister Transport Canada	January 18, 1991 Toronto

Witness	**Date and Place of Testimony**
Cherry Leigh Wolframe Customer service agent Canadian Partner and Dryden Air Services	November 23, 1989 Toronto

Appendix E

Inquiry Schedule

Hearings

Commenced	May 26, 1989
Closed	January 24, 1991
Total number of days of hearings	168

Hearing Dates

Week 1	May 26, 1989 (preliminary hearing)	Toronto
Week 2	June 16, 1989 (preliminary hearing)	Toronto
Week 3	July 17–21, 1989	Dryden
Week 4	July 24–25, 1989	Dryden
Week 5	September 11–14, 1989	Thunder Bay
Week 6	September 25–29, 1989	Thunder Bay
Week 7	October 10–12, 1989	Thunder Bay
Week 8	November 14–17, 1989	Toronto
Week 9	November 20–23, 1989	Toronto
Week 10	December 4–8, 1989	Toronto
Week 11	January 23–26, 1990	Toronto
Week 12	January 30 – February 2, 1990	Toronto
Week 13	February 13–16, 1990	Toronto
Week 14	February 20–23, 1990	Toronto
Week 15	March 5–9, 1990	Toronto
Week 16	March 27–29, 1990	Toronto
Week 17	April 3–6, 1990	Toronto
Week 18	April 9–11, 1990	Toronto
Week 19	April 23, 25–26, 1990	Toronto
Week 20	April 30 – May 4, 1990	Toronto
Week 21	May 22–23, 1990	Toronto
Week 22	June 12–15, 1990	Toronto
Week 23	June 18–22, 1990	Toronto
Week 24	June 25–26, 1990	Toronto
Week 25	July 3–6, 1990	Toronto
Week 26	August 14–17, 1990	Toronto
Week 27	August 20–24, 1990	Toronto
Week 28	August 27–31, 1990	Toronto
Week 29	September 10–14, 1990	Toronto
Week 30	September 17–21, 1990	Toronto
Week 31	October 1–3, 5, 1990	Toronto

Week 32	October 9–10, 12–13, 1990	Toronto
Week 33	October 15, 1990	Toronto
Week 34	October 22–26, 1990	Toronto
Week 35	October 29 – November 2, 1990	Toronto
Week 36	November 13–17, 1990	Toronto
Week 37	November 19–23, 1990	Toronto
Week 38	November 27 – December 1, 1990	Toronto
Week 39	December 3–4, 1990	Toronto
Week 40	December 10–14, 1990	Toronto
Week 41	December 17–20, 1990	Toronto
Week 42	January 14–18, 1990	Toronto
Week 43	January 21–22, 1991	Toronto
	January 23–24, 1991 (Submissions)	Toronto

Transcripts
168 volumes 33,648 pages

Exhibits
Total number of public exhibits 1343

Witnesses
Total number of witnesses called at the Inquiry 166

Appendix F

Ministry of the Solicitor General — Office of the Chief Coroner

Ministère du Solliciteur général — Bureau du coroner en chef

26 Grenville Street
Toronto, Ontario M7A 2G9

26, rue Grenville
Toronto (Ontario) M7A 2G9

Telephone/Téléphone:
(416) 965-6678

Fax#/Télécopieur
(416) 324-3766

July 15, 1991

The Honourable Virgil P. Moshansky
Commissioner
Commission of Inquiry into the
Air Ontario Crash at Dryden, Ontario
595 Bay Street, 14th Floor
Toronto, Ontario
M5G 2C2

Dear Sir:

As Chief Coroner for the Province of Ontario, it is my responsibility to ensure that all deaths within Ontario are investigated with the following three principles in mind:

1) the public must be satisfied that the death of any member of the community will not be taken lightly, but instead will be as fully and completely investigated as is reasonably possible;

2) all of the facts surrounding each death must be made known to the public;

3) most importantly, those deaths which are preventable must be identified and all efforts made to delineate and invoke practical recommendations with a view to preventing similar deaths in future.

As a result of investigations into aviation accidents in Canada prior to the Air Ontario crash at Dryden, Dr. Bennett, the Chief Coroner at that time, and I were concerned about the margin of safety in the Canadian aviation industry.

A review of the literature demonstrates that enlightened accident investigation entails a careful analysis of the human factors aspects of a crash. In other words, it is not sufficient simply to

Page 2

identify the ultimate error resulting in the crash without further exploring the pressures and influences which allow or, in some cases, invite that ultimate error to occur. In this context, we were concerned that deaths resulting from aviation accidents were not being examined in sufficient depth to prevent the recurrence of similar deaths in future.

At the inception of the Commission of Inquiry, you invited the Office of the Chief Coroner to participate fully in the Inquiry process. At their first meeting with you, our representatives expressed to you the concerns which Dr. Bennett and I shared. They were assured from the start that this Inquiry would be conducted in an open forum, would be thorough, and would give full attention to the human factors analysis approach of accident investigation. Such an approach was needed and was overdue. It was on this basis that we determined that a separate and parallel investigation in the form of a coroner's inquest would be unnecessary, inefficient, and perhaps counterproductive, and that the expense associated with full participation throughout the Inquiry process was fully justified. In the course of time I have become absolutely convinced that this was the correct decision.

For the purposes of representing the Chief Coroner at the Commission of Inquiry, we chose Mr. Paul Bailey, Crown Attorney for the County of Kent, and Dr. Robert Huxter, Regional Coroner for Metropolitan Toronto. Each of these individuals came equipped with extensive investigative and aviation experience. I trust that Mr. Bailey and Dr. Huxter were able to assist in and enhance the process by which the evidence that came before you was gathered, tested, and analysed.

It is an arduous task to preside over a public hearing. Participating interest groups often have competing interests and conflict is inevitable. Your approach to the varying interests have allowed everyone to be heard without any compromise with respect to ascertaining the truth. The interests of aviation safety are well served by your experience and wisdom in this regard.

I have been kept apprised on an ongoing basis of the facts discovered and the conclusions reached by you. I am pleased to assert unequivocally that the interests and goals of the Office of the Chief Coroner on behalf of the Province of Ontario have been fully met by the Commission of Inquiry into the Air Ontario Crash at Dryden. In my opinion, your Commission of Inquiry has established a new and badly needed benchmark for the investigation of major aviation accidents in Canada.

Page 3

I fully endorse the approach you took, and the recommendations you have made. In the event of a further major accident, I am confident that my colleagues in other provinces and I will carefully compare the actual performance of the aviation industry and aviation regulators with the standard of conduct you have carefully delineated in your reports.

It is my hope that such scrutiny will not be needed. I strongly urge that the individuals and organizations that are mandated to invoke your recommendations do so. I am encouraged by the improvements that have already been made by air carriers and Transport Canada. The further changes you advocate, however, must also be effected. Only then will a recurrence of the death and suffering caused by the Dryden crash be avoided.

Thank you again for the opportunity of collaborating on this worthwhile endeavour.

Yours sincerely,

James G Young MD

James G. Young, M.D.
Chief Coroner for Ontario

JGY:fl

Appendix G

Time Sequence of Events during the Station Stop at Dryden Municipal Airport and Events Occurring at the Crash Site, March 10, 1989

The following time sequence of events surrounding Air Ontario flight 1363 on March 10, 1989, is based on information from the following sources:

- Piedmont Airlines' F-28 Operations Manual
- Transcript of Kenora Flight Service Station (FSS) taped log
- Data from simulator trials carried out by the Canadian Aviation Safety Board's (CASB) flight operations group
- Testimony of witnesses
- Ambulance tachographs
- Dryden and airport fire channel tape

References in *italic* type are to exact times; all references in roman type are best estimates.

Time	Events
11:39 a.m.	Flight 1363 lands at Dryden
11:40	Flight ramps at Dryden. Flight is marshalled in by Mr Vaughan Cochrane, with Mr Jerry Fillier standing by with baggage cart. Light snow falling; none accumulating on the ramp or the aircraft.
11:41	Mr Cochrane puts in nose-wheel chocks and stands by the front door while flight attendant opens it. Mr Fillier proceeds to forward cargo hold to unload and load baggage.
11:42	First Officer (FO) Keith Mills leaves cockpit and goes to lavatory at rear of aircraft. Captain George Morwood remains in seat.

Time	Events
11:43	Mr Cochrane goes to cockpit to give pilots the baggage count. (He does not remember whether or not both pilots were there at that time.) Mr Cochrane leaves cockpit and tells Mr Fillier to get the fuel truck. Mr Cochrane then goes into the terminal and calls crash, fire-fighting, and rescue (CFR) unit.
11:45	FO Keith Fox, a passenger travelling from Thunder Bay to Dryden, talks to Mr Cochrane at the Air Ontario ticket counter.
11:47	FO Fox returns to cockpit to inquire about missing baggage. He speaks with Captain Morwood; FO Mills is not in the cockpit. Still snowing. Intensity has increased. Special weather observation taken at 1747Z (issued at 1748Z) shows visibility reduced to 2 ½ miles in snow. Snow starting to accumulate on the wings.
11:48	Mr Fillier returns with fuel truck. Does not hook up but proceeds to cockpit to get details for refuelling. Both pilots are in cockpit. Captain tells Mr Fillier that 13,000 pounds total is required – 6500 pounds per side.
11:50	Mr Fillier commences to hook up for refuelling when Mr Cochrane returns and tells him to refuel a NorOntair flight and a Cessna 206. Both these aircraft are parked in front of the fuel pumps.
11:52	Captain Morwood leaves cockpit and proceeds into terminal. He is seen by Mr Fillier leaving the aircraft as the latter walks towards the NorOntair flight. Light, wet snow falling; more is accumulating on wings. Weather observation taken about 1750Z (issued at 1800Z) gives visibility as 2 ½ miles in light snow.
11:53	Captain Morwood arrives at Air Ontario ticket counter and talks with Ms Jill Brannan.
11:56:03	*FO Mills calls YQK FSS: "Kenora Dryden it's Ontario 363."*
11:56:10	*YQK FSS replies: "Ontario 363 Kenora."*

Time	**Events**
11:56:16	*GX 363: "Yes Sir, we are just sitting on the ramp here, I wonder if you could in Dryden could you go ahead the latest Brandon, Winnipeg, Kenora, ahh and Thunder Bay please."*
11:56:31	*YQK FSS: "Roger stand by."*
11:56:48	*YQK FSS: "And for Ontario 363 Kenora the Winnipeg weather, seventeen hundred sky partially obscured, five hundred then scattered. Twelve thousand thin broken visibility three fog. Temperature two dew point zero, wind one two zero wind one twenty at ten, altimeter three zero zero one. At Thunder Bay sky partially obscured, four thousand, five hundred scattered, measured ceiling seven thousand broken, nine thousand overcast, one and a half miles in fog, temperature minus two, dew point minus three, winds calm, altimeter 30.17, sun dimly visible, and was that Brandon and what other location?"*
11:57:30	*GX 363: "Brandon, Kenora, also Canadian Sault please."*
11:57:36	*YQK FSS: "Roger, Brandon balloon ceiling eight hundred overcast, three miles fog, temperature one, dew point zero, winds one forty degrees at six, altimeter two nine nine six, stratus nine. Kenora we are at two thousand special at one seven one seven, two thousand two hundred scattered, estimated ceiling five thousand broken, four miles fog, temperature zero, dew point minus two, one zero zero degrees five, altimeter three zero one zero. Canadian Soo eight thousand thin broken, estimated ceiling two seven thousand broken, visibility more than fifteen, temperature zero, dew point minus six, wind one four zero degrees nine, altimeter three zero three two."*
11:58:00	*Captain places call to London SOC centre from telephone at the ticket counter.*
11:58:28	*GX 363: "Okay let me check those all okay. And can we have an updated terminal please for if there's any amendments to Dryden, Kenora, and Winnipeg please."*

Time	Events
11:58:47	*YQK FSS: "The Dryden forecast valid from seventeen hundred to zero three hundred is for three thousand scattered, ceiling is ten thousand overcast, occasionally ceiling's three thousand broken, ten thousand overcast, five miles in light rain, light freezing rain and fog, becoming by nineteen hundred Universal eight hundred scattered, ceiling's four thousand overcast, occasionally sky partially obscured, ceiling's eight hundred overcast, two miles light rain, fog, risk of a light thunder shower til twenty-one hundred Universal and after zero zero ceilings fifteen hundred broken, four thousand overcast. For Kenora, valid from seventeen hundred Universal, seven hundred scattered, ceiling's four thousand overcast, five miles light snow showers, occasionally sky partially obscured, ceiling seven hundred overcast, one mile light rain showers, light snow showers, fog, risk of a thunder shower in snow, becoming by nineteen hundred eight hundred scattered, ceilings four thousand broken occasionally, sky partially obscured ceilings eight hundred broken, five miles fog, by twenty-one hundred Universal fifteen hundred scattered, ceilings four thousand broken, occasionally ceilings fifteen hundred broken, four thousand broken, how on that so far?"*
11:59:50	*Captain completes call to dispatch and starts back to aircraft.* Before returning to aircraft the captain speaks with FO Fox and Ms Carol Anne Petrocovich, both passengers who had travelled from Thunder Bay to Dryden, at the Dryden Flight Centre counter.
12:00:10 p.m.	Captain arrives in cockpit
12:00:15	*GX 363: "Okay we got that pretty much okay the, it's after twenty-one Z Kenora goes fifteen hundred scattered and that was VFR."*
12:00:25	*YQK FSS: "Affirmative well, occasionally down to fifteen hundred broken after that time."*
12:00:30	*GX 363: "Okay we check that, we're down to about a mile and a half in Dryden in snow right now, quite puffy, snow, looks like it's going to be a heavy one. Uh, okay and go ahead with the rest."*

Time	Events
	Snow has increased in intensity. Visibility now down to 1 ½ miles (FO Mills's estimate) from 2 ½ miles at 1747Z.
12:00:44	*YQK FSS: "Okay Winnipeg, valid from seventeen hundred, sky partially obscured, ceilings five hundred broken, one mile fog, variable five hundred scattered, ceilings four thousand broken, five miles fog, by twenty hundred, eight hundred scattered, ceilings four thousand broken, occasionally sky partially obscured, ceilings eight hundred broken, three miles in fog, and improving, well I don't know if improving after zero two hundred tonight, one thousand broken, four thousand broken, winds zero four zero degrees at ten, occasionally five miles light snow showers and a risk of a freezing drizzle, and ceilings tomorrow about fifteen hundred broken, stand by I'll see if there's any segmets [SIGMET] out for that area."*
12:01:00	Mr Cochrane arrives in the cockpit with fuel figures. Captain asks if de-icing is available and Mr Cochrane says yes, it is, and points out Mr James Esh, who is walking by on the ramp, as the man who would do it. According to Mr Cochrane this is the end of the short conversation.
12:01:20	Mr Cochrane leaves the aircraft, and the door is closed. FO Mills has been completing the weight and balance form while the captain and Mr Cochrane are conversing.
12:01:30	FO Mills completes the weight and balance form. The door is already closed so he does not give the form to Mr Cochrane.
12:01:32	*FO Mills calls FSS: "Okay we're just firing up here now and uh we'll give you a call requesting the IFR as well."*
12:01:35	Before-start check – through flights (Piedmont F-28 Operations Manual); called by FO Mills and actioned by Captain Morwood. No Smoking and Seatbelt . . . . ON Instruments . . . . SYNC AND X-CHECKED Parking Brake . . . . SET Fuel . . . . ___Min,___OB [On Board]

Time	Events
	Radios, Radar, Transponder . . . SET AND STANDBY TTC Switches (2) . . . . TAKEOFF Rudder and Aileron Trim . . . . CHECKED Papers . . . . ABOARD Thrust Index . . . . SET - - - - - - - - - - - -Cleared for Start- - - - - - - - - - - - Anti-Collision Lights . . . . ON Booster Pumps (4) . . . . ON Start Pressure . . . . ___PSI [Note: This check should take about 60 seconds to complete.]
12:01:50	*YQK FSS: "And 363 Kenora there is a segmet [SIGMET] out, correction, for Winnipeg area, radar shows reports confirm north to south line of scattered thunder cells, twenty miles wide from Bissett to Gretna moving eastward at forty-five knots, tops at twenty-eight thousand, severe clear icing and turbulence associated. That's about it."* No answer from flight 363. The pilots are probably busy starting the engine or reading check lists.
12:02:30	Crossbleed start (Piedmont F-28 Operations Manual); called by FO Mills and responded to by Captain Morwood. CROSSBLEED START If difficulties are experienced with APU air or an external air source with one engine running, a crossbleed start can be made. Prior to using this procedure, ensure that the area to the rear is clear. Increase thrust on the operating engine until there is a 30 psi duct pressure and use this air source to start the remaining engine. CAUTION: A crossbleed start should not be attempted during pushback. Engine Bleed Air Main Switches . . . . ON APU Bleed Air Switch . . . . OFF Throttle Lever . . . . ADVANCE Advance throttle lever on the operating engine until duct pressure reads 30 psi. Start remaining engine using normal procedures. After starter cutout, reduce power.

Time	Events
	[Note: This check should take about 50 seconds to complete.]
12:03:20	After-start check (Piedmont F-28 Operations Manual); called by FO Mills and actioned by Captain Morwood.
	<u>AFTER START</u> Warning & Door Lights .... OUT Electrical .... GENERATORS ON CHECKED APU Air .... OFF Starter Master Switch .... OFF Air Cond. and Press .... BOTH ON, SET Anti-Ice .... AUTO/ON Pitot Heat .... ON HP Fuel Valve Levers .... OPEN Flight Control Lights .... OUT
	[During or following this check the flaps are selected down and almost immediately back up. Flaps up would conform with recommended practice when taxiing on contaminated surfaces. Note: This check should take about 35 seconds to complete.]
12:03:43	*YQK FSS: "Ontario 363 Kenora."* Snow intensity continues to increase. Special weather observation taken about 1803Z (issued at 1806Z) shows precipitation ceiling at 300 feet above ground level (AGL) and visibility 3/8 of a mile in moderate snow.
12:03:46	*GX 363: "We're fired up, taxiing for departure requesting the airways to Winnipeg."*
12:04:03	*FHJS (Cessna): "There any chance that plane can hold, I'm having real bad weather problems here."*
12:04:07	*GX 363: "Okay three sixty three's, holding short of the active, be advised you are down to a half a mile or less in snow here."* FO Mills confirms the MET observer's observation is still valid at 1804:07Z. Snow continues to accumulate on the wings; ramp is starting to build up layer of slush.

Time	Events
12:04:10	Captain Morwood calls Ms Brannan on radio and advises they have to hold for a light aircraft.
12:04:15	*C-FHJS: "That's a roger."*
12:04:31	*C-FHJS: "I'm about one mile south of the Airport."*
12:05:00	*YQK FSS: "Juliette Sierra Kenora, special VFR is approved in the Dryden control zone til one eight one five. Call final."*
12:05:05	Captain Morwood makes a PA announcement to the passengers, explaining the delay.
12:05:16	*C-FHJS: "We're on final."*
12:05:18	*YQK FSS: "Juliette Sierra Kenora, roger."*
12:06:22	*GX 363: "Kenora Ontario [three six three], we're taxiing out at this time, three sixty three Dryden, we check there's a single engine just landed here."*
12:06:42	*YQK FSS: "Are you using Runway one one or two nine?"*
12:06:46	*GX 363: "We'll go for 29."*
12:06:52	*GX 363: "Kenora you copy 363 taxiing for Departure 29."* Continues to snow heavily. Snow squall is heaviest at the 29 end of the runway (the east end of airport). Snow is becoming quite thick on the wings. Runway at the east end is building up slush and snow at the runway edges and, possibly, in the centre as well. The contaminated runway procedures expected to have been followed by the flight crew of C-FONF Taxiing: Most air carriers have their own procedures for taxiing on snow- and/or slush-covered runways. This usually calls for leaving the flaps up and delaying the Before Takeoff Checklist until in the vicinity of the threshold of the departure runway.
12:06:56	*YQK FSS: "363 Kenora stand by."*

Time	Events
12:07:24	*YQK FSS: "Ontario 363 Kenora your clearance Sir."*
12:07:33	*GX 363: "Go ahead for three sixty three."*
12:07:35	*YQK FSS: "ATC clears Ontario 363 to the Winnipeg Airport, Dryden direct, maintain flight level two zero zero, departure Runway two nine, proceed on course, squawk code one three zero zero."*
12:07:49	*GX 363: "ATC clears 363 to the Dryden Airport, maintain to, uh Dryden direct maintain two zero zero off twenty-nine on course, thirteen hundred on the box."*
12:07:56	*YQK FSS: "Roger that was cleared to the Winnipeg Airport."*
12:07:59	*GX 363: "Affirmative, Winnipeg Airport."*
12:08:24	*YQK FSS: "Ontario three six three Kenora, call airborne time one eight zero eight, three-quarters (30 on T.I.U.)."*
12:08:29	*GX 363: "Call Kenora airborne three sixty three."*
12:08:35	Taxi and Takeoff (Piedmont F-28 Operations Manual); called by FO Mills and responded to by Captain Morwood.

TAXI & TAKEOFF

Yaw Damper . . . . IN
Flight Controls . . . . CHECKED
Flaps . . . . ____
Stabilizer Trim . . . . ____UNITS UP/DOWN
Liftdumpers . . . . ARMED, RDY
Collector Tank Indicators . . . . BLACK
Control Cabin Door . . . . LOCKED
Shoulder Harness . . . . SECURED
Takeoff Data and Brief . . . . . . REVIEWED, BUGS SET

[Note: Approximate elapsed time 40 seconds to complete this check.]

Time	Events
	Cleared For Takeoff APU .... ON/OFF Flight Att. Advisory .... GIVEN Transponder .... ON
	Engine anti-icing during ground operation and takeoff. Engine inlet icing may occur at a temperature above freezing when there is no evidence of icing on the aircraft. Switch on engine anti-icing after engine start when icing is observed or anticipated, i.e., when the ambient temperature is below +10°C and visible moisture (rain, slush, snow, fog, etc.) and/or wet runways exist. To check engine anti-icing pressure controlling in the range 45 to 57 psi, HP rpm may be momentarily increased during taxiing. CAUTION: IN FOG AND RAIN AT TEMPERATURES BELOW +10°C THE ENGINE ANTI-ICING SYSTEM MAY NOT BE CAPABLE OF KEEPING THE ENGINES CLEAR OF ICE DURING PROLONGED TAXIING AND/OR LONG PERIODS OF IDLING. IN THESE CONDITIONS IT IS RECOMMENDED TO ACCELERATE THE ENGINES TO APPROXIMATELY 90% HP ROM FOR 3 TO 4 SECONDS AT INTERVALS OF NOT MORE THAN 8 MINUTES. BEFORE COMMENCING THE TAKEOFF ROLL, SELECT TAKEOFF POWER ON THE BRAKES TO CHECK SATISFACTORY ENGINE BEHAVIOUR.
	Aircraft turned around at the button of Runway 29, and engines run up apparently in accordance with the above procedures, prior to brake release.
12:09:29	*GX 363: "And Kenora Dryden Ontario three sixty three, is about to roll twenty-nine at Dryden."*
12:09:35	*YQK FSS: "Ontario three six three Kenora, roger."* Snow intensity is decreasing slightly. Special observation taken at 1809Z (issued at 1211Z) gives precipitation ceiling of 1000 feet AGL and visibility of ¾ of a mile in snow.
12:09:35	Short engine run up

Time	Events
12:09:40	Aircraft begins takeoff roll.
	Takeoff: The aircraft was equipped with standard chined nosewheel tires. A flap setting of 18° is recommended, thereby eliminating possible trapping of slush between vane and flap during retraction after takeoff. The takeoff is based on V_1/V_R=1.0 to avoid the possibility of insufficient acceleration after engine failure. It is recommended to raise the nosewheels out of the slush as soon as the elevator becomes sufficiently effective and to continue acceleration with the nosewheels just clear of the slush. Thereby the contribution of the nosewheels to the total slush drag is eliminated. However, care should be taken not to over-rotate, as this would increase the aerodynamic drag. At V_R commence rotation to approximately 10° nose-up pitch and continue the takeoff in the normal manner. CAUTION: SLUSH DRAG PRODUCES SIGNIFICANT NOSE-DOWN PITCHING MOMENTS. THE SUDDEN REDUCTION IN DRAG AT THE MOMENT OF ROTATION MAY RESULT IN OVER-ROTATION.
12:09:56	Aircraft reaches 80 knots. This is the speed where captain is committed to take off unless an engine fails before V_1/V_R.
12:10:45	Aircraft crashes in bush 950 metres west of the runway.
12:10:54–12:12:45	*Kenora FSS asks Winnipeg ATC if it has contact with Air Ontario 363. The FSS and ATC both try to locate the aircraft and then Kenora FSS speaks with CFR Chief Ernest Parry, who is in Red 3 on the runway at Dryden.*
12:12:47	*Chief Parry tells Kenora FSS that aircraft may have gone down west of the airport.*
12:14	*Chief Parry informs town dispatch and asks that emergency plan be activated.*
12:18	Chief Parry in place at McArthur and Middle Marker roads.

Time	Events
12:19	Red 1 arrives at end of Middle Marker Road. CFR crew chief Stanley Kruger takes his portable radio and first-aid kit and proceeds to crash site.
12:24	*Command centre in town is set up and ready for requests.*
12:26	*Chief Parry calls for pumper from town.*
12:27–28	*Chief Parry asks airport to send field maintenance "guys" and "at least a loader."*
12:29	*Chief Parry asks if any ambulances are available.*
12:30	Sergeant Douglas Davis of the OPP arrives at McArthur and Middle Marker roads.
12:32	*Chief Parry reports "twenty/twenty-five walking wounded" out at road.*
12:34	UT of O Rapid Attack truck arrives and parks on McArthur Road.
12:35	*First ambulance arrives and drives down Middle Marker Road to where Red 1 is parked. From a comparison of all other available information, it appears that the clock in the TACH unit in unit 644 was about nine minutes fast. The TACH unit says it arrived at the site at 12:44 p.m., but Chief Parry reports that the ambulance arrived at the site at 12:35 p.m.*
12:40	UT of O tanker truck arrives and parks on McArthur Road.
12:43	Red 2 arrives and drives down Middle Marker Road. Shortly thereafter, it backs out to allow the ambulance to depart. Red 2 loses the air in the brake system and is parked on McArthur Road.
12:44	*Two Town of Dryden fire trucks arrive at Middle Marker Road.*
12:45	UT of O fire chief Roger Nordlund arrives at McArthur and Middle Marker roads.

Time	Events
12:46	*The number of people on board C-FONF is confirmed at 69 in a radio communication from Peter Louttit, manager of Dryden Municipal Airport, to Chief Parry.*
12:52	*Chief Parry advises that "5 or 6 private vehicles and police cars" have left the site for the hospital with survivors. This is in addition to unit 644, which departed the site at 12:51 with seven survivors.*
12:55	*Ambulance unit 645 – Sandra Walker – arrives at site carrying supplies and bringing Dr Gregory Martin and Dr Alan Hamilton. Ms Walker is the emergency medical care attendant.*
1:05	*Ambulance unit 645 departs site with Mrs Nancy Ayer for hospital.*
1:08	*Dryden Fire 5 on a portable from the site advises that all survivors are out to the road.*
1:10	*Crew chief Kruger confirms that all survivors are out and remarks, "We need a road in here badly and if we can get some handlines in here somehow."*
1:11	*Chief Parry calls for a heavy dozer to punch a road to the site.*
1:12	*Crew chief Kruger advises, "We have got two more survivors ... we pulled out of the wreckage." These survivors are Mr Michael Kliewer and Mr Uwe Teubert. A discussion ensues about getting a helicopter to land at the site to take out these two remaining survivors. It is concluded that it will take too long for a helicopter to arrive, and the two men are carried out of the bush.*
1:30	Some time after 1:30, the two UT of O fire trucks are driven down Middle Marker Road and set up for fire suppression.
1:37	*Ambulance unit 645 returns to the site.*
1:45	*Ambulance unit 645 departs the site with Mr Kliewer, Mr Teubert, and Dr Martin.*

Time	Events
2:00	First foam is applied to the burning aircraft.
2:00	*Ambulance unit 645 arrives at Dryden hospital.*

Notes to Time Sequence

1 The time sequences are based on the assumption that all required checks were carried out by the pilots.

2 All times are local.

3 All the evidence has been considered with respect to weather data for the various times. Some of this evidence is conflicting. In an attempt to resolve contradictions, more reliance was placed on the evidence of trained observers than on the evidence of untrained observers. In this context, professional pilots are considered trained observers.

4 The times that are accurate are:
(a) The radio transmissions between GX 363 and Kenora FSS. First Officer Mills makes all the calls to FSS. Captain Morwood makes the calls to Dryden Flight Centre.
(b) The telephone call from Captain Morwood to the SOC centre in London.
(c) Times obtained from the Dryden and airport fire channel tape.
(d) Ambulance tachographs (adjusted).

5 The times noted as normal for completion of the cockpit checks take into consideration the relatively low experience level of the two pilots on the F-28.

6 There is an assumption that the taxi speed was normal.

7 Except where noted, all event times following the takeoff of the aircraft are taken from the Kenora FSS tape, the Dryden and airport fire channel tape, or the ambulance tachographs.

Appendix H

Summary of Fatalities and Survivor Injuries

Summary of Fatalities in Crash of Flight 1363

Seat	Name	Cause of Death
A	Morwood, George John	Gross blunt force trauma including ruptures of the heart
B	Mills, Keith B.	Smoke inhalation and presumption of blunt force trauma to abdomen
C	Say, Katherine	Generalized body burns
1a	Allcorn, Don	Generalized body burns
1b	Kliewer, Pamela	Generalized body burns
1c	Kliewer, Brian	Multiple trauma, severe head injury, and terminal aspiration of blood
1d	Syme, Steve	Generalized body burns
2b	Kliewer, Lisa	Multiple trauma, CO 21%
2c	Kliewer, Michael	Massive trauma
2d	Rabb, Hilda	Burns to body
3a	Kozak, Ryan	No anatomic cause of death (grave destruction of body)
3b	Kozak, George	Undetermined (charred body with fractured femoral shafts)
3c	McLeod, Kenneth John	Trauma

Seat	Name	Cause of Death
4a	McColeman, Wilfred P.	Undetermined
4b	McColeman, Geraldine	Trauma with terminal aspiration of blood
4c	Gallinger, Fred	Trauma
5a	Monroe, Mark	Traumatic injury with terminal aspiration of blood, CO 15%
5b	Schweitzer, William	Traumatic injury
5c	Rossaasen, Alvin	Smoke inhalation and burns to the body, CO 65% – lethal range
6a	Finlayson, Donald	Smoke inhalation, CO 23%. No anatomic cause detectable.
6b	Fortier, Wendy	Smoke inhalation, toxic CO 33%. No anatomic cause detectable.
6c	Fortier, Greg	Soot in airway, CO 21%. No anatomic cause of death.
7a	Barton, Rudy	Undetermined (charred body)
7c	Ayer, Nancy	Extensive full-thickness cutaneous burns and hypovolemic shock

Summary of Injuries

Seat	Name	Documented Injuries
1e	Syme, Karen	Hospitalized. Grief reaction and superficial laceration to scalp.
2a	Teubert, Uwe	Hospitalized. 2d and 3d degree burns to back. Lacerations of L face, chin, and L thigh requiring suturing. Abrasions and bruising to chest, lower limbs, and R buttock. Loss of consciousness and concussion. Smoke inhalation.
2c	Kliewer, Michael	Hospitalized but FATAL. Massive trauma and skull fracture.
2e	Phibbs, Jack	Hospitalized. Abrasions to L flank. Bruising of L shoulder. Fractured R thumb. Significant head injury with questionable concussion. Preponderance of L-sided injuries.
3d	Waller, Richard	Hospitalized. Abrasions to forehead and legs. Significant impact and bruising to L shoulder and L chest wall. Physician worried about a ruptured spleen. Chip fracture of L lateral epicondyle. Preponderance of L-sided injuries.
3e	Ditmars, Clyde	Bruising and abrasions to L leg, forehead, nose, and L ribs. Sprained L ring finger. Preponderance of L-sided injuries.
4d	Adams, Brian	Hospitalized. Laceration to R palm and L thumb requiring sutures. Bruising and abrasions to L leg, ankle, and L eye. Preponderance of L-sided injuries.
4e	Perozak, Brian	Bruising to L shoulder and L leg. Preponderance of L-sided injuries.

Seat	Name	Documented Injuries
5d	Haines, Shannon	Laceration to R leg. Abrasion to L leg. Bruising to forehead and L leg.
5e	Archer, John	Abrasions to scalp and hands. Bruising to anterior chest.
6d	Tucker, Gordon	Bruising to R chest and L forearm. Sore neck and R chest.
6e	Maronese, Tina	Abrasions to L foot and bruising to L flank, chest, and scapula. Slight preponderance of L-sided injuries.
7b	MacDougall, Allan	Hospitalized. 3d degree burns to R foot, back, and L shoulder involving 6% of body surface area. Laceration to L forehead. Bruising to L hip. Fracture of L forearm (radius). Preponderance of L-sided injuries. Questionable loss of consciousness. Smoke inhalation?
7c	Ayer, Nancy	Hospitalized but FATAL. Extensive full-thickness cutaneous burns and hypovolemic shock.
7d	Campbell, Ricardo	2d degree burns to face, head, and shoulders involving 5% of body surface area. Lacerations and bruising of L leg.
7e1	Podiluk, Shelley	Hospitalized. 1st degree burns to hands. 2d degree burns to midback, groin, and feet. 9% of body surface area affected by burns. Sore neck and chest. Significant hyperflexion/extension neck sprain noted. Questionable 3rd degree sprain or avulsion fracture of L lateral talofibular ligament (L ankle). Bruising to occiput. Likely smoke or fume inhalation.

Seat	Name	Documented Injuries
7e2	Podiluk, Megan	Hospitalized. 2d to 3d degree burns to 3% of body surface area. No smoke or fume inhalation. Small laceration of the scalp.
8a	Harris, Tom	Hospitalized. 1st and 2d degree burns to L hand, forearm, elbow, and shoulder, and R hand and forearm. 14% of body surface area affected by burn.
8b	Knott, Byron	Hospitalized. Bruising and abrasions to head and body. Dislocated R elbow. Sprained R back.
8c	Mandich, Ron	1st degree burn to face with singed hair. Sore neck and sprained L wrist.
8d	Hartwick, Sonia	Bruising and abrasions to R forehead. (Also diagnosed skull fracture.)
8e	Taggert, Paul	Bruising and abrasions to wrists, face, R knee, and L ribs
9a	Godin, Lori	Abrasions to R lateral knee. Sore neck and R collarbone.
9b	Godin, Dan	No emergency reports. Likely not treated for any injuries.
9c	Bertram, Alfred	Abrasion to L wrist and R chin
9d	Godin, Susan	Bruising and abrasions to R lower waist. Sore neck.
9e	Godin, Danielle	Bruising and sprained/strained back. Conjunctivitis of R eye.

Seat	Name	Documented Injuries
10a	Menzies, Donna	Hospitalized. Sprain/strain to lower back but walked out of woods.
10b	Mackenzie, Kelly	Bruising to L hip, thigh, and parietal area of the head. Abrasions to R wrist.
10c	Mackenzie, James	Bruising and abrasions to R shoulder, hand, and calf
10d	Ferguson, Susan	Hospitalized. Laceration to L scalp requiring 5 sutures. Bruising and abrasions to legs. Admitted for observation.
10e	Ferguson, Michael	Superficial laceration to the L scalp and lower lip. Bruising to R upper arm and R lower leg.
11a	Gatto, Michael	Bruising to shoulder, waist, and L lower leg
11b	Gatto, Ryan	No injuries, just shaken up
11c	Haines, Lois	Hospitalized. 1st to 3d degree burns to both legs and 10% of body surface area. Bruise to R posterior chest, face, and temple with questionable LOC. Sore neck. Laceration of L ankle requiring 4 sutures.
11d	Woods, Violet	Hospitalized. Laceration to L forehead. Bruised periorbital area, R shoulder, and scapula. Dislocated L foot tarsal joint.
11e	Biro, John	Hospitalized. 2d degree burns to scalp. Laceration to lip and R ear requiring sutures. Sore neck. Admitted for concern over past cardiac problems.

Seat	Name	Documented Injuries
12a	Berezuk, David	Hospitalized. Bronchospasm and wheezing secondary to cold exposure or fumes. Laceration to R face needing sutures. Abrasions to R arm, face, and legs. Minor injuries but hospitalized.
12b	Berezuk, Michael	Abrasions to R leg
12c	Berezuk, Sandra	Superficial laceration R forearm, both legs and hips. Fractured R 9th posterior rib.
12d	McFarlane, Douglas	Hospitalized. Fracture L ribs #2, 3, and 4 which resulted in a mild haemothorax. Fracture and dislocated L ankle. Bruising to R frontal scalp, forehead, L flank, R lower thigh, and knee. Preponderance of L-sided injuries.
12e	McFarlane, Gary Scott	Laceration of R lower leg and L knee requiring sutures. Sprained R ankle. Bruise to head. Abrasion to shoulder.
13a	Jackson, Gary	1st and 2d degree burns to both hands. Laceration and puncture of L ear. Abrasion of L leg.
13b	Crawshaw, Donald	Burned or singed hair. Superficial laceration of nose. Sprained L wrist.
13c	Swift, Dennis	Hospitalized. Open compound comminuted fracture of R femur. Abrasions to the face and bruising to the L thigh.
13d	Haines, Murray	Bruise to hip and back
13e	Haines, Jessi	No significant injuries

Appendix I

Minutes of Debriefing Meetings, Town of Dryden, March 13 and 16, 1989

DISTRIBUTE IN ENVELOPES MARKED CONFIDENTIAL:

THE CORPORATION AT THE TOWN OF DRYDEN

March 13, 1989

Minutes of a debriefing meeting held at 10:00 a.m. on the above date in the Boardroom of the Town Hall.

Present: Mayor Jones, Airport Commission Chairman D. McDonald, Fire Chief L. Maltais, Project Engineer T. McConnell, Construction Superintendent W. Yasinski, Deputy Fire Chief D. Herbert, Welfare Administrator D. Smith, Treasurer P. Heayn, Administrator J. Callan, Telephone Manager W. Greaves, Police Chief R. Phillips, Town Engineer M. Fisher, Clerk B. Hoffstrom, Office Staff: G. Odell, E. Boyce, M. Wiedenhoeft, E. Realini.

Chief Maltais chaired the meeting and announced the purpose of the meeting was to review any problem areas which arose during activation of our Emergency Plan following the crash around noon on Friday, March 10th of an Air Ontario F-28 jet. The aircraft was fully loaded and carried a total of 69 crew and passengers. There were 45 survivors and 24 fatalities. Chief Maltais noted that discussions at this meeting are confidential to those in attendance. He then requested each person to give individual comments.

TOM MCCONNELL reviewed his activities in the plan and indicated that the operation appeared to be well organized from his point of view.

WILL YASINSKI reviewed the Public Works activities, noting that diaries were maintained at the Public Works office of communications received and dispatched, noting that it was difficult in the early stages to convince people that this was not a practice. He noted a small problem with the portable power plants which were obtained at Canadian Pacific Forest Products in that the plants were available but there was no lighting to go with them. He noted also that Ontario Hydro and Bell Canada have portable generators but they are not on our contact list. They also have snowmachines and should be on our list. There was discussion on whether the power plants should be stored on our site or at Bell or Ontario Hydro, and if they are, we should have the name of a contact person for access after regular working hours. He noted Public Works would be holding their own debriefing later today.

DARRYL HERBERT advised that his pager did not alert him, instead he went to the Fire Hall on his own volition after hearing something on the radio. He noted his involvement was primarily in assisting the Fire Chief. Also, all but four firemen, who are out of town, responded to this emergency. Firemen will be debriefing tonight.

GLENNA ODELL indicated she had a rather hectic ride to the hospital, also that proper forms were not initially available at the hospital. After Maurette arrived with the proper documentation, etc., there appeared to be very little problem.

ESTHER BOYCE acted as secretary at the Emergency Operations Centre. She commented on the excess of unnecessary people in the EOC, and suggested that the Red Cross should have a representative on the Control Group. Another suggestion was that the media people should be kept out of the control room.

LOUIS MALTAIS suggested that everyone involved in this event should do a personal diary on the extent of their involvement. He noted also that there was a need for a designated code so that people involved are able to determine that a real emergency is not a practice.

MAURETTE WIEDENHOEFT reported on communication problems with the Red Cross, the frantic ride to the hospital, the fact that we should have purchased toys or books or something for the children to keep them occupied, the need to ensure that an internal plan is developed for all departments, and she recommended that more employees attend the Arnprior training centre.

DOROTHY SMITH commented on the conflict with the Red Cross and their involvement in registering people. She also expressed concern with the operations of the media at the motels noting they should be controlled better by the Police Department, and noting that more police are required in that regard.

PAUL HEAYN noted that Ken Rentz was helpful in preparing a meeting place for relatives of the victims in the basement of the United Church.

He noted we should ensure there is a good supply of body bags on hand at all times, also that the ID badges need updating.

ELSIE REALINI reported on the co-operation she received from local merchants, particularly The Bay. The personal hygiene bags prepared for the injured people were very much appreciated. It was suggested an information package on Dryden complete with paper and pen be available for distribution to injured people in such circumstances as most of them are unaware of very much of what is available in Dryden. With respect to the hospital activities, she noted there was some duplication of information being requested from the victims and this was somewhat of a problem, particularly as time went by and the injured became more anxious and tired, etc. She also expressed a concern with people ending up totally alone in a motel room after such a harrowing experience.

WALTER GREAVES noted the importance of having telephones installed well in advance as much as practical because if telephone installers are required, it reduces the fire crew by up to three people. He was not aware of any other particular problems with communications. It has been suggested that the telephones in our EOC should have a hold button so that if it is necessary to have a caller wait for some information, the room noise is not picked up by the receiver. It was also suggested that large numbers indicating the telephone number of each phone be positioned above the phone location so that it is readily visible from all points in the room.

RUSS PHILLIPS commented on a number of problems, including the OPP role and how it fits in with our plan, communications in general between the control group and the outside world, ordering of supplies, fuel, medical services, media releases. He suggested we file our Town Emergency Plan in Kenora for their information. He suggested some of the roles in our Plan require clarification. Also the media should have a room separated from the EOC, and the control room made more secure. He advised that, in the future, Nancy Murdick will be involved at the outset of any emergency and will act as the scribe. He also suggested that telephones be installed on a permanent basis in the control room.

MEL FISHER noted he requires two copies of the Emergency Plan, and he suggested there should be maps available of the whole area surrounding the town rather than maps only of the town itself. He agreed the control centre requires greater security, and suggested there was a possible need for radio communications with all departments.

JOHN CALLAN advised he thought the people involved had functioned well and while the control centre facility had certain inadequacies, it was much better than the centre utilized for the November exercise. He agreed with the comments made earlier with respect to separation of the media by providing a separate room for them, however he noted that the use of Hugh Syrja for dealing with the media appeared to work well. He commented on the problems with the Red Cross with respect to their role, their relationship with our plan, the need for badges for on-site workers and/or arm bands, the conflict over role and authority with the OPP, the excellent co-operation received from the Ministry of Natural Resources, and the problems experienced in controlling the media on Saturday at the Lenver Inn. He indicated that letters of commendation would be sent to various individuals.

BRUCE HOFFSTROM concurred with the concerns raised with respect to the security for the EOC in particular and with the other concerns in general.

DICK MCDONALD commented on his activities and involvement with this event. In his opinion, the plan was well organized and well executed. He commented on the coincidental availability of the Hercules and the mid-flight change of plans to pick up experienced staff in Winnipeg.

LOUIS MALTAIS indicated there was a problem with the initial alert being placed by radio as this immediately alerted anybody operating a scanner. Future alerts are proposed to be by telephone. With respect to media, he suggested there should be both press and radio involved with press releases to be issued through the Administration. A communications problem resulted when people and equipment directed to specific locations did not confirm to the control group when they had arrived at these locations. He commented on the chain of command and noted this nearly fell apart a couple of times and that it must be maintained in order to avoid chaos. He suggested there should be one spokesman in the control centre for each major organization involved, i.e. Red Cross, etc. He noted the need for telephones on a permanent basis and for maps covering the area at least 10 kilometers surrounding town. He advised that Andrew Skene has arranged for a psychological team to be in Dryden to deal with workers if it is required.

He advised a debriefing has been scheduled for 2:00 p.m., Thursday, March 16th, 1989 involving all the resource agencies and people involved, to be held in the basement of the Anglican Church. Coffee and sandwiches will be available.

He commented on the ID badges and the need to have them updated and, in some cases, badges are not sufficient. There is a necessity for civilians to be provided with armbands which clearly indicate they are representing the Town of Dryden Emergency Group and perhaps their designation.

TOMMY JONES commented on our plan and on the coincidental meeting held Friday morning just before the crash. He noted that the internal plans are supposed to be updated by April 15th. He noted as well that the crash did occur beyond our jurisdiction outside the town limits and beyond the airport, and our involvement in the plan was to act as an evacuation centre to help and assist the injured.

He suggested that when our plan is revised, it should include detailed responsibilities, including delegation of the roles, definition of responsibilities, for at least three levels downward when people are away. We were fortunate this time that nearly everyone was present and available.

He noted that the letters of commendation referenced by Mr Callan should be sent to the individuals' superiors as well as to themselves.

He suggested there should be a special phone number for the plan co-ordinator so that in the event of an exercise or a real emergency an attempt can be made to contact the co-ordinator. He then philosophized on emergency planning in Dryden, particularly with respect to our vulnerability due to the Canadian Pacific Forest Products function, the CPR, the Trans Canada Highway, etc.

In closing, he extended his compliments to all on a job well done.

PAUL HEAYN asked that all invoices for expenses related to this occurrence be processed as quickly as possible.

Meeting adjourned at 11:40 a.m.

Following adjournment, the Emergency Control Group met to review the arrangements for the general debriefing to be held Thursday, adjourning at 12:00 noon.

Source: Exhibit 37

* * *

THE CORPORATION AT THE TOWN OF DRYDEN

March 16, 1989

Minutes of a debriefing meeting held at 2:00 p.m. on the above date in the basement of the Anglican Church.

Present:

Louis Maltais	Fire Chief	Dryden
John Callan	Administrator	Dryden
Bruce Hoffstrom	Clerk	Dryden
Bob Mitchell	District Manager ICG	Ignace
John Hyndman	Secretary, Dryden Ministerial Assoc.	Dryden
Walter Greaves	Dryden Telephone	Dryden
Russ Phillips	Police Chief	Dryden
Dick McDonald	Chairman, Airport Commission	Dryden
Tom Varga	Sergeant, OPP	Dryden
Maxine Moulton	Direct of Nursing, Hospital	Dryden
Harold Rabb	Dryden Ambulance	Dryden
Carl Eisener	Chief of Staff, Hospital	Dryden
Andrew Skene	C.E.O., Hospital	Dryden
Mel Fisher	Town Engineer	Dryden
Robert L. Rolls	Rector of St. Luke's	Dryden
Peter Louttit	Airport Manager	Dryden
Ernie Parry	Chief, Crash Fire Rescue	Dryden
Ken Bittle	V.P. Maintenance, Air Ontario	Dryden
Bill Deluce	President, Air Ontario	Dryden
H.H. Sampson	Regional Director, Emerg. Preparedness	
Major Don Christie	Central Region Operations, Dept. of National Defence	
Marleen Griffiths	Emergency Planning Ontario	
Jim Ellard	Deputy Co-ordinator, Emergency Planning Ontario	
Des. Risto	Emergency/Disaster Co-ordinator, Transport Canada	Winnipeg
Roger Nordlund	Fire Chief, UT of O	Wainwright
Hugh Syrja	Manager, CKDR	Dryden
Trevor Woods	Program Manager, Fire Manager, Ministry of Natural Resources	Dryden
Len Suómu	Chief Forester, Canadian Pacific Forest Products	Dryden
Ted Broadhurst	Mill Manager, Canadian Pacific Forest Products	Dryden
Gerry Ferguson	Director of Recreation	Dryden

Archie McNeil	Office Manager	Dryden
Craig Nuttall	Councillor	Dryden
Carl Bleich	President, Red Cross	Dryden
Vic Kameda	Facility Superintendent	Dryden
Dorothy Smith	Welfare Administrator	Dryden
Paul Heayn	Treasurer and Deputy Clerk	Dryden
Ken Rentz	Emergency Representative, Amateur Radio	Dryden
Tom Hinton	Director of Investigation, Canadian Safety Aviation Board	Dryden
Maj. Jim Armour	Accident Investigator, Canadian Safety Aviation Board	Dryden
Const. Klaus Larsen	Identification Officer, City Police	Thunder Bay
Det. Sgt. J. Bolduc	Criminal Investigation Div., Police	Thunder Bay
Allan Slota	Emergency Services, Red Cross	Dryden
Will Yasinski	Construction Superintendent	Dryden
Ken Kurz	Captain, Volunteer Firefighters	Dryden
Randy Smith	By-law Enforcement Office E.M.O.	Keewatin
Darold Anness	Canadian Pacific Forest Products	Dryden
Art Burnell	General Hospital	Sioux Lookout
Sylvia Arkeson	Director Nursing Service	Sioux Lookout
John Coagie	Chief of Security, Canadian Pacific Forest Products	Dryden
Raymond Godfrey	Lieutenant, U.T.of O.	Dryden
Ralph Fulford	Fire Chief	Fort Frances
Gary Rivard	CFR	Dryden
Fred Bouter	Ex Staff Officer, Flight Crew Training Fokker Aircraft	
John Albanese	Councillor	Fort Frances
Jack Murray	Police Chief	Fort Frances
Nancy Murdick	Secretary, Police Force	Dryden
Joe Abela	Communications Supervisor, Ministry of Natural Resources	Dryden
Dave Wessel	President, Amateur Radio Society	Dryden
Dave Beasiey	Laverendrye General Hospital	Fort Frances
Constable Brent Black	Police Force	Kenora
W.F. Beatty	Public Affairs Manager, Canadian Pacific Forest Products	Dryden
J.A. Riley	Security Assistance	Dryden
Tim Eady	Hydro Superintendent	Dryden
Mario Facca	Captain, Fire Department	Sioux Lookout
Darryl Herbert	Deputy Fire Chief	Dryden
Ed White	Deputy Fire Chief	Kenora
D.J. Milliard	Firefighter	Kenora
F.C. Harvey	Inspector, OPP	Kenora

Mayor Jones opened the meeting by calling on Canon Robert Rolls for a prayer. Following this, Mayor Jones introduced selected individuals and called on all others to stand and be identified. He welcomed all present to this meeting, announcing that the purpose of the meeting was to review any problem areas which may have arisen with respect to the implementation of the Dryden Emergency Plan following the crash shortly after 12:00 noon on Friday, March 10th of an Air Ontario F-28 jet. He then turned the meeting over to Fire Chief and Emergency Planning Co-ordinator Louis Maltais.

Fire Chief Maltais indicated that each individual involved would have an opportunity to speak and comment on any areas of concern which had come to their attention.

The following comments were received:

PETER LOUTTIT	– Responded in his own vehicle (has no FM radio) had trouble finding control centre number – had some confusion as to who was "Fire No. 1" (control centre) – suggested there is a need for a radio identifier for the centre.
ERNIE PARRY	– Made his first call to the Police Dispatcher – received calls from "Fire No. 1" (confirmed need for a radio identifier) – had no difficulty working with Emergency Control Centre (ECC) personnel.
MAYOR JONES	– Suggested that individuals speaking identify any weaknesses they found in their own plan or in the overall plan.
PETER LOUTTIT	– Indicated there had been minor deficiencies with the airport plan, but only with the identification of Fire No. 1 with the Town plan.
CANON ROLLS	– Problems getting a phone line at the hospital – no means of communication except for Fax – supports the use of ham operators – problems with the media attempting to obtain information from victims at the hospital and at the Lenver Inn.
REV. RENTZ	– With respect to the ham operators, noted they had forgotten to have a local direct long distance set up put in place.

MEL FISHER – Noted he had a peripheral relationship with the ECC – needs a direct line between Public Works and ECC – need for a dedicated room for an ECC – problem with using the firemen's room, public infiltration, etc. – noted the need for detailed area maps with current information, and fixed in position on the walls – noted the need to order heavy equipment (ie D8 bulldozer) early, particularly in cold weather due to warm up time required.

ANDREW SKENE – Had trouble contacting ECC due to telephone lines being jammed – suggested a Fax machine in the ECC – noted that worldwide media coverage on air crashes is much greater than he had expected, and more planning is required in this regard – noted there were 37 active beds at the hospital, and if there had been more casualties, the capabilities of the hospital would have been correspondingly reduced – responded that the hospital had been aware of the availability of the Hercules ambulance aircraft and in at least four different conversations from the hospital, had advised the Hercules was not required.

KEN BITTLE – Gave general comments, details not available.

DR. EISENER – Noted the impact of the media and the need for some control and guidelines – gave accolades to Town workers and volunteers, noting the same remarks had been made from certain media.

HAROLD RABB – Noted ambulance service had no particular problems – responded that maybe 25 patients had been moved by private vehicles – responded that the impact of using private cars increased the intensity of the work load at the hospital but there were, in fact, 12 doctors on hand – reported two doctors went to the accident site leaving 10 at the hospital – noted this may not always be an option – responded that, in his opinion, conditions at the accident site appeared to be well under control – noted he was the third vehicle to arrive and that capable direction was being given by Ernie Parry.

MAXINE MOULTON – Confirmed the problem with communications – noted there was no idea of the passenger capacity of the aircraft from the designation – "F-28-" (most civilians aren't familiar with this information) – hospital was not given any idea of the number of patients.

ANDREW SKENE – Commented the Red Cross was a great help in keeping track of names.

INSP. HARVEY – Extended compliments to all workers involved – noted his primary concerns were with onsite security, search and rescue, locate and identify – noted 58 OPP officers were on site – indicated no particular problems other than those with the media.

REV. RENTZ – Expressed concern that the media had tied up the telephone at the airport.

CARL BLEICH – Commented on the good co-operation received from the OPP Sergeant Munn – recommended the OPP obtain a Fax machine.

PETER LOUTTIT – Commented on the tight security and that there was very little unnecessary traffic or spectators.

INSP. HARVEY – Expressed concurrence on the remarks on the need for a Fax for the OPP and noted this would be looked into – responded that he did not think there had been any duplication of communication – indicated the helicopters had been engaged by the media and this did create a problem which interfered with police communications due to the noise as the helicopter were hovering over the crash site.

REV. RENTZ – Commented that in his opinion, the common frequency is the best way to maintain communications.

SGT. VARGA – Noted it was optional for Dryden to become involved in an incident which occurred off the airport site and commended all involved for their excellent participation – commented on the C130's which although were not required at this time, should be kept in mind in the event of a future need.

JOHN CALLAN – Commented that he had ordered the helicopters which, as it turned out, were not required at this time.

ERNIE PARRY – Noted that helicopter pads had been constructed at the hospital.

DICK MCDONALD – Commented briefly on his activities and involvement at the crash site noting he had taken one roll of photographs and turned the prints over to the authorities.

CHIEF PHILLIPS – Noted his first contact was to Andrew Skene at the hospital and the district headquarters of the OPP – commented on the role of the OPP in our emergency plan and the relationship with the Emergency Control Group, the Dryden Police Force – suggested there was some overlap which needs to be addressed – provisions should be made for the Police Dispatcher during events of this nature as the regular work goes on – there should be a way to shorten the length of transmissions, i.e. 10 codes – facilities should be twinned so that an extra operator can be brought in to handle the emergency situation, leaving the other to handle the regular business – the communications process requires further clarification and definition – ham radio operators should be used as much as possible – it may be that additional telephone lines are required and the telephone sets should have a hold button on them – there should a direct line from the Emergency Control Centre to the police office – he will be taking his own personal scribe with him to the next incident – media should be in a separate room – Hugh Syrja should be identified as the media officer in our emergency plan.

INSP. HARVEY – Agreed with the need for a personal scribe and control of the media – agreed with the need for improvements and clarifications of roles, details, with respect to the role of the OPP and how it is involved in the Dryden Emergency Plan – apologized for the removal of the ham operator away from the site by the OPP – agreed with the suggestion that proper identification of such volunteers to demonstrate their right to be present would facilitate operations at the site.

ERNIE PARRY – Noted ham operators are new in our emergency plan – a good idea but it didn't work at the site for himself, needs some refining – confirmed the need for individuals to have a scribe at hand, he could have used one but didn't have one.

CHIEF MALTAIS – Confirmed scribes would be available next time for those who need them.

PETER LOUTTIT – Confirmed the aircraft had departed the airport at 12:09 p.m.

ERNIE PARRY – Noted that communications with helicopters at the site was a problem.

CHIEF PHILLIPS – Commented the problem we had was that there were too many people trying to speak on the frequencies and very often whole transmissions had to be repeated – there appears to be a need for some separate channels or implementation of 10 codes.

PETER LOUTTIT	– Questioned the purpose of a specific frequency and how this could be implemented.
CHIEF PHILLIPS	– Commented on how the media picked up everything on the 2-way radios, perhaps "voice guards" should be used – confirmed the need to keep transmissions concise and brief or alternatively implement use of 10 codes.
WALTER GREAVES	– Noted telephones had been installed at the ECC by 12:35 p.m. – suggested discussions be held with the hospital and any other organization that may require additional telephones in the event of an emergency so that plans and strategies can be developed in advance.
REV. HYNDMAN	– Confirmed the shortage of telephones at the hospital and expressed commendations for the hospital staff.
CANON ROLLS	– Commented on the arrangements made for relatives of victims at the First United Church but there was no list of names made available.
BOB MITCHELL	– Noted he was involved in a stand-by role only, however equipment is available through ICG i.e. snowmachines, helicopters, etc.
INSP. HARVEY	– Commented on the problem with helicopters at the scene due to the low ceiling and the actual site of the accident well off the end of the runway.
ANDREW SKENE	– Responded to previous remarks that it was fortunate there were few Dryden residents on the aircraft as this would no doubt have added to the pressure and congestion at the hospital and other places.
REV. RENTZ	– Noted that ham is a communications support and in this occasion there was particularly speedy response from members – equipment worked well – link arranged between Winni-

	peg and Toronto but nobody here to connect – he noted a problem with identification on the radios and this is to be discussed in conjunction with the Town emergency plan – he noted the room used for an ECC was not designed for communications, and an outside antenna with Coax cable is required so they can plug in at both the hospital and the Town office – he noted their batteries are worn down and they are changing their equipment to handle this better in the future – he agreed frequencies are over used by the users – recommends we have a single common frequency.
ERNIE PARRY	– Questioned who called in the helicopters and was the hospital aware and acknowledged the use of helicopters was not viable due to the low ceiling – questioned whether there was a transportation officer in the emergency control group – recommended there be a plan for working with helicopters.
CHIEF MALTAIS	– Responded that Ministry of Natural Resources radios on the base are available for communication with helicopters.
JOHN CALLAN	– Confirmed that these matters would be looked into.
DOROTHY SMITH	– Noted the overlap with the Red Cross on registration, and our forces were then spent primarily on obtaining clothing – noted the need for information packages for the victims – noted the importance of having identification, armbands or something, for the workers.
VIC KAMEDA	– Noted the potential for security problems at the arena used as a temporary morgue, however actual problems were minimal.
CARL BLEICH	– Noted the Red Cross was prepared to look after clothing but the Town had handled this – noted their workers already have emergency identification – acknowledged the problem

with overlap in the Town plan – noted that at the airport, CFR Chief Ernie Parry calls the Red Cross while in town there is some confusion as to their role, which requires clarification – problem with information from Air Ontario in that it was known that there was a large number of survivors and many inquiries, and it was very difficult to deal with people inquiring as to passengers whose names are not on the list of survivors, this may be one area where guidance would be helpful in dealing with this type of inquiry – noted the need to quickly obtain an accurate, up-to-date passenger manifest – noted that the Red Cross has telephone access to the Red Cross in Winnipeg, Thunder Bay and Toronto and numerous inquiries are directed to those locations.

KEN BITTLE – Noted the passenger manifest request is not as straight forward as it might appear, due to reservations which may be used by someone other than the person who made the reservation, also there are some walk-on passengers – noted the security process to identify bodies – noted that survivors names are not released to the public in order to protect the privacy of themselves and their families.

ALLAN SLOTA – Confirmed the need for a good registration system and inquiry file for response – noted that workers need to know in advance what types of information can be given and to whom and where to direct other inquiries.

GERRY FERGUSON – Confirmed problems with the media – noted there were no problems with respect to rescheduling of activities due to the emergency requirement for the use of the second arena – he noted the pool staff are available as fully trained personnel in first aid and CPR.

TED BROADHURST – Noted the need for Canadian Pacific Forest Products to ensure that their emergency group is adequately staffed, also to review their equipment list.

LEN SUOMU	– Confirmed that equipment is available in an emergency although it is usually quite remote from town.
DAROLD ANNESS	– Commented on the lighting plant, noting the need for more details on the type of equipment required on the first request – noted one individual had gone to the scene with a power saw but did not receive good directions on where to go – questioned whether there is a need for a forester or an MNR type person familiar with maps, bush roads, etc. – suggested there should be clarification in where to call at anytime of the day or night for help.
TED BROADHURST	– Noted that Canadian Pacific Forest Products has a good supply of long distance telephone lines available for use in the event of a real emergency.
TREVOR WOODS	– Commented on the helicopters – noted that blankets and sleeping bags had been made available – noted the trailer unit and the kitchen tent had been made available, complete with workers and heaters – noted that Bell Canada and Ontario Hydro also offered to assist – noted there are snowshoes, communications base, etc. on the station – suggested there might be a need to review the contact person to be used, and the facilities which are to be made available.
HUGH SYRJA	– Suggested there is a need for more news lines and hold buttons on the telephones – also suggested a private line for the PR person – noted the confusion between the number of people on the flight, it was either 57 and 4 or 65 and 4.
ROGER NORDLUND	– Only problem was that there was only one message from dispatchers.

DES RISTO	– Commented on the various emergency exercises conducted at the Dryden Airport and how they gradually improved, and he noted how the practice had paid off.
ANDREW SKENE	– Final comment, Community Counselling Service is being offered during the evening this week and will continue if required or the hospital will arrange to bring in an emergency trauma team from Toronto.
REV. RENTZ	– Noted the need to look at our procedure for finding places for people to stay.
INSP. HARVEY	– Noted that the identification officers have identified, at this point in time, 17 of the 22 dead.
CHIEF MALTAIS	– Commented on the benefits of the Arnprior training received by many of the Town employees.
JOHN CALLAN	– Noted the need to continue the fine tuning process, invited questions from all present, welcomed representatives from Emergency Planning Ontario and Emergency Planning Canada – noted the differences between the exercises and the real thing.
PETER LOUTTIT	– Commented that the exercise builds up the frame work for the real event.
BILL DELUCE	– Extended compliments on the rescue service provided by the Town and the emergency workers – noted his willingness to co-operate in any way with further development of our emergency plan.
JIM ELLARD	– Noted that the Dryden experience will no doubt be beneficial to many other municipalities.
MAJOR CHRISTIE	– Noted that Canadian Forces plans may be different than civilian plans but offered to

	discuss how their services can be accessed – noted one problem with this event in that Trenton was contacted by both the OPP and the Ontario Air Ambulance with conflicting information as to whether it was wanted or not wanted – it is recommended there be only one method of contact.
H.H. SAMPSON	– Extended compliments of Emergency Preparedness College on a good job well done.
KEN BITTLE	– Expressed his thanks to all who are involved.
MAJOR ARMOUR	– Noted there is a need for the Canadian Aviation Safety Board to interview more witnesses – noted the municipality operates the airport and is involved and will be requested to comment on the report of the CASB before it is finalized.

Mayor Jones, in his closing remarks, indicated the need to update our Emergency Plan and continue holding exercises on a regular basis. He commented on the need for discipline in the exercising of any plan, the need to keep the delegation line in place, and the need to maintain communications with citizens.

All present were invited to remain after the meeting for sandwiches and coffee.

Meeting adjourned at 4:35 p.m.

DISTRIBUTION: Mayor, Council, John Callan, Bruce Hoffstrom, Paul Heayn, Mel Fisher, Archie McNeil, Sgt. Varga, Det. Sgt. Bolduc, Ed White, John Albanese, Mario Facca (Box 1326, Sioux Lookout) and Maureen Griffiths.

Appendix J

U.S. Department of Transportation
Federal Aviation Administration

Appendix II

Advisory Circular

Subject: COCKPIT RESOURCE MANAGEMENT TRAINING

Date: 12/1/89
Initiated by: AFS-210

AC No: 120-51
Change:

1. PURPOSE. This advisory circular (AC) presents guidelines for developing, implementing, and evaluating a cockpit resource management (CRM) training program. This training is designed to be a regular part of all training for crewmembers.

2. RELATED FAR SECTIONS.

a. SFAR 58, Advanced Qualification Program.

b. Part 121, Subpart N (Training). 121.400-405, 121.409-421, 121.424, 121.427.

c. Part 121, Subpart O (Crewmember Qualifications). 121.432-433, 121.434, 121.440-443.

d. Part 135, Subpart E (Flight Crewmember Requirements). 135.243-245.

e. Part 135, Subpart G (Crewmember Testing Requirements). 135.293-295, 135.299-301.

f. Part 135, Subpart H (Training). 135.321-331, 135.335-351.

3. RELATED READING MATERIAL. For detailed information on the recommendations made in this AC, the reader is encouraged to review Cockpit Resource Management Training: Proceedings of a NASA/MAC Workshop, 1987. The National Aeronautics and Space Administration (NASA) Conference Proceedings (CP) number is 2455. Copies may be purchased from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161, (703) 487-4650.

4. BACKGROUND.

a. Investigations into the causes of air carrier accidents have shown that human error is a contributing factor in approximately 70 percent of all air carrier incidents and accidents. Most airlines, however, provide technical training with little emphasis on the human element. This AC provides guidelines for FAR Parts 121 and 135 certificate holders to establish training that is designed to increase the efficiency with which flight crewmembers interact in the cockpit by focusing on communication skills, teamwork, task allocation, and decisionmaking.

b. Since 1979, an increasing amount of evidence has accumulated suggesting that between 60 and 80 percent of air carrier incidents and accidents have been caused, at least in part, by a failure of the flightcrew to make use of readily available resources. A long-term NASA research program has demonstrated that these types of incidents have many common characteristics. One of the most compelling observations of this program and other research studies is that, often, the problems encountered by flightcrews have very little to do with the more technical aspects of operating a multicrewmember aircraft. Instead, they are associated with poor group decisionmaking, ineffective communication, inadequate leadership, and poor management. In addition, most training programs emphasize almost exclusively the technical aspects of flying and do not deal effectively with various types of crew management strategies and techniques that are also essential to safe flight operations.

c. These observations have recently led to a developing consensus in both industry and government that more training emphasis needs to be placed upon the factors that influence crew coordination and the management of crew resources. Briefly defined, CRM is the effective utilization of all available resources--hardware, software, and people--to achieve safe and efficient flight operations. CRM training programs have been or are being developed by several major air carriers, and although the concept is receiving widespread acceptance, insufficient progress has been made in the industry as a whole. Moreover, there is substantial confusion in the industry with respect to the key elements of CRM training and how to go about developing a CRM training program.

d. A 1987 NASA workshop on CRM training, comprised of various segments of the aviation community, has produced a series of recommendations for training programs in this area. These guidelines, while not mandatory, are very useful in understanding the critical elements of a CRM training program.

5. <u>BASIC CONCEPTS OF CRM TRAINING</u>.

a. <u>General</u>. While there are probably many approaches and techniques useful in CRM training, it seems clear that certain features are necessary. The program should focus on the functioning of crews as <u>intact teams</u>, not simply as a collection of technically competent individuals, and should provide opportunities for crewmembers to practice the skills that are necessary to be good team leaders and members. This requires training exercises that include all crewmembers together in the same roles they normally perform in flight. The program should help crewmembers learn how to use their own personal and leadership styles in ways that foster crew effectiveness. The program should <u>also</u> help crewmembers learn that how they behave during normal, routine circumstances can have a powerful impact on how well a crew functions during high workload, stressful situations. During these emergency situations, it is highly unlikely (and probably undesirable) that any crewmember will take the time to reflect upon his or her CRM training to figure out how to act. However, actions taken during more relaxed times probably increase the chances that a crew will handle stressful situations more competently.

b. Research studies from the behavioral sciences strongly suggest that behavior change in any environment cannot be accomplished in a short period, even if the training is very well designed. Trainees need time, awareness, practice and feedback, and continual reinforcement to learn lessons that will endure over long periods of time. In order to be effective, CRM training must be accomplished in several phases over time.

c. Therefore, CRM training programs should include at least three distinct phases:

(1) An awareness phase where CRM issues are defined and discussed.

(2) A practice and feedback phase where trainees gain experience with CRM techniques.

(3) A continual reinforcement phase where CRM principles are addressed on a long-term basis. Each of these phases is discussed in more detail in paragraph 7 and in NASA CP number 2455.

d. Summary. CRM is defined by the following basic concepts:

(1) It is a comprehensive system for improving crew performance.

(2) It is designed for the entire crew population.

(3) It can be extended to all forms of aircrew training.

(4) It concentrates on crewmember attitudes and behaviors and their impact on safety.

(5) It provides an opportunity for individuals to examine their own behavior and make individual decisions on how to improve cockpit teamwork.

(6) It uses the crew as the unit of training.

(7) It is a training program that requires the active participation of all cockpit crewmembers.

6. PHASES OF CRM TRAINING.

a. Overall Objective of CRM. CRM training is designed to prevent incidents and accidents.

b. Awareness Phase.

(1) The awareness phase of CRM training consists of classroom presentations and focuses on interpersonal relations and crew coordination. This part of the training also provides a common terminology and conceptual framework for identifying and describing crew coordination problems.

(2) This training phase can be accomplished by a combination of training methods such as lecture presentations, discussion groups, role-playing exercises, computer-based instruction, and videotape examples of good and poor team behavior in the cockpit.

(3) A useful way of beginning the awareness phase may include the development of a curriculum addressing CRM skills that should be acquired, such as:

(i) <u>Communication</u>. (E.g., cultural influences, barriers such as rank, age, and position, assertiveness, participation of all crewmembers, cockpit-cabin crew coordination, listening, feedback, and legitimate ways of expressing dissent.)

(ii) <u>Situation Awareness</u>. (E.g., reality versus perceptions of reality, fixation, monitoring, incapacitation.)

(iii) <u>Problem Solving/Decisionmaking/Judgment</u>. (E.g., conflict resolution, review.)

(iv) <u>Team Management</u>. (E.g., team building, managerial skills, authority, barriers, cultural influences, roles, workload management.)

(v) <u>Stress Management</u>. (E.g., fitness to fly, fatigue, incapacitation.)

(vi) <u>Team Review</u>. (E.g., premission analysis and planning, critique, ongoing review, postmission.)

(vii) <u>Interpersonal Skills</u>. (E.g., listening, conflict resolution, and legitimate avenues of dissent.)

(4) Awareness promotes credibility and helps in changing attitudes, however, it is important to recognize that it is only a necessary first step. Many programs rely almost exclusively on this aspect of training, but classroom instruction alone may not fundamentally alter crewmember attitudes and behavior over the long term.

c. <u>Practice and Feedback Phase</u>.

(1) The practice and feedback phase of CRM training is designed to provide participants with self- and peer-critique in order to improve communication, decisionmaking, and leadership skills. This phase is best accomplished through the use of simulators and video equipment. Video feedback, under the direction of a facilitator, is particularly effective because it allows participants to view themselves from a third-person perspective; this promotes acceptance of one's weak areas, which encourages attitude and behavior changes.

(2) Practice and video feedback during debriefing can be accomplished as follows:

(i) Line oriented flight training (LOFT) sessions or other simulated or actual operation scenarios can include CRM training. In these cases, crewmembers would be in a simulator and asked to respond to a series of incidents which could or could not lead to emergencies. They would be evaluated for technical expertise, as well as communication, coping, and coordination abilities (as part of the CRM training).

(ii) Video feedback during debriefing should optimally be provided so that crewmembers could evaluate their skills.

(iii) In cases where simulators are not available, crewmembers can participate in complicated group problem-solving exercises. Through video feedback during debriefing, they can then evaluate the positive and negative actions of all crewmembers.

(iv) Crewmembers can also participate in role-playing exercises designed to provide practice in developing strategies for dealing with incidents and to allow analyses of behaviors during incidents. Again, video feedback is recommended for evaluation and feedback during debriefing of crewmember abilities in such areas as decisionmaking, team participation, and team leadership sharing.

(v) Personality and attitude measures can also be used to provide feedback to participants, thereby allowing them to assess their strengths and weaknesses.

d. Reinforcement Phase.

(1) The third phase is reinforcement. No matter how effective the classroom curriculum, interpersonal drills, LOFT exercises, and feedback techniques are, a single exposure will be insufficient. The attitudes and norms which contribute to ineffective crew coordination are ubiquitous and have developed over a crewmember's lifetime. Thus, it is unrealistic to expect a short training program to make up for a lifetime of development. To be maximally effective, CRM should be embedded in the total training program. It should be continually reinforced, and it should become an inseparable part of the organization's culture. The latter is often overlooked, but it is clear that effective CRM training requires the support of the highest levels of management.

(2) CRM training should be instituted as a regular part of the recurrent training requirement. Recurrent CRM training should include refresher curriculum and practice and feedback exercises such as LOFT with video feedback, or a suitable substitute employing video feedback. It is particularly important that some of these recurrent CRM exercises take place with a full crew--each member operating in their normal crew position. For example, recurrent training LOFT exercises designed for CRM should be conducted only with an actual crew.

(3) There is a natural tendency to think of CRM as training only for the "managers" or captains. However, this notion misses the essence of the

primary CRM training objective--the prevention of crew-related incidents and accidents. It should be most effective in the entire crew context, and this requires training exercises that include all crewmembers working together and learning together. In the past, much of flightcrew training has been separated by crew position, and while this may be effective for certain types of training (e.g., technical skills and systems knowledge, etc.), it is not appropriate for CRM training.

7. THE ROLE OF CRM INSTRUCTORS AND CHECK AIRMEN.

a. General.

(1) The success of any CRM training program should ultimately depend upon the skills of the personnel responsible for administering the training and observing its effects. Thus, it is vitally important that CRM training instructors, facilitators, and check pilots be highly skilled in all areas related to CRM performance, and they should also be expert observers of crew coordination dimensions. These skills are different from those associated with traditional flight instruction. Gaining proficiency in CRM instruction and observation will require special additional training for instructors and check pilots in CRM training methods such as role-playing exercises, systematic crew observation, providing effective feedback, and LOFT administration.

(2) In addition, simulator and line check pilots should utilize every available opportunity to emphasize the importance of crew coordination skills and techniques. This should be accomplished by not only pointing out deficiencies, but by noting and reinforcing instances of highly effective crew coordination whenever such behavior is observed.

8. EVALUATION OF CRM TRAINING PROGRAMS.

a. General.

(1). CRM training is a relatively new concept still in the process of evolution. For this reason, it is vitally important that each program be evaluated in order to determine whether it is achieving the desired result, the improvement of flightcrew coordination and performance. Thus, each organization should organize a systematic evaluation program to track the effect of their training program and as a means of making continuous improvements. The emphasis of this evaluation process should be on crew performance, not at the individual level of analysis. The major areas that should be assessed are: interpersonal coordination and communication; problem-solving and conflict resolution; workload management; and technical performance.

(2) The purpose of this evaluation is not to assess individual crewmembers on CRM-related dimensions as a means of assessing their fitness for duty. The current state-of-the-art in the measurement of CRM-related behavior does not allow such fine discriminations at the present time. However, the importance of these dimensions should be emphasized to individual

crewmembers at all available opportunities, and improvements in assessment techniques may allow CRM-related criteria to be utilized on a more formal basis in the future.

9. COLLECTION OF EVALUATION DATA. In an optimal research design, data on crewmember's CRM attitudes and behavior should be collected prior to the awareness phase of CRM training and again at intervals after training to determine both initial and enduring effects of the program. In many cases, however, this pure evaluation strategy cannot be applied, as many crewmembers may have already completed some type of CRM training. The goal should be to obtain an accurate picture of the state of the organization before formal adoption of this type of training and to continue to monitor the same elements after adoption.

10. EVALUATION TOOLS.

a. Data collection could include a survey of crewmember's attitudes regarding CRM concepts and also their evaluation of the impact of formal CRM training, LOFT, or of an operational scenario. (An example of a crewmember survey is provided in Appendix 1.)

b. Additional data could be collected by check airmen, qualified line observers, and/or LOFT instructors trained in the formal evaluation of crew coordination. An evaluation worksheet could be completed after LOFT periods or other operational simulations. The evaluation worksheet should contain evaluations of the crew's utilization of the key concepts of CRM described in paragraph 6, as well as a global evaluation of overall technical performance and crew coordination. Additional information for each crew should include a description of special circumstances (i.e., abnormal or emergency situations imposed or encountered) and amplifying comments regarding extremely good or poor instances of CRM behavior. (An example LOFT CRM Evaluation Worksheet is provided in Appendix 2.)

11. DATA BASES. Information collected from line crewmembers, check airmen, qualified line observers, and other evaluators should be maintained in computer-resident data bases. The data should be oriented toward group rather than individual performance. Data should not identify individual crewmembers by name, but should include the following demographic identification:

a. Aircraft type.

b. Crew position.

c. Approximate age (range).

d. Approximate experience in position and aircraft.

e. Formal training in CRM.

f. Experience with LOFT of operational scenarios.

(1) On both crewmember surveys and evaluations, the instructor or check airman should be identified. Information from participants in training and the characteristics of evaluations given by check airmen and other evaluators may be used as measures of the quality of instruction and evaluation.

(2) It should be stressed that the reasons for collecting evaluation data include:

(i) To measure the operational state of the organization.

(ii) To determine areas in need of further instruction.

(iii) To find which aspects of training work most effectively.

(iv) To ensure that all individuals involved in training and evaluation are well prepared and standardized.

Daniel C. Beaudette
Director, Flight Standards Service

Appendix K

Ministre des Transports | Minister of Transport
CANADA

June 6, 1991

The Honourable Mr. Justice Virgil P. Moshansky
Commissioner
Commission of Inquiry into
The Air Ontario Crash at Dryden, Ontario
P.O. Box 687 Adelaide Station
Toronto, Ontario
M5C 2J8

Dear Mr. Justice Moshansky:

RE: AVIATION SAFETY RECOMMENDATIONS
DRYDEN COMMISSION OF INQUIRY, SECOND INTERIM REPORT

I am writing in reply to the recommendations contained in Part 5 of the Commission's Second Interim Report which was tabled in the House of Commons on December 11, 1990.

These interim recommendations were made in the interests of aviation safety as a result of the Commission's ongoing investigation into the circumstances surrounding the accident involving an Air Ontario F-28 aircraft, at Dryden Ontario, on March 10, 1989.

My staff and I have reviewed these recommendations and I am pleased to provide you with the attached written response which formalizes the department's initial response given at the time of the report release.

Sincerely,

Jean Corbeil

Attachments

Ottawa, Canada K1A 0N5

TRANSPORT CANADA RESPONSE
TO THE
INTERIM RECOMMENDATIONS
OF THE SECOND INTERIM REPORT
DRYDEN COMMISSION OF INQUIRY

INTERIM RECOMMENDATION NO. 1 - RUNWAY-END DE-ICING/ANTI-ICING:

"Transport Canada should, on a priority basis and in co-operation with major air carriers, implement interim runway-end de-icing/anti-icing facilities at Pearson International Airport. The target should be to have the first of such facilities in place on an interim basis as early as possible in the 1990-91 icing season. Subsequent permanent installations should be designed and constructed to satisfy both safety and environmental concerns."

TRANSPORT CANADA RESPONSE:

Transport Canada accepts the need for dedicated facilities for de-icing. Construction of dedicated de-icing facilities for the 1990/91 winter season was not possible as it was too late to initiate and complete a construction project of this magnitude. In addition, agreement by all carriers on standard de-icing procedures and additional de-icing equipment is required. In the long term, there is general agreement between Transport Canada and the air carriers that dedicated de-icing facilities are required at Lester B. Pearson International Airport (LBPIA). NORR Airport Planning Associates completed a feasibility study in February 1991. The study recommended two of the three proposed airfield sites as being suitable. A recommended development plan was forwarded to the LBPIA Airline Consultative Committee (ACC) for review. A recommendation will be made by the project manager by the end of May 1991. The study addresses LBPIA but could provide national guidance.

INTERIM RECOMMENDATION NO. 2 - GATE-HOLD PROCEDURES:

"Transport Canada should examine and, if feasible, implement air traffic control gate-hold procedures at Pearson International Airport as a means of reducing departure delays during conditions of freezing precipitation."

TRANSPORT CANADA RESPONSE:

Transport Canada, in cooperation with the aviation industry, has implemented gate-hold procedures at LBPIA during periods of freezing precipitation. In addition, an Air Carrier Advisory Circular was sent on January 3, 1991 informing air carriers of the procedures being implemented at LBPIA to eliminate aircraft congestion at the runways during inclement weather.

- 2 -

INTERIM RECOMMENDATION NO. 3 - RAMP AREA EXPANSION:

"In addition to the already announced feasibility studies for two new runways and supporting taxiways at Pearson International Airport, Transport Canada should investigate and, if feasible, proceed to implement an expansion of existing ramp space on the airport to reduce congestion and consequent departure delays. This undertaking should be given high priority."

TRANSPORT CANADA RESPONSE:

A study was undertaken to examine this matter. The consulting firm, Aviation Planning Services of Montreal has completed the analytical work and are discussing the details with airport staff.

INTERIM RECOMMENDATION NO. 4 - USE OF TYPE II ANTI-ICING FLUIDS:

"Transport Canada should strongly encourage and support the use by Canadian air carriers of type II anti-icing fluids that meet AEA specifications for turbo jet aircraft and, where applicable, for propeller-driven aircraft."

TRANSPORT CANADA RESPONSE:

The Minister of Transport has written to all Canadian air carriers strongly encouraging and supporting the use of type II fluids.

INTERIM RECOMMENDATION NO. 5 - RAMP AREA LIGHTING:

"Transport Canada should, in the interest of employee safety and in order to facilitate reliable inspection of aircraft surfaces after de-icing/anti-icing, ensure that adequate and sufficient exterior lighting exists in all gate and ramp areas where de-icing and anti-icing operations are conducted at Pearson International Airport and at other major airports in Canada."

TRANSPORT CANADA RESPONSE:

The lighting levels on the apron areas where de-icing operations are conducted have been evaluated on a number of occasions and found to be consistent with Transport Canada and International Civil Aviation Organization (ICAO) apron floodlighting standards. Notwithstanding the above, steps have been taken to improve lighting levels. Construction will begin in April, 1991 on a program to improve apron lighting at terminal 1, with completion scheduled for fall 1991. Two sets of high pressure sodium lights have been installed at terminal 2 for test and evaluation purposes.

INTERIM RECOMMENDATION NO. 6 - CLEAN AIRCRAFT COMPLIANCE:

"Transport Canada should, on a priority basis, provide, where necessary, enforcement resources to ensure that the clean aircraft regulation is complied with, including runway-end spot checks of aircraft surfaces in adverse winter weather."

TRANSPORT CANADA RESPONSE:

Transport Canada regulatory officials were tasked to monitor and enforce the regulations during inclement weather this winter at LBPIA and other Canadian airports. Monitoring guidelines were issued to assist inspectors in enforcing the regulations. These guidelines include the requirement for spot checks at appropriate locations on airports.

INTERIM RECOMMENDATION NO. 7 - PROVISION OF DE-ICING/ANTI-ICING SERVICE:

"Transport Canada should strongly encourage Canadian air carriers to form joint entities to provide all air carrier de-icing/anti-icing services at Pearson International Airport and at other major airports in Canada, and to have available, for use when necessary, equipment capable of applying both type I and type II fluids."

TRANSPORT CANADA RESPONSE:

The Minister of Transport has written to all Canadian air carriers strongly encouraging and supporting this recommendation.

INTERIM RECOMMENDATION NO. 8 - DE-ICING/ANTI-ICING PROCEDURES TRAINING:

"Transport Canada should require that air carriers produce aircraft ground de-icing/anti-icing procedures and training standards for both flight and ground Personnel. Implementation of such procedures and standards should be made a mandatory requirement of an air carrier's operating certificate."

TRANSPORT CANADA RESPONSE:

Transport Canada developed and distributed a training program to all carriers in November, 1990 which included procedures and standards for aircraft ground de-icing and anti-icing. This program has been distributed for immediate implementation as required by regulation. All training, including the new de-icing/anti-icing material, is required to be included in the carrier's Operation Manual, which is a condition of issue of the operating certificate.

- 4 -

INTERIM RECOMMENDATION NO. 9 - TC INSPECTOR/MAJOR CANADIAN AIRPORTS:

"Transport Canada's Airports Authority Group should place on the staff of each of its major airports, individuals with substantial flight operations expertise. Such individuals should report directly to the airport manager on any issue related to operational safety. Furthermore, a mandatory reporting process should be put in place to ensure that aviation safety-related issues are promptly brought to the attention of the appropriate decision-making level of senior management and to ensure that such issues are addressed within a specified period of time."

TRANSPORT CANADA RESPONSE:

Transport Canada has staffed such a position at Lester B. Pearson and Vancouver airports. The Department will study the applicability to other major airports in Canada and will determine the reporting relationships to ensure that safety-related issues are promptly brought to the attention of the appropriate level of senior management.

INTERIM RECOMMENDATION NO. 10 - HOLD-OVER TIMES/DEPARTURE DELAYS:

"Transport Canada should examine, on a priority basis, Canadian airports served by air carriers to ascertain if the incompatibility between departure delays and de-icing/anti-icing fluid hold-over times, as identified at Toronto's Pearson International Airport, exists at other sites. Should such incompatibilities be found, Transport Canada should ensure that appropriate corrective measures are taken."

TRANSPORT CANADA RESPONSE:

Through Transport Canada's monitoring of airports during inclement weather conditions, congestion problems, if existing elsewhere than LBPIA, will be noted and appropriate corrective measures will be taken. Instructions have also gone out to all Transport Canada Airport Managers to work with the air carriers to expedite operations during poor weather conditions and to report on any problems where safety is a concern.

INTERIM RECOMMENDATION NO. 11 - CLEAN-UP OF DE-ICING/ANTI-ICING FLUID:

"Transport Canada and/or the air carriers should, in the interests of ramp employee safety and for environmental reasons, maintain suitable equipment and develop appropriate procedures for the clean-up and disposal of de-icing/anti-icing fluids in areas utilized by air carriers."

TRANSPORT CANADA RESPONSE:

Glycol pickup equipment was acquired for LBPIA on a priority basis. This equipment reduced the glycol environmental problem to the maximum extent possible for the 1990/91 winter season. In the long term, the dedicated de-icing facilities will also include a glycol recovery system. It should be noted that the new Terminal 3 at LBPIA has an underground glycol collection facility.

INTERIM RECOMMENDATION NO. 12 - CANADA - DE-ICING/ANTI-ICING TECHNOLOGY:

"Transport Canada should take an active and participatory role in the work currently underway within the international aviation community to advance aircraft ground de-icing/anti-icing technology. This should include involvement in the development of international standards, development of guidance material for remote and runway-end de-icing facilities, and development of more reliable methods of predicting de-icing/anti-icing fluid hold-over times."

TRANSPORT CANADA RESPONSE:

The Transport Canada Transportation Development Centre has, for a number of years, in collaboration with other government agencies including the Department of National Defence and the National Research Council, the U.S. Federal Aviation Administration and the European as well as North American aviation industry, been actively researching and developing state of the art aircraft anti-icing and de-icing technologies. Current research centres on the use of anti-icing fluids along with associated hold-over times and the development of aircraft sensors to detect ice on wings and other critical surfaces. Transport Canada, recognizing the importance of this issue internationally, has asked that a working group be established in ICAO, with Transport Canada participation, with the objective of pooling research information on de-icing/anti-icing fluids and techniques, and establishing an international standard of operating procedures.

INTERIM RECOMMENDATION NO. 13 - FLUID HOLD-OVER TIME CHARTS:

"Transport Canada should strongly encourage Canadian air carriers to provide their flight crews with de-icing/anti-icing fluid hold-over time charts that are based on the most recent technological information. These charts should be used as guidelines."

TRANSPORT CANADA RESPONSE:

The Minister of Transport has written to all Canadian air carriers encouraging them to use hold-over time charts as a guidance to flight crews.

- 6 -

AMENDMENT #8 — May 3, 1991

includes comments by:

AAX
AAR
AKPT

Appendix L

Commission of Inquiry
into the Air Ontario Crash
at Dryden, Ontario

CANADA

Commission d'enquête
sur l'écrasement d'un avion
d'Air Ontario à Dryden (Ontario)

Commissioner
The Honourable Virgil P. Moshansky
Counsel
F.R. von Veh, Q.C.
Associate Counsel
G.L. Wells
Administrator
R.J. McBey

Commissaire
L'honorable Virgil P. Moshansky
Conseiller juridique
F.R. von Veh, c.r.
Conseiller juridique associé
G.L. Wells
Administrateur
R.J. McBey

CONFIDENTIAL

*

*

Dear *******:

RE: INQUIRIES ACT, SECTION 13
Affected Party - *********

The Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario was established by Order in Council P.C. 1989-532, dated March 29, 1989, to inquire into, and report on the contributing factors and causes of the crash of Air Ontario Flight 1363 at Dryden, Ontario, on March 10, 1989. Commissioner Moshansky was also asked to make such recommendations as he deemed appropriate in the interests of aviation safety.

Throughout the course of the Commission hearings, all Participants were afforded the opportunity to cross-examine all witnesses, either through their counsel or representative, to submit written briefs to the Commission and, if they so desired, to recommend to the Commissioner that additional witnesses, other than the ones called by the Commission, be called to testify. As well, all Participants, either through their counsel or representative, were given a synopsis of witnesses evidence and copies of all relevant documentation before any given witness was called to testify. Such documents were subsequently filed before the Commission as exhibits. In addition, at the conclusion of the public hearings of this Commission, all Participants were given full opportunity to present submissions to the Commissioner as they saw fit.

P.O. Box/C.P. 687, Succursale Adelaide Station
Toronto, Canada M5C 2J8

(416) 973-2904 FAX: (416) 973-2908

- 2 -

Section 13 of the Inquiries Act states that:

> No report shall be made against any person until reasonable notice has been given to the person of the charge of misconduct alleged against him and the person has been allowed full opportunity to be heard in person or by counsel.

This letter shall constitute notice that the Commissioner will hear and consider any submissions that you or your counsel may wish to make in relation to adverse findings made against you. Although the Inquiries Act addresses a "charge of misconduct", in the interest of fairness, Commissioner Moshansky has directed that notice be afforded to all persons against whom he may make adverse findings. The Commissioner has advised me that he does not view the findings enumerated below as constituting "misconduct" within the meaning of Section 13 of the Inquiries Act.

****

INSERT ADVERSE FINDINGS

****

Please consider this letter as official notice pursuant to the provisions of section 13 of the Inquiries Act, and advise the Commission in writing on or before Friday, September 20, 1991, if you wish:

1. to be heard in person or by counsel;
2. to be heard by means of written submissions; or
3. not to be heard by the Commission.

SHOULD YOU NOT RESPOND ON OR BEFORE FRIDAY SEPTEMBER 20, 1991, IT WILL BE TAKEN TO MEAN THAT YOU HAVE WAIVED YOUR RIGHT TO BE HEARD PURSUANT TO THE INQUIRIES ACT, SECTION 13.

It is to be noted that any submissions presented pursuant to this procedure will be carefully considered by the Commissioner in preparation of his Final Report. Written submissions are to be received by the Commission on or before **FRIDAY, SEPTEMBER 27, 1991.**

If you choose to make submissions in person or by counsel, the Commission will hold individual hearings in camera at 595 Bay Street, 14th floor, Toronto, Ontario. In such event, a hearing date will be scheduled after receipt of your response to this notice and you will thereafter be notified in writing of the date set for the hearing.

- 3 -

In order to prevent disclosure of the potential findings of this Commission prior to release of the Final Report, the Commissioner requires that the contents of this correspondence be kept in absolute and strict confidence.

If you have any questions regarding any of the foregoing, please do not hesitate to contact me.

Yours truly,

F.R. von Veh, Q.C.
Commission Counsel

FVV/sct

Appendix M
Rulings

1 Rulings Regarding Status Applications on behalf of Victims, Survivors and their Families (May 26, 1989)

THE COMMISSIONER: I at this time wish to extend a welcome to everyone who is present here this morning. We are here to deal with the issue of status, which is most important to the orderly conduct of a commission of inquiry. By the Order in Council, which has been filed as an exhibit and which is dated March 29th, 1989, this Commission was directed to inquire, pursuant to the provisions of part I of the *Inquiries Act*, into the contributing factors and causes of the crash of the Air Ontario F-28 aircraft at Dryden, Ontario, on March 10th, 1989, and to report thereon, including such recommendations as may be deemed appropriate in the interests of aviation safety.

In order to assist the Commission in these investigatory and advisory functions, the participation of interested parties is most welcome. However, in order to facilitate the effective, efficient, timely, and fair conduct of the Inquiry, party participation must necessarily be limited.

Legal and practical considerations dictate the necessity of establishing boundaries to participant status which will permit the fair, orderly, timely, and effective conduct of the Inquiry.

It is my intention that the concept of procedural fairness shall be a basic tenet of this Inquiry. To that end I have previously directed that certain interested parties shall be entitled to full status as participants on the various investigative teams involved in the investigation of this matter. This marks the first time that interested parties have been granted such status in the process of aircraft accident investigation in Canada. Up to the present time, interested parties have only been accorded observer status on investigative teams. It is the view of all concerned that interested parties have much to contribute to the investigative process by seconding to the investigative teams persons with specialized expertise in various areas under investigation.

Having regard to the statutory authority vested in me as Commissioner and having regard to the terms of reference and to the developments in the law relating to commissions of inquiry, I have concluded that it is appropriate to permit three categories of party participation, and these will be: full participant, special participant, and observer. All participants will have access to working spaces at designated counsel tables in the Commission's hearing rooms.

I will first deal with the category of full participant.

Parties who are granted the status of a full participant will be permitted representation by counsel. Their counsel will be able to cross-examine Commission witnesses, submit written briefs to the Commission, and, if necessary, to recommend to the Commissioner the calling of certain witnesses. In the course of any commission of inquiry, allegations will be made at public hearings which will reflect adversely on certain parties. It is my position that any party adversely implicated by testimony at the public hearings of the Commission shall be given a full opportunity to be heard.

I will now deal with the category of special participant status.

This category of status could apply to the participation of crash survivors and the estates of crash victims. While one has great sympathy for these parties and, while the testimony of survivors will be no doubt important in discovering the causes of the accident, it is believed that their individual involvement as full participants would not contribute significantly to the present Inquiry into the contributing factors and causes of the crash.

Given the large number of parties similarly situated in this regard, it is believed that their individual participation at public hearings would become unwieldy and ultimately counterproductive. However, recognizing their profound interest in the findings of this Inquiry and having regard to the practical difficulties inherent in their individual participation, I am prepared to hear representation this morning in connection with the granting of special participant status to one counsel representing the collective interests of the crash survivors and the estates of the crash victims. It is my intention that the representative counsel on behalf of the special participant would be entitled to cross-examine Commission witnesses and to submit written briefs to the Commission.

The final category of participants who may be involved in the Inquiry is that of observers. Individual representatives of survivors and of estates, if they so request, and any other party establishing a special interest in these proceedings, will be granted status as an observer at the Commission.

An observer will be entitled to submit written briefs to the Commission. Additionally, observers will be permitted to submit written suggestions to Commission counsel regarding the calling of evidence. Without limiting the generality of the foregoing these written suggestions may include prospective questions that the observer believes should be asked of a particular witness by Commission counsel or may include suggestions as to prospective witnesses that the observer believes should be called before the Commission. The form and substance of the response to these suggestions will, however, be at the complete discretion of Commission counsel.

A letter outlining rules of procedure will be mailed to all participants shortly. Additional specific rules of procedure may also be outlined at the initial formal hearing of the Commission which is scheduled to commence in Toronto on June 16th, 1989.

We will now proceed to hear the applicants for status.

(Transcript, vol. 1, pp. 7–12)

THE COMMISSIONER: On the basis of the representations that I have heard, I deem it appropriate in these circumstances to grant to the applicants special participant status to one counsel to represent the collective interests of the group in question with the proviso that such counsel position may be filled by two or more counsel as are agreed upon by the parties.

(Transcript, vol. 1, pp. 19–20)

2 Ruling Regarding Applications for Legal Costs – Survivors and Victims' Families – CUPE Airline Division (September 11, 1989)

THE COMMISSIONER: At the status hearings of this Commission held in Toronto, Ontario, on the 26th day of May, 1989, there appeared before me Mr Alexander Zaitzeff and Mr W. Danial Newton in their respective capacity as counsel on behalf of several victims, estates, and/or survivors of the crash of Air Ontario Flight 1363 at Dryden, Ontario, on March 10th, 1989.

Mr Zaitzeff and Mr Newton appeared also as representatives of a group of legal counsel acting on behalf of a majority of the remaining crash survivors and victims' estates with the concurrence of all such counsel. They made an application on behalf of all of those parties whom they represented and to whom I shall hereinafter refer as "the Applicant group" for status before this Commission with full rights of cross-examination.

Having regard to all of the circumstances and the arguments advanced by counsel, I deemed it appropriate to exercise my discretion by granting special participant status to a single representative of the collective interests of the survivors and the estates of the crash victims, notwithstanding the absence of any precedent for so doing.

The said counsel appearing for this Applicant group then made a further application before me on behalf of the Applicant group seeking financial assistance with respect to their legal costs. Counsel for the Applicant group represented to me that without such assistance the Applicants would be unable to actively participate at the hearings of this Commission. I reserved decision with respect to this application pending the submission by counsel for the Applicant group, at my request, of written argument in support of their application. Such written argument was subsequently received by me.

In addition, some 25 letters were received by the Commission during the month of July 1989 from various counsel, representing the majority of the survivors and victims involved, in support of the position taken by Mr Zaitzeff and Mr Newton in their request for funding.

A further application for financial assistance with respect to legal costs was also made at that time by Ms Leanne Chahley, counsel for the Canadian Union of Public Employees, Airline Division, which organization's request for full participant status was granted at the said status hearings of this Commission. On July 10th, 1989, Ms Chahley wrote a letter to the Commission in response to my request that she provide a written submission in support of her application for funding. She indicated that the organization of which she represents has a membership of more than 8,400 flight attendants and customer service agents, and that it has a demonstrated history of participation in inquiries relating to the airline industry ... having previously appeared at several hearings in Canada and the United States.

There is nothing in the material submitted to me to suggest that these previous appearances at such hearings were funded out of the public purse.

Although the Canadian Union of Public Employees, Airline Division, does not have a specific allocation of funds for this type of proceeding, as was indicated by Ms Chahley in her letter, I am not at all persuaded by the material before me that an organization of this magnitude would be unable to make other arrangements to fund legal representation before the Commission if it saw fit. Its previous history of participation infers as much. In any event, I am not persuaded that it is in the public interest in this case to recommend funding to institutions or organizations who have sought participant status. This application is, therefore, declined.

The Government of Canada in this matter have seen fit to provide in the terms of reference for this Commission of Inquiry established under part I of the *Inquiries Act* a direction to the Commissioner to advise the Governor in Council as to which, if any, of the groups or individuals that may appear before him should receive assistance with respect to the legal costs that they may incur in respect of their appearance before the Commission. And the extent of such assistance where such assistance would, in the opinion of the Commissioner, be in the public interest.

Paragraph (e) of the minutes of a meeting of the committee of the Privy Council establishing this Commission held on the 29th day of March, 1989, reads as follows:

> (e) The Commissioner be directed to advise the Governor in Council as to which, if any, of the groups or individuals that may appear before him should receive assistance with respect to the legal costs they may incur in respect of those appearances, and the extent of such assistance where such assistance would, in the opinion of the Commissioner, be in the public interest.

It will be seen from a reading of paragraph (e) of the minutes referred to that the Commissioner is not empowered to grant legal costs as such but, rather, is authorized to make recommendations for the funding of the legal costs of a participant where, in the opinion of the Commissioner, such assistance would be in the public interest.

At the status hearings of this Inquiry, I expressed my intention that the Inquiry would be conducted in accordance with the principle of procedural fairness, a doctrine which is flexible in concept and whose content varies depending on the nature of the Inquiry and the consequences to the individuals involved. It is my view with respect to the present application, that my discretion in this matter ought to be exercised having regard to the principle of procedural fairness and also the public interest itself.

Counsel for the application group have, in their written argument, referred to certain criteria which were applied to the question of participant funding at the Mackenzie Valley Pipeline Inquiry, from which criteria certain guidelines have been set out in a text entitled *A Handbook on the Conduct of Public Inquiries in Canada* (1985) by R.J. Anthony and A.R. Lucas.

I have found these guidelines to be useful in my consideration of the application made by the Applicant group which guidelines are as follows:

> (a) There should be a clearly ascertainable interest that ought to be represented at the inquiry.
> (b) It should be established that separate and adequate representation of that interest will make a necessary and substantial contribution to the inquiry.
> (c) Those seeking funds should have an established record of concern for, and should have demonstrated their own commitment, to the interest they seek to represent.
> (d) It should be shown that those seeking funds do not have sufficient financial resources to enable them adequately to represent that interest, and will require funds to do so.
> (e) Those seeking funds should have a clear proposal as to the use they intend to make of the funds, and should be sufficiently well organized to account for the funds.

On the basis of the material before me, I am satisfied that the Applicant group has met the criteria set out in paragraphs (a) to (d) inclusive.

With respect to paragraph (e) counsel for the Applicant group have proposed the following uses of the funds which it seeks. The funds that would be made available to the group would be for the compensation of counsel and appropriate and limited support staff for purposes of the hearings.

The counsel would be required to submit detailed accounts for services rendered in the normal fashion to the Commission offices for review. There would also have to be budget monies available for distribution of information, correspondence, copies of evidence, transcripts, and the multitude of disbursements that a matter of this nature necessarily attracts.

While I am not bound in the exercise of my discretion by the decisions of previous commissions of inquiry, it is nevertheless useful to examine funding decisions made in other inquiries, several of which have been referred to in the written submission filed with the Commission by Mr Zaitzeff.

A principle which clearly emerges from previous inquiry decisions is that funding is almost invariably provided to individuals who may be personally vulnerable to adverse testimony before the Commission, and who were unable to finance legal representation.

In the case of the Royal Commission into the Donald Marshall Jr Prosecution, in addition to recommending funding for legal counsel for individuals who were involved in the arrest and prosecution of Donald Marshall, the Commission also recommended funding for the following:

> (a) A parent who was endeavouring to protect the reputation of his son, the murder victim, whose character was under attack by testimony before the Commission.
> (b) Two public interest groups, the Black United Front and the Union of Nova Scotia Indians, both of whom held the view that the discrimination and racism influence the administration of justice in Nova Scotia and may have contributed to Marshall's conviction.

The Commission in its ruling stated the following:

> We believe that the public interest requires, in a proper case, that the point of view of organized and affected minority groups be appropriately represented and articulated. This is such a proper case.

While there is no parallel between the present applicants and those individuals whose interests were vulnerable to adverse testimony before the Marshall Inquiry, it is arguable that there is some similarity between the parties referred to in subparagraphs (a) and (b) above and the present Applicants.

There is, however, a strong similarity between the Applicant group herein and the group of parents who were granted participant status in the Royal Commission of Inquiry into Certain Deaths at the Hospital for Sick Children and Related Matters conducted by Mr Justice Grange who made the following statement on the issue of participant funding:

> I want to say a word about funding. Some of the parties represented are well able to look after themselves financially and with them, we are not concerned. There are those who have a legitimate interest and who are not so able and, where appropriate, I intend to make recommendations for funding of their legal expenses by the Provincial Government.

Chief Justice Parker who conducted the Commission of Inquiry into the Facts of Allegations of Conflict of Interest Concerning the Honourable Sinclair M. Stevens commented favourably on the decision of Mr Justice Grange with regard to the funding of the legal costs for the parents of deceased children in the course of his own ruling regarding the funding of parties as follows:

> Then, again, there are counsel here who have standing because they are interested in the Commission, but they do not act for parties that are being affected or may be affected.
>
> The two that have asked for funding are in the last category. They are not acting for parties that may be directly affected by the outcome in the sense that Mr. Stevens is. It is true that, on occasion, funding has been granted to parties. In certain circumstances funding may be justified. A clear case, it would seem to me, would be the inquiry into the Hospital for Sick Children where certain persons were funded for their costs.

It is my view that the position of the Applicant group before me is completely analogous to that of the parents of the deceased children involved in the Grange Inquiry. It is beyond dispute that the Air Ontario crash survivors and the victims' personal representatives have a direct and legitimate interest in the conduct of this Inquiry.

Furthermore, they can claim, as in fact they do, to represent the point of view of at least a segment of the travelling public on the dual issues of airline operations and flight safety, both of which are within the purview of this Commission. It is arguable that they have a contribution to make to this Inquiry from that perspective and it is impossible to exclude the possibility that this group may raise an issue which others have overlooked notwithstanding due diligence.

In my opinion, it would be manifestly unfair to exclude them from the process of this Inquiry by reason of impecuniosity. To hold otherwise would be to reduce the grant of special participant status to the Applicants to a hollow victory indeed.

It is, in my view, in the public interest that they be included in the process.

I subscribe to the comments of the Commission in the Marshall Inquiry contained in its decision of May 14th, 1987, with respect to the question of funding of various parties which comments are to be found at page 1 of the decision:

> However, we do believe that, absent any prohibition, it is implicit in the Terms of Reference of any Royal Commission that it has the capacity, and indeed the obligation, to respond to any party who has been granted standing and who raises an issue of participant funding. To refuse to respond to such a request would be inconsistent with a tradition of Royal Commissions, a tradition which encourages full participation in a public and independent forum. In recent times similar requests have been responded to by then Mr. Justice Berger, Mr. Justice Grange, Mr. Justice Estey and Mr. Justice Parker.

It is also noted that in the matter of the recently concluded Code Inquiry in Alberta into the affairs of the Principal group of companies full funding of legal costs at public expense was granted to a large group of investors who were given participant status with representation by one counsel acting on behalf of the collective group.

Entirely apart from the evidence before this Commission indicating the inability of the Applicant group to finance the costs of representation by legal counsel at the hearings of this Commission, I would deem it in the public interest for the other reasons already stated that this collective group of survivors and the victims' families receive assistance with their legal costs incurred with respect to appearances at the Inquiry.

I will, therefore, recommend to the Governor in Council the payment of reasonable legal costs of counsel representing them including necessary disbursements.

Taking into consideration the fact that Commission counsel have the primary responsibility of presenting before this Inquiry all relevant evidence gathered by the investigators acting under my direction and perceiving the role of counsel for the Applicant group to be in the nature of a less onerous interest role and being conscious of the fact that public funds are involved, I think it appropriate to fix the extent of assistance with respect to legal fees and expenses to be recommended for counsel on behalf of the Applicant group as follows:

(a) Counsel fees are to be calculated at an hourly rate on the basis of the fee schedule in use by the Government of Canada for outside legal counsel.
   Firstly, the hours for which counsel shall be entitled to assistance shall be the total of the hours actually spent by the representative counsel of the Applicant group at the hearings of this Commission.
   And secondly, recognizing that preparation time is a necessary element of counsel work, I direct that counsel for the Applicant group shall be entitled to compensation for a maximum of one hour of preparation time for each hour actually spent at the hearings of the Commission.
(b) The travel and living expenses of counsel representing the Applicant group incurred while attending hearings of the Commission shall be reimbursed on the same basis as the expenses of Commission counsel under the current guidelines of the Government of Canada.
(c) The reasonable and necessary disbursements incurred by counsel in the course of representing the Applicant group.

In the event that such funding is approved by the Governor in Council, I deem it appropriate to direct that counsel for the Applicant group shall present detailed statements of accounts on a monthly basis for approval by the secretary to the Commission or by the Commissioner or his designate.

In addition, I direct that no extraordinary expenditures shall be undertaken by counsel for the Applicant group without obtaining the prior approval of the secretary of the Commission or by the Commissioner or his designate.

Finally, I would say that I have reduced my reasons for decision to writing, in both English and French versions, and the written reasons are available for any interested parties.

(Transcript, vol. 10, pp. 9–23)

3 Ruling Regarding Admissibility of Evidence on Pilot Attitudes and Aviation Safety Concerns. The Objectives of Cross-Examination. (September 26, 1989)

THE COMMISSIONER: During the hearings yesterday afternoon, agreeing with objections raised by Mr Jacobsen and Mr Keenan, I ruled that hearsay evidence pertaining to the reputation for competency of First Officer Mills, where such evidence was tendered as proof of the truth of the subject matter, itself, was inadmissible. I have not retreated from that view.

However, this morning Mr Jacobsen, counsel for Air Ontario, and Mr Keenan, counsel for CALPA, have joined in objecting to both the manner of cross-examination and the content of the cross-examination of Captain Berezuk, the witness presently on the witness stand, being conducted by Mr Bailey who is the counsel for the chief coroner of Ontario.

Mr Jacobsen perceives Mr Bailey's manner of cross-examination to be objectionable. He describes it to be discourteous and of a badgering nature. I will deal with that issue first.

While one might say that Mr Bailey's manner of cross-examination is vigorous, I would certainly not characterize it as discourtesy; nor do I consider Mr Bailey to be badgering the witness.

He is entitled to point out inconsistencies in the evidence, if there are any, and also to test the credibility of the witness. I do not equate such a legitimate objective of cross-examination as badgering.

It is my view that it is important to know whether there is some sort of unwritten rule or code of honour or attitude or accepted blind trust among airline pilots that prevents professional pilots who are, themselves, passengers on commercial flights from communicating their urgent flight safety concerns to the cockpit crew even at a time of perceived danger.

Furthermore, it is important to know whether this is what influenced or constrained this witness from communicating his own obvious concerns to the cockpit crew of the F-28 which crashed.

This is a legitimate area of concern for this Inquiry from the point of view of aviation safety, the subject which clearly is within the terms of reference establishing this Commission. If there is a subtle form of peer pressure or intimidation or even simply a professional attitude among pilots which discourages the communication of perceived dangerous situations by a pilot/passenger to the cockpit crew, then the larger public interest requires that this be examined.

A full airing of issues potentially impinging on the larger question of aviation safety is, in my view, more important than the preservation of the niceties of evidentiary rules by which a Commission of Inquiry in any event is not bound.

It is, therefore, my ruling that Mr Bailey may proceed with his cross-examination.

(Transcript, vol. 15, pp. 48–50)

4 Ruling Regarding Prejudicial Effect of Adverse Evidence and Air Ontario's Application to Call Witness out of Sequence – Inquiry Procedure – Ongoing Investigation (November 20, 1989)

THE COMMISSIONER: At the conclusion of proceedings on Friday afternoon last, Mr Jacobsen, counsel for Air Ontario, made application for a direction to Commission counsel to call as a witness out of sequence one Wayne Copeland, an employee of Air Ontario at its London, Ontario, SOC headquarters.

Mr Copeland, it is indicated, was the person at the London, Ontario, SOC office of Air Ontario who spoke on the telephone with Captain Morwood shortly prior to the departure of flight 1363 from the Dryden airport on March 10, 1989.

The object of the application as outlined by Mr Jacobsen is to end speculation, which he alleges is occurring in the media and among the public, as to the contents of the telephone conversation in question.

It is contended that the evidence that has been heard from several witnesses, who variously described Captain Morwood's demeanour after this telephone conversation as being one of either anger or upset, is prejudicial to Air Ontario and that fairness requires that Air Ontario be permitted to have Mr Copeland called at this stage of the proceedings instead of at the planned hearings of the Commission either in late January or February of 1990.

Mr Jacobsen urged that it would be simple and a non–time-consuming matter to have Mr Copeland inserted as a witness at this stage of the proceedings. He estimated that only 15 minutes would be needed to put in Mr Copeland's direct evidence.

This time estimate, of course, does not take into consideration the time which various counsel will require for cross-examination of Mr Copeland. One of these counsel has already informed Commission counsel that he will require at least one half day for cross-examination of Mr Copeland.

While on the face of it the application appears to be innocuous, a careful consideration of all the factors involved reveals a number of additional areas of concern, some of which were raised by Commission counsel, Mr von Veh, and by Mr Bailey, counsel for the chief coroner of Ontario, both of whom argued against the application.

Mr von Veh pointed out that Commission counsel, who has the responsibility for the order of calling of witnesses, has a pre-planned sequential program for the introduction of evidence pursuant to which he anticipates dealing with the area of evidence involving Mr Copeland in the new year, calling Mr Copeland now would be out of context and seriously disruptive to the planned schedule; moreover, there is an investigation by the Ontario Provincial Police still ongoing concerning

Captain Morwood's telephone call or calls from the Dryden airport terminal.

It is indicated by Commission counsel that it has been established by the Ontario Provincial Police investigation thus far that Captain Morwood spoke on the telephone to at least one other person at the Air Ontario SOC offices besides Mr Copeland on March 10th and that calling Mr Copeland now would prejudice that ongoing investigation. In my view, this alone is sufficient reason to deny the application.

There are, however, other cogent reasons for doing so. There is evidence already on record which some parties other than the Applicant could perceive to be adverse to their interests. Probably there will be more. That being the case, I am of the view that to allow this application would set a troublesome precedent which could conceivably cause chaos to the proceedings of this Inquiry by unleashing demands by other parties adversely affected by the testimony of a particular witness that they then and there be permitted to call a witness to respond to such adverse testimony.

This is not a privilege enjoyed even by persons accused of a serious criminal offence. Although a commission of inquiry is not to be equated with a criminal trial, a comparison with criminal procedure is instructive. Criminal trial procedure in our system of justice does not permit an accused to take the stand during the course of the presentation of evidence by the Crown in order to refute adverse testimony arising during presentation of the Crown's case.

It seems to me that a party at an inquiry under the *Inquiries Act* who perceives that certain evidence is adverse to that party is hardly entitled to a privilege not extended to an accused who is prejudiced by adverse testimony and whose personal liberty in fact may be at stake.

Having regard to all the circumstances, it is my view that the potential prejudicial effects upon the conduct of the Inquiry of allowing the application in question far outweigh any perceived prejudice to the interests of the Applicant.

The concept of fairness requires that the party adversely affected by evidence be given full opportunity to respond to adverse testimony. That principle was recognized from the very first days of this Commission. The Applicant will be given full opportunity to do so but at the appropriate time. The application is therefore dismissed.

(Transcript, vol. 26, pp. 1–5)

5 Ruling Regarding Testimony of Pilots with Respect to Confidentiality of Pilot Surveys – Claim for Privilege – Exclusion of Witnesses (May 22, 1990)

THE COMMISSIONER: Well, I will deal with that point first. It strikes me that there is really no analogy between the position of these pilots and a party accused in a criminal matter and a party in a civil action. I don't think I can come to the conclusion that you suggest, Mr Keenan, with respect to the pilots.

In this matter, it is not in dispute that five Air Ontario F-28 pilots gave certain information to their safety officer, Captain Stewart, after the March 10th crash at Dryden and that Captain Stewart recorded this information.

Commission counsel proposes to call Captain Stewart and the five pilots in order to establish the circumstances under which the information was given to Captain Stewart by these pilots, and he argues that those circumstances are relevant to the larger issue of privilege based on confidentiality which is being asserted on behalf of those pilots with respect to that information.

This is a two-stage issue. The first stage involves the circumstances out of which a claim for privilege based on confidentiality arises. The second stage involves examining the issue of whether or not a claim for privilege can be sustained on the basis of confidentiality. At this point, we are concerned only with the first stage.

Counsel for Air Ontario and for the Canadian Air Line Pilots Association representing the five pilots argue that the pilots who gave statements to Captain Stewart should not be called as witnesses at this stage, nor should their identities be made public prior to a decision being made on the larger issue of privilege itself. It is suggested that I hear only the evidence of Captain Stewart on this point. However, to hear the evidence of Captain Stewart alone would be to only hear one side of the story.

The question is not so much one of whether an offer of confidentiality was made but whether that information which was received by Captain Stewart would not have been given to him by the pilots in question in the absence of an undertaking as to confidentiality.

The available jurisprudence on the subject indicates that a tribunal faced with a claim of privilege on the basis of confidentiality must hear evidence as to the circumstances giving rise to such claim. In this case, I can think of no evidence more germane to the issue of such circumstances than that of the five individuals with respect to whom a claim for privilege is being asserted on the basis of confidentiality.

The circumstances under which the statements in question were given go to the very heart of the matter. That evidence can only be given by the pilots themselves. Position statements made by counsel on their behalf is not evidence.

In short, in order to intelligently adjudicate on the main issue, I feel that I have to hear those who claim privilege and their evidence must be subject to the tests of cross-examination.

At this stage, no reference to the content of the actual statements given by each of the pilots will be made. It is already public knowledge that certain statements were made.

In my view, it cannot reasonably be inferred that any injury will accrue to these pilots or to the general pilot group by merely hearing the evidence of the five pilots as to the circumstances under which their individual statements were made to Captain Stewart.

I therefore conclude in all the circumstances of this case that it is appropriate that Captain Stewart and the five pilots be called as witnesses in this stage of the process of ultimately determining the efficacy of the claim for privilege.

Counsel for the chief coroner of Ontario has moved that there be exclusion of witnesses during this phase of the Inquiry. This is routinely done in courts at all levels. Because of the delicate nature of this matter, I deem it to be in the best interests of all concerned, including the said pilots themselves, that an order for exclusion be made.

I accordingly make the following order. First, all witnesses who are to be called to testify in this phase of the Inquiry shall be excluded from the hearing room while other witnesses testify. Second, witnesses who are yet to be called to testify are hereby directed not to watch the television monitor at Commission premises during the hearings. Third, witnesses who are to be called shall not discuss their evidence or the evidence of any other witness with any other person excluding counsel for those persons.

Witnesses who are yet to be called to testify are directed not to read the transcripts of evidence given by other witnesses who have testified ahead of them during this phase of the Inquiry.

I think that takes care of it.

(Transcript, vol. 74, pp. 72–76)

6 Ruling Regarding Application for Exclusion of Witnesses – Several Individuals To Be Examined on Specific Subject with Respect to Which They Gave Previous Statements Separately (August 14, 1990)

THE COMMISSIONER: Well, having heard the arguments both pro and con, I am of the view that this particular situation can be distinguished from any other situation that we have faced to the present point in time.

We have here a small group of individuals who apparently will be testifying on a very specific area, with respect to which they gave statements separately. I think it's in the general interest of all concerned that the application should be granted. I see no reason why aspersions of any sort should be cast upon the group of individuals who will be testifying by reason of the fact that they will be excluded while the evidence is being heard.

It's very common, as has been pointed out by Mr Friesen – I think he summed it up very well – for witnesses to be excluded during the course of trials, both civil and criminal, and no connotations or aspersions are cast upon a group of witnesses who are so excluded in those situations, and I don't see why it should happen here. I think it's in their own interest as well as the general interest that the application should be granted, and I am going to make that order.

(Transcript, vol. 91, pp. 10–11)

7 Ruling Respecting Admissibility of Witness Pre-Hearing Interview Transcripts for Purpose of Cross-Examination of Interviewee – Question of Privilege (September 20, 1990)

THE COMMISSIONER: During the adjournment, I have reviewed those sections of the transcripts of the interview conducted with Captain Deluce which are alleged to contain statements which are inconsistent with what he said in his viva voce evidence on the witness stand.

In addition, I have considered the question of whether there is any sort of privilege to be attached to the transcripts which were produced of the interviews. It has been suggested by Mr MacDougall and Mr Keenan in particular that there was some sort of understanding that these statements would not be used in any proceeding before this Commission.

I have spoken to those Commission counsel who were present during the interview with Captain Deluce, and they indicate to me and my understanding of their view of the situation was that any statements which might have been perceived to grant some sort of privilege to the witness statements during the interview were in fact directed in the minds of Commission counsel specifically to certain personal problems which were drawn to their attention by Mr Deluce's counsel. And I certainly would not expect any of those statements to become any part of the public record.

However, on further examination of the record, I also noted that Mr Jacobsen at volume 1 of the transcript – and Mr Jacobsen was counsel representing Captain Deluce – made a statement:

> This is an intimidating process for him, rightly or wrongly, and what I wanted to – I wanted to put that on the record in hopes that people would be understanding when we are looking at this.

Now, this, in my mind, equates with an expectation that indeed this was a record and that it might be looked at in the future. There, it is noted, were objections by counsel from time to time regarding certain questions. The interview went both on and off the record at times.

And having regard to all of this evidence, it is my view that it would not be in the public interest to prevent the witness from being asked to explain certain inconsistent statements, if there were inconsistent statements, made by him during the course of the interview.

Now, with respect to the question of whether or not there were inconsistent statements made by this witness insofar as what he has told us on a viva voce basis on the witness stand is concerned, I have perused in volume 2 of the transcripts, pages 309 and 310 in particular – these were the passages which are cited to me as being the passages in contention.

And I, having read those passages, am of the view that there clearly was an inconsistent statement made during the course of the interview with respect to the wing check relating to the speed at which it was conducted as compared to what the witness has said on the witness stand.

That being the case, I deem it entirely appropriate that the witness should be called upon to explain the inconsistency. I think he should be given that opportunity, from his own point of view, and I think it is desirable in the public interest as well.

(Transcript, vol. 113, pp. 106–109)

8 IN THE MATTER OF the Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario ("the Commission")

AND IN THE MATTER OF PART I of the Inquiries Act, R.S.C. 1985, c.I-11, s.13

AND IN THE MATTER OF an application before Commissioner Virgil P. Moshansky made by Paterson, MacDougall on behalf of Air Ontario Inc. and ten individuals ("the Applicants")

An in camera hearing was held before me on Wednesday, October 9, 1991, at which time representations were made to me by D. Bruce MacDougall, Q.C., Mr. Peter M. Jacobsen, and Mr. Gerard A. Chouest of the firm Paterson, MacDougall, counsel to the Applicants. Also in attendance were Commission Counsel, F.R. von Veh, Q.C, and Assistant Commission Counsel, Mr. Laurence C. Goldberg.

I will briefly set out the background and the issues that gave rise to the October 9, 1991, in camera hearing.

This Commission of Inquiry is established pursuant to Order in Council PC-1989-532 and Part I of the *Inquiries Act.* Accordingly, this Commission is bound by the Order in Council that requires me:

> ... to inquire into the contributing factors and causes of the crash of Air Ontario Flight 363 Fokker F-28 at Dryden, Ontario, on March 10, 1989, and report thereon, including such recommendations as the Commissioner may deem appropriate in the interests of aviation safety.

On August 19, 1991, Commission Counsel forwarded, by registered mail, letters of notification to, among other organizations and individuals, the Applicants.

As well, copies of all the letters were delivered to their counsel, Mr. D. Bruce MacDougall, on August 19, 1991. I should explain at the outset the role of Paterson, MacDougall and other counsel in this inquiry.

Throughout the hearings before me, a lawyer from Paterson, MacDougall attended every day of the hearings when an Air Ontario witness was being questioned. At times there were two Paterson, MacDougall counsel present, at times a counsel from another law firm assisted, and very frequently a senior executive from Air Ontario assisted counsel who appeared before me. Furthermore, Paterson, MacDougall had transcripts of proceedings supplied to it on a daily basis. Moreover,

- Before any witness testified, a synopsis of such witness's anticipated testimony, based on witness interviews, was forwarded to all representative counsel, including Paterson, MacDougall.
- Before any witness testified, photocopies of all exhibits proposed to be introduced through a given witness were forwarded to all representative counsel, including Paterson, MacDougall.
- All representative counsel appearing before me, including Paterson, MacDougall, were afforded broad rights of cross-examination of all witnesses.
- All representative counsel, including Paterson, MacDougall, were afforded the right to file written briefs as they saw fit, for my consideration.
- All counsel appearing before me, including Paterson, MacDougall, were afforded the opportunity to call such further evidence as they saw fit, in addition to the evidence called by Commission Counsel.

Paterson, MacDougall chose not to call any evidence other than through one witness, Constable E.A. Grenier of the Ontario Provincial Police.
- All counsel appearing before me, including Paterson, MacDougall, were afforded the opportunity to present closing arguments.

The hearings ended on January 24, 1991. Since that time I have been engaged in sifting through the evidence and formulating my analysis and potential findings and conclusions.

The August 19, 1991, letters forwarded by Commission Counsel, on my direction, to a number of organizations and individuals contained the following provision:

> Section 13 of the *Inquiries Act* states that:
>
> > No report shall be made against any person until reasonable notice has been given to the person of the charge of misconduct alleged against him and the person has been allowed full opportunity to be heard in person or by counsel.
>
> This letter shall constitute notice that the Commissioner will hear and consider any submissions that you or your counsel may wish to make in relation to adverse findings made against you. Although the Inquiries Act addresses a "charge of misconduct", in the interest of fairness, Commissioner Moshansky has directed that notice be afforded to all persons against whom he may make adverse findings. The Commissioner has advised me that he does not view the findings enumerated below as constituting "misconduct" within the meaning of Section 13 of the Inquiries Act.
>
> The substance of the intended findings adverse to ... [named organization or individual] ... are that, at material times ...

By correspondence dated August 30, 1991, from Mr. MacDougall to Commission Counsel, further information and particulars were sought.

By letter dated September 6, 1991, Commission Counsel responded to Mr. MacDougall's correspondence by forwarding a 13-page letter of particulars.

By correspondence dated August 29, 1991, one Applicant, a recipient of an August 19, 1991, letter from Commission Counsel, wrote to Commission Counsel advising of a desire to submit written representations to the Commission. That Applicant's written representations, dated September 8, 1991, were in fact forwarded to Commission Counsel by facsimile transmission on September 9, 1991.

Two letters, both dated September 13, 1991, were forwarded by Mr. MacDougall to Commission Counsel, setting out representations relating to Section 13 and again requesting further particulars.

By correspondence dated September 26, 1991, Commission Counsel forwarded a 66-page letter to Mr. MacDougall addressing various issues raised in the two September 13, 1991, letters above noted, including a detailed elaboration of particulars. Mr. MacDougall was further advised to the following effect:

> Should you take issue with any of the foregoing, or wish to comment thereon, the Commission will entertain your further written representations on or before Monday, October 6, 1991, or hear your viva voce submissions in camera, but on the record, on Wednesday, October 9, 1991 at 9 a.m. in the boardroom located at the Commission's offices. Should you wish to make viva voce submissions, the Commissioner has requested that a brief written summary of such submissions be delivered to the Commission offices by 12:00 noon on Tuesday, October 8, 1991.

By correspondence dated October 4, 1991, Mr. MacDougall wrote to Commission Counsel. This letter, received at the Commission's offices on the afternoon of Friday, October 4, 1991, is hereafter set out in full.

> Dear Sir: ...
>
> Thank you for your letter of September 26, 1991.
>
> We have taken note of the options set out at page 65 of your letter and wish to inform you that we shall be making viva voce submissions before the Commissioner on October 9, 1991 and, in accordance with your request, shall provide a brief written summary of those submissions by 12:00 noon on October 8, 1991. As we expect you will be opposing, we should request a written summary, by 5:00 p.m. on the 8th, of any points you intend to raise beyond those set out in your letter of September 26, 1991.
>
> In general terms, we shall be submitting that the Commissioner cannot properly make a report of misconduct against any of the persons referred to in your letters to us.
>
> In addition, we shall also be submitting, in any event, that the notice of the charges of misconduct as contained in your letter of September 6, 1991, as expanded by your letter of September 26, 1991, falls short of being reasonable notice.
>
> Although we and our clients are anxious for this matter to be concluded, we must point out that if the Commissioner rules against us on the names issue, even leaving aside a possible judicial review, it will be necessary for us to make a formal request for a further extension of time for response, as we will be advising all of the named persons of their right to retain counsel independent of Air Ontario, as their personal position could conflict with that of the company.

In addition, apart entirely from the names issue, we shall be requesting additional time to respond, on proper notice, to the charges.

Please let us know if these arrangements are satisfactory.

Yours very truly,
D. Bruce MacDougall

Commission Counsel responded to the above-noted October 4, 1991, correspondence on Monday, October 7, 1991. The response is hereafter set out in full.

Dear Mr. MacDougall: ...

I thank you for your letter of October 4, 1991.

Please be advised that the position of Commission Counsel is set out in my correspondence of September 26, 1991. Accordingly, I do not at the present envision the necessity of raising any further points before the Commissioner on October 8, 1991.

In paragraph two (2) of your noted correspondence you state:

> "In general terms, we shall be submitting that the Commission cannot properly make a report of misconduct against any of the persons referred to in your letters to us."

It is reiterated that the various observations and findings proposed to be made by the Commissioner are not viewed by the Commissioner as constituting "misconduct" as that term is used in section 13, but rather, either are or could be construed to be adverse findings, which were communicated in the interest of fairness.

I have forwarded a copy of your October 4, 1991 correspondence to the Commissioner, and look forward to seeing you on Wednesday, October 9, 1991 at 9:00 a.m. and also receiving your written summary of submissions to be made by 12:00 noon on Tuesday, October 8, 1991.

Yours very truly,
F.R. von Veh

After the above-noted sequence of events, an in camera hearing was convened by me in the boardroom of the Commission offices on Wednesday, October 9, 1991, at 9:00 a.m.

The Applicants' position may be summarized as follows:

1. that I cannot properly make a report of misconduct against any of the persons who were recipients of the August 19, 1991, letters;

2. that I should make findings and observations only of a generic nature, without naming any individuals;
3. that reasonable notice has not been afforded to the recipients of the August 19, 1991, letters to enable them to respond properly; and
4. that, should I name individuals, then more time is required to enable Paterson, MacDougall to advise all recipients of the August 19, 1991, letters of their right to retain independent counsel since their personal interests could conflict with those of Air Ontario Inc.

These four points were supported by reference to the *Inquiries Act*, the case law, and the *Canadian Charter of Rights and Freedoms*, s.7.

Having regard to all of the circumstances, the exhibits filed before me, and the argument advanced by counsel, I will now deal with the above-noted four points.

Reporting Misconduct

When Commission Counsel first raised with me the question of communicating with certain individuals who might be expected to be named in my Report, it was my view that the various observations and findings I had under consideration would not constitute charges of misconduct as that term is used in Section 13. I viewed such proposed observations and findings as being, at most, adverse findings. However, in order that all persons potentially affected by such adverse findings be treated fairly, I directed Commission Counsel to notify all potentially affected persons of the observations and findings that I proposed to consider in order that they could avail themselves, if they desired, of a further opportunity to be heard. On August 19, 1991, Commission Counsel wrote to, among other individuals and organizations, Air Ontario Inc. and the ten individuals named herein, setting out the adverse findings that I considered could be made against them. As stated earlier, this correspondence contained the following provision:

> Although the Inquiries Act addresses a "charge of misconduct", in the interest of fairness, Commissioner Moshansky has directed that notice be afforded to all persons against whom he may make adverse findings. The Commissioner has advised me that he does not view the findings enumerated below as constituting "misconduct" within the meaning of section 13 of the Inquiries Act.

Accordingly, in view of the fact that I do not propose to make "charges of misconduct" within the meaning of Section 13 of the *Inquiries Act*, the factual basis does not exist for counsel's first point and I need not consider it further.

Generic Findings without Naming Individuals

In the earliest stages of this Commission, I consulted with internationally recognized experts in the field of aviation accident investigation. I concluded, on the basis of these consultations, that, in order to conduct a thorough investigation into an airline accident such as this, it was necessary to examine all operational elements which could potentially have a bearing on the accident. Internationally accepted standards of aviation accident investigation required an examination of, among other things, the flight crew, the aircraft and its systems, the infrastructure immediately involved in the aircraft operation leading up to the accident, the air carrier, and the regulator. Only in this way could all of the contributing factors and causes of an airline crash be properly determined.

At the first formal public hearing on June 16, 1989, I outlined my interpretation of the terms of reference of the Inquiry:

> I interpret the terms of reference to provide a broad mandate to inquire not only into the Air Ontario crash but also into any derivative matters which affect aviation safety, with respect to which I am directed to make such recommendations as I may deem appropriate. The Commission may, from time to time, enlarge, consolidate, delete, and/or modify any of the said areas of inquiry as the evidence unfolds.

Evidence was adduced from 166 witnesses, resulting in an evidentiary record consisting of approximately 34,000 transcript pages and approximately 177,600 pages of exhibits and related documentation.

I am obligated to report to the Governor in Council on my observations and findings based on the evidentiary record before me. To discharge this mandate and to make meaningful recommendations in the interests of aviation safety, it is necessary that such findings and recommendations be supported by an analysis of specific evidence before me. In my view, a proper analysis of the "contributing factors and causes of the crash of Air Ontario Flight 363" requires observations and findings adverse to some organizations and individuals to be made.

In my view, I would be remiss in carrying out my mandated duties as specified in the Order in Council dated March 29, 1989, if I did not specifically name organizations or individuals, where appropriate, to lend clarity to the narrative of events and to identify clearly and without ambiguity the particular events that in my view contributed to the crash, or that give rise to my specific recommendations concerning aviation safety.

To refer only to nameless and unspecified individuals could do an injustice by casting a cloak of doubt over the conduct of other individuals, who are blameless, and others who did not have the opportunity to appear before me and be heard. This I am not prepared to do.

In my view there is no conflict between the way in which I propose to fulfil my terms of reference and the requirements of natural justice, or, in *Charter* terms, the requirements of fundamental justice.

In considering the argument advanced on this second point, I have reviewed all of the cases referred to, and in particular *Re Nelles et al. and Grange et al.* (1984) 9 D.L.R. (4th) 79 (Ont. C.A.) (hereinafter "*Nelles*"); *Re First Investors Corporation Ltd.; Re Associated Investors of Canada Ltd.* (1988) 58 Alta. L.R. (2d) 39 (Alta. Q.B.) (hereinafter "*First Investors*"); and *Robinson v. R.* (1986) 4 W.W.R. 729.

In *First Investors*, an inspector was appointed pursuant to the *Alberta Business Corporations Act*, S.A. 1981, c.B-15, to inquire into the dealings of two corporations. Public hearings were conducted by the inspector, and one of the principals of the subject corporations made application to the Court seeking an order, the effect of which would limit the inspector in the conduct and reporting of his investigation. Mr. Justice Berger of the Alberta Court of Queen's Bench rejected the applicability of the *Nelles* case to the Alberta inspector's investigation. The judgement at page 59 states:

> The applicant relies, in part, upon the pronouncement of the Ontario Court of Appeal in *Nelles v. Grange* (1984) 42 C.P.C. 109 9 D.L.R. (4th) 79, 3 O.A.C. 40. The decision of the Ontario Court of Appeal is premised, in part, on the notion that (at p. 89):
>
> > ... if no charge is subsequently laid, a person *found responsible* by the commissioner would have no recourse to clear his or her name [my emphasis].
>
> In the case at bar the inspector's mandate is to investigate. I have held that he is not authorized to fix criminal liability. While evidence of criminal activity may emerge, the investigation neither usurps nor undermines the function of the judicial process in the ordinary courts.
>
> In the proceedings to date, the inspector has, in keeping with the principles of fundamental justice, allowed the applicant the right to be represented by counsel and the right to cross-examine witnesses. The applicant does not submit that there is evidence of procedural unfairness. His argument appears to be prospective in nature. In that respect, the observations of Legg J. in *Robinson v. B.C. (Govt.)*, [1986] 4 W.W.R. 729, 3 B.C.L.R. (2d) 77, 28 C.C.C. (3d) 489 (sub nom. Robinson v. R.) (S.C.), at p. 747 are of assistance.
>
> > I agree with counsel for the Attorney General that the commission of inquiry appointed by the Order in Council is a recom-

> mendatory, not an adjudicative, body. It will report findings to the Lieutenant Governor in Council. It will make no determinations as to guilt or innocence or civil or criminal liability. It cannot terminate the employment of or otherwise discipline any person. Nor will its report necessarily lead to any subsequent proceedings against anyone. That being so, it cannot be said that the inquiry will deprive any person of liberty or security of the person ... "

In support of their submissions, counsel for the Applicants relied on the *Nelles* case, as had been done by the applicant in *First Investors*.

I am unable to accept such a submission.

Every commission of inquiry is governed by its own terms of reference. The terms of reference of the instant investigative and recommendatory Commission of Inquiry mandated me:

> ... to inquire into the contributing factors and causes of the crash of Air Ontario Flight 363, Fokker F-28 at Dryden, Ontario, on March 10, 1989, and report thereon, including such recommendations as the Commissioner may deem appropriate in the interests of aviation safety.

The terms of reference of the *Nelles/Grange* inquiry specifically precluded the commissioner of that inquiry from making findings of civil or criminal responsibility. While I have no intention of assigning criminal or civil liability, the terms of reference of this Commission contain no such limitation. In my judgement, my terms of reference not only contemplate, but, having regard to the record of evidence before me, require that I make findings of fact that may be regarded as critical or adverse.

I am dealing with a crash that resulted in the death of 24 individuals. The record indicates that the crash did not occur free of human, corporate, and regulatory error. I intend to report my findings fairly and accurately. I cannot do so without identifying the individuals, corporations, and organizations in question. Counsel for the Applicants acknowledged in argument that it would be appropriate "to name" the pilots of C-FONF. I do not see any rational basis on which to limit the "naming of names" in this way. All individuals and regulatory and corporate entities involved in this Commission have been afforded to the full the benefit of the principles of fundamental justice.

For these reasons, I am not prepared to make observations and findings of only a generic nature without naming any individuals. Individuals will be named in observations and findings in cases where the evidentiary record and the discharge of my mandate so warrant.

I might also point out that the *Nelles/Grange* inquiry was established pursuant to the Ontario *Inquiries Act,* while the instant Commission of Inquiry is established pursuant to the federal *Inquiries Act.* This fact negates the necessity of addressing the constitutional issues that were so important to the disposition of the issues before the Ontario Court of Appeal in its consideration of the procedures of the *Nelles/Grange* inquiry.

The Issue of Reasonable Notice

Counsel for the Applicants argued that the recipients of the August 19, 1991, letters have not had sufficient particulars or time to respond properly to the proposed adverse observations and findings. I do not agree with this submission. With respect to particulars, Commission Counsel's 66-page letter of September 26, 1991, provided Paterson, MacDougall with notice in considerable detail of the points and the circumstances that may give rise to an adverse finding in my eventual Report. Counsel for the Applicants have access to the full evidentiary record, and their day-to-day participation in the Inquiry, together with Commission Counsel's 66-page letter, can leave them in no doubt about the issues that must be addressed. In the present application, Paterson, MacDougall intimated that nothing less than my report in draft form would satisfy their requirements. The request, in my view, indicates the extent to which the Applicants have misconstrued the limits of procedural fair play and fundamental justice.

With respect to the issue of timing, the following chronology is of significance:

(a) The August 19, 1991, letters were sent by registered mail to 11 persons. Each notice contained the following notification concerning timeliness:

> Please consider this letter as official notice pursuant to the provisions of section 13 of the Inquiries Act, and advise the Commission in writing on or before Tuesday, September 3, 1991, if you wish:
> 1. to be heard in person or by counsel;
> 2. to be heard by means of written submissions; or
> 3. not to be heard by the Commission.
>
> **SHOULD YOU NOT RESPOND ON OR BEFORE TUESDAY, SEPTEMBER 3, 1991, IT WILL BE TAKEN TO MEAN THAT YOU HAVE WAIVED YOUR RIGHT TO BE HEARD PURSUANT TO THE INQUIRIES ACT, SECTION 13.**

> It is to be noted that submissions presented pursuant to this procedure will be carefully considered by the Commissioner in preparation of his Final Report. Written submissions are to be received by the Commission on or before **TUESDAY, SEPTEMBER 10, 1991.**

Only one Air Ontario witness wrote to Commission Counsel and made written submissions as requested in the August 19, 1991, letter.

(b) A copy of each August 19, 1991, letter was delivered to Mr. Bruce MacDougall on August 19, 1991. By correspondence dated August 30, 1991, Mr MacDougall wrote to Commission Counsel requesting more particulars and setting out his position in relation to Section 13. There are two paragraphs of particular significance in this correspondence:

> We are writing to you with respect to Section 13 notices you have provided to us as counsel to Air Ontario and to several of the witnesses who gave evidence at the inquiry.
>
> The above information will assist us greatly in preparing our response to the notices that you have provided to us. Obviously the sooner we are in possession of this information the sooner we will be able to respond.

It is clear from reading the letter *in toto* and particularly the two paragraphs quoted therefrom that Paterson, MacDougall was acting as counsel to Air Ontario and to persons employed by Air Ontario who appeared before me.

(c) Two letters dated September 13, 1991, were forwarded by Mr. MacDougall to Commission Counsel, essentially requesting further particulars. Both letters initially set out the context in which they were forwarded to the Commission:

> We are writing this letter as Counsel for Air Ontario Inc., a participant in the Inquiry, and as Counsel also representing the interests of the witnesses ... in response to the Notices of "intended findings" contained in your various letters to them of August 19, 1991.

and

> We are writing to you as counsel for Air Ontario Inc. in response to your letter of August 19, 1991 to the president for the company.

Having regard to the role that Paterson, MacDougall assumed in this Inquiry; the degree of specificity of the particulars that were sent to Mr. MacDougall; the passage of fifty-one (51) days from August 19, 1991, to the date of the in camera hearing; and the role Paterson, MacDougall assumed in the Inquiry process by representing the interests of all but a few of the Air Ontario employees in interviews and dealings with the Commission, by representing them at all hearings before me, and by the very correspondence leading up to this application, as earlier noted, I am left in no doubt that all of the persons who were forwarded letters on August 19, 1991, had reasonable and sufficient time to respond to such letters, either individually or through Paterson, MacDougall, the counsel representing their interests.

Counsel for the Applicants argued that there was an unreasonable delay in the service of the letters from the Commission dated August 19, 1991, September 6, 1991, and September 26, 1991, upon the Applicants. In the circumstances, I do not agree. This Commission of Inquiry was constituted on March 29, 1989, hearings commenced on July 17, 1989, and hearings ended on January 24, 1991. Since that time I have been reviewing a vast volume of documents and transcript evidence. The letters to the Applicants were forwarded as soon as I was satisfied with my review of the evidentiary record.

In the interests of fairness to all concerned, notwithstanding my decision set out above, I am hereby granting an extension of time until noon on Thursday, October 24, 1991, by which time the remaining ten persons may make written representations to me concerning the notices such persons were forwarded on August 19, 1991, as amplified by correspondence dated September 6 and 26, 1991. Such representations may be individually sent, as was done by one Applicant, or may be submitted by counsel.

Possible Conflict of Interest in Legal Representation of Individuals

I have given particular consideration to counsel's assertion that individuals may need more time to respond since Paterson, MacDougall "will be advising all of the named persons of their right to retain counsel independent of Air Ontario, as their personal position could conflict with that of the company."

The conduct of Paterson, MacDougall throughout this Inquiry led me to believe that any issues of conflict had been addressed by Paterson, MacDougall and its clients at a very early stage; and further, that such early consideration of such issues resulted in Paterson, MacDougall representing all of the individuals that they purported to represent. I am of the view that Paterson, MacDougall cannot now argue that it is unable to provide these individuals with independent counsel as the Inquiry draws to a close and delivers its Final Report, after such individuals were interviewed and appeared as witnesses before me represented by Paterson, MacDougall during the investigation phase of this Inquiry.

With respect to the individuals themselves, if any person who received an August 19, 1991, letter from the Commission feels aggrieved by reason of the representation of Paterson, MacDougall and now wishes separate representation, then such persons can come forward before me as individuals to make submissions on Thursday, October 24, 1991.

Charter of Rights

Counsel for the Applicants argued that the procedure proposed by the Commission would violate the individual Applicants' common law right to reputation and their right under Section 7 of the *Charter of Rights and Freedoms* not to be deprived of "security of the person" except in accordance with the principles of fundamental justice. I very much doubt that the "security of the person" of any individual will be put at risk as a result of the Final Report of this Commission of Inquiry. To the extent that "security of the person" may be an issue, there has been and will be scrupulous adherence to the principles of fundamental justice.

For the foregoing reasons the Application is denied.

DELIVERED AT TORONTO, ONTARIO,
THIS 11th DAY OF OCTOBER, 1991.

THE HONOURABLE Mr. JUSTICE
VIRGIL P. MOSHANSKY, COMMISSIONER

FINAL REPORT

TECHNICAL APPENDICES

DSS cat. no. CP32-55/4-1992E
ISBN 0-660-14383-6

COMMISSION OF INQUIRY INTO THE AIR ONTARIO CRASH AT DRYDEN, ONTARIO

Final Report

Technical Appendices

The Honourable Virgil P. Moshansky
Commissioner

COMMISSION OF INQUIRY INTO THE AIR ONTARIO CRASH AT DRYDEN, ONTARIO

The Final Report consists of three volumes: I (Parts One–Four), II (Part Five), and III (Parts Six–Nine and the General Appendices); and this volume of Technical Appendices. The contents of volumes I, II, and III of the Final Report are found at the end of this volume.

COMMISSION OF INQUIRY INTO THE AIR ONTARIO CRASH AT DRYDEN, ONTARIO

Final Report

Technical Appendices

The Honourable Virgil P. Moshansky
Commissioner

Printed in Canada
Cat. No. CP 32-55/4-1992E

This volume has been translated by the translation services of the Secretary of State, Canada, and is available in French

CANADIAN CATALOGUING IN PUBLICATION DATA

Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario (Canada)

Final report: technical appendices
Issued also in French under title: Rapport final, appendices techniques.
ISBN 0-660-14383-6
DSS cat. no. CP32-55/4-1992E

1. Aeronautics – Ontario – Accidents – 1989.
I. Moshansky, Virgil P. II. Title.

TL553.5.C65 1992 363.12'492 C92-099562-4

CONTENTS

PREFACE

Independent research and analysis were conducted by Fokker Aircraft B.V., the manufacturer of the Fokker F-28 Mk1000 aircraft; and, with Fokker, by the Canadian Aviation Safety Board. On behalf of this Commission, research and analysis were carried out by individuals with expertise in the areas of aerodynamics, physics, meteorology, and psychology.

This volume of Technical Appendices contains the reports used by this Commission of Inquiry in analysing the performance of Fokker Aircraft F-28 Mk1000, C-FONF, during its last takeoff from Dryden Municipal Airport, on March 10, 1989. It also contains an analysis relating to the human factors aspects surrounding the accident. What follows is a brief description of each of the reports contained in this volume.

1 Structures/Site Survey Group Report LP 38/89: Accident: Fokker F28, Mk 1000, Registration C-FONF, 10 March 1989 Occurrence No. 825-89-C0048: Canadian Aviation Safety Board

The Structures/Site Survey Group Report was entered as Exhibit 484 through Mr James W. Hutchinson, chief, engineering analysis, Canadian Aviation Safety Board. It represents an analysis of the final flight path of the aircraft, a fire damage analysis of the aircraft wreckage, and the crashworthiness aspects of the accident. This report was spoken to by Mr Hutchinson during his testimony before this Commission on April 9, 1990.

2 Fokker Aircraft B.V. Amsterdam, Fokker Aerodynamics, Report No. L-28-222: Note on the Aircraft Characteristics as Affected by Frost, Ice or Freezing Rain Deposits on Wings

Fokker Aircraft Report No. L-28-222, dated December 16, 1969, was the result of wind tunnel tests and studies conducted by Fokker Aircraft dealing with the effects of sandpaper roughness on the wings of both jet- and propeller-powered aircraft. The report specifically describes the degradation in takeoff lift and acceleration characteristics of the F-28 aircraft caused by surface roughness on the wings due to contamination such as frost, ice, or freezing rain. This report was entered as part of Exhibit 532 and was spoken to by Mr Jack van Hengst, chief aerodynamic analyst, Fokker Aircraft B.V., during his testimony before this Commission on May 1, 1990.

3 Fokker Aircraft B.V. Amsterdam, Report No. VS-28-25: Flight Simulator Investigation on the Take-off Performance Effects of Slush on the Runway and Ice on the Wings of a Fokker 100

Fokker Aircraft Report No. VS-28-25 was the result of simulation flights conducted by Fokker Aircraft and Commission investigators using Fokker Aircraft's Fokker 100 engineering flight simulator, adjusted to approximate the flight characteristics of an F-28 Mk1000 aircraft. It summarizes Fokker's data and findings used to assess the takeoff performance of a Fokker F-28 Mk1000 aircraft with contamination on the aircraft wings and on the runway. The report was entered as Exhibit 544 and was spoken to by expert witnesses Mr Gary Wagner and Mr J. Murray Morgan, and by Mr Jack van Hengst, during their respective testimony before this Commission on May 4, May 3, and May 2, 1990.

4 A Report on the Flight Dynamics of the Fokker Mk 1000 as They Pertain to the Accident at Dryden, Ontario, March 1989

The flight dynamics report was researched and prepared by Mr J. Murray Morgan of National Aeronautics Establishment, National Research Council Canada; Mr Gary A. Wagner, Air Canada pilot, physicist, and aeronautical engineer; and Mr Richard H. Wickens, National Research Council Canada. The objective of the flight dynamics report was to develop a range of possible flight path scenarios in order to approximate that flown by C-FONF on its last flight, on March 10, 1989. The report contains an aerodynamic analysis to support simulation work and to provide background for the accident analysis and investigation. This report was spoken to by Messrs Wickens, Morgan, and Wagner during their respective testimony before this Commission on April 30, May 3, and May 4, 1990.

5 Wind Tunnel Investigation of a Wing-Propeller Model Performance Degradation due to Distributed Upper-Surface Roughness and Leading Edge Shape Modification

The report on propeller performance degradation is based on research conducted by Mr Richard H. Wickens and Mr V.D. Nguyen of the National Research Council Canada relating to the effects of performance degradation on propeller-driven aircraft due to wing contamination. This report was spoken to by Mr Wickens during his testimony before this Commission on April 30, 1990.

6 Freezing Precipitation on Lifting Surfaces

This report was prepared by Dr Myron M. Oleskiw of the National Research Council Canada to determine the effects of snow on the wings of aircraft C-FONF on March 10, 1989, and the possibility of snow turning to ice through such factors as adiabatic and evaporation cooling caused by airflow over the wing and the possibility of snow adhering to the wings due to wing surface cooling. This report was entered as Exhibit 521 and was spoken to by Dr Oleskiw during his testimony before this Commission on April 26, 1990.

7 Human Factors Aspects of the Air Ontario Crash at Dryden, Ontario: Analysis and Recommendations to the Commission of Inquiry

The human factors aspects analysis, prepared by Dr Robert L. Helmreich of the University of Texas, was based on the evidence and information before this Commission and on previous research in the area of human performance in flight operations. The report was entered as Exhibit 1270 and was spoken to by expert witnesses Dr Robert L. Helmreich, Dr Charles O. Miller, and Mr David Adams during their testimony before this Commission on December 17, 18, 19, and 20, 1990.

Appendix 1

Occurrence No. 825-89-C0048
Structures/Site Survey Group Report
LP 38/39

Accident: Fokker F28, Mk 1000, Registration C-FONF, 10 March 1989

Canadian Aviation Safety Board
Investigation Team:
J.W. Hutchinson, Structures Chairperson
J.E. Foot, Site Security and Survey Chairperson

Occurrence No. 825-89-C0048

STRUCTURES/SITE SURVEY

GROUP REPORT

LP 38/89

Accident: Fokker F28,Mk 1000
Registration C-FONF
10 March 1989

Structures Chairperson:
J.W. Hutchinson, P. Eng.
Chief, Engineering Analysis
Canadian Aviation Safety Board

LICENSED PROFESSIONAL ENGINEER
JAMES W. HUTCHINSON
PROVINCE OF ONTARIO

Site Survey Chairperson:
J.E. Foot
Elec/Mech Engineering Specialist
Canadian Aviation Safety Board

TABLE OF CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 Fokker F28-Mk 1000, registration C-FONF crashed shortly after take-off near the end of runway 29 from Dryden Municipal airport, Dryden Ontario. The accident occurred at 12:11 hours CST on March 10, 1989. The aircraft crashed in heavily wooded terrain in one to two metres (m) of snow. The aircraft was operated by Air Ontario on a scheduled commercial flight (number 363) from Thunder Bay to Winnipeg with a stop at Dryden. Of the 65 passengers and four crew members on board, 22 received fatal injuries at impact and two more severely injured passengers died later in hospital.

1.2 The aircraft path was considered in three segments. The first segment from the end of runway 29 for a distance of 726 metres (m), on a heading of 290 degrees magnetic. In this segment the aircraft struck the tops of eighteen trees, the first one being 126 m off the end of the runway. The second segment is identified as the upper half of the wreckage trail and represents the aircraft striking a substantial number of trees near the top of a knoll and begin its descent through the trees a further distance of 144 m remaining on approximately the same heading of 290 degrees. The third segment is identified as the lower half of the wreckage trail and represents the aircraft making primary impact with the ground and sliding about 80 m to a stop against a stand of trees.

1.3 A three view drawing of the F28-Mk 1000 is depicted in Figure 1 showing the general overall dimensions.

2.0 FINDINGS

2.1 The aircraft first contacted a single tree top 126 m off the end of runway 29 (293 magnetic), 3 degrees to the left of the runway centre line. The tree top was broken off at an elevation of 413.1 m above sea level (ASL). The elevation at the end of runway 29 is 413 m ASL.

2.2 The aircraft clipped the tops of eighteen trees over the next 600 m prior to striking a substantial number of trees near the top of a knoll. The heights of the broken tops of all the trees contacted between the first tree and the top of the knoll remained relatively constant at 413 metres (+-1.5 m).

2.3 The aircraft descended into the trees, cutting a swath for 224 m in length. The terrain elevation at the top of the knoll was 404 m and sloped downwards to 390 m ASL. Aircraft wreckage was scattered along the entire swath of cut trees. The majority of the wreckage came to rest at a Latitude of 49 degrees 45 minutes 11 seconds and Longitude 92 degrees 46 minutes 8 seconds (UTM 5520300 N, 516650 E).

2.4 The initial pieces of wreckage found consisted of pieces of the red lens cap from the rotating beacon, which was broken off the belly of the fuselage. These pieces were found in the vicinity of the first tree strike off the end of runway 29.

2.5 The next pieces of wreckage were located at the main tree strikes and consisted of the left wing tip, main landing gear doors (MLG) and pieces of the radome. The majority of the fuselage, right wing and the empennage stayed relatively intact until the aircraft came to rest.

2.6 Approximately 50 m after contacting the more heavily treed area, a fire developed which traveled down the length of the wreckage trail and culminated in the almost total destruction of the cockpit and fuselage area aft to the rear pressure bulkhead. The empennage and engines were superficially sooted and remained relatively unburnt.

2.7 All major control surfaces, doors, and hatches were found in the main wreckage scatter zone. Except for the MLG doors the remaining doors and hatches were determined to be in the closed and locked position prior to impact.

2.8 It was determined that the landing gear was in transit up when major tree contact occurred.

2.9 Reconstruction of the wreckage and examination of the break-up patterns showed that they were consistent with either tree or ground impact damage.

2.10 The initial evidence of fire was noted to be approximately 50 m after the aircraft struck trees at the top of the knoll which was consistent with the rupturing of the left fuel tank. There was no evidence of an in-flight fire prior to the aircraft striking the trees.

3.0 WRECKAGE SURVEY AND BREAK-UP SEQUENCE

3.1 During the ground searches carried out as part of the on-site investigation, most pieces of aircraft wreckage were located, tagged, assigned an item number and staked. The majority of these pieces were identified with assistance from the manufacturer and the operator of the aircraft. In some cases, when a number of pieces of wreckage were found in close proximity to each other, they were grouped together under the same item and stake number. The position of each stake was then surveyed by ground survey and incorporated into a wreckage distribution plot shown in Figure 2. A Wreckage Catalogue listing the wreckage items surveyed along with a brief description is contained in Appendix 'A'. A second ground search was also carried out in May 1989 when the ground was clear of snow. A number of wreckage pieces were found and tagged. The locations of these items relative to the accident site were then recorded using a standard police grid search method. The Wreckage Catalogue in Appendix 'B' identifies the location along with a brief description all of the pieces of wreckage found during the second ground search.

3.2 During the second search phase, numerous pieces of the red lens from the rotating beacon were found just beyond the first tree strike, 126 m off the end of Runway 29. This beacon is normally mounted on the belly, in the centre of the fuselage, just aft of the main landing gear inboard doors. Figures 3 and 4 show the location of the rotating beacon on the belly of the fuselage of another F28, C-FONG. Figure 5 shows the numerous pieces of the broken red lens recovered from the vicinity of the first tree strikes. All other pieces of wreckage found during the second search were located within either the upper or lower part of the wreckage trail.

3.3 As the aircraft began striking a substantial number of trees near the top of the knoll, the aircraft started to receive major structural damage. The wreckage distribution plot (Figure 2) shows to scale the location of all the main pieces of wreckage recovered.

3.4 Among the first items recovered near the top of the knoll were the left and right outboard main landing gear (MLG) doors, both essentially intact, and various pieces of both inboard MLG doors, including the gear access panels. The inboard MLG doors are normally stowed when the gear is either fully up or down. When the gear is selected up after take-off, the inboard gear doors will open down and in, hinged to the fuselage at the inboard end of the doors. They will remain open while the gear is in transit. Due to the location of these doors near the beginning of the wreckage trail, it is considered that they were open when the aircraft entered the trees. The nature of the impact damage to the MLG doors was consistent with them having been opened normally, as opposed to being forced open due to tree strikes, etc.

3.5 A review of the wreckage distribution shows that as the aircraft proceeded through the trees, it shed most of its left wing in the upper half of the wreckage trail, due to impact damage with trees. Near the top of the knoll, on the left side near the start of the wreckage trail, the left wing tip navigation light holder and a small piece of the red lens were found. Only the stub section of the left wing inboard from lift dumper (spoiler) #2, remained attached to the fuselage structure after the aircraft came to a stop. The lift dumpers are numbered 1 to 5 on each wing from the inboard end outward.

3.6 Sections of all the major control surfaces were accounted for at the wreckage site between the top of the knoll and where the aircraft finally came to a stop. Found along the wreckage trail were sections of the left elevator, the left inboard and outboard flaps and sections of the flap leading edge vanes, the flap shroud doors, the left aileron and trim tab, and lift dumpers 3, 4, and 5 from the left wing. The remaining control surfaces, including the majority of the right wing were found still attached to the fuselage structure, or in close proximity to the main wreckage. Figure 6 shows an aerial photograph of the main wreckage trail with overlays depicting the outline of the tree cut swath (overlay 1), an outline of the tree fire damage (overlay 2), location of wreckage items identified as coming from the left wing or left elevator (overlay 3), location of wreckage items identified as coming from the main and nose landing gear doors (overlay 4).

3.7 The main wreckage consisted of three major pieces. There were two major breaks in the fuselage, one just aft of the main passenger door, and the second through the fuselage at approximately seat row 12. The first major piece of wreckage consisted of the tail section, which was facing forward on the right side and approximately in line with the lower half of the wreckage trail. The vertical fin and both mounted engines were essentially intact. The complete speed brake assembly (doors, frame, support structure) had separated from the tail of the aircraft and was found in a reversed position just behind the tail section. The right horizontal stabilizer and elevator were intact. The left elevator had separated from the horizontal stabilizer and the tip of the stabilizer had been torn away. The main section of fuselage between the two major breaks was turned approximately 130 degrees to the left with respect to the tail section. The right wing had remained attached to the fuselage structure until it came to rest, and became partially separated during the post-impact ground fire. The cockpit section forward of the break had rotated a further 90 degrees to the left with respect to the fuselage, such that the main wreckage formed an approximate 'U-shape'.

3.8 Reconstruction and examination of the wreckage are detailed in Appendix 'C'.

4.0 AIRCRAFT PATH

4.1 The aircraft flight path was reconstructed based upon the physical evidence of the clipped tree tops and the location of wreckage. A total of eighteen tree tops were clipped starting at 126 m from the end of runway 29. Pieces of the red lens from the rotating beacon were found adjacent to the first tree. The position and elevation of the eighteen clipped trees were determined during the ground survey and recorded in UTM co-ordinates and heights ASL. The tree positions were then plotted on a Dryden Site Plan (Figure 7) and the heading was determined to be 290 degrees magnetic based on the fact that the aircraft had to contact each tree. The aircraft maintained this heading or ground track for 600 m until it came into contact with a substantial number of trees at the top of a small knoll. A profile (Figure 8) of the flight path showed that the elevation of the eighteen tree tops remained relatively constant at 413 m (+- 1.5 m).

4.2 The attitude of the aircraft as it passed through the eighteen trees prior to the major tree strike was reconstructed using computer modeling to scale of the aircraft and the cut trees. Appendix 'D' depicts the aircraft attitude at the various locations along the flight path. The flight path was estimated based on the location of the first pieces of wreckage found (rotating beacon red lens) and the possible positions of the aircraft required to strike all eighteen trees. The assumption was made that the aircraft was not yawed, that is, its heading and ground track remained essentially constant. The accuracy of the aircraft attitude varies with the number of trees cut at any one time and the attitudes depicted are considered to be the best possible fit.

4.3 The cut tree canopy starting at the top of the knoll was documented by aerial photography in conjunction with the deployment of numerous target blankets. The target blankets were surveyed and tied into the original UTM co-ordinate system. Photogrammetric analysis of the aerial photographs determined the position of each of the individual cut trees in terms of UTM co-ordinates and their height ASL. A scale model (1:72) of the cut trees, over the first 45 m through the tree canopy, was built based upon this survey information, to determine the aircraft attitude at this point. A model aircraft (1:72) of an F-28-3000 was obtained for this purpose. A model 1000 was not available but the only difference between the two is that the 3000 model has a 1.5 m longer wing span; all other dimensions are the same. Flaps were scaled and glued onto the model aircraft at the 25 degree position. This position had been determined from the examination of the flap track screw jacks. Landing gear was scaled and added to the model in the full down position. It had been determined that the gear was in transit at this time but the exact location had not been determined.

4.4 The aircraft was then fitted to the cut tree model which showed that the aircraft was in a left bank (angle between the lateral axis of the aircraft and the horizontal estimated to be 7 degrees (+- 2 degrees) which increased to 15 degrees over the next 45 m. This was consistent with the pieces of left wing located in this area. There was no distinct path which would indicate that the main landing gear was fully extended at this point. The aircraft pitch angle (angle between the longitudinal axis of the aircraft fuselage and the horizontal) was determined to be nose-down approximately 1-3 degrees. This appeared to remain relatively constant over the next 45 m. Figures 9 and 10 show the model depicting the aircraft as it entered the tree canopy at the top of the knoll.

4.5 As the aircraft proceeded into the trees at the top of the knoll it began to receive major structural damage, primarily to the left wing. The width of the swath cut through the trees was about 20 - 25 m, but began to narrow to about 12 m, which indicates that the aircraft continued to roll to the left and finally impacted the ground predominantly on the left side. The primary ground impact was at about 144 m from the top of the knoll. The aircraft then yawed to the left with the right wing dropping and the aircraft sliding about 80 m to a stop against a stand of trees.

5.0 CRASHWORTHINESS

5.1 FIRE DAMAGE

The initial pieces of wreckage that exhibited fire damage, were items number 11, outboard wing leading edge and number 12, LH piece outboard wing structure containing a hot-air anti-ice exhaust louvre and part of the fuel tank (Appendix 'A'). Both items were found in close proximity to each other on the left side of the wreckage trail approximately 50 m from the first major tree strikes near the top of the knoll. Both items exhibited small areas of superficial charring and sooting and were adjacent to burnt trees. The remaining pieces of wreckage from this point forward until the main wreckage all exhibited some form of burn damage such as charring or sooting. It appears that as the left wing started to break apart fuel was lost and was ignited almost immediately. The ignition point of the fuel was not determined but may have been the result of electrical arcing as the wires in the wing were torn out or by fuel vapours being ignited by the engines. The ensuing fire traveled or followed the aircraft path until the aircraft finally came to rest. The post crash fire was confined to the trees down and adjacent to the wreckage trail with many of the trees exhibiting superficial charring. Figure 11 is an infrared aerial photograph showing the wreckage trail looking back towards the airport. The use of infrared photography clearly displays the fire damage to the trees as depicted by the outline of darker coloured trees.

The fuselage from the interior of the cockpit back to the rear pressure bulkhead was gutted by post crash fire. Although the fuselage was gutted the fire appeared to have been more intense on the left side than the right. This is based upon the observation that part of the right side of the fuselage (containing the overwing exit and nine windows) was still in place and the exterior paint scheme, although charred, was still recognizable. The exterior nose of the aircraft was relatively free of fire damage. The cockpit floor was burnt away revealing the remains of the nose gear and steel belts from the tires. The left side of the instrument panel was completely burnt out whereas the centre (engine panel) and right panel were relatively intact although they were also burnt and physically damaged. The engines, tail section and empennage exhibited superficial sooting and the interior of the tail section was in good condition.

There was no evidence of an in-flight fire prior to the aircraft striking the trees near the top of the knoll.

F28 ENGINEERS GUIDE

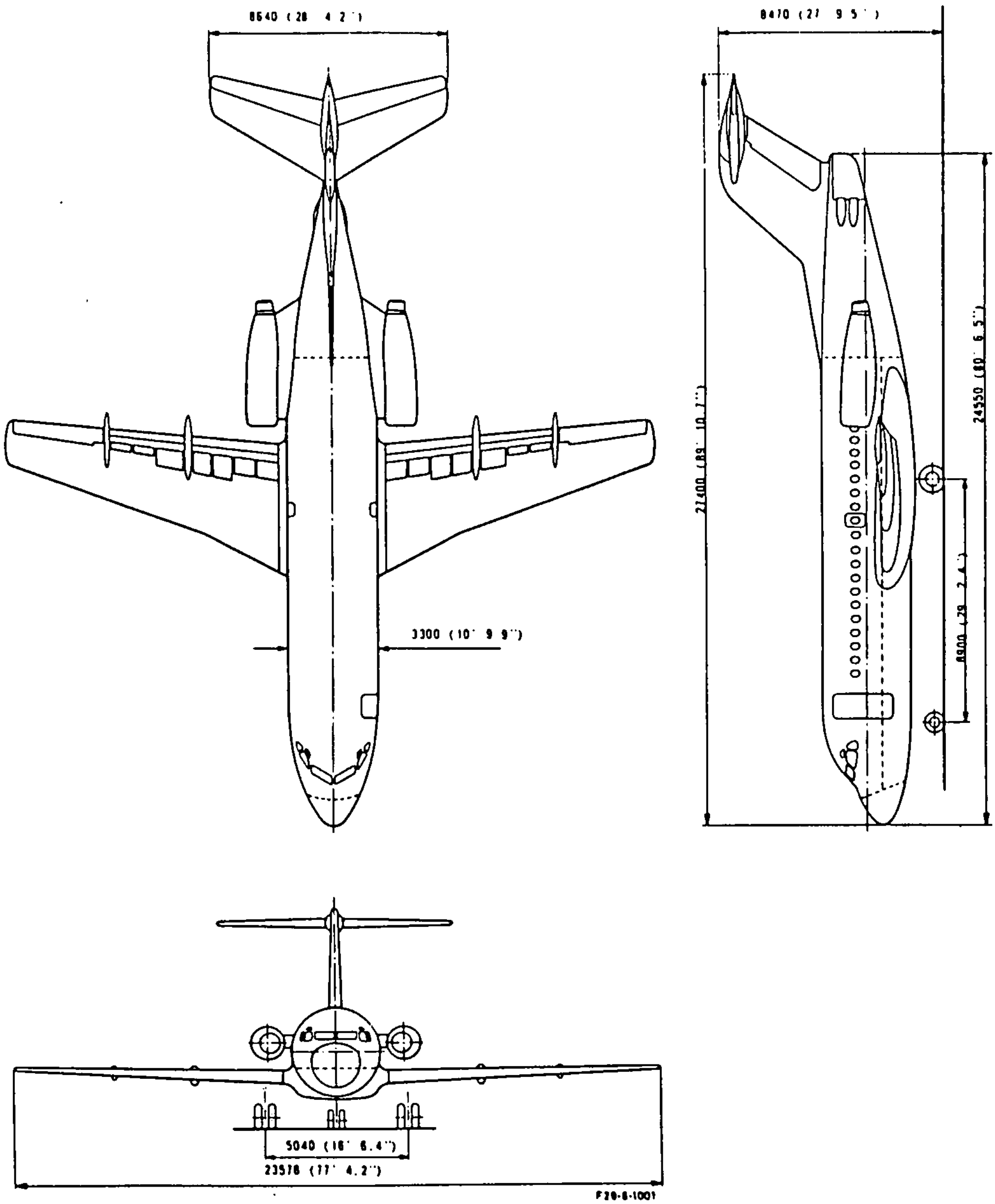


FIG. 1 GENERAL ARRANGEMENT

Figure 2

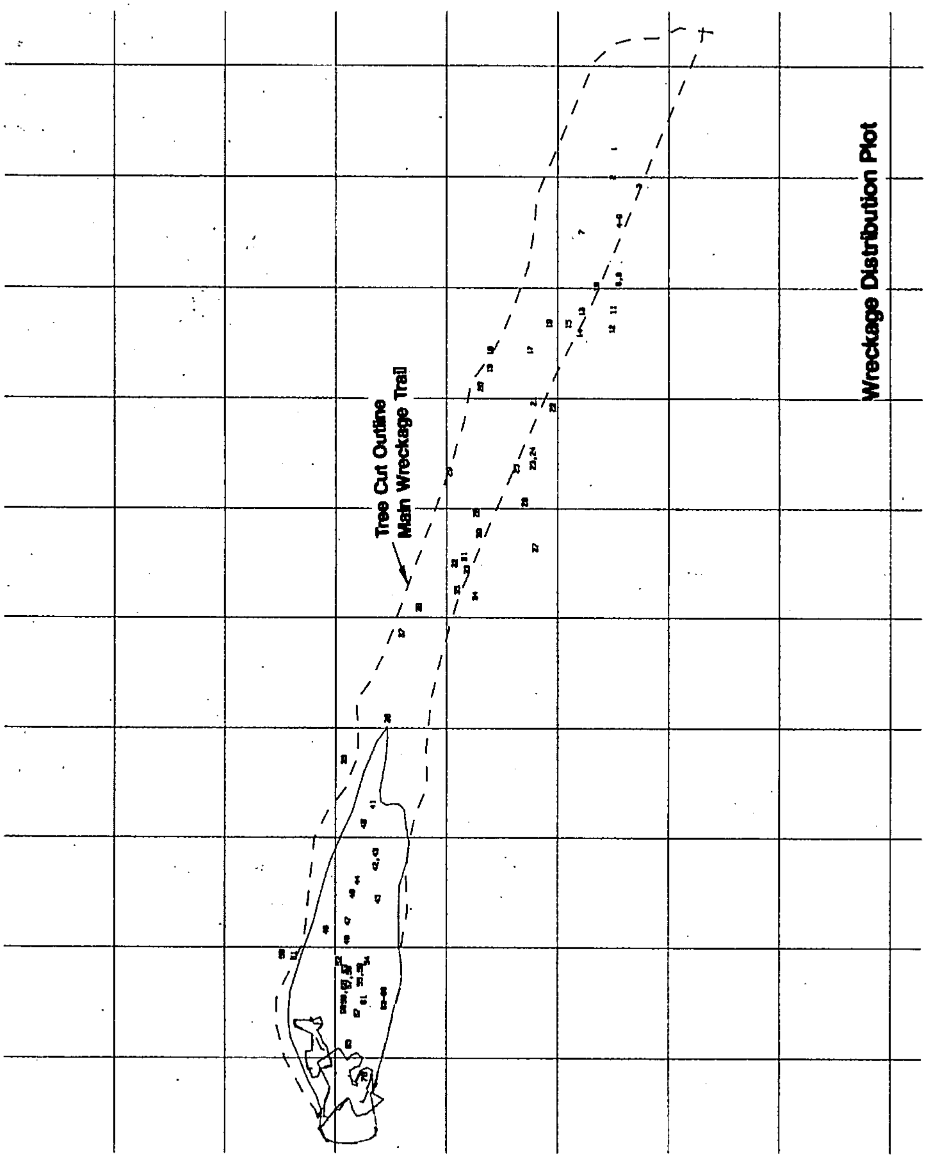

Wreckage Distribution Plot
Tree Cut Outline
Main Wreckage Trail

Figure 3 - View of Fokker F28, C-FONG, showing the location of the anti-collision light mounted on the fuselage belly (arrow).

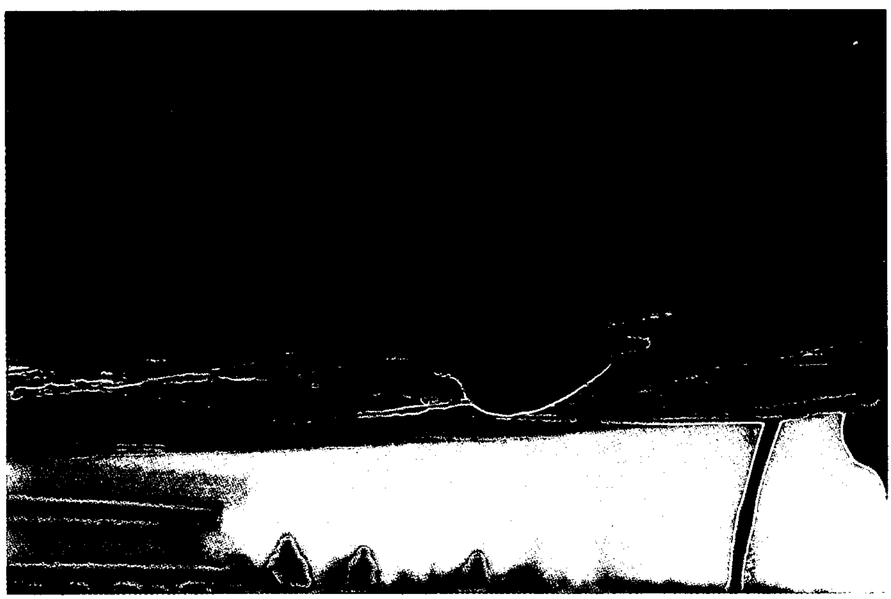


Figure 4 - As in Figure 3, close-up view.

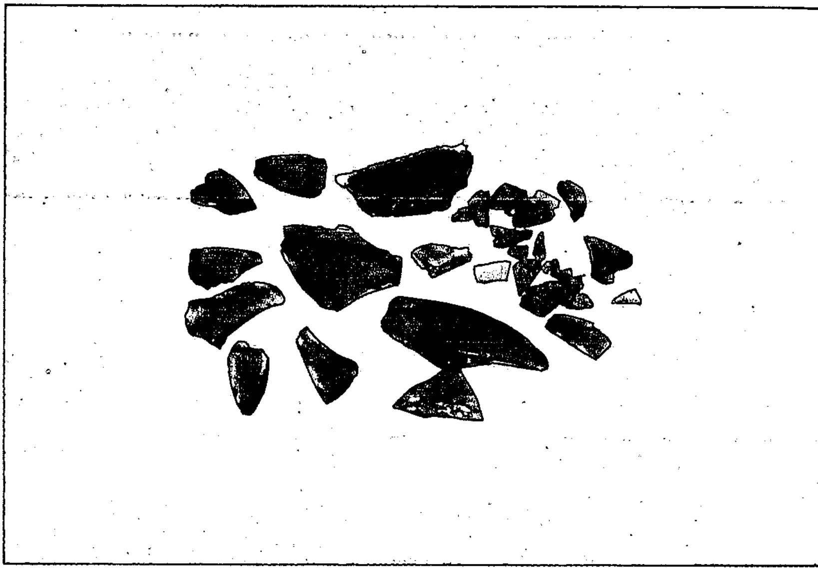


Figure 5 - Photo of all the pieces of the red lens from the anti-collision light recovered from the vicinity of the first clipped trees off the end of Runway 29.

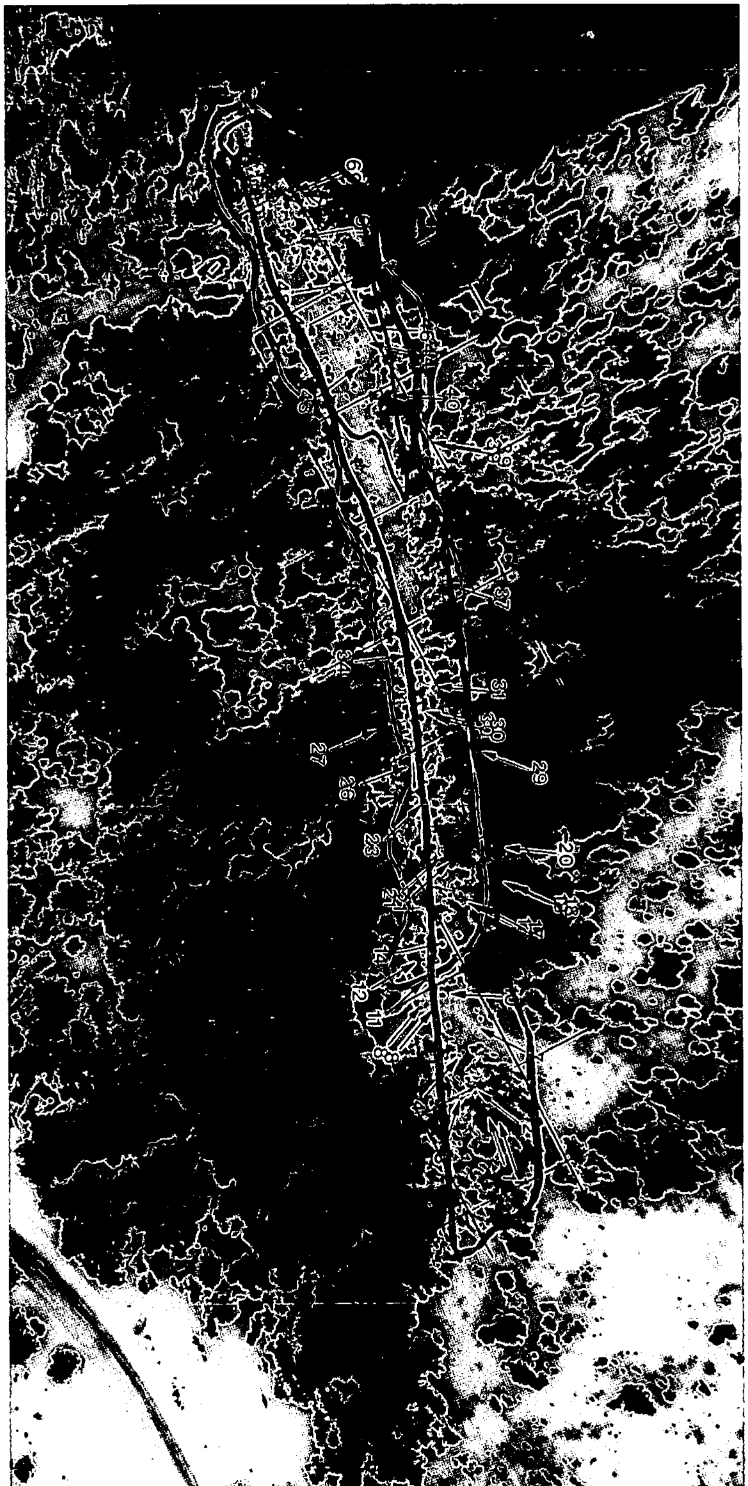


Figure 6

Overlay 1: Tree Cut Swath

Overlay 2: Tree Fire Damage

Overlay 3: Left Wing and Left Elevator

Overlay 4: Main and Nose Landing Gear Doors

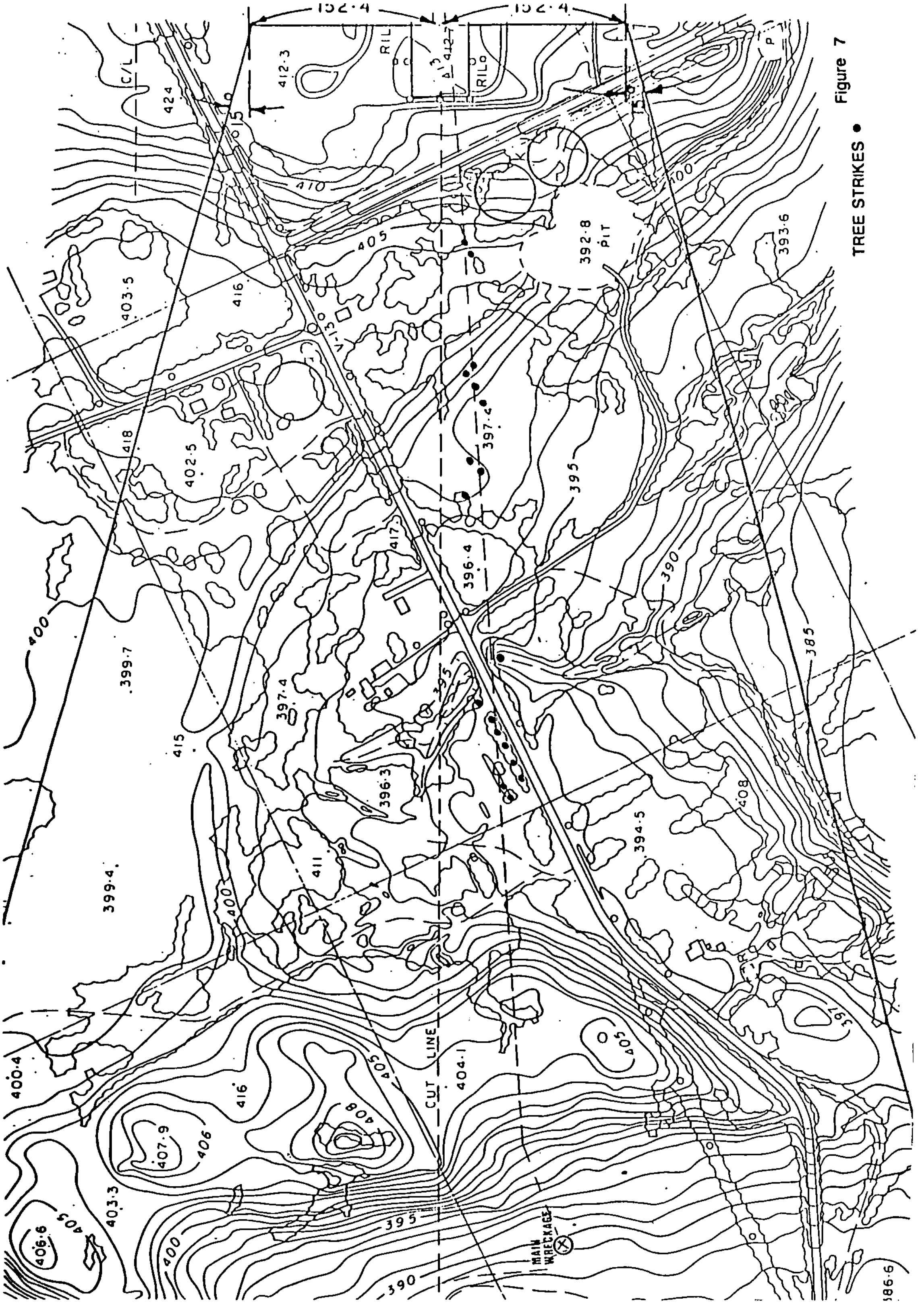


Figure 7

TREE STRIKES ●

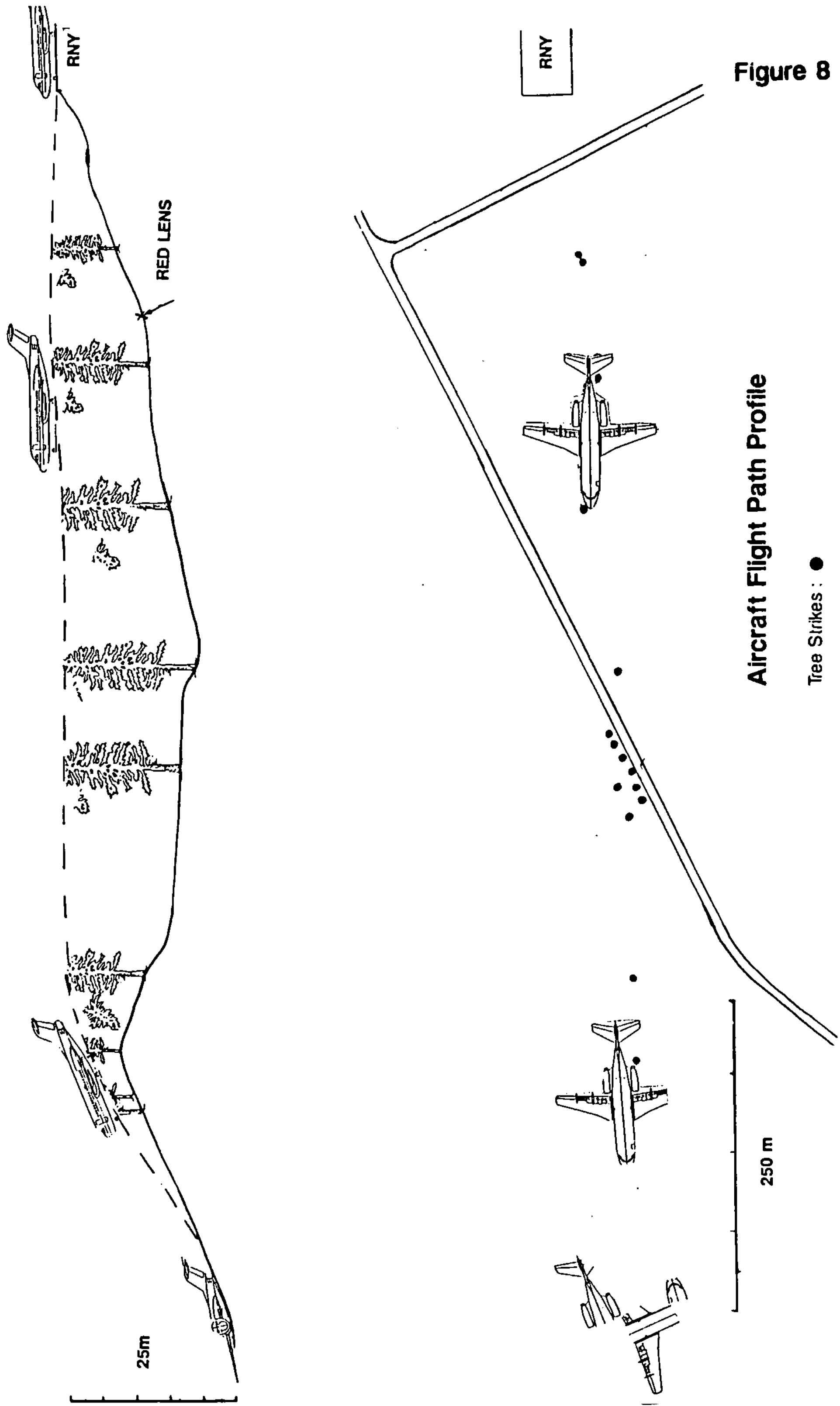


Figure 8

Aircraft Flight Path Profile

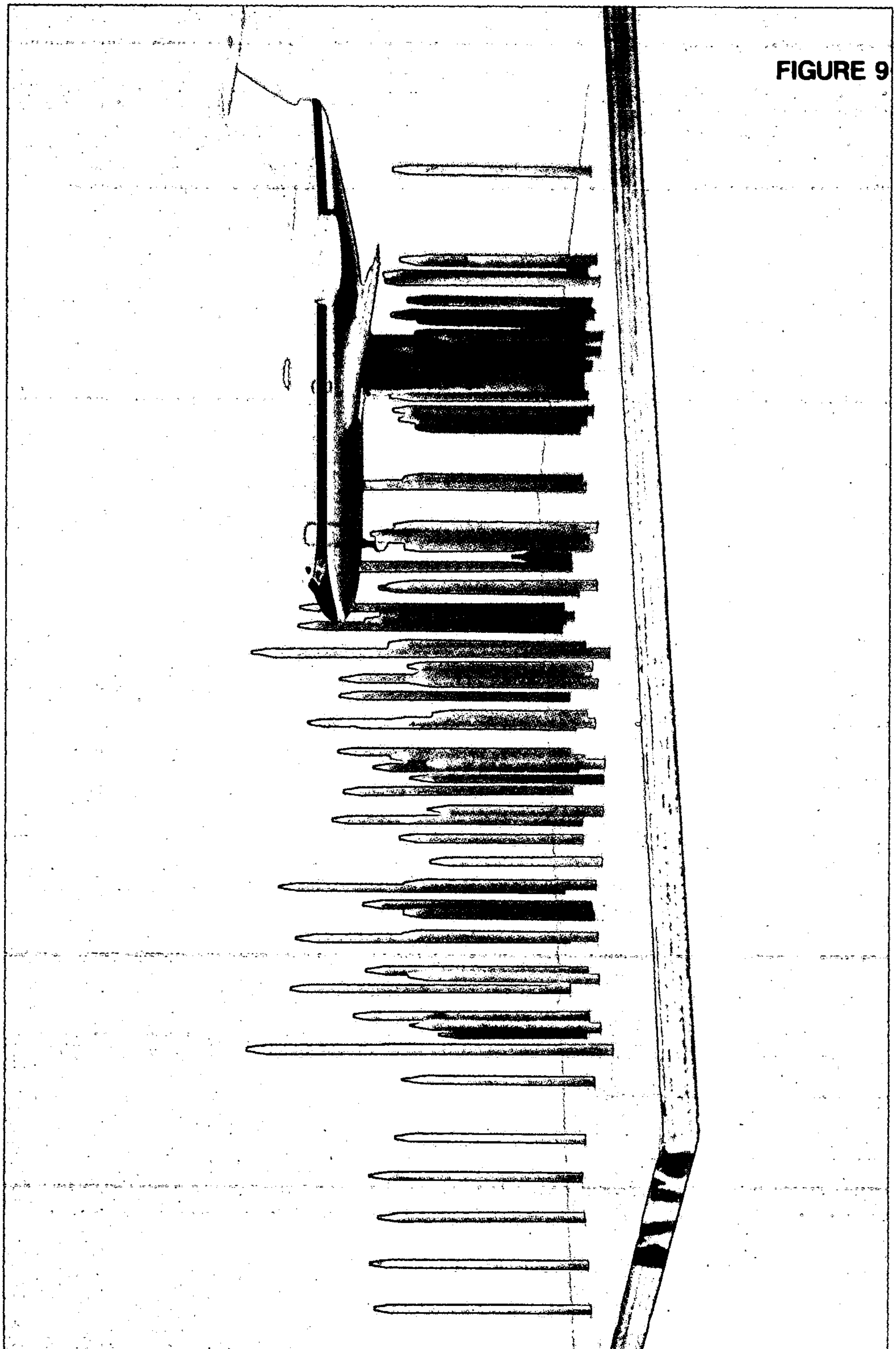


FIGURE 9

FIGURE 10

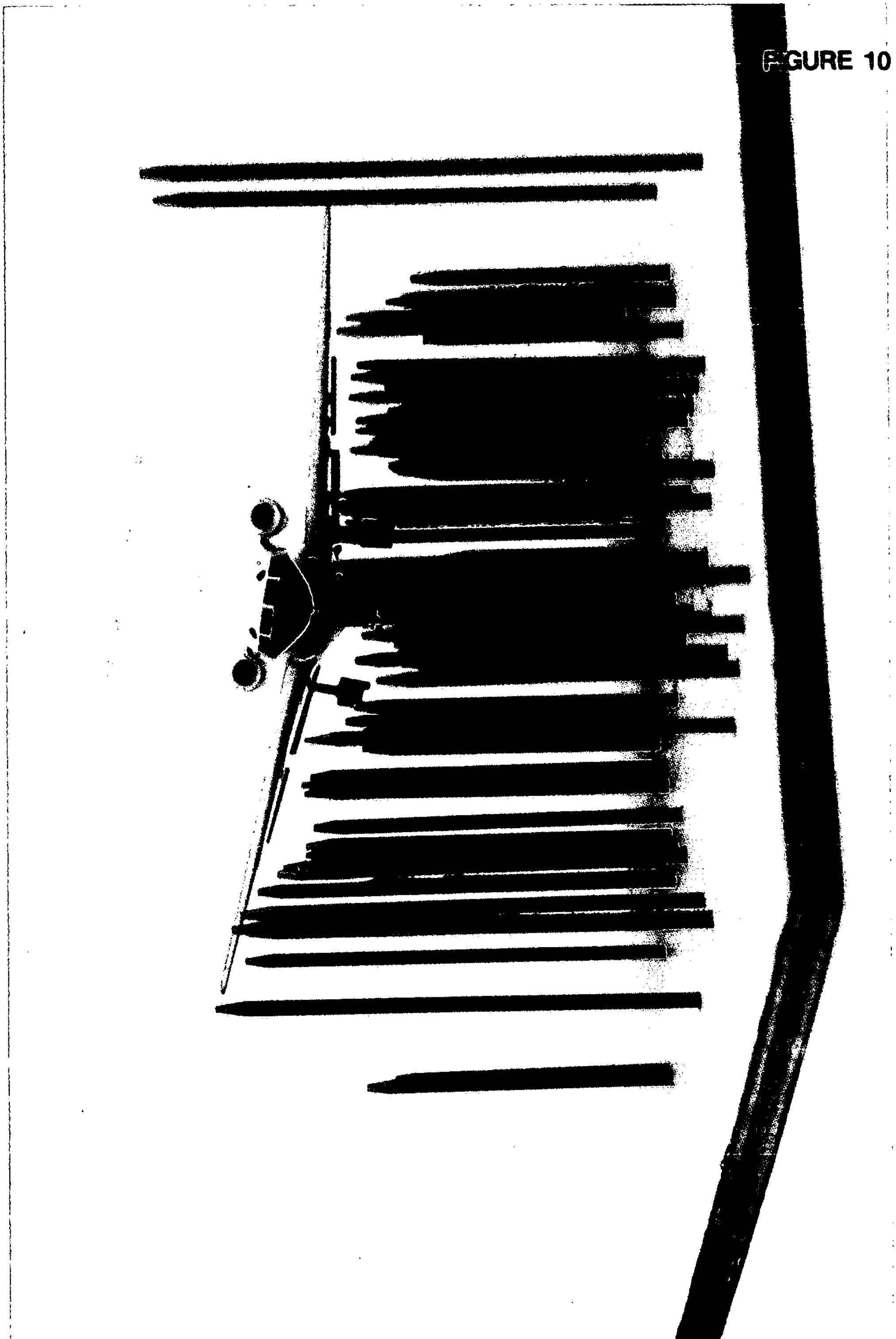
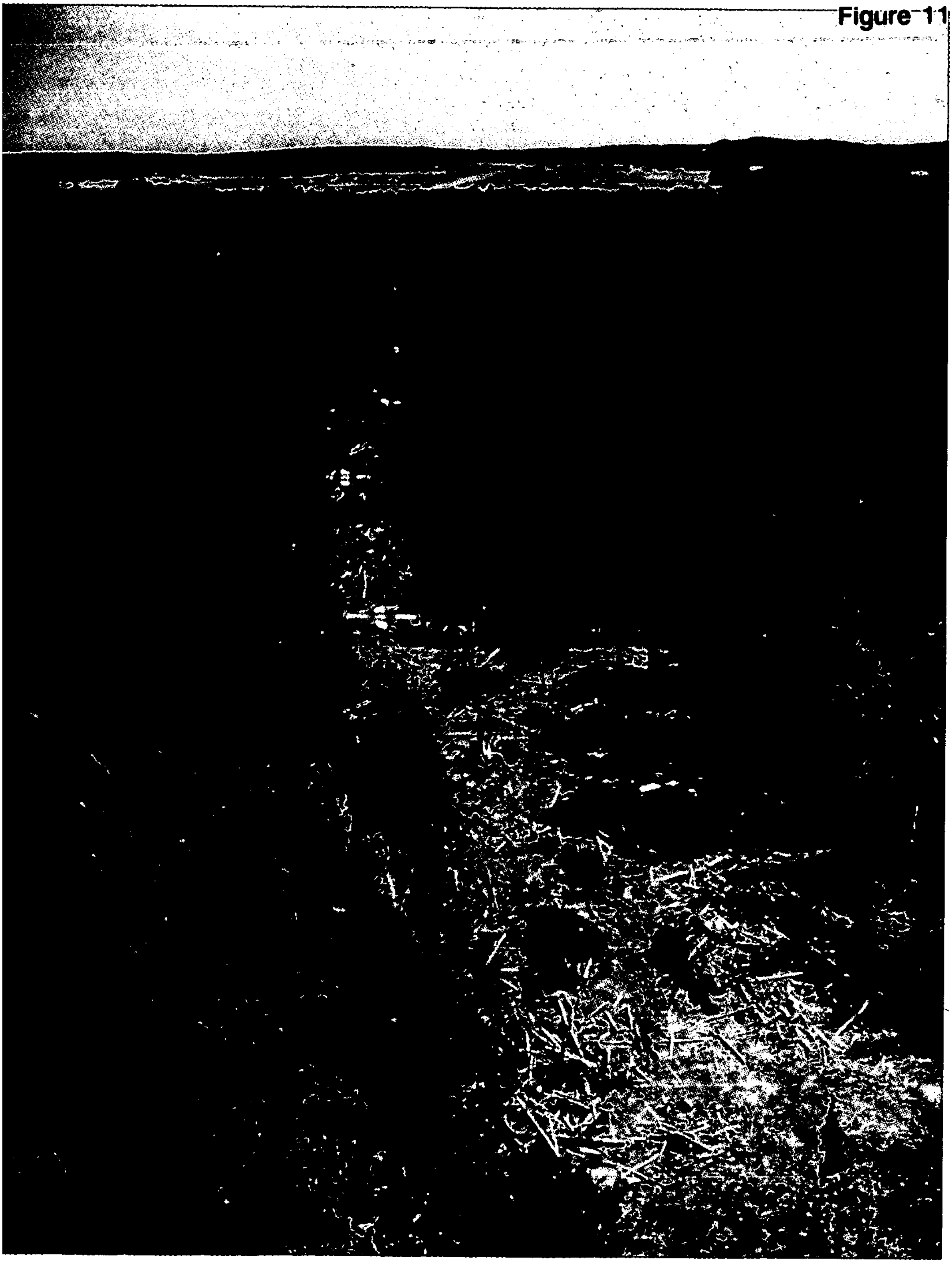


Figure 11



Tree Fire Damage

WRECKAGE CATALOGUE APPENDIX 'A'

ITEM #	DESCRIPTION
1	A) RH inboard main landing gear (MLG) door. B) Small piece red lens cover from left Nav light amoung freshly broken spruce branches. C) ADF Sense antenna.
2	A) RH outbord (MLG) door P/N A11440-420, S/N CH 52.
3	A) Piece of LH wing leading edge P/N A143124401. B) Left wing tip navigation light holder.
4	A) Piece of LH wing tip structure with static discharge wick. B) Piece of leading edge duct for anti-ice.
5	A) LH wing tip piece (trailing).
6	A) Extendable light (flare or taxi light). B) Wing ribs/stringers.
7	A) LH inboard gear access door (red on inside) 2 pin latches in "out" position
8	A) LH outboard MLG door A11440-423. B) Piece of wing skin.
9	A) LH wing skin.
10	A) LH outboard wing structure with aileron fitting. Number 75F stenciled on panel. Top panel exhibits black strip with "Ne pas Marcher" written on it. Access panel numbered "1" for fuel quantity probe.
11	A) LH outboard wing structure.
12	A) LH outboard wing structure number 75E contains outboard aileron hinge and flux valve.

- A2 -

13	A) Piece wing leading edge A12430-001.
14	A) Mid section of LH aileron and aileron tab. B) Vent float valve.
15	A) Stringers. B) Piece wing skin. C) Piece of radome.
16	A) VHF comm. antenna.
17	A) RH inboard MLG access door. B) Piece of radome
18	A) Section of LH inboard MLG door.
19	A) Top centre piece of nose above radome.
20	A) LH outboard end of aileron (number 83W).
21	A) Section of LH inboard MLG door. B) LH wing fence.
22	A) Piece of wing fence. B) Stringers.
23	A) Piece of wing skin - fuel cell.
24	A) Middle section of LH outboard flap vane.
25	A) Piece of wing leading edge with heat duct. B) Piece of radome.
26	A) Section of LH wing skin with access panel numbered 5. Fuel quantity probe.
27	A) Piece of wing skin with inboard end rib (fuel cell).
28	A) Part of flaptrack fairing (1 of 8). B) Piece of wing skin.
29	A) RH nose gear door with number 281, (see item #305 Appendix B for LH door) B) Glideslope antenna. C) Pieces of radome.

\- A3 -

30	A) Outboard flap with flap vane. B) Piece of lower wing skin. C) Section of RH inboard MLG door
31	A) Inner aft shroud door of LH flap. B) Piece of wing skin.
32	A) Landing light. B) Flap track fairing.
33	A) Inner forward shroud door of RH flap B) Pieces of wing skin.
34	A) Pieces of wing skin, fuel cell area.
35	A) Flap fairing. B) Wing panel, A-frame support.
36	A) Piece of wing skin. B) Oil service door.
37	A) Section of RH MLG door P/N A11320-4LP, S/N 5H51. B) Drive cap. C) Air valve temperature sensor. D) Piece wing skin - fuel cap number 4. E) Bellcrank W.S. 8056.
38	A) Piece of trailing edge of wing number 52B. B) Landing light.
39	A) Flap shroud panel - 2 pieces outer O/B aft L.H. B) Small piece of LH nosegear door, red number 28.
40	A) LH outboard flap track with trailing edge wing structure and inboard section of aileron and trim tab. B) Trailing edge upper wing fairing flap with abrasive strip and shroud door damper.
41	A) Piece fuselage skin with green insulation. B) Piece wing skin.
42	A) LH inboard flap track canoe. B) Piece of radome.
43	A) LH inboard flap track with section of wing structure attached.

- A4 -

44 A) Mid section of LH inboard flap vane.
B) Piece of flap fairing.
C) Piece of engine nacelle.
D) LH lift dumper #4 (counting from inboard out).
E) Leading edge of horizontal stabilizer A03507-401, S/N 066.

45 A) Piece of wing skin number 52E, 50C, 45A.
B) Piece of leading edge of LH stabilizer P/N A03507-401, S/N 066.
C) Support flap - A-frame.

46 A) Inner and outer forward shroud doors from LH outboard flap.

47 A) Piece of LH elevator P/N A04-001-415, S/N 064.
B) Piece of engine cowling.

48 A) LH Wing structure with #5 lift dumper attached.
B) Flap rod torque tube.
C) Fuel quantity transmitter.

49 A) Piece of flap.
B) Main wheel well structure.

50 A) Transmitter and pressure switch, located in wheel well.

51 A) Piece of tail cone.

52 A) Engine cowling and lock.

53 A) Leading edge of wing root.

54 A) Piece of fuselage skin with antenna mount.

55 A) Lower fuselage skin P/N A128 30-401.

56 A) Engine fuel drain.

57 A) Piece of wing skin.

58 A) Shroud door bellcrank.

59 A) Skin with number 91L.

60 A) Wing fillet skin-lift dumper line.

- A5 -

61	A) LH inboard flap with flap vane (mid section of vane missing).
62	A) ADF loop antenna.
63	A) Bell
64	A) Seat frame.
65	A) Static inverter P/N 601698-2.
66	A) Piece of cabin floor.
67	A) Piece of engine support beam carry-through P/N 13103003-2.
68	A) Piece of engine cowl.
69	A) LH inboard wing structure with lift dumper #3 attached.
70	A) Main wreckage.

FOKKER F-28, C-FONF
2ND GROUND SEARCH
WRECKAGE SURVEY

APPENDIX 'B'

In May 1989, after the snow had melted from the ground, a ground search was carried out with the assistance of an OPP Search and Rescue Team and three members of the CASB Investigation Team.

A datum line was established from the end of runway 29 through the centre of the accident site to the edge of the beacon road, on a heading of 290 (see survey drawing).

Two search paths were laid out, one north of the datum (North Team) and one south of the datum (South Team). The first search was from the beacon road eastward to the airport fence, with the return search westward back to the beacon road. Each search path was approximately 15 metres wide, with the total search width about 60 metres wide.

Item locations were identified by distance measured along datum line from point 0,0 at the edge of the beacon road, and distance north or south of datum line. Items 200-223 located north of datum, items 300-322 located south of datum. All measurements in metres translated from the standard OPP grid search method of Tally's and Paces, where;

63 paces = 1 tally
10 tallys = 1 kilometre
(average pace estimated to be 1.3 metres)

- B2 -

ITEM #	IDENTIFICATION	LOCATION
200	Skid control valve, Ass'y # 9543466	118, 9 (NORTH)
201	Skid control valve, Unit # 9542718	134, 14
202	Structure w/door lock bar	140, 13
203	Wing structure	166, 7
204	Skid control valve (see item 200)	169, 12
205	Right I/B skid control gen. drive	169, 9
206	Piece of door hinge	177, 9
207	Small piece of casting	177, 4
208	Small AC induction motor	192, 9
209	Torque tube	211, 12
210	Small piece of structure	216, 13
211	Pressure transmitter P/N 3567645-3701	220, 12
212	Hydraulic valve	248, 5
213	Small bracket	270, 7
214	Lift dumper hydraulic accumulator	282, 9
215	Low inertia motor	324, 9
216	Fuel guage transmitter P/N 391067-06098	334, 4
217	Piece of trailing edge aileron (6"x6")	346, 3
*	Group of tree tops knocked off	282, 0
218	Pieces of red lens (anti-collision light, lower)	772, 5 785, 5
219	Pieces of red lens (anti-collision light, lower)	841, 9 865, 0
-----------------	RETURN SWEEP	-----------------
220	AC motor	260, 20
221	Access panel 95A	231, 17
222	Access panel frame 95D	213, 21
223	piece of wing skin	165, 21

\- B3 -

ITEM #	IDENTIFICATION	LOCATION
300	Piece of wing panel (burned)	143, 3 (SOUTH)
301	Piece of wing structure	143, 5
302	Service door 21A (fwd of nose gear bay)	155, 14
303	AC motor & landing light G/B see #220	158, 6
304	weather radar unit P/N 2067568-0501	176, 7
305	Section of LH nose gear door	200, 2
306	Tube	222, 0
307	Small gearbox	229, 1
308	Electrical conector	235, 6
309	Landing light pot	242, 3
310	Fuel guage transmitter 391057-06097	283, 7
311	small bushing	298, 9
312	Fuel tank supply fitting	306, 0
313	Pieces of landing light glass	458, 6
314	Piece of ADF antenna	486, 0
315	Pieces of red lens (anti-collision light, lower)	686, 6
316	Pieces of red lens (anti-collision light, lower)	780, 0
317	Pieces of red lens (anti-collision light, lower)	792, 0
	-------------------RETURN SWEEP-------------------------	
318	Piece of fuel tank w/cap	402, 21
319	Piece of engine structure	272, 26
320	Tube fitting	216, 14
321	Servo motor	185, 18
322	Servo motor	172, 0
323	Aircraft manual	109, 20

WRECKAGE RETRIEVAL AND LAYOUT RECONSTRUCTION — APPENDIX 'C'

A. RETRIEVAL

Upon completion of the site survey, all of the wreckage along the wreckage trail was retrieved and slung out of the site by helicopter to a secure area at Dryden airport, where it was loaded onto enclosed trailers, sealed and shipped by rail to the CASB Engineering Lab in Ottawa. The remaining pieces of the main wreckage required some sectioning to allow removal from the site by truck. The main fuselage was separated by a longitudinal cut through the middle section of the floor. The right stabilizer and elevator were separated from the vertical fin, as was the reamaining section of the left stabilizer. Both engines had already been removed from the aircraft by the Powerplants Group and removed from the site.

The nose section of the aircraft, both halves of the fuselage, the right wing , the tail section and sectioned pieces of the stabilizer were removed from the site by truck and shipped to Ottawa by rail.

B. LAYOUT RECONSTRUCTION

FUSELAGE

All of the wreckage was sorted and a partial reconstruction of the major pieces was carried out. In this manner, the break-up patterns and fire damage could be examined, and all major components of the fuselage and wings could be identified. The tail section was essentially intact, and although the cockpit area was gutted due to post-impact fire, it was roughly in one main piece. A general photo of the burned out cabin area of the fuselage is shown in Figure C-1.

LEFT WING

The wreckage of the left wing is shown laid out in Figure C-2. The middle and outboard left flap tracks were recovered from the wreckage trail, but the flap screw jack for the middle track was not recovered. The mounting points where the middle screw jack was attached to the track were examined. There was evidence of severe impact damage to the track adjacent to the rear mounting point and the mounting bracket was found to have failed due to overload. The translating nut had broken in two due to overload and the front mounting point was deformed due to bending. These failures allowed the screw jack to separate from the track. The middle flap track (survey item #43) was found near the bottom of the wreckage trail adjacent to a large outcropping of rocks. It is considered that the screw jack likely separated from the track due to impact with the ground at this point, and was projected forward, becoming buried under the snow and debris near the main wreckage. During the retrieval of the main wreckage, this area was cleared away to the edge of the wreckage zone and the screw jack may have been trapped in the debris at this time.

RIGHT WING

The right wing is shown laid out in Figure C-3. The right wing was found essentially in its proper orientation in the field on the right side of the aircraft where it had come to rest. Much of the destruction to the right wing occurred due to the post-crash ground fire. All the major control surfaces of the right wing were identified.

PASSENGER/EMERGENCY AND CARGO DOORS

There is one main passenger door, located on the forward left side of the aircraft, and a service/emergency door on the forward right side (Refer to Figures C-4 and C-5). The passenger door is hinged at the bottom and is kept closed by a latching mechanism which has two hook latches in the door lintel engaging into the latch fittings of the door. The door was found in place, still attached to the fuselage. Both hook latches had separated from the door lintel due to fire damage, but they were recovered and found in the locked position. The service/emergency door is a plug-type door which is kept in the closed position by four wedge -shaped latch pins engaging into holes recessed into the door aperture. The door was found free of the fuselage, but was recovered in the immediate vicinity of the main wreckage. The four latch pins were in the out (locked) position. Both of these doors were damaged due to impact and fire.

There are two cargo doors, both on the right side, one on the lower forward fuselage and one on the lower aft fuselage (Refer to Figures C-6 and C-7). Both cargo doors are hinged at the bottom to the main structure and both were found still attached by their hinges. The doors are normally held in the closed position by two hook latches engaging onto latch fittings in the door lintel. For the forward cargo door both latch hooks were still on the door in the locked position, although the door lintel had been destroyed by the fire. The forward half of the rear cargo door was consumed by fire as was the door lintel. One latch hook was still attached to the door and was found in the locked position. The other latch hook had separated, but was also found in the locked position.

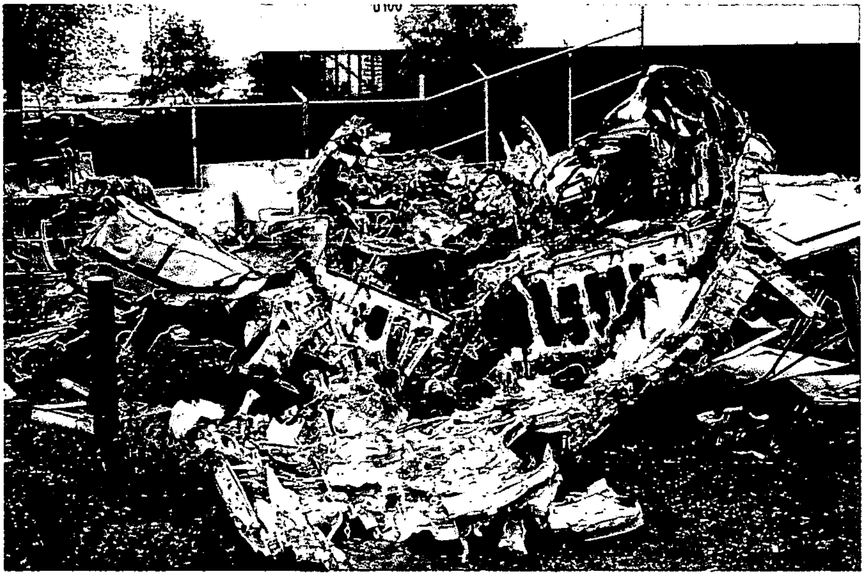
- C3 -

There is one over-wing emergency exit window on each side of the aircraft at seat row 8. Only two small pieces of exit window were recovered (Figure C-8), both pieces found in the main wreckage zone. Although not determined positively, both pieces were likely from the same exit window on the right side of the aircraft. The remainder of the right exit window, as well as the left exit window, were most probably consumed by the post-impact ground fire.

LANDING GEAR DOORS

Most pieces of the nose gear doors, and the left and right main gear doors were identified. Figures C-9, C-10 and C-11 show the doors laid out during reconstruction.

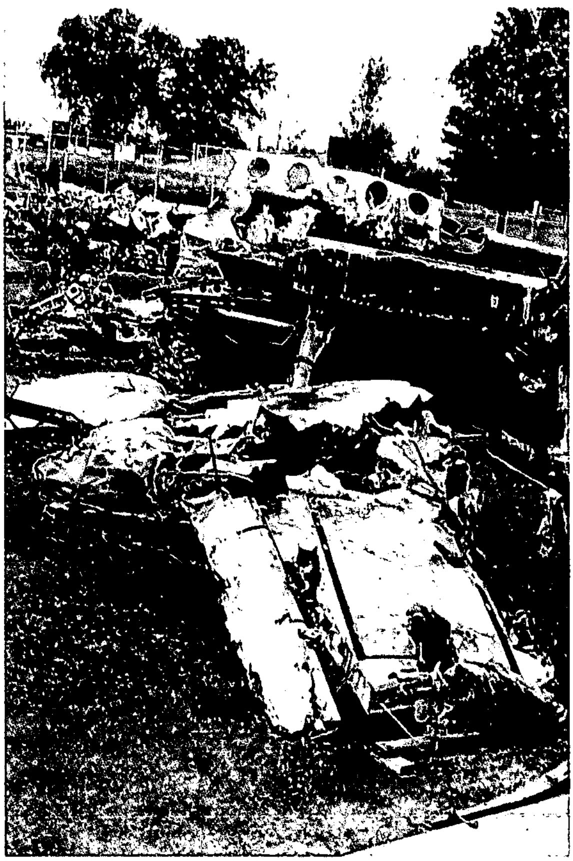
Figures C-1, C-2



Fuselage view from rear showing burnt out cabin area.

Wreckage of left wing laid out during reconstruction

Figure C-3



Wreckage of right wing laid out during reconstruction

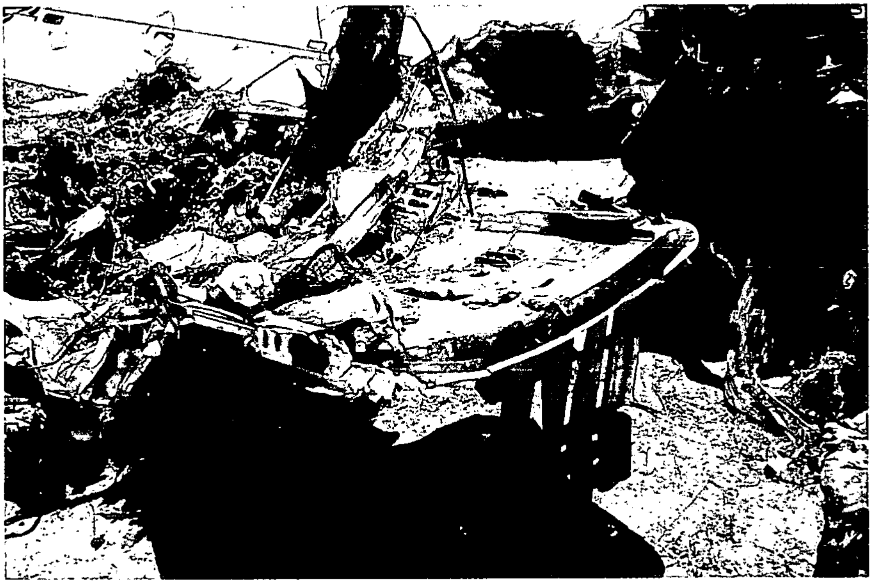
Figure C-4

Main Passenger Door

Figure C-5

Service/Emergency Door

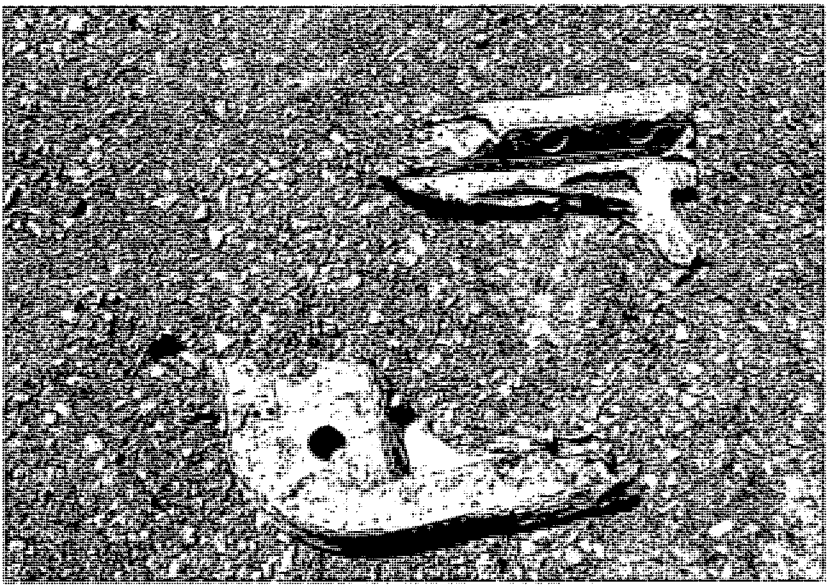
Figures C-6, C-7



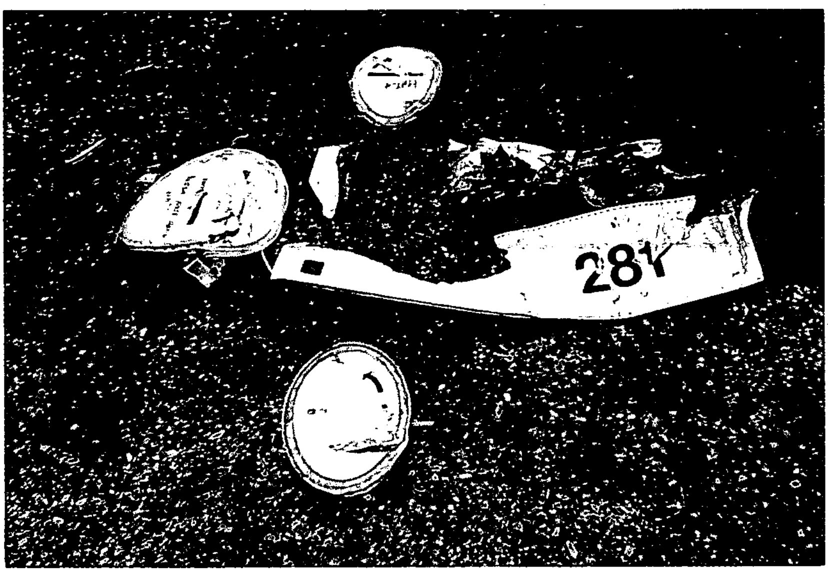
Right Front Cargo Door

Right Rear Cargo Door

Figures C-8, C-9

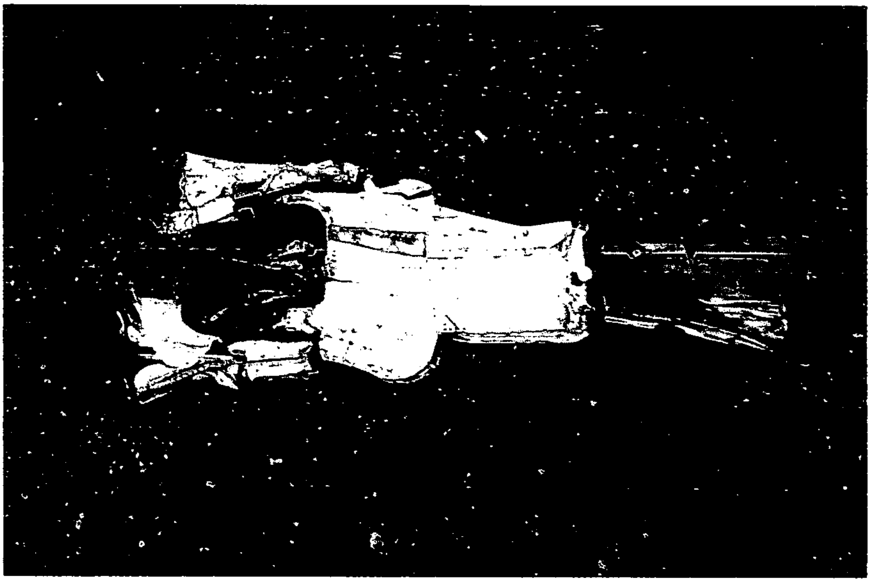


Exit Window

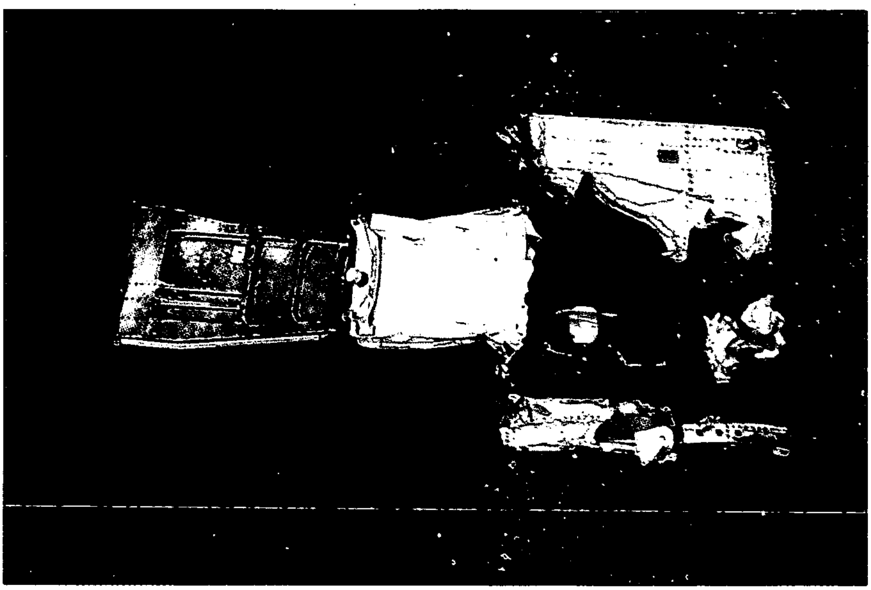


Nose Gear Doors and Service Doors 21A, 23A, 24A

Figure C-10, C-11



Left Main Gear Door



Right Main Gear Door

Appendix D

Occurrence No. 825-89-C0048

FLIGHT PATH RECONSTRUCTION REPORT

LP 97/89

Accident: Fokker F-28-1000
Reg. # C-FONF
10 March 1989

21/08/89 21.8.89

Prepared by:

M.R. Poole, P.Eng.
Superintendent, Computer Systems Engineering
Engineering Branch
Canadian Aviation Safety Board

R. Hoyle,
Computer Scientist/Analyst
Engineering Branch
Canadian Aviation Safety Board

L. Landriault,
Systems Manager/Technologist
Engineering Branch
Canadian Aviation Safety Board

1.0 INTRODUCTION

1.1 On Friday, March 10, 1989, a Fokker F28 (C-FONF) crashed in a wooded area shortly after take-off.

1.2 In support of the overall investigation, a three-dimensional flight reconstruction was requested by the Engineering Branch technical coordinator for the Dryden Accident. The flight reconstruction associated with this paper is depicted on standard VHS video tape (reference LP097/89). The video tape depicts a few sample views chosen to demonstrate the reconstruction. It should be realized that any desired view (including witness location views) can easily be generated.

1.3 Normally, flight reconstructions of this nature are based largely on flight recorder information. As no flight recorder data was available, the reconstruction was based on a review of the witness statements, the physical evidence of the trees cut by the aircraft on its trajectory, and past flight recorder data for this particular aircraft (reference LP040/97 - Flight Recorders Group Report).

1.4 The runway and surrounding geographical information were modeled in UTM grid coordinates from maps and photographs of Dryden Municipal Airport. Tree data was input as supplied by the Site Survey Group for the Dryden accident. Figure 1 shows an overall view of the airport and trees.

1.5 The F-28 aircraft was modeled from engineering drawings provided by Fokker.

1.6 It is important to note that this reconstruction depicts an approximation of the aircraft's flight path and behavior from the limited data available. The results are qualitative and should not be used for quantitative analysis. Any conclusions based on this reconstruction should be reviewed in light of the manner in which the reconstruction was produced.

2.0 INVESTIGATION

2.1.0 Assumptions for the Reconstruction

2.1.1 In order to reconstruct the estimated flight path, the following basic assumptions were made:

1 The aircraft does not begin to rotate until 3400 feet of distance (taxi-way alpha) based on witness statements.

2 The aircraft reaches Vref (126 knots indicated air speed as determined by the Operations Group) at 3400 feet of consumed runway (constant acceleration) and continues at Vref for the remainder of the flight.

3 The first rotation is at a 'typical' pitch rate based on previous flight data from C-FONF. The pitch attitude is allowed to reach 13 degrees. Thirteen degrees represents the maximum pitch attitude the aircraft may have reached (reference Performance Group Report).

4 At 13 degrees of pitch attitude the aircraft is rotated back down to an arbitrary attitude of five degrees. This was done so that the aircraft had two noticeable rotations as per witness statements.

5 The aircraft is then rotated for the second time to 11 degrees of pitch attitude (consistent with Performance Group scenarios).

6 The aircraft reaches an altitude of six feet during the first rotation and ten feet during the second rotation. Both altitudes are completely arbitrary.

7 The aircraft does not yaw or drift throughout the flight.

8 All tree cuts represent the point at which the aircraft contacted the tree. In other words, the trees did not bend or break off at a point lower than the point of contact.

9 The breakup sequence is not considered in the final group of trees.

10 The trees do not affect the flight path of the aircraft due to the relative mass of the aircraft and that of the trees.

- 3 -

11 The flaps were set at 25 degrees for the purpose of fitting the aircraft through the trees. (refer to the Systems Group Report).

12 The landing gear was assumed to be in the down position (refer to Structures Group Report).

2.2.0 Take-off Roll

2.2.1 The constant acceleration required to accelerate the aircraft to Vref at 3400 feet was determined as follows:

$$V_{ref} = at$$
$$d = 0.5\ at^2$$
Hence, $212.5\ ft/s = at$
$$0.5\ at^2 = 3400\ ft$$

$$0.5\ (212.5)t = 3400\ ft$$
$$t = 32.0\ s$$

$$a = 212.5\ ft/s\ /32.0\ s$$
$$a = 6.64\ ft/s/s\ (.21\ g)$$

2.2.2 Take-off fifteen (LP040/89) had an average acceleration of approximately .25 g. Higher take-off weight and runway slush would contribute to the lower acceleration level calculated above.

2.3.0 Tree-cut Path and Attitude Determination

2.3.1 A linear regression was initially fit through the x-y tree location data. The aircraft was then placed along this regression path at discrete locations (Figure 2). At each discrete location, a fit of roll, pitch, and altitude were attempted. In some cases, it was required to move the aircraft slightly off the regression to obtain a good fit. A smooth spline was then fit through the refined locations, as well as the take-off roll. This spline was then used as the flight path. This spline produced a smooth curve from the time the aircraft was assumed airborne during the second rotation to the heading determined from the regression through the trees.

2.3.2 In general, roll attitudes were more apparent than pitch attitudes due to the fact that pitch is in the same direction as the direction of flight. It was discovered that a number of different fits were possible, especially during the first tree locations where there were very few trees. In general, the solutions which yielded the least attitude deviations from level flight were chosen to estimate the flight path.

2.3.3 The attitudes and altitude (with respect to the mean runway elevation) for each of the eight fit locations were determined as follows (figures 3 through 10):

Location	Time (sec)	Roll (degrees)	Pitch (degrees)	Altitude (feet)
1(see note)	47.2	6.4	5.5	-1.3
2	48.6	-1.1	5.5	2.0
3	50.0	6.0	5.5	-2.3
4	53.2	6.4	3.1	-5.5
5	56.2	-10.1	-1.0	-10.8
6	56.3	-10.3	-1.3	-10.5
7	56.4	-10.5	-1.3	-11.1
8	56.5	-13.9	-3.6	-10.5

Note: For the first location, it was reported that the anti-collision light on the belly of the aircraft was struck off by one of the two trees. Due to the geometry of the aircraft, the aircraft would have to have been pitched up a least 5.5 degrees such that the nose gear would clear the top of the clipped tree. If the aircraft were level, for instance, the nose gear would have clipped the tree and the tree would have then been too short to hit the anti-collision light.

2.4.0 Data Generation Summary

2.4.1 A graphical representation of the ground velocity, heading, roll, pitch and altitude data used in the reconstruction is shown in Figure 11.

2.4.2 Once the reconstruction is generated, the 'camera' positions, perspectives and orientations the computer system can generate are infinite. Typical orientations are chase plane views, cockpit views and fixed views in space. Since the witness locations were plotted in the reconstruction, it was possible to place the observer at a witness location to view the sequence. A 'knob box' input device allowed the user to rotate the observer's head from left to right or up and down. This view revealed the relative size of the aircraft, given the distances involved. In general, views generated from the witness locations demonstrated that the aircraft would have been difficult to see due to the distances involved, even in the best of environmental conditions.

2.4.3 The tree-fit data where available was considered more reliable than witness information. The physics and geometry of the circumstances of the Dryden accident do not allow for a great deal of flexibility in the reconstruction. For example, the aircraft could not have reached much altitude when clearing the end of the runway in order to hit the first trees and continue on a fairly flat altitude. Similarly, roll and pitch attitude rates are generally limited by the mass and consequent momentum of the aircraft.

2.4.4 The positive pitch attitudes determined through the initial trees correlate with the relatively flat altitude history. A positive pitch attitude would likely have been required to maintain the altitude displayed through the trees.

3.0 EVALUATION

3.1 The flight reconstruction represents an approximate depiction of the aircraft's flight path and attitudes during the accident sequence. The reconstruction is based on the physical evidence of the tree strikes, witness information and past empirical flight recorder data.

3.2 For the purposes of this flight reconstruction, witness information was considered very subjective and qualitative. The physical evidence of the tree strikes was considered to have relatively good reliability. The data provided many possible flight attitudes. In general, attitudes were chosen which deviated the least from level flight. The reconstruction should therefore be viewed with caution. Any conclusions drawn based on the flight reconstruction should be made with full cognizance of its method of production, assumptions and approximations.

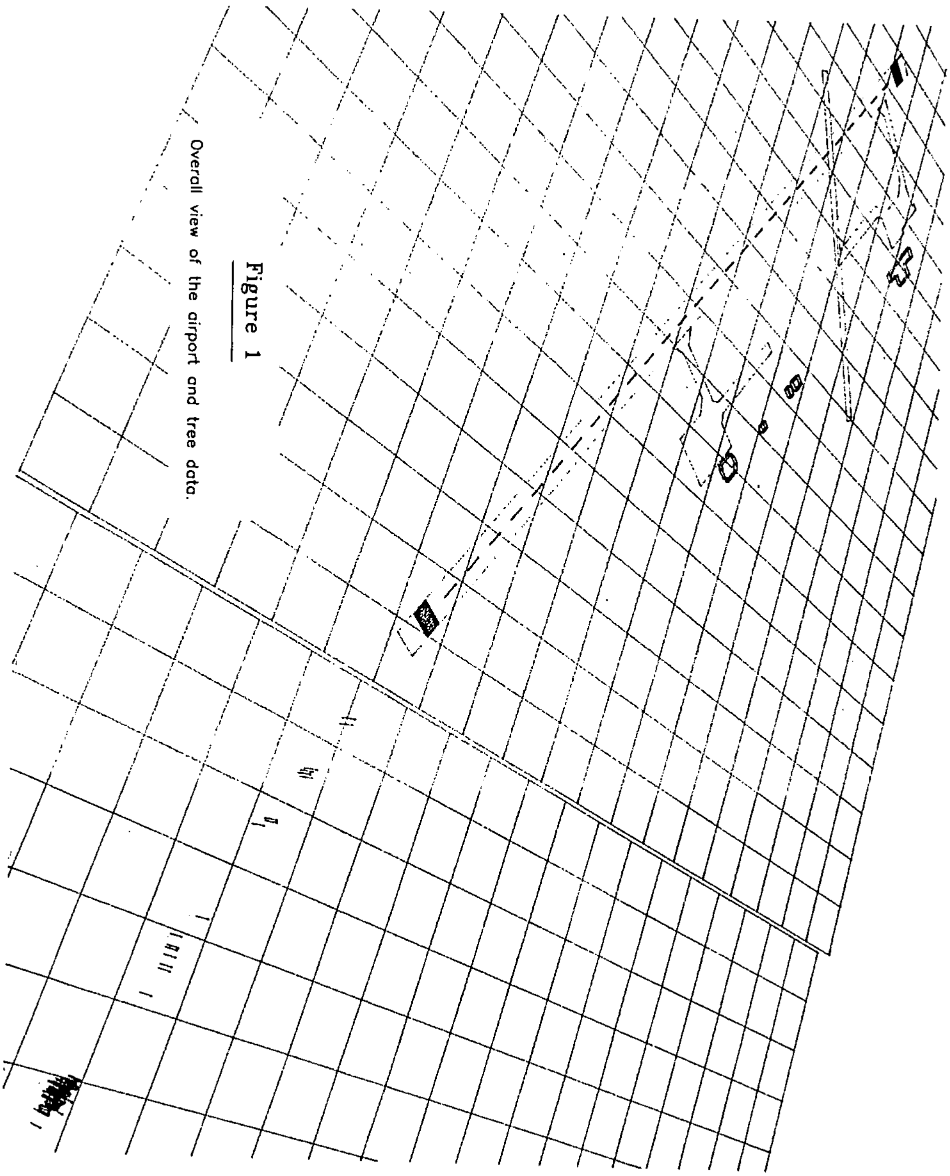


Figure 1

Overall view of the airport and tree data.

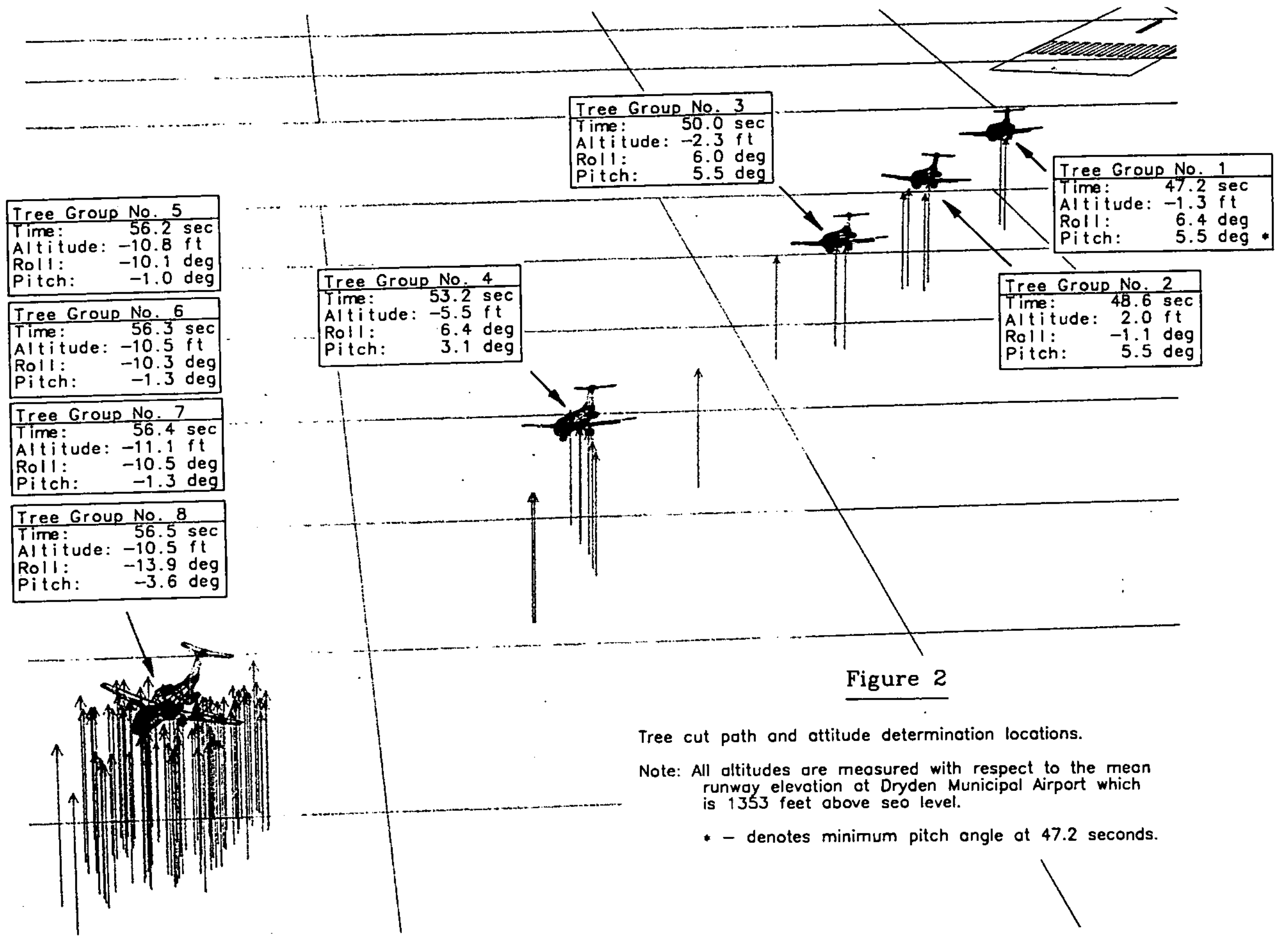


Figure 2

Tree cut path and attitude determination locations.

Note: All altitudes are measured with respect to the mean runway elevation at Dryden Municipal Airport which is 1353 feet above sea level.

* – denotes minimum pitch angle at 47.2 seconds.

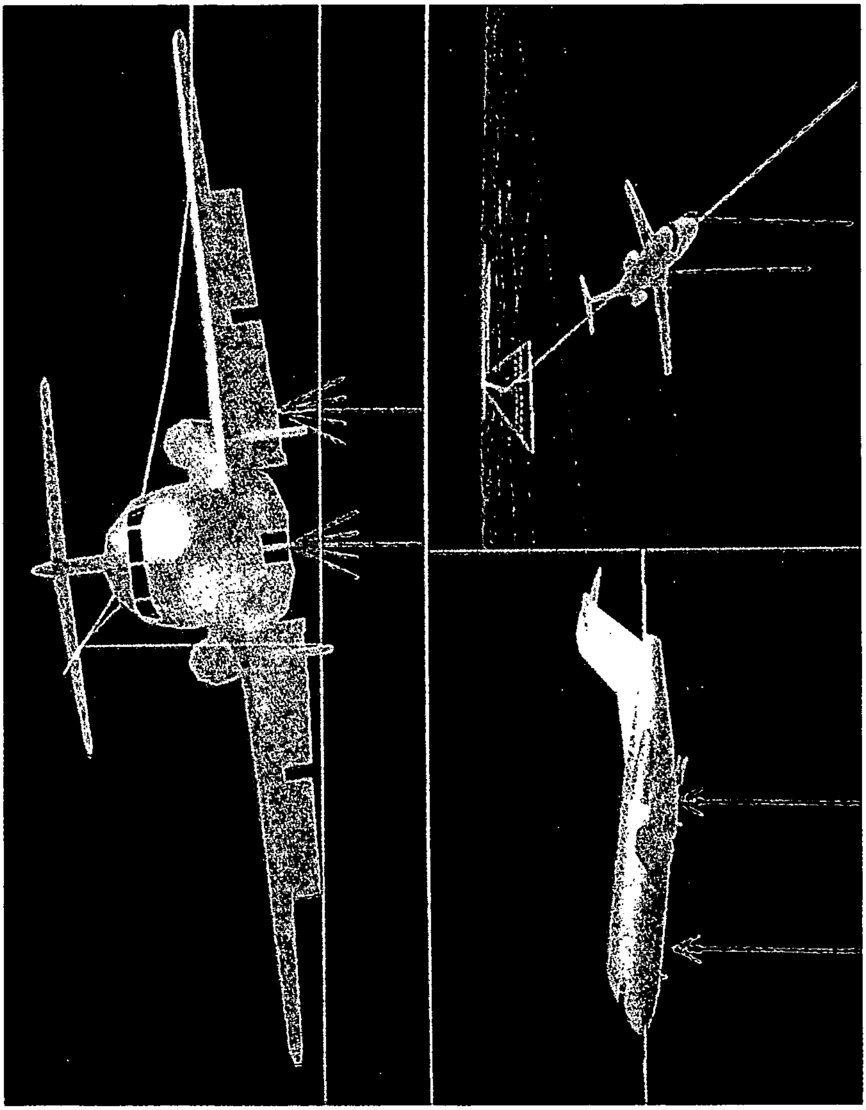


Figure 3 - Fit at location 1.

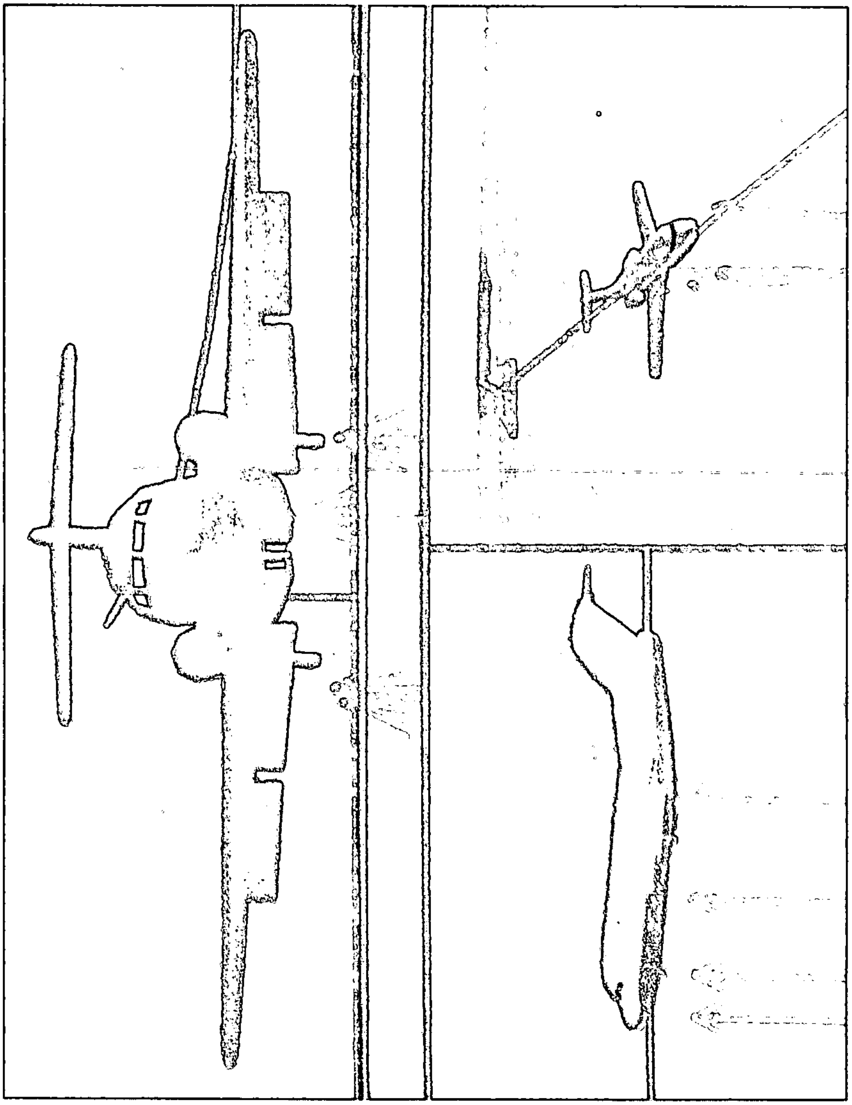


Figure 4 - Fit at location 2.

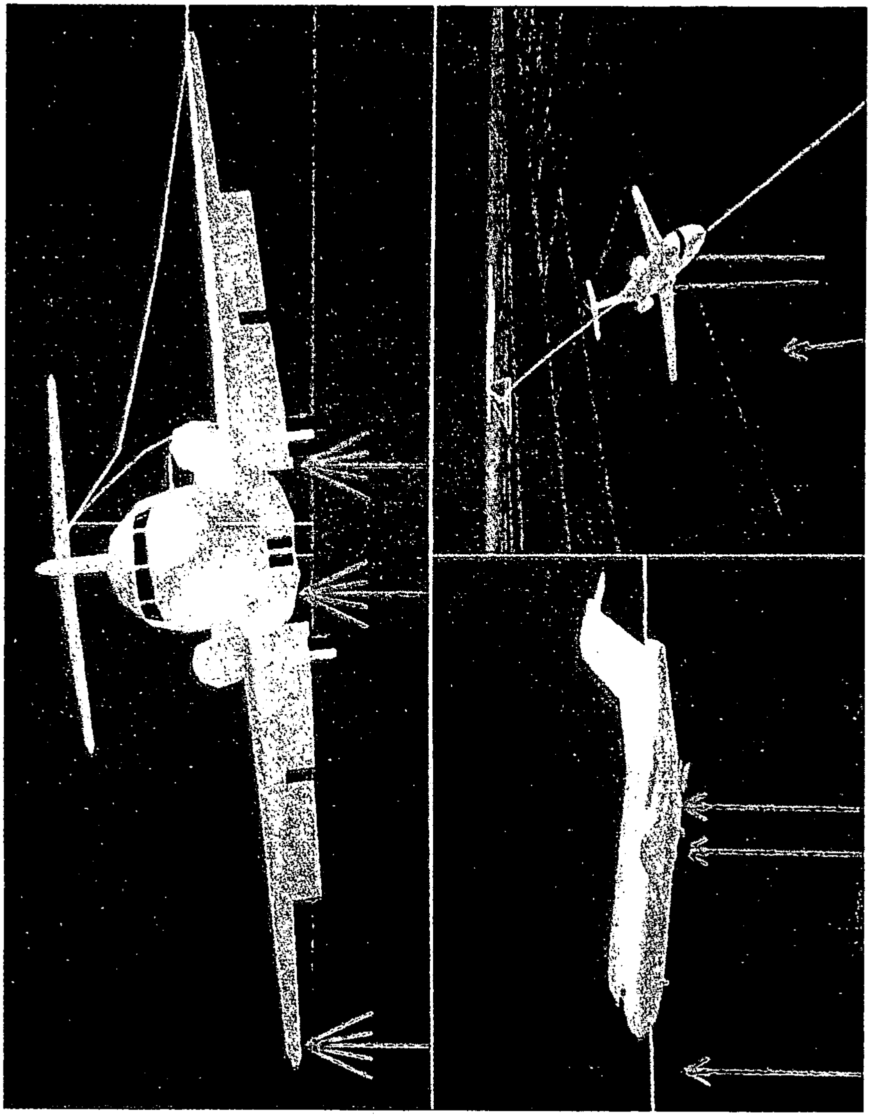


Figure 5 - Fit at location 3.

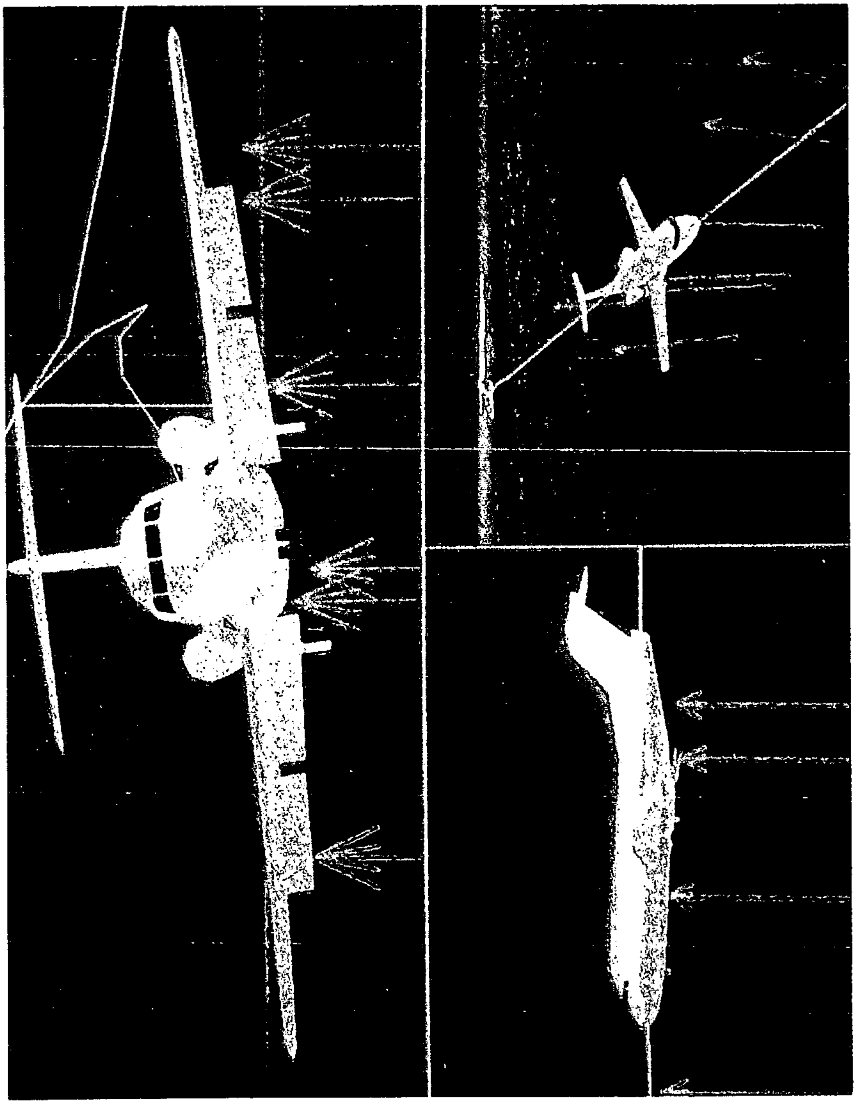


Figure 6 - Fit at location 4.

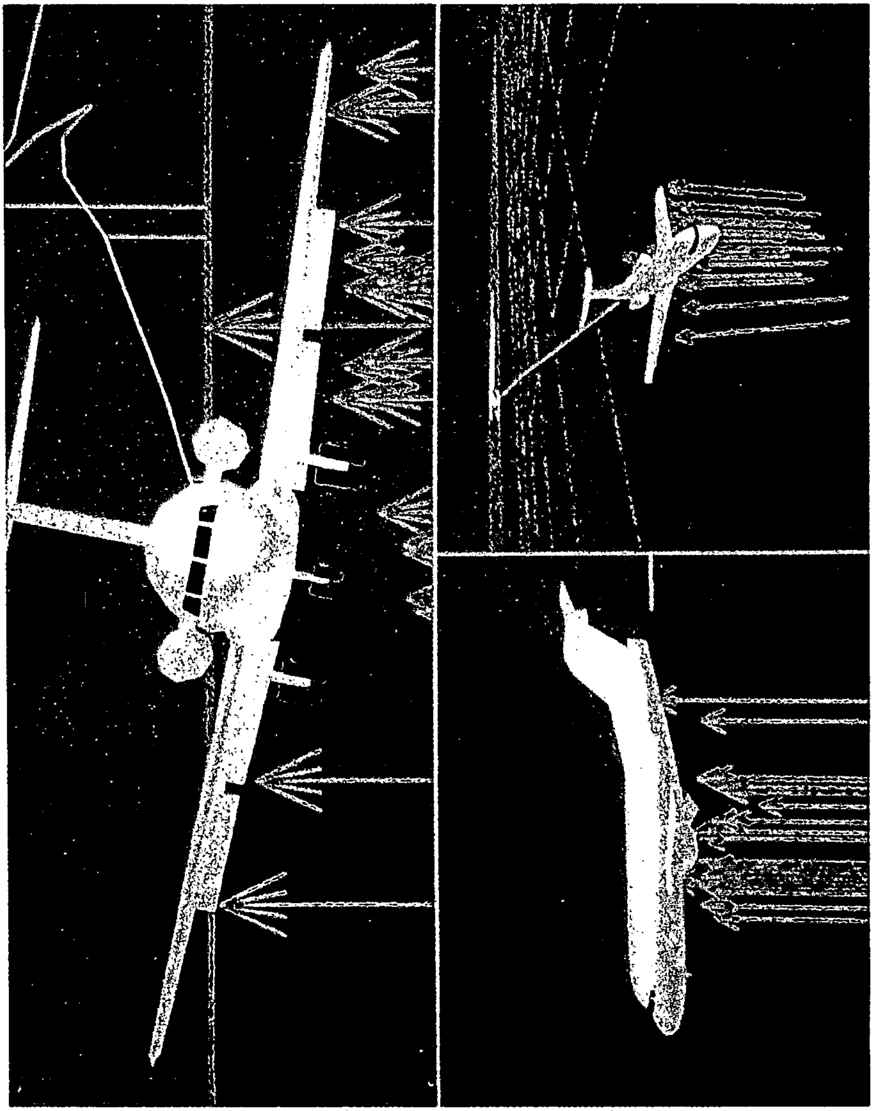


Figure 7 - Pit at location 5.

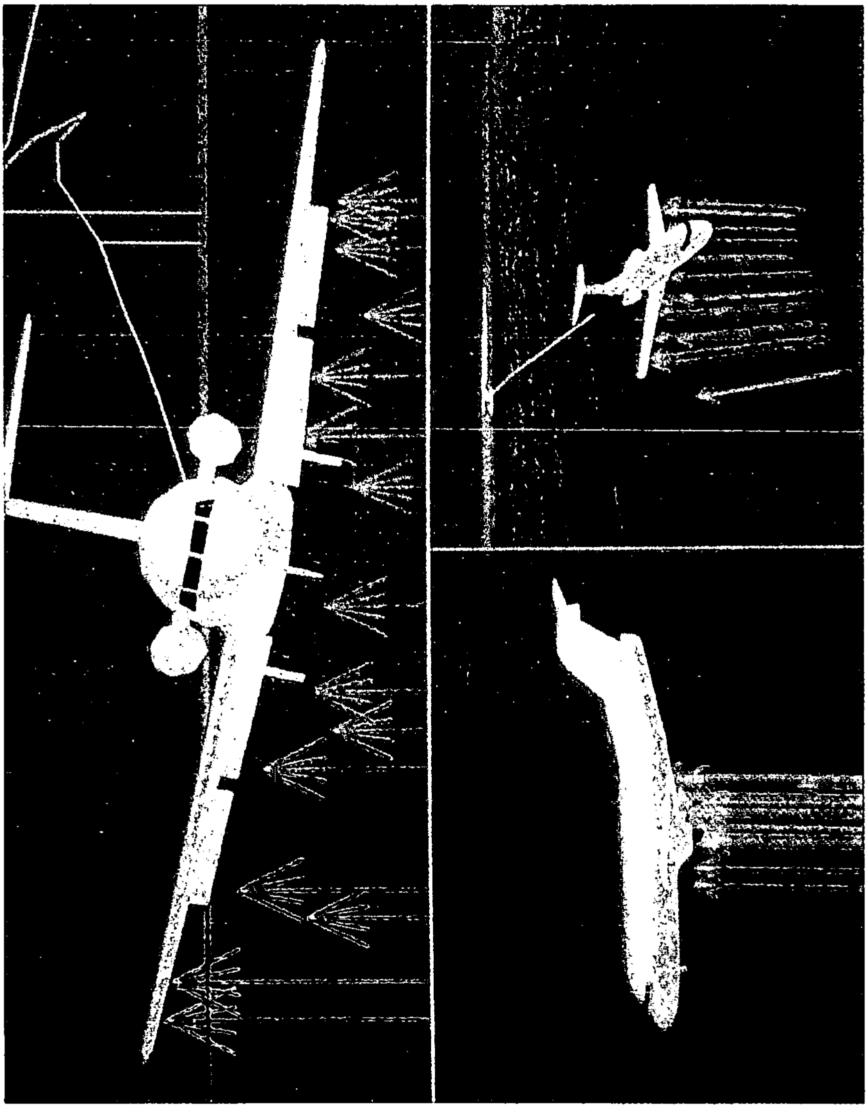


Figure 8 - Fit at location 6.

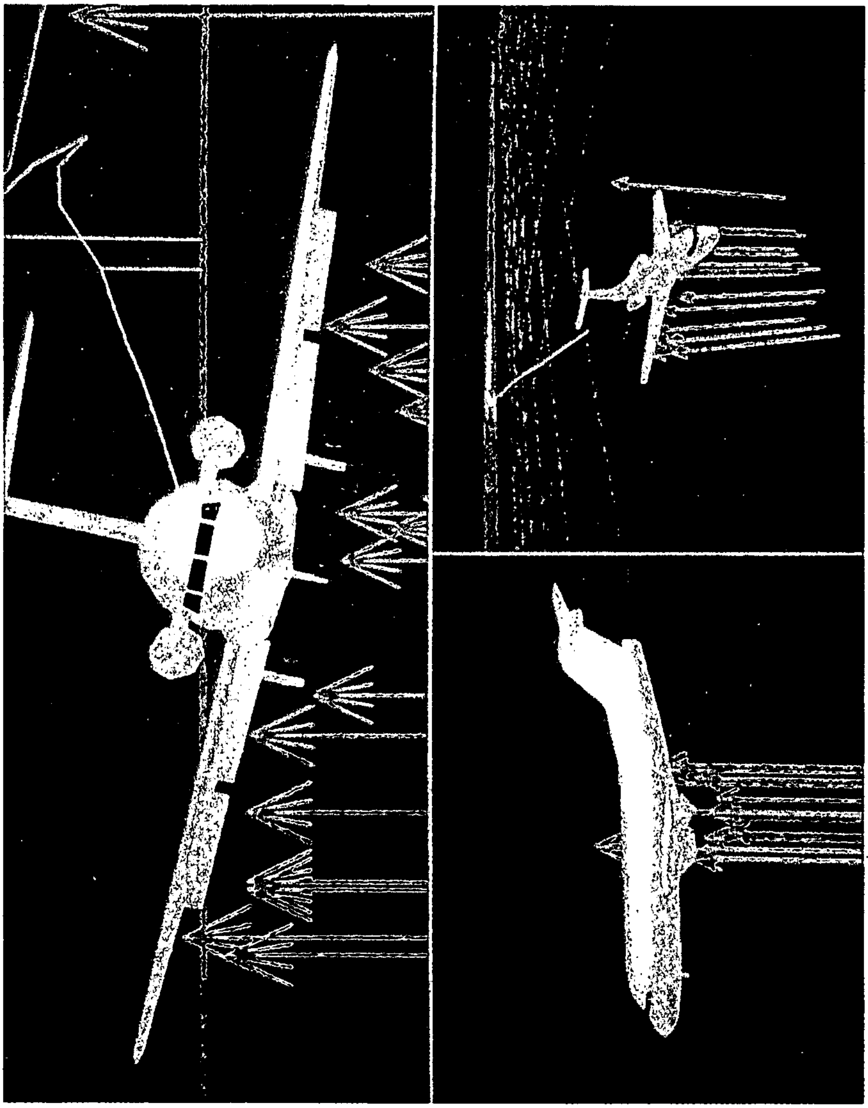


Figure 9 - Fit at location 7.

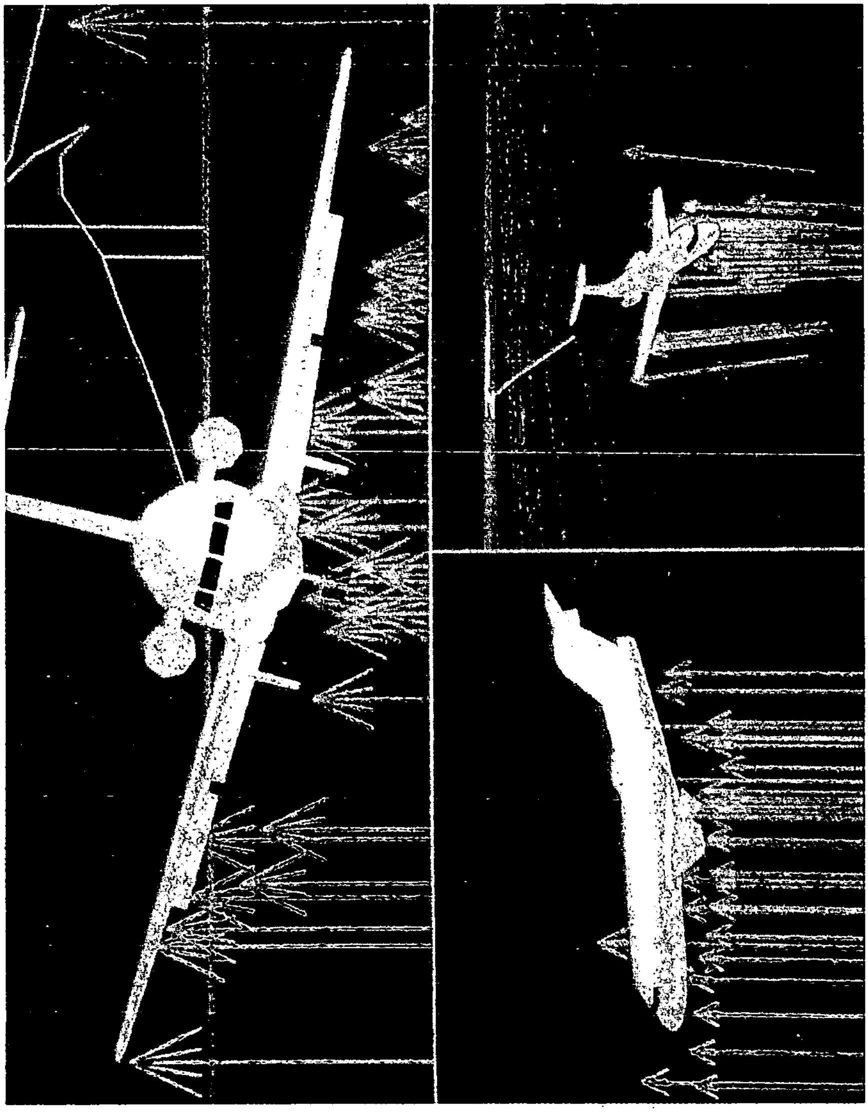


Figure 10 - Pit at location 8.

CFONF Estimated Velocity, Heading, Attitude and Altitude vs. Flight Time

– *based on previous flights and tree-cut analysis*

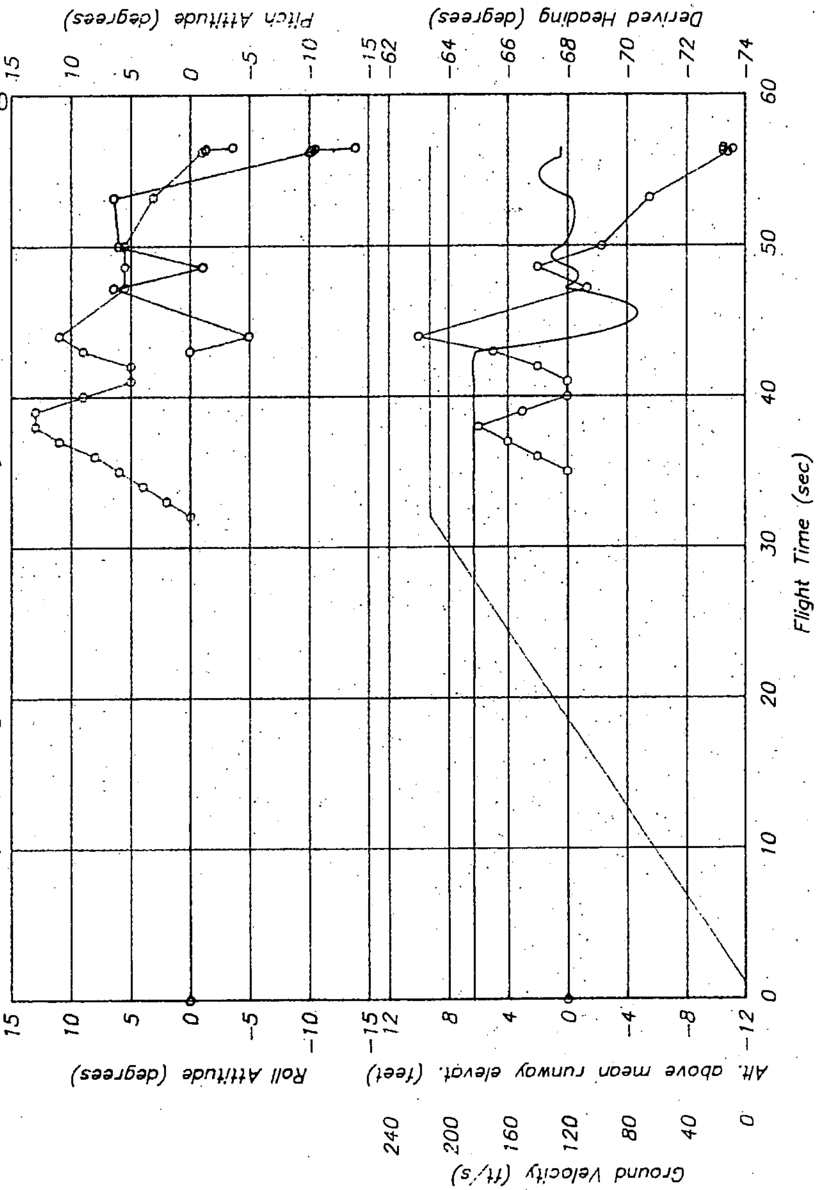


Figure 11

Engineering Branch/CASB

Appendix 2

Fokker Aircraft B.V. Amsterdam
Fokker Aerodynamics
Report No. L-28-222
Note on the Aircraft Characteristics as Affected by Frost, Ice or Freezing Rain Deposits on Wings

December 16, 1969

Fokker

N.V. KONINKLIJKE NEDERLANDSE VLIEGTUIGENFABRIEK FOKKER
ROYAL NETHERLANDS AIRCRAFT FACTORIES FOKKER
SCHIPHOL-ZUID THE NETHERLANDS

RAPPORT ÷ REPORT

AFDELING DEPARTMENT	Aerodynamics Department	RAPPORT NR. REPORT NR.	L-28-222
DATUM DATE	December 16th, 1969	RUBRICERINGS-KODE CLASSIFICATIONS CODE	RK

ONDERWERP ÷ SUBJECT Note on the aircraft characteristics as affected by frost, ice or freezing rain deposits on wings.

SAMENVATTING ÷ SUMMARY

OPGESTELD ÷ PREPARED
Ir. Tj. Schuringa
J.H.D. Blom

GEZIEN ÷ APPROVED
J.H.D. Blom

GEKONTROLEERD ÷ CHECKED

AANTAL BLADEN ÷ NUMBER OF PAGES 1 + 7

FORMAAT ÷ SIZE A4 = 8
A3 =
A2 =
A1 =

FOTO NRS. ÷ PHOTO NRS.

TEKENING NRS. ÷ DRAWING NRS.

HERZIENINGS-NR ÷ RE-ISSUE NR. DATUM ÷ DATE

WIJZIGINGEN ÷ REVISIONS DATUM ÷ DATE

KOPIE AAN ÷ COPY TO

Introduction

Generally, it is well known that the contamination of the wing and tail of parked aircraft by snow produces a potential hazard during take-off and subsequent flight. It is, therefore, a widely accepted practice to remove snow prior to take-off. However, the effects of thin layers of deposits, resulting from e.g. frost or light freezing rain, are often not considered to be detrimental to the take-off characteristics.

This Note deals with these deposits, which create some sort of sandpaper like roughness on the wing upper surface. Firstly a general discussion is given, secondly the take-off characteristics as affected by precipitation will be discussed. The Note closes with a conclusion.

1. Take-off lift as affected by sandpaper wing roughness

The effect of thin deposit layers on wing surfaces causing sandpaper-like roughness can be shown by comparing the lift characteristics of a contaminated wing with those of a clean wing.

In figure 1 the relationship is depicted between lift and incidence of a clean, thus non-contaminated wing. The amount of lift to get the aircraft off the ground at the lift-off speed, V_{LOF}, is less than the maximum lift which the wing is able to deliver. This reserve in lift is ensured by the Airworthiness Requirements on Performance used during the certification of the aircraft.
During the take-off run the aircraft will rotate up to an incidence at which the lift is sufficient to get the aircraft off the ground. In the case of a jet aircraft, see lower curve in figure 1, this occurs at point A ensuring an incidence reserve against the stall incidence by the margin a.

For the case of the same wing being used on a propeller driven aircraft with the same T.O.W., this incidence reserve is much greater as the propeller slipstream increases the wing lift. In both cases, however, the V_R-, V_{LOF}- and V_2 speeds are based on the same power-off conditions.

For a typical case of a propeller driven aircraft, see upper curve in figure 1, the lift curve shows lift-off at point B and an incidence reserve against stalling of margin b.

In figure 2, which is based on windtunnel tests simulating the full scale frost or light freezing rain type roughness on the windtunnel model, a considerable reduction is shown in both maximum lift capability and stall incidence of a contaminated wing compared with the clean wing in figure 1.

The propeller aircraft, lifting off at the same incidence, B, has a considerably reduced reserve against stalling; the margin b in figure 1 is reduced to margin b' in figure 2. This situation will however escape notice in flight, at least with all engines operating, as the behaviour of the aircraft is essentially the same as with a clean wing. This is more the case as the difference in wing drag due to the assumed roughness will not be critical under these conditions.

The jet aircraft, however, will be in a stalled condition when it is rotated up to and beyond the incidence at point A. Consequently, it will show characteristics quite different from those at a "normal" take-off.

2. Take-off characteristics

In figure 3 the effects of "sandpaper" roughness on take-off characteristics are shown in more detail. The graphs of lift versus incidence and versus aerodynamic drag are based on windtunnel and flight tests of the F-28. Windtunnel tests show that comparable jet aircraft suffer similar lift and drag penalties due to the same type of roughness.
When the aircraft is rotated at V_R the body angle of incidence does not normally exceed approximately 8 degrees, leaving a 3 degrees reserve before stickshaker activation and approximately 5.5 degrees before the maximum lift is reached. This latter corresponds with a flight condition out of ground proximity.. When on the other hand "sandpaper" roughness is present on the wing top surface the probability of encountering a wing stall at the normal maximum incidence of 8 degrees is rather high. This depends somewhat on type and extent of the frost roughness.

The wing stall developed under these conditions is particularly dangerous because the inherent good stalling characteristics of the clean wing are lost. An uncontrollable roll accompanies the asymmetric stall provoked by roughness, and in addition a tremendous increase in drag develops upon slight overrotation of the aircraft. The latter is very likely to happen in ground proximity when the aircraft does not appear to gain its customary height.
Both effects are further illustrated in figure 3.

The F-28 wing is designed for a slow progression of flow separation towards the wing tip with increasing incidence, thus ensuring perfect roll control throughout a stall test manoeuvre. The uncontaminated wing shows initial local separation at the stickshaker incidence, 11 degrees angle of incidence , the maximum lift is reached at 13 to 14 degrees angle of incidence and flow separation does not affect roll control until an incidence of 20 degrees is reached.
In ground proximity with the main wheels in light touch with the ground the maximum angle of incidence which could be tested, without tail scrubbing, was 15 degrees.
At this angle the flow separation was still restricted to the area inboard of the kink in the wing leading edge and perfect roll control was preserved.
With frost roughness present on the wing upper surface the characteristic of slow stall progression towards the wing tip is lost and uncontrollable roll may develop at angles of incidence as low as 10 degrees, as indicated in the left graph of figure 3.
In the right graph of figure 3 the effects of roughness on drag are illustrated. The drag of the clean wing is such that the aircraft is capable of climbing away at the required climb angle at V_2 with one engine inoperative. In the case of a contaminated wing the drag may, however, be doubled due to a wing stall which occurs at an angle of incidence only slightly greater than that for stickshaker operation.
Consequently, acceleration is lost even with all engines operating at T.O. power.

Conclusion

In the interest of flight safety complete removal of relatively thick layers of snow and ice from wing and tail surfaces is very common.
However, also sandpaper-like roughness caused by thin deposits due to frost or light freezing rain must be completely removed prior to take-off, in particular of jet propelled aircraft.

N.V. KONINKLIJKE NEDERLANDSE VLIEGTUIGENFABRIEK FOKKER
ROYAL NETHERLANDS AIRCRAFT FACTORIES FOKKER

RAPPORT NR. ÷ REPORT NR.
L-28-222

blad. page 5

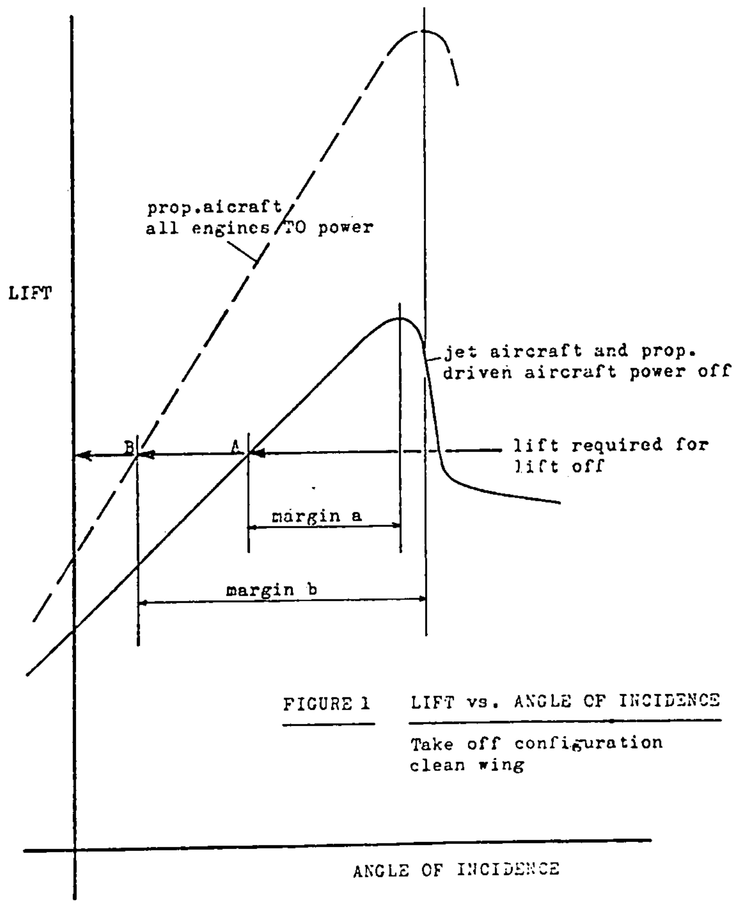


FIGURE 1 LIFT vs. ANGLE OF INCIDENCE

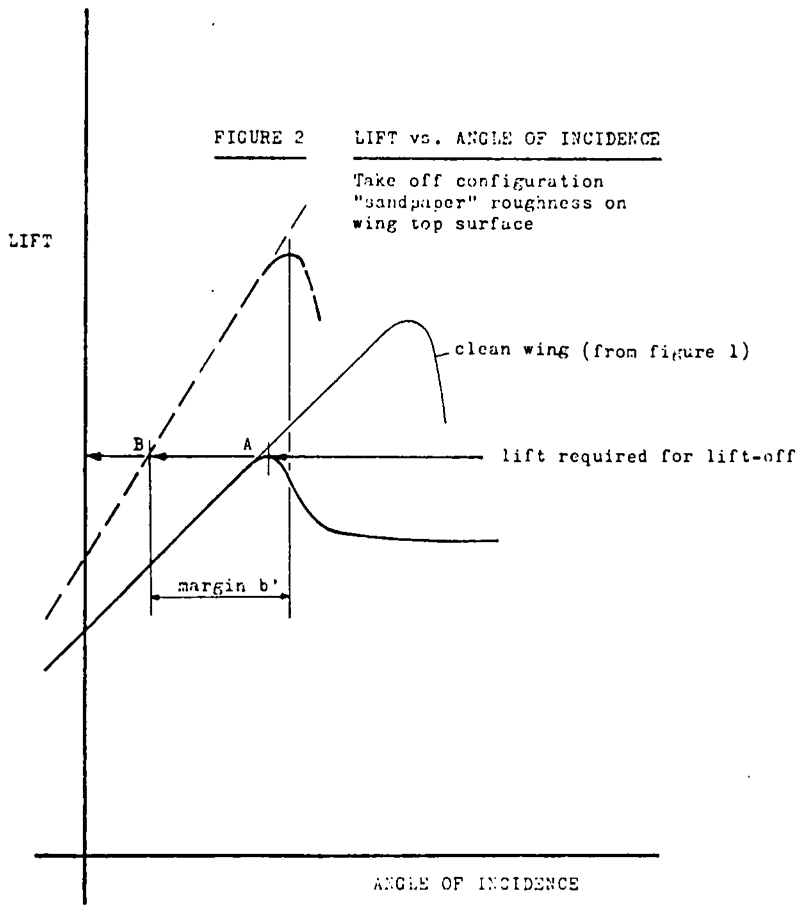
Take off configuration
clean wing

N.V. KONINKLIJKE NEDERLANDSE VLIEGTUIGENFABRIEK FOKKER
ROYAL NETHERLANDS AIRCRAFT FACTORIES FOKKER

RAPPORT NR. ÷ REPORT NR.
L-28-222

blad. page 6

FIGURE 2 LIFT vs. ANGLE OF INCIDENCE

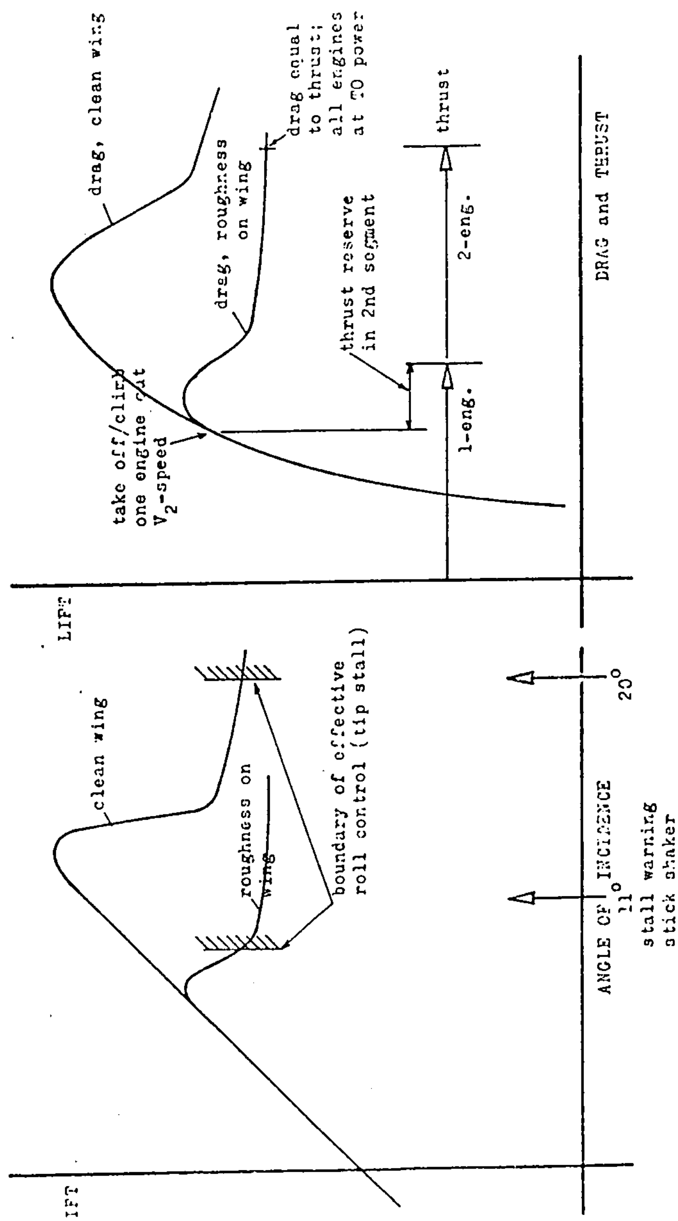


N.V. KONINKLIJKE NEDERLANDSE VLIEGTUIGENFABRIEK FOKKER
ROYAL NETHERLANDS AIRCRAFT FACTORIES FOKKER

RAPPORT NR. - REPORT NR. 1-28-222

blad. page 7

FIGURE 3 FOKKER F28 EFFECT OF "SANDPAPER" ROUGHNESS ON TAKE OFF/CLIMB



Appendix 3

Fokker Aircraft B.V. Amsterdam
Report No. VS-28-25
Flight Simulator Investigation into the Take-off Performance Effects of Slush on the Runway and Ice on the Wings of a Fokker 100

August 1989

REPORT
Fokker Aircraft B.V. Amsterdam
The Netherlands

issue date: August 1989 issue no: 2

security class Restricted	report no. VS-28-25
plant/department Schiphol/EDAA	order no. 22192
controlled copies ED100 Mr. den Hertog EQFA Mr. Jellema EDVP Mr. de Boer EDAA Mr. van Hengst ELTS CASB via EQFA	title: Flight simulator investigation into the take-off performance effects of slush on the runway and ice on the wings of a Fokker 100.
	enclosures:

summary:

Simulations have been executed on the Fokker fixed base engineering flight simulator, in which the Fokker 100 was modelled.
Test conditions were selected to represent the take-off performance of the F-28 Mk1000 as during the accident on Dryden Airport, Ontario, on March 10, 1989.
A comprehensive set of runway slush and wing ice conditions has been investigated.

Issue 2: Test results for flap 25 is added.

prepared/department	checked/department	original issue date
B.J. Warrink/EDAA/SB BW	N. v.d. Bovenkamp/EDAA/SB	June 1989
approved/department	approval others	
J. v. Hengst/EDAA	R. Jellema/EQFA	

page 1 of 52 pages

form 1146 02-85 3 90 01

REPORT
Fokker Aircraft B.V. Amsterdam
The Netherlands

issue date: August 1989 issue no: 2

security class Restricted | report no. VS-28-25

LIST OF EFFECTIVE PAGES

Page	iss.date	iss.nr	Prepared	Checked	Approved
1	August'89	2	B.J. Warrink	N. v.d. Bovenkamp	J. van Hengst
2	"	2	"	"	"
3	"	2	"	"	"
4	"	2	"	"	"
5	"	2	"	"	"
6	June '89	1	"	"	"
7	"	1	"	"	"
8	"	1	"	"	"
9	August'89	2	"	"	"
10-37	June '89	1	"	"	"
38-49	August'89	2	"	"	"
50-51	June '89	1	"	"	"
52	August'89	2	"	"	"

form 1146 02-85 3 90 01

R E P O R T
Fokker Aircraft B.V. Amsterdam
The Netherlands

issue date: August 1989 issue no: 2

security class Restricted | report no. VS-28-25

Introduction

In the week of June 5th-9th, 1989, a delegation of the Canadian investigative authorities visited Fokker at Schiphol to discuss the accident of an F-28 Mk1000 near Dryden Airport on March 10. The discussion with respect to performance and flight handling was with:

Mr. D. Langdon	CASB
Mr. G. Wagner	Concordia University (CALPA/Advisor to Commissioner)
Mr. M. Morgan	NAE
Mr. D. Wickens	NAE

No calculation- or simulation models were available of the F28 Mk1000. To investigate the effect of slush on the runway and ice on the wings, use has therefore been made of the Fokker 100 simulation model. The use of this model in stead of the F28 Mk1000 can be justified with:

- a take-off weight (87000 lbs) was selected which resulted in the same take-off speeds as for a Mk1000 at the weight in the Dryden accident (63500 lbs).
- a thrust setting was selected which gave the same thrust/weight ratio and thus the same take-off distance and climb performance.
- a c.g. position was used (30% mac) that gives the same rotation pitch response as a Mk1000 with the c.g. at 22% mac.
- the simulation of ice and ground effects is much better in the Fokker 100 aero model than in the former F-28 Mk1000 (n.b. The Fokker 100 aero model is certified by the FAA to phase 2 standard).
- the Fokker 100 angles-of-attack for stall warning and stall are close to those of the F28 Mk1000 (flap 18, clean wing): F28 Mk1000 11.0 deg and 13.5 deg and Fokker 100 13.0 deg and 15.5 deg respectively.

Due to differences in lift/drag ratio etc., the representation of F28 Mk1000 by the Fokker 100 is of course not perfect, but considered close enough for a qualitative assessment.

On request of the Canadian investigative authorities, the take-off performance for flap 25 has been investigated by Fokker in August 1989.

The simulation results are presented in this report. They are intended to support the investigation into the cause of the Dryden accident.

REPORT
Fokker Aircraft B.V. Amsterdam
The Netherlands

issue date: August 1989 issue no: 2

security class Restricted | report no. VS-28-25

Simulation model

The aerodynamic model as used in the simulations is according to reference 2.

Ice on the wing is simulated as a change in lift-, drag- and pitching moment coefficient. The magnitude of it has been determined in the windtunnel, in which one inch thick horn shaped ice on the leading edge was simulated. From tests with different ice shapes and from literature it is known that these effects are also valid for rime ice or frozen slush in the leading edge region. Through calculations in which static equilibrium conditions are determined the effect of 1 inch ice (in ground- effect) on lift, flight path angle and elevator deflection has been assessed. See figures 1, 2 and 3.
In the simulation the effect of ice on the wing could be linearly varied between 0 and 1.0 inch.

Slush on the runway was modelled through a rolling friction coefficient (upto mu = .15) in the ground roll model. This coefficient depends on the Equivalent Water Depth and the ground speed, according to reference 3. The slush thickness was varied between 0 and 0.5 inch E.W.D. in the simulation.

Simulator tests

Three series of simulator sessions on the fixed-base simulator were executed, two flown by mr. G. Wagner and the third flown by mr. J. Hofstra (Fokker test pilot).

1. June 7th. Preliminary investigations into the effect of slush and ice. Take-offs at ISA/SL, Flap 18.
   See table 1 for the conditions and the take-off distances.

2. June 8th. Detail investigations thru 20 take-offs at Zürich, 1500 ft elevation/0 C, Flap 18.
   See table 2 and the figures 4 to 22.

3. August 1. Detail investigations thru 12 take-offs at Zürich, 1500 ft elevation/0 C, Flap 25.
   See table 3 and the figures 23 to 34.

REPORT
Fokker Aircraft B.V. Amsterdam
The Netherlands

issue date: August 1989 issue no: 2

security class Restricted | report no. VS-28-25

Parameters

The following parameters are presented in the plots:

Parameter	Unit	Description
ALFA	deg	Angle of attack
CAS	kts	Calibrated airspeed
DE	deg	Elevator deflection
HRADIO	m	Radio height; equals zero for stretched undercarriage at zero pitch-angle. At lift-off HRADIO = .7 m due to pitch angle
TETA	deg	Pitch angle
XDIST	m	Distance along runway. XDIST = 0 at start of take-off roll.

Observations from the tests

1. The take-off distance without slush or ice has been approximated fairly through weight and thrust selection (at 1500 ft field elevation/0 C):

		F28 Mk1000 AFM	Fokker 100 simulation	Flap
TOD	m	1400	1455	18
	ft	4600	4770	
	m	1350	1340	25
	ft	4430	4400	

2. The increment in take-off distance (from standstill to 35 ft altitude) agrees well between simulation and AFM (no ice on wing), Flap 18 only.

Slush Depth inch EWD	F28 Mk1000 AFM ft	Fokker 100 simulation ft
0	0	0
.15	350	
.2	520	440
.25	650	850
.5	1770	1490

3. The effect of ice on the wing is considerable (see figures 35,36 and 37). Above a certain ice thickness the performance loss is so large that the aircraft cannot climb out off ground-effect (30 m) anymore.

4. Engine failure at V_1 is catastrophic when combined with slush on the runway and some ice on the wing leading edge.

5. The airfield elevation (1500 ft versus sea-level) has increased the sensitivity to ice on the wing. Compare figures 35 and 36.

REPORT
Fokker Aircraft B.V. Amsterdam
The Netherlands

issue date: August 1989 issue no: 2

security class Restricted | report no. VS-28-25

References

1. Fokker report L-28-269, issue 5.
   Flight Simulator Data for the Fokker F28 Mk0100 aircraft.
   E. Obert/Dept. CB-AP/April 1973.

2. Fokker report L-28-336, issue 8.3.
   Aerodynamic data of the Fokker 100.
   EDAA/SB/Oct. 1988.

3. Fokker F28 Mk1000 Airplane Flight Manual Section 2.11.5
   "Take-off from slush covered runways".

REPORT
Fokker Aircraft B.V. Amsterdam
The Netherlands

issue date: August 1989 issue no: 2

security class Restricted | report no. VS-28-25

Table 1

Take-off distances of simulations on June 7th
Fokker 100, Flaps 18 deg, W - 87000 lbs, CG = 30%, EPR = 1.62, ISA/SL,
V_1 = 124 kt, V_2 = 128 kt. (see page 2)

Run	Slush inch EWD	Ice	Rotation	TOR m	TOD (to 35 ft) m
1	.5	0	Normal	1290	1480
2	0	0	"	970	1180
3	.5	0	Nosewheel lift	1280	1460
4	.5	0	" "	1230	1450
5	0	.25	Normal	950	1180
6	0	.50	"	970	1260
7	0	.75	"	960	1640
8	0	1.00	"	980/2380	2690
9	.5	.75	"	1290	1920
10	.5	1.00	"	1330/4860	5300

form 1146 02-85 3 90 01

REPORT
Fokker Aircraft B.V. Amsterdam
The Netherlands

issue date: August 1989 issue no: 2

security class Restricted | report no. VS-28-25

Table 2

Take-off distances of simulations on June 8th
Fokker 100, Flaps 18 deg, CG = 30%, EPR = 1.62, 1500 ft/0xC
V_1 = 124 kt, V_2 = 128 kt. (see page 2)

Run	Figure	Weight lbs	Slush inch EWD	Ice	Remark	TOR m	TOD (to 35′) m
1	4	87000	0	0		1265	1455
2	5	87000	.25	0		1500	1715
3	6	87000	.2	0		1395	1590
4	7	87000	.5	0		1730	1910
5	8	87000	.2	.5		1430	1730
6	9	87000	.15	.5		1380	1705
7	10	87000	.15	.6		1410	1870
8	11	87000	.15	.7		1575	2090
9	12	87000	.15	.75		1585	2255
10	13	87000	.15	.75		1545	2285
11	14	87000	.15	.75	Slow rotation	1555	1850
12	15	87000	.15	.8		1830	2410
13	16	89000*	.15	.75		1665	2410
14	-	89000	.15	.8			
15	17	89000	.15	.8		2260	4490
16	18	89000	.15	.825		1935	crash
17	19	89000	.15	.8		2745	crash
18	20	89000	.15	.4	Engine failure V_1	1680	crash
19	21	89000	.15	.25	Engine failure V_1	1545	crash
20	22	89000	.15	.1	Engine failure V_1	1540	crash

* to simulate weight increment due to snow and ice on wing and fuselage

form 1146 02-85 3 90 01

R E P O R T
Fokker Aircraft B.V. Amsterdam
The Netherlands
issue date: August 1989 issue no: 2

security class Restricted | report no. VS-28-25

Table 3

Take-off distances of simulations on August 1
Fokker 100, Flaps 25 deg, CG = 30%, EPR = 1.62, 1500 ft/0 C
V_1 = 120 kts, V_2 = 128 kts.

Run	Figure	Weight lbs	Slush inch EWD	Ice	Remark	TOR m	TOD m
1	23	83900	0	0		1165	1340
2	24	83900	.15	.5		1300	1545
3	25	83900	.15	.6		1285	1580
4	26	83900	.15	.7		1290	1695
5	27	83900	.15	.75		1270	2360
6	28	83900	.15	.8		1250	3210
7	29	83900	.15	.9	No lift off	1270	-
8	30	85900*	.15	.5		1270	1580
9	31	85900	.15	.6		1285	1716
10	32	85900	.15	.7		1300	2015
11	33	85900	.15	.75		1300	CRASH
12	34	85900	.15	.8		1300	CRASH

* to simulate weight increment due to snow and ice on wing and fuselage

form 1146 02-85 3 90 01

REPORT
Fokker B.V. Amsterdam
The Netherlands

issue date: JUNE 1989 issue no.:

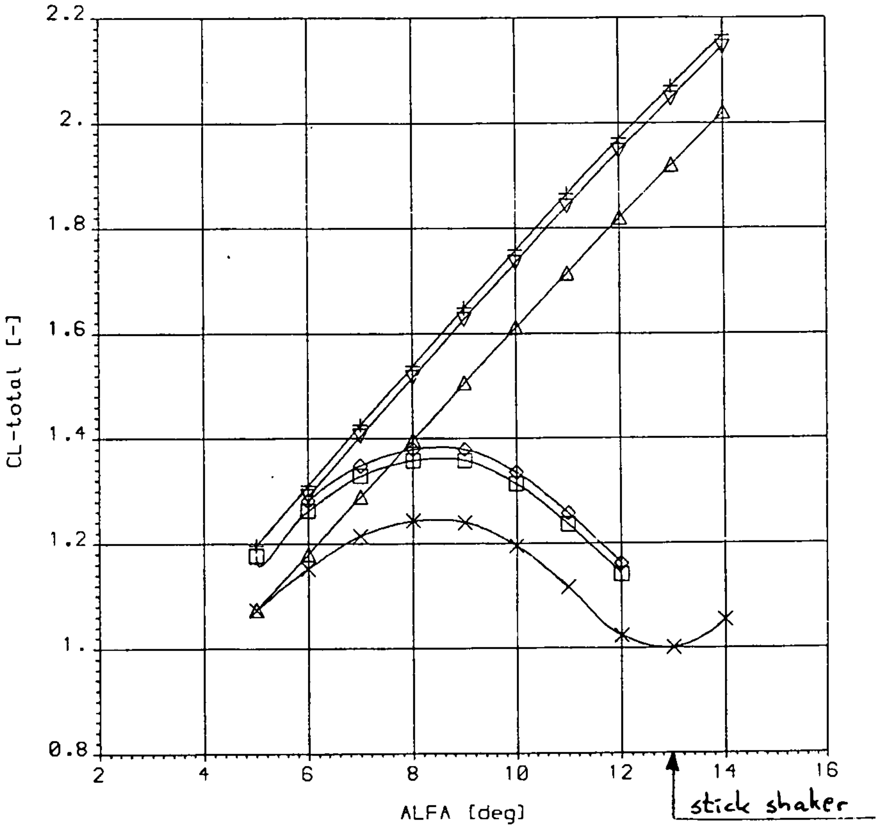
security class: RESTRICTED

report no.: VS-28-25

TAKE-OFF WITH ICE

FOKKER 100
W = 39500 kg
TAKE-OFF THRUST
FLAP 18

	ICE ON WING	GROUND-EFFECT
△	NO	NO
▽	NO	YES, H = 1M
+	NO	YES, H = 0
×	YES	NO
□	YES	YES, H = 1M
◇	YES	YES, H = 0



plotted: WARRINK
date : 7-JUN-89

page 10

Fig 1

REPORT
Fokker B.V. Amsterdam
The Netherlands

issue date: JUNE 1989 issue no.:

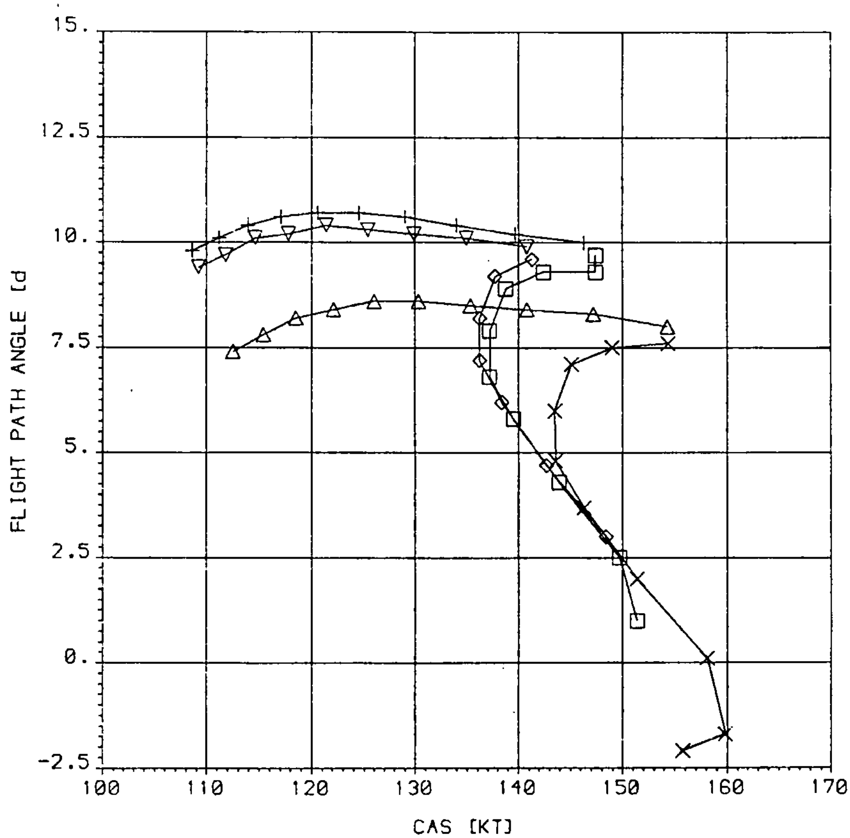
security class: RESTRICTED

report no.: VS-28-25

TAKE-OFF WITH ICE

FOKKER 100
W = 39500 kg
TAKE-OFF THRUST
FLAP 18

	ICE ON WING	GROUND-EFFECT
△	NO	NO
▽	NO	YES, H = 1M
+	NO	YES, H = 0
×	YES	NO
□	YES	YES, H = 1M
◇	YES	YES, H = 0



plotted: WARRINK
date : 7-JUN-89

page 11 Fig 2

REPORT
Fokker B.V. Amsterdam
The Netherlands

issue date: JUNE 1989 issue no.:

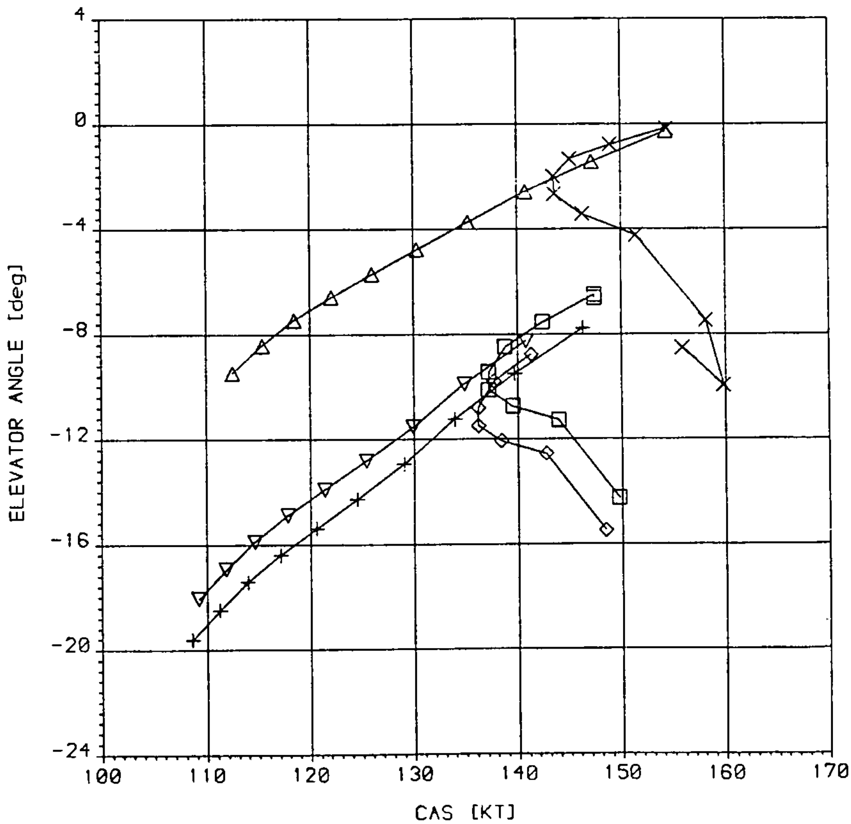
security class RESTRICTED

report no.: VS-28-25

TAKE-OFF WITH ICE

FOKKER 100
W = 39500 kg
TAKE-OFF THRUST
FLAP 18

	ICE ON WING	GROUND-EFFECT
△	NO	NO
▽	NO	YES, H = 1M
+	NO	YES, H = 0
×	YES	NO
□	YES	YES, H = 1M
◇	YES	YES, H = 0



plotted: WARRINK
date : 7-JUN-89

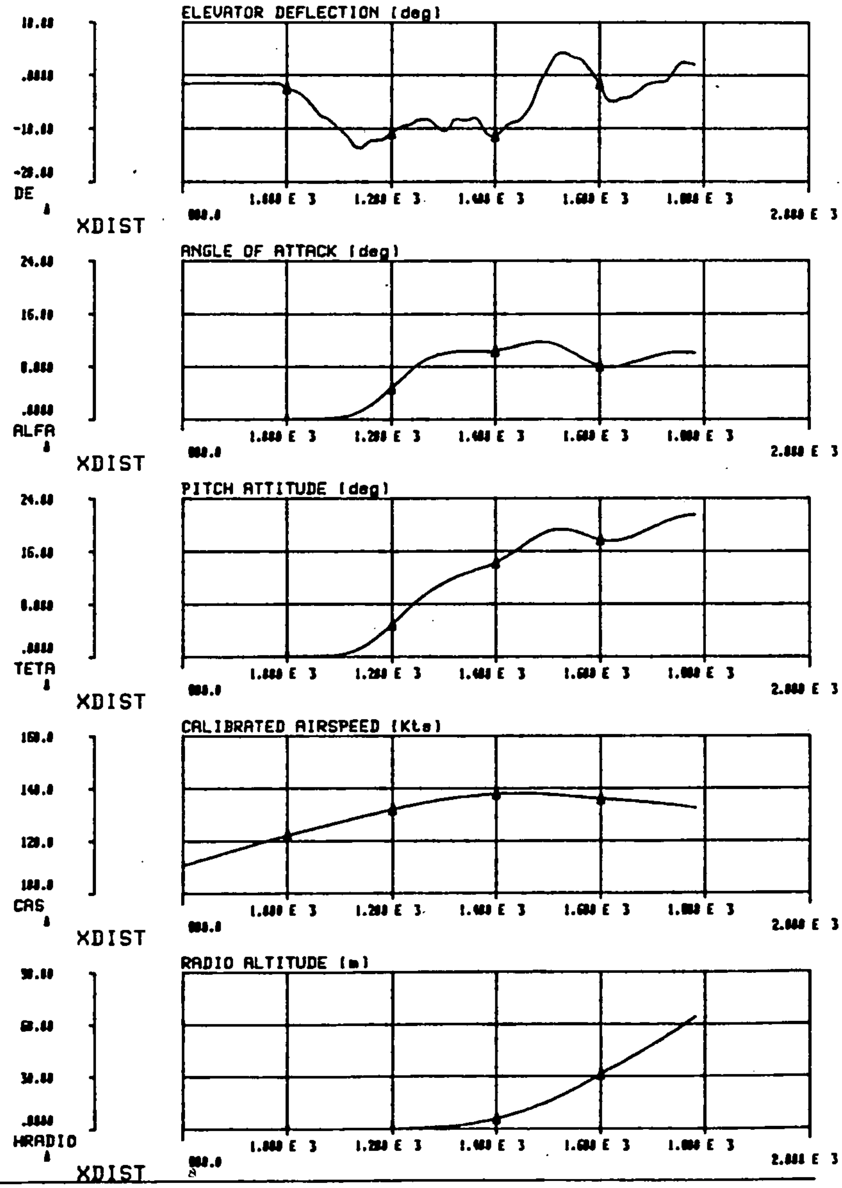
page 12 Fig 3

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

Issue date: JUNE 1989 Issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 1: Ice = 0.0 Slush = 0.0



Fokker

REPORT

Fokker Aircraft B.V.

Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	V5-28-25

Fokker 100 / TAY620 Condition 2, Ice = 0.0 Slush = 0.25

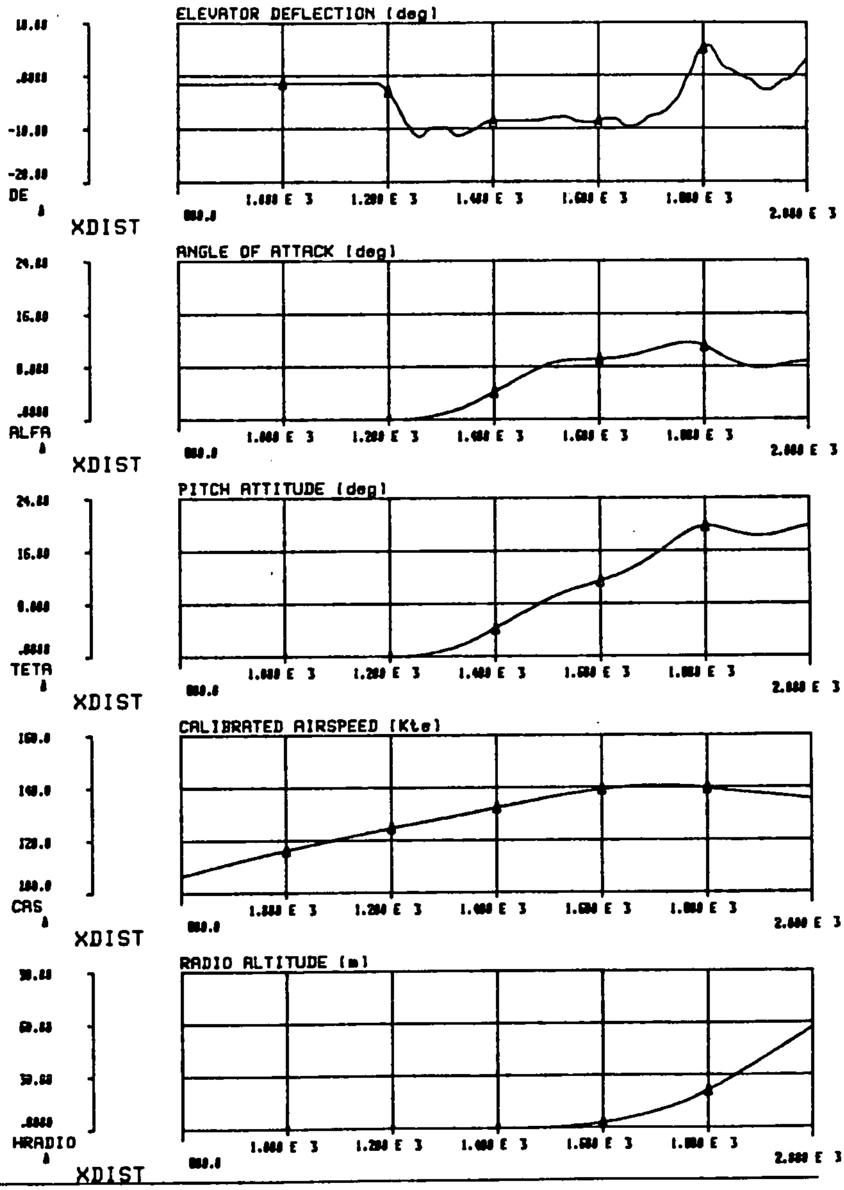


Fig 5

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 3, Ice = 0.0 Slush = 0.2

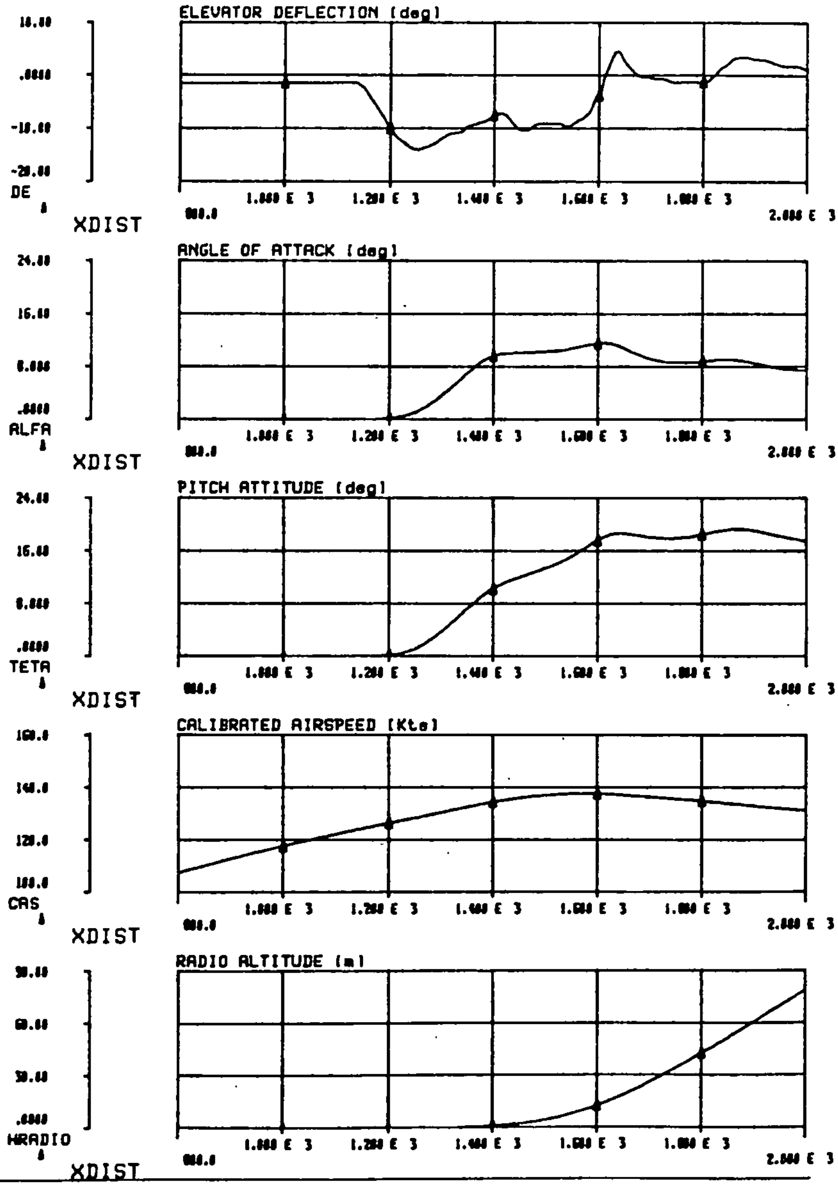


Fig 6

REPORT

Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date. JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TRY620 Condition 4: Ice = 0.0 Slush = 0.5

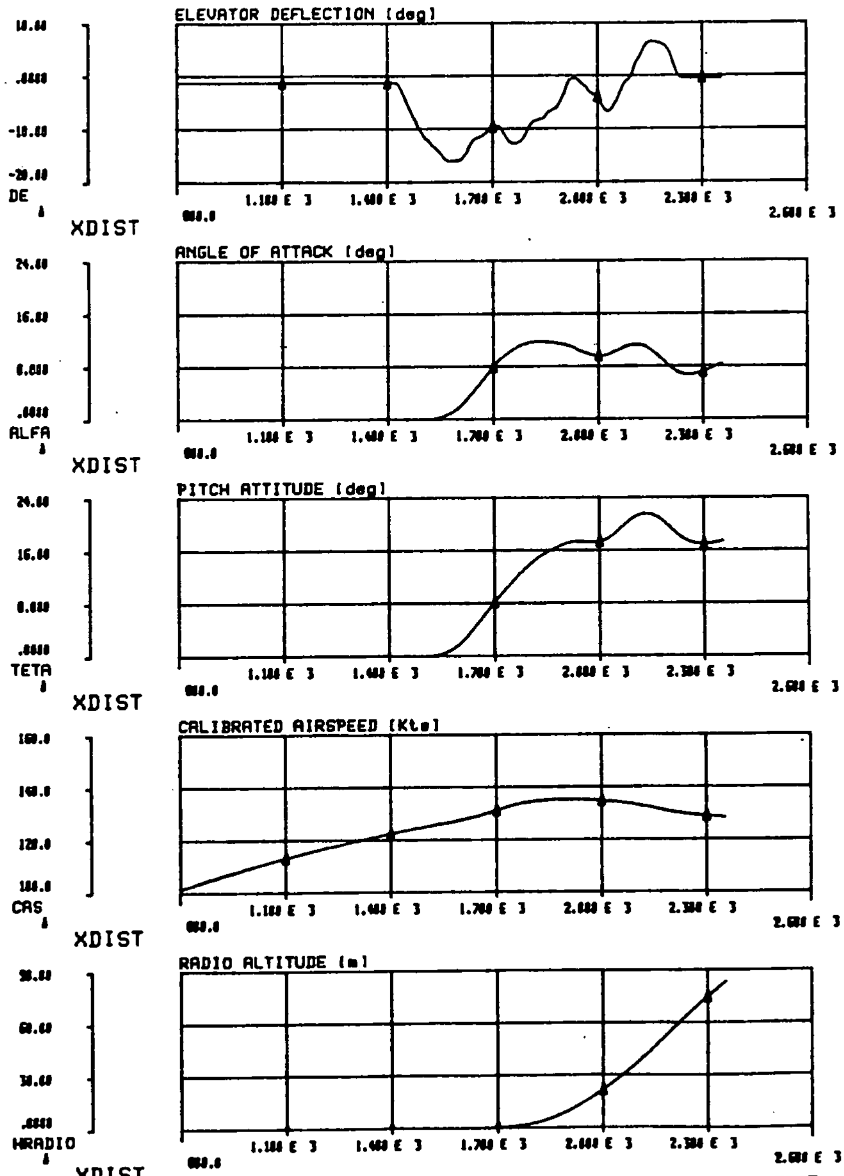


Fig 7

REPORT

Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 6: Ice = 0.5 Slush = 0.15

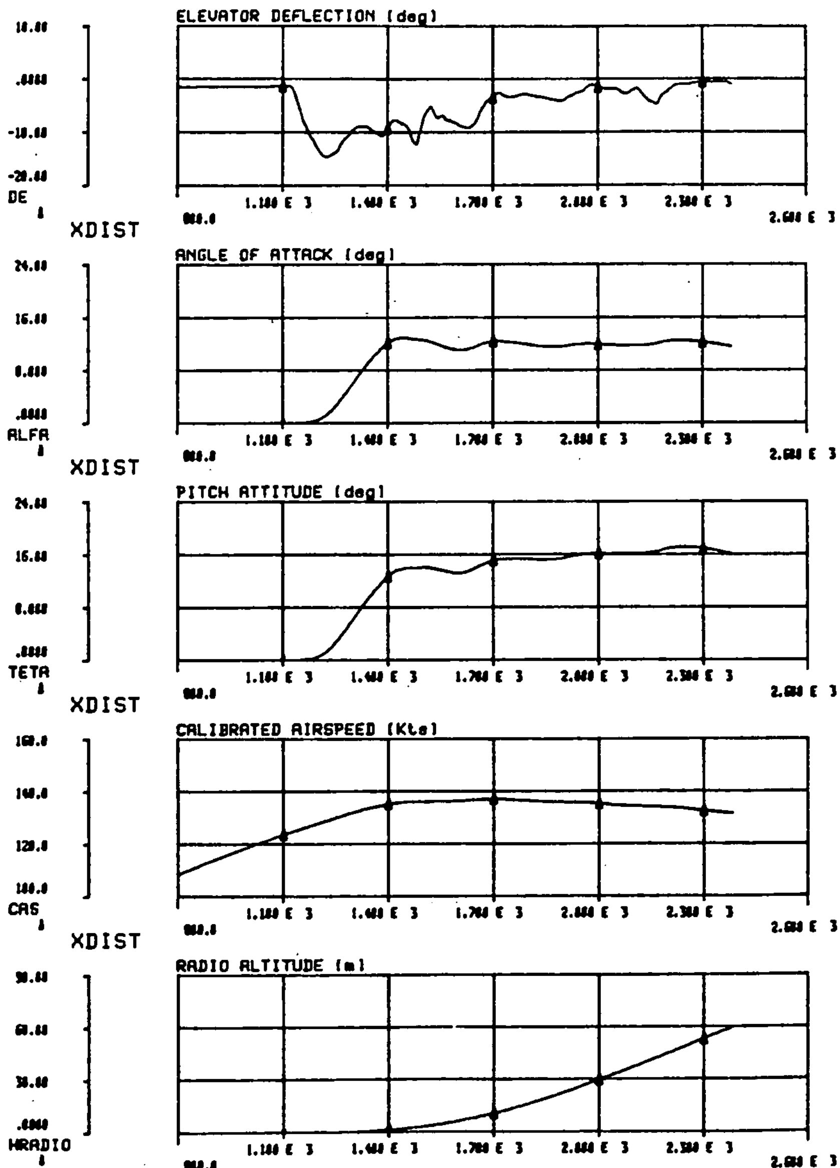


Fig 8

REPORT

Fokker Aircraft B.V.

Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 5: Ice = 0.5 Slush = 0.2

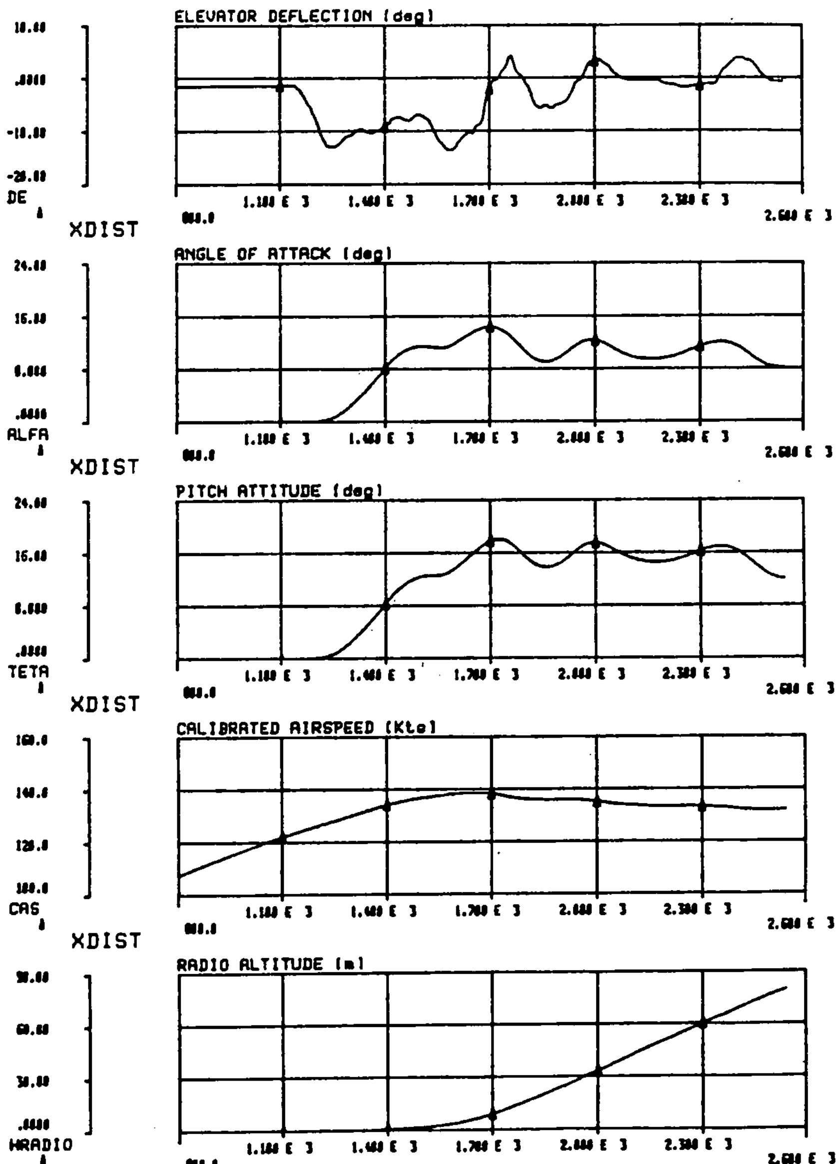


Fig 9

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 7, Ice = 0.6 Slush = 0.15

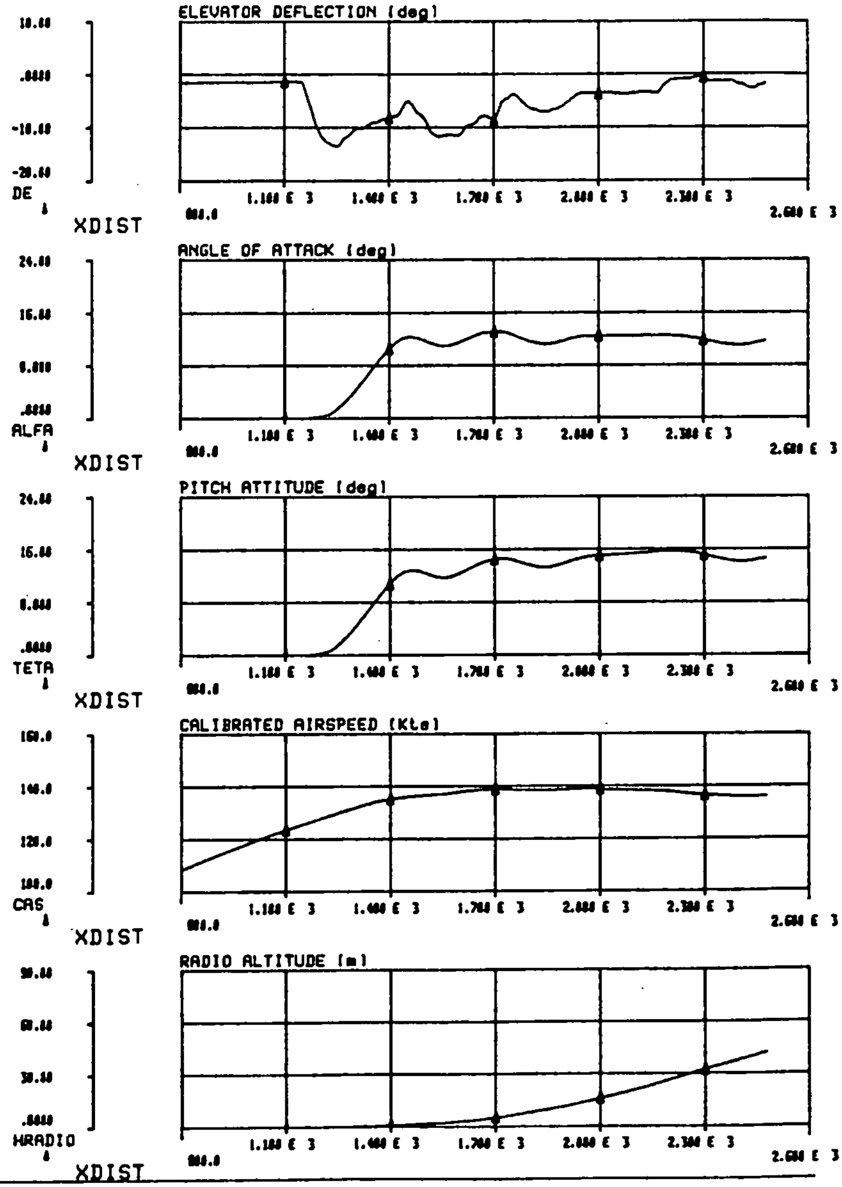


Fig 10

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 8: Ice = 0.7 Slush = 0.15

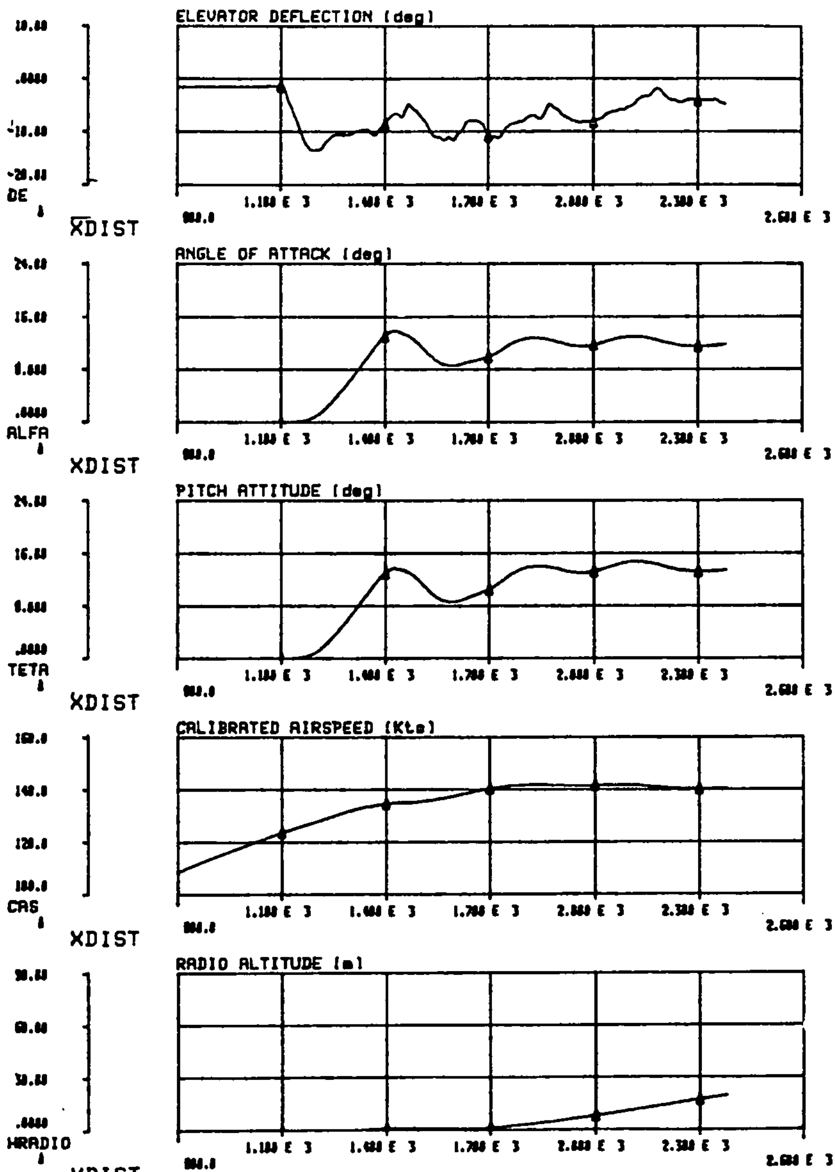


 Fig 11

Fokker

REPORT

Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989   issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620   Condition 9: Ice = 0.75   Slush = 0.15

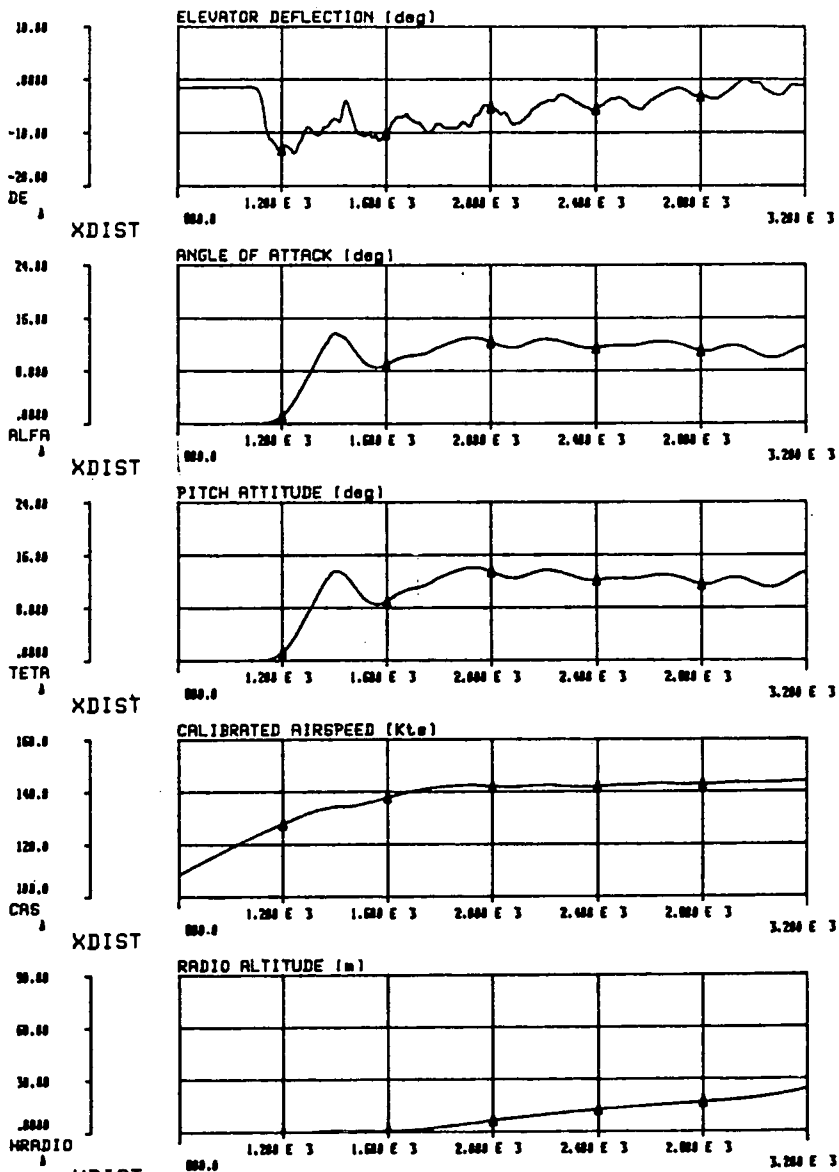


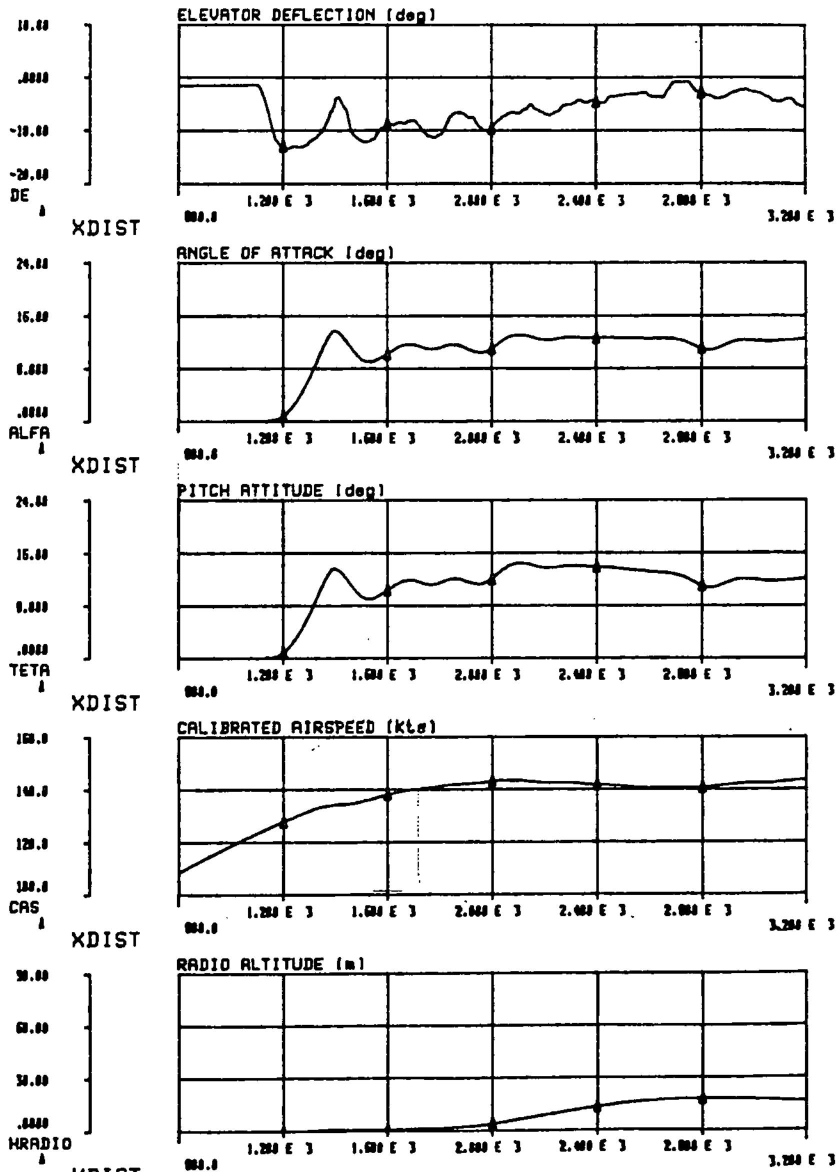
Fig 12

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 10: Ice = 0.75 Slush = 0.15



REPORT

Fokker Aircraft B.V.

Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 11: Ice = 0.75 Slush = 0.15

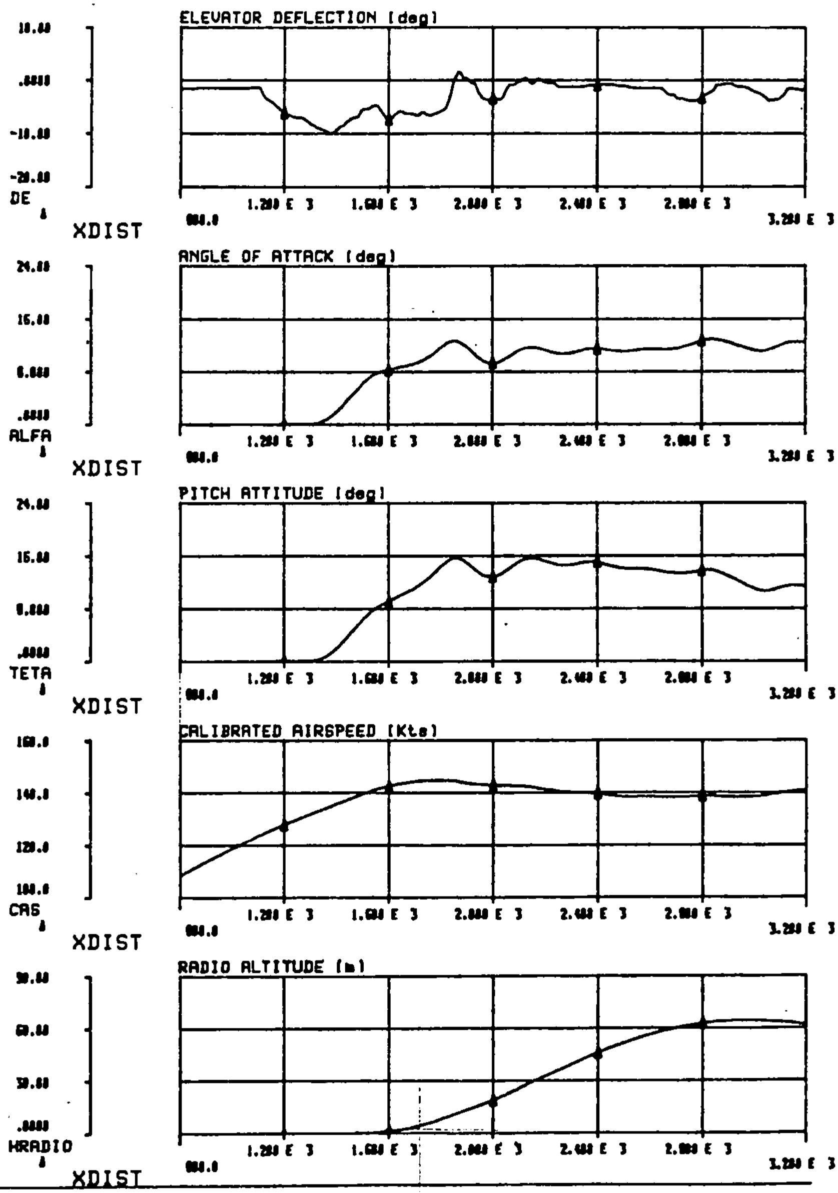


Fig 14

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 12: Ice = 0.8 Slush = 0.15

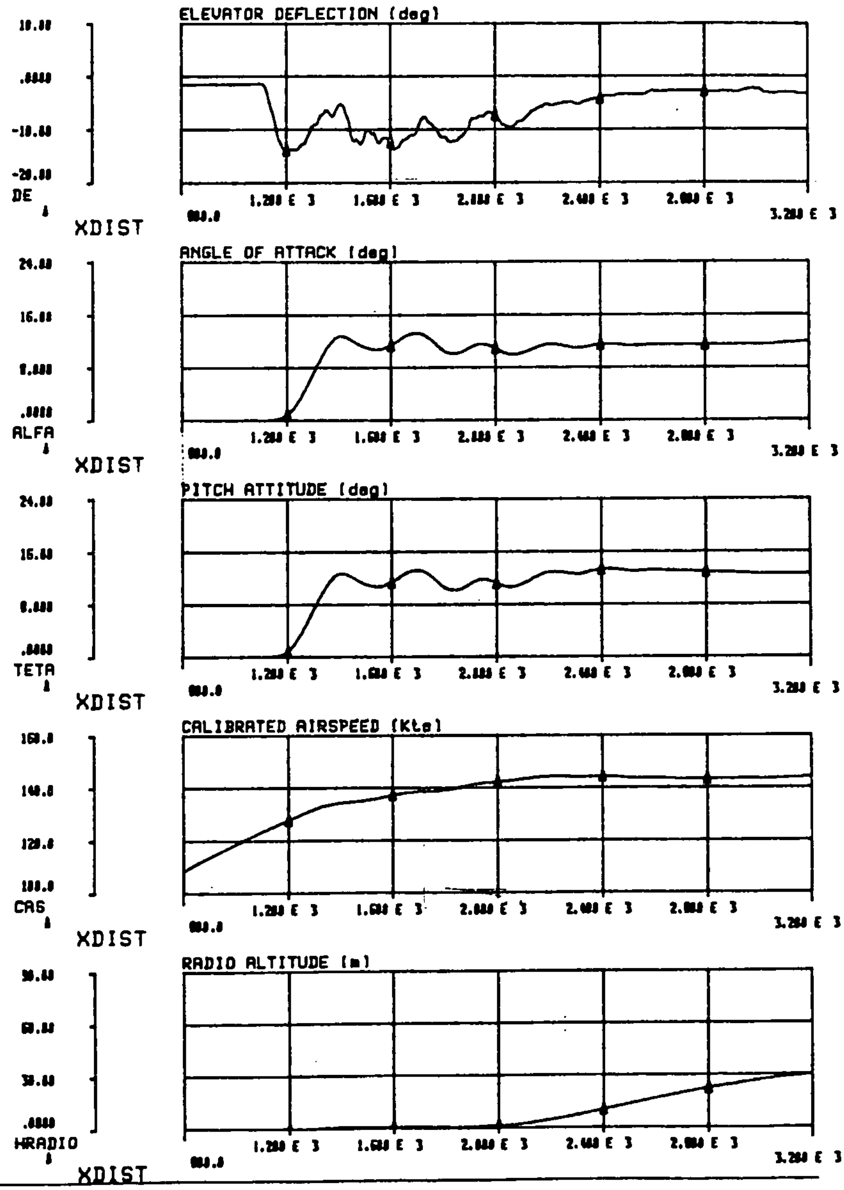


Fig 15

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 13: Ice = 0.75 Slush = 0.15

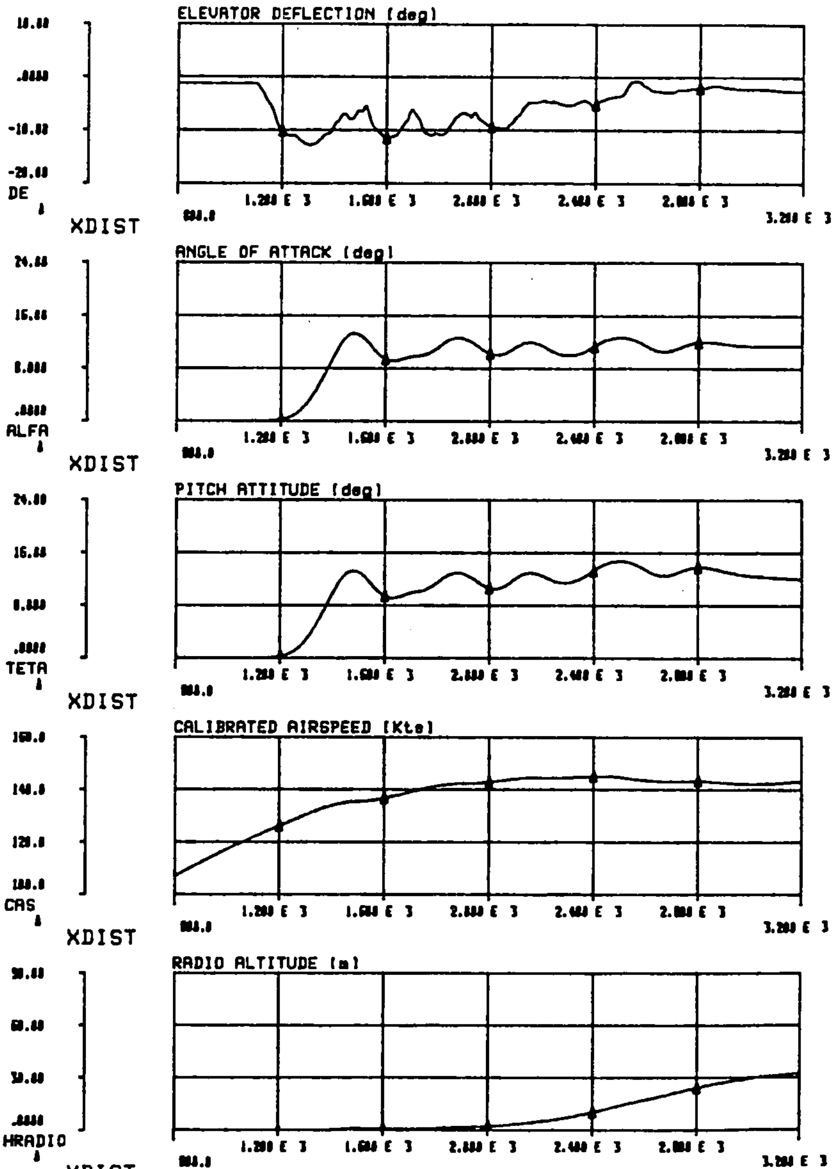


Fig 16A

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 13: Ice = 0.75 Slush = 0.15

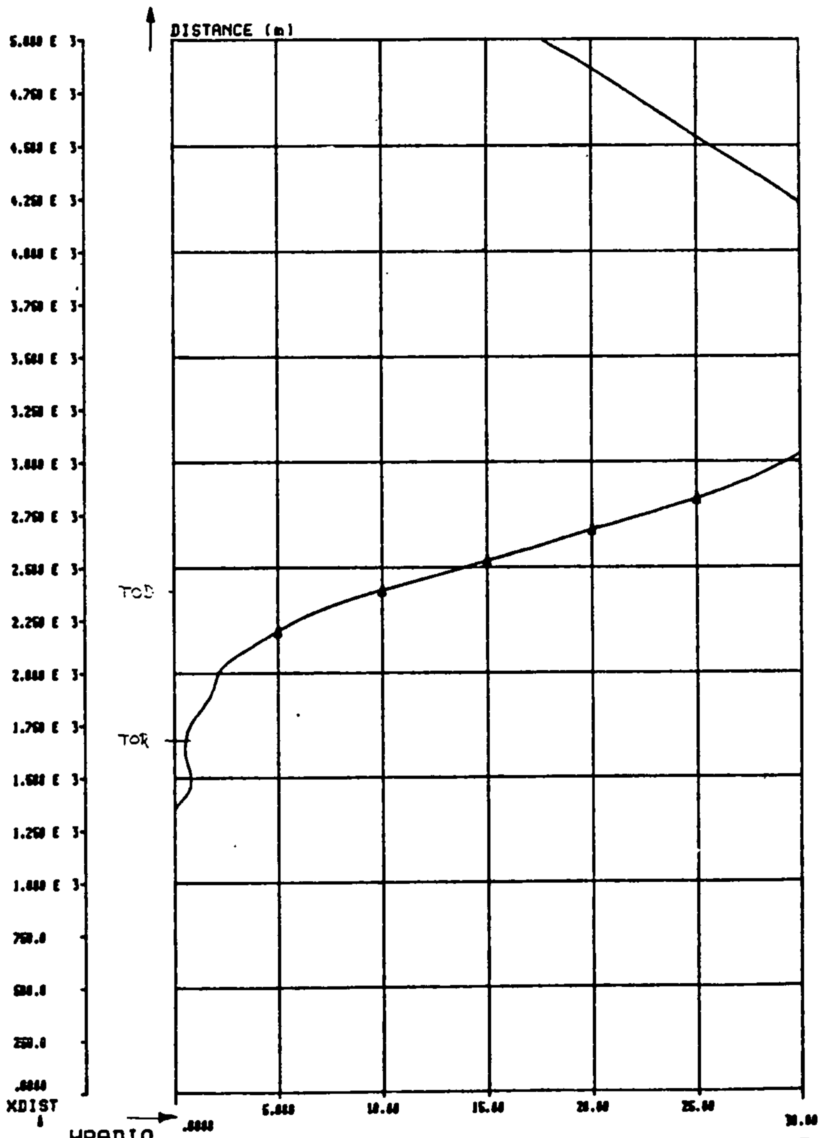


Fig 16 B

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 15: Ice = 0.8 Slush = 0.15

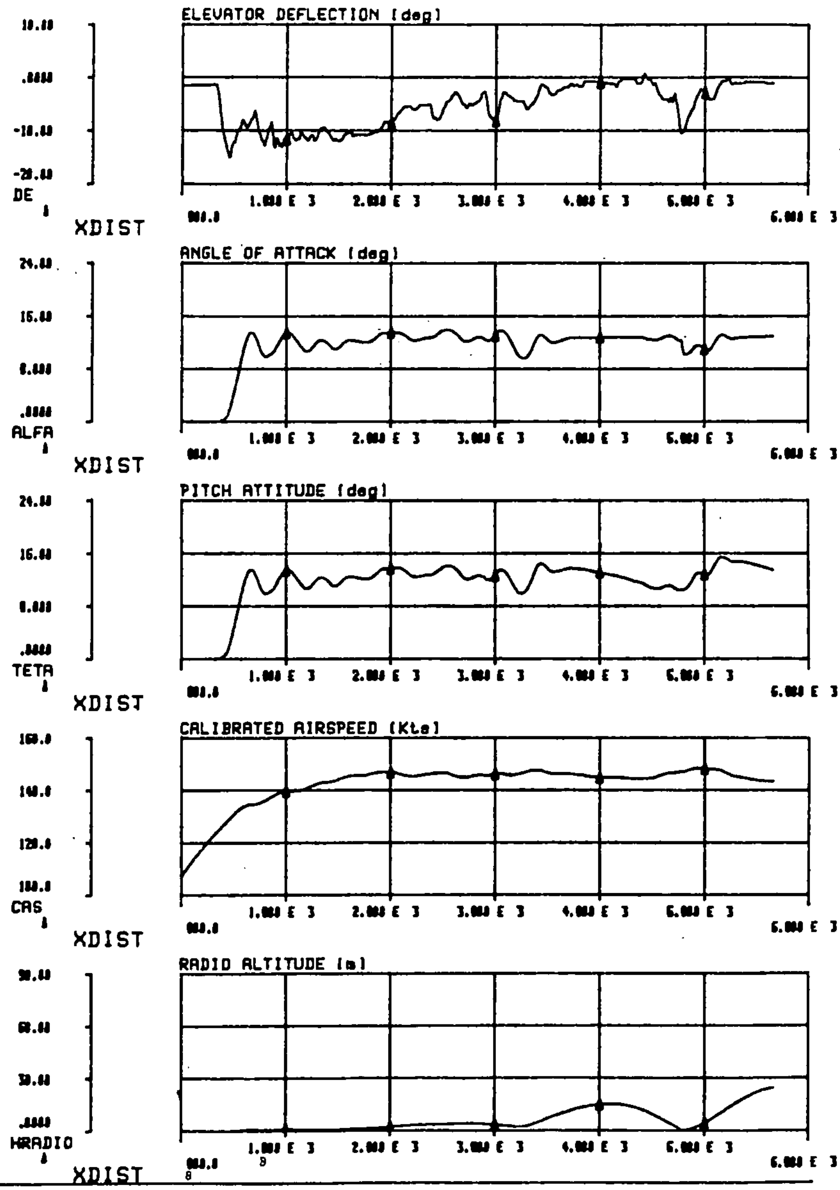


Fig 17 A

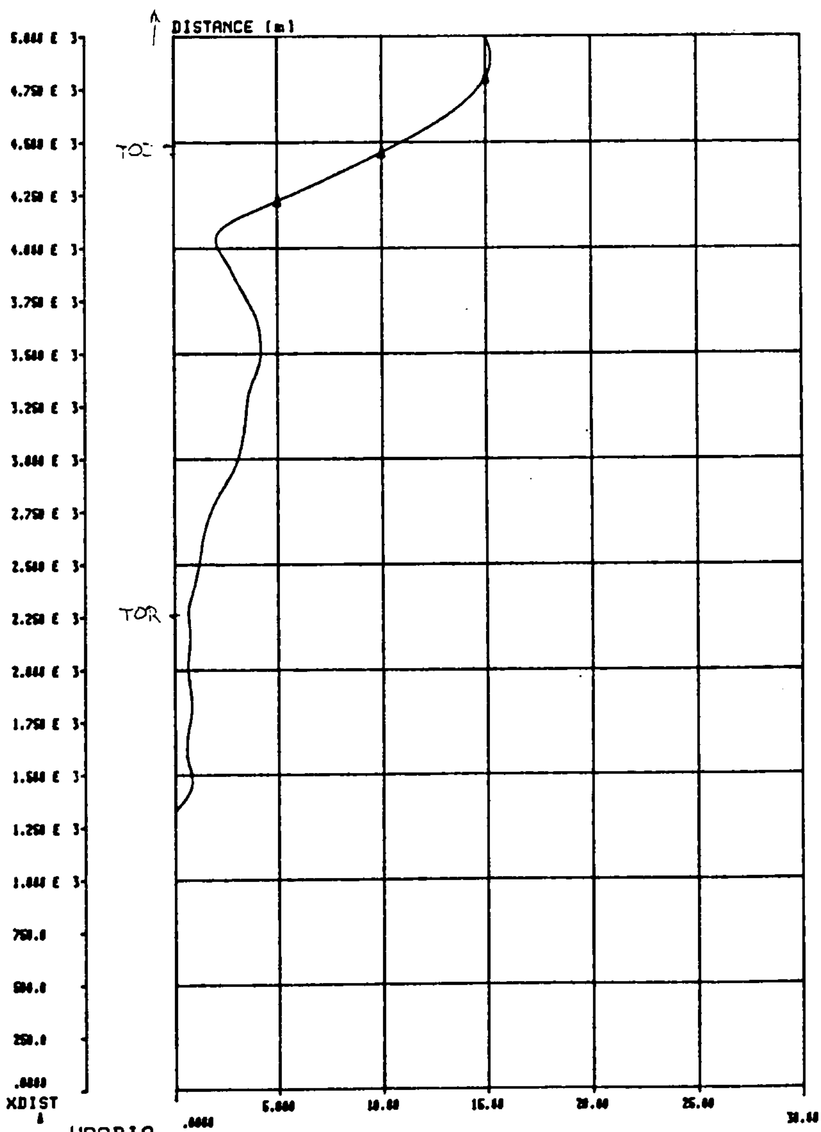
REPORT

Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 15: Ice = 0.8 Slush = 0.15



REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

Issue date: JUNE 1989 Issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 16: Ice = 0.825 Slush = 0.15

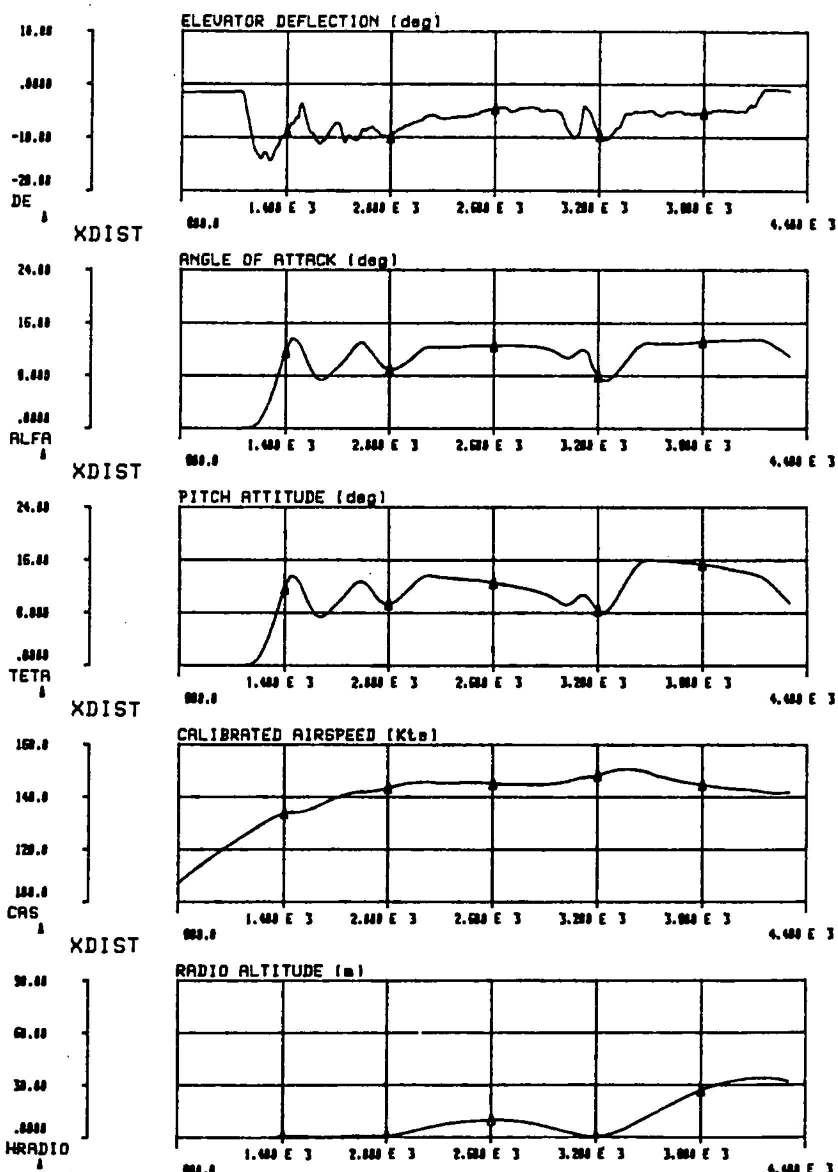


Fig 18 A

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 16: Ice = 0.825 Slush = 0.15

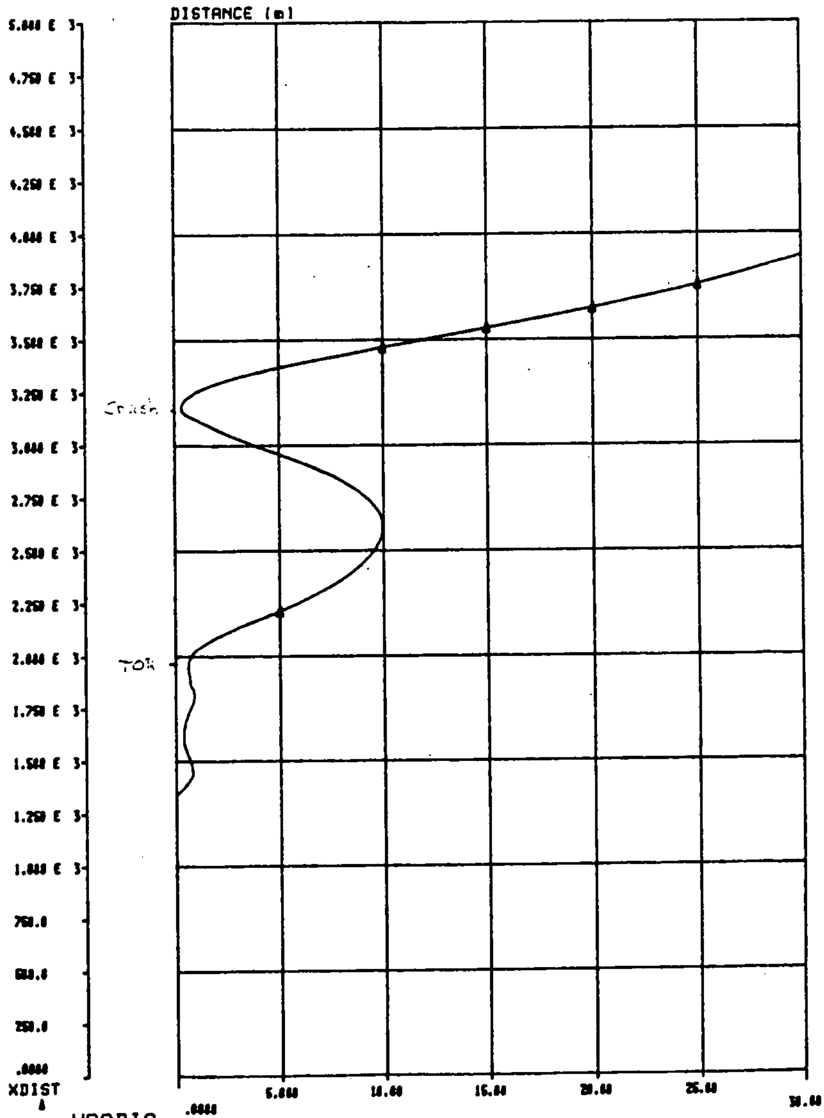


Fig 18B

REPORT

Fokker Aircraft B.V.
Amsterdam The Netherlands

Issue date: JUNE 1989 Issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 17: Ice = 0.8 Slush = 0.15

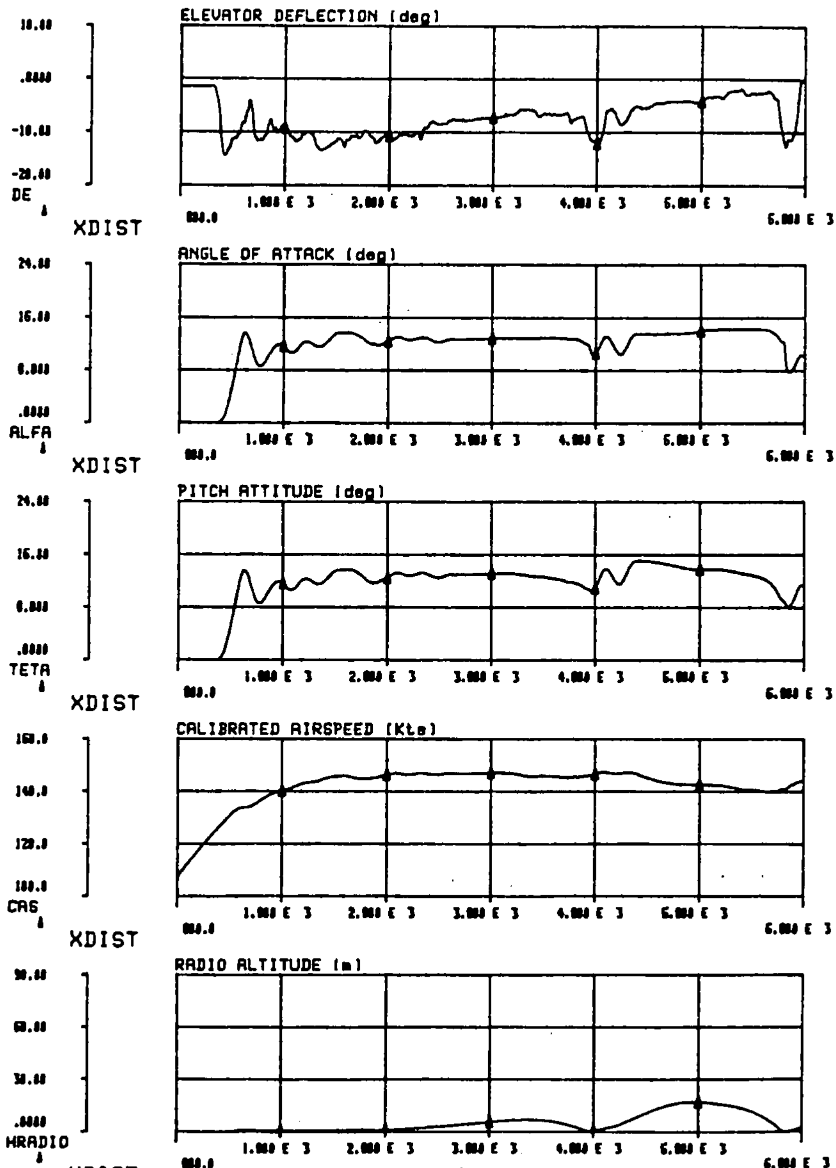


Fig 19A

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 17: Ice = 0.8 Slush = 0.15

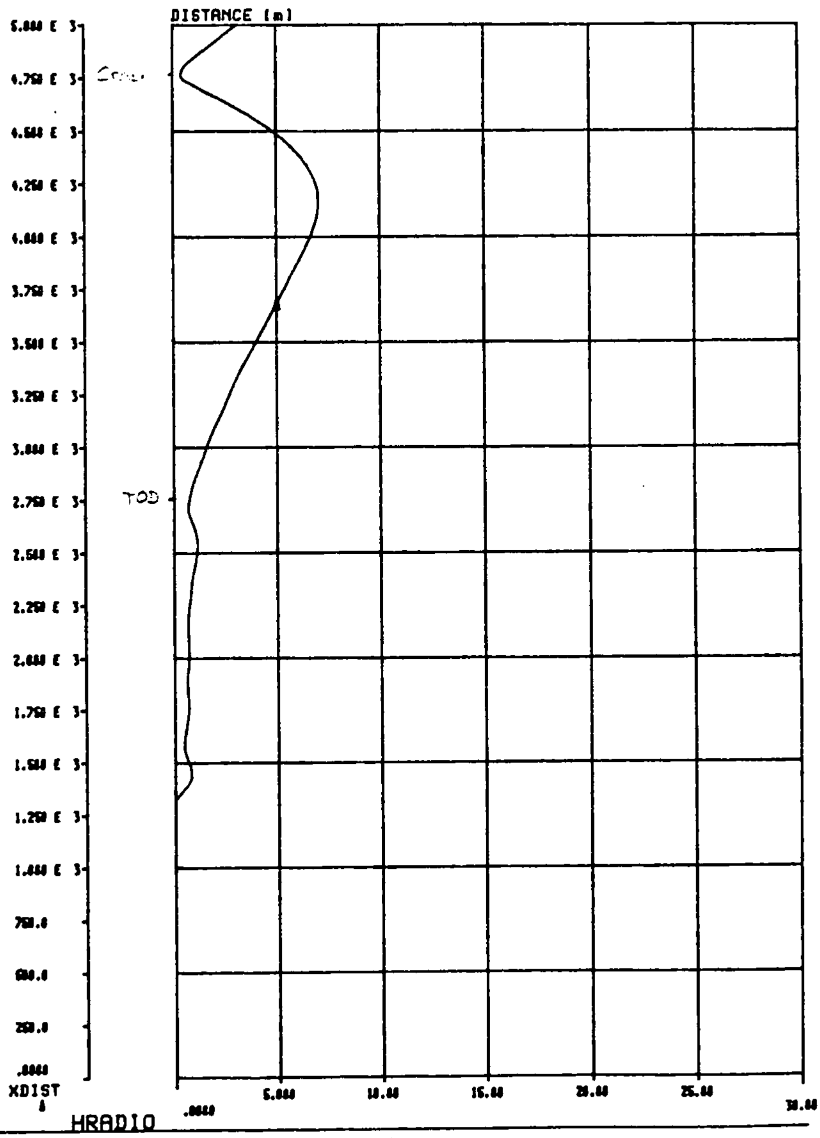


 Fig 19B

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

Issue date: JUNE 1989   Issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TRY620 Condition 18: Ice = 0.4 Slush = 0.15

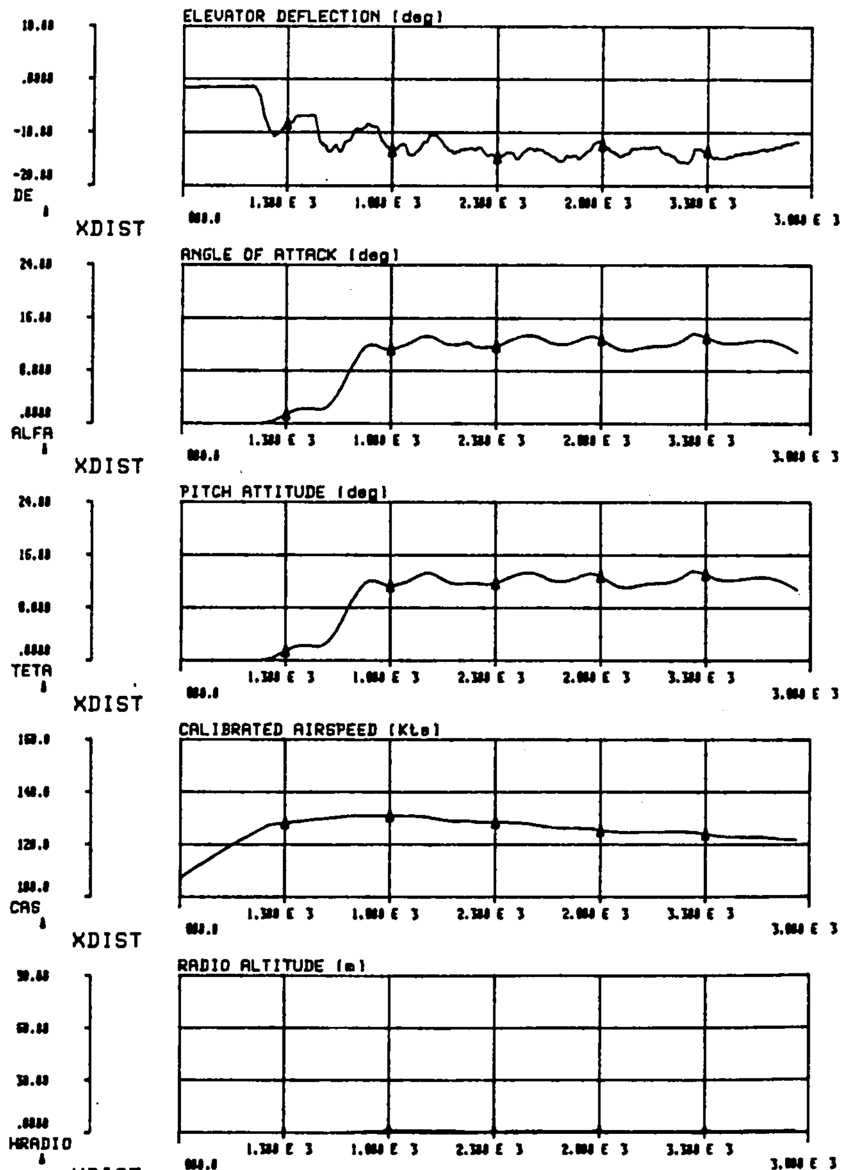


Fig 20

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 19: Ice = 0.25 Slush = 0.15

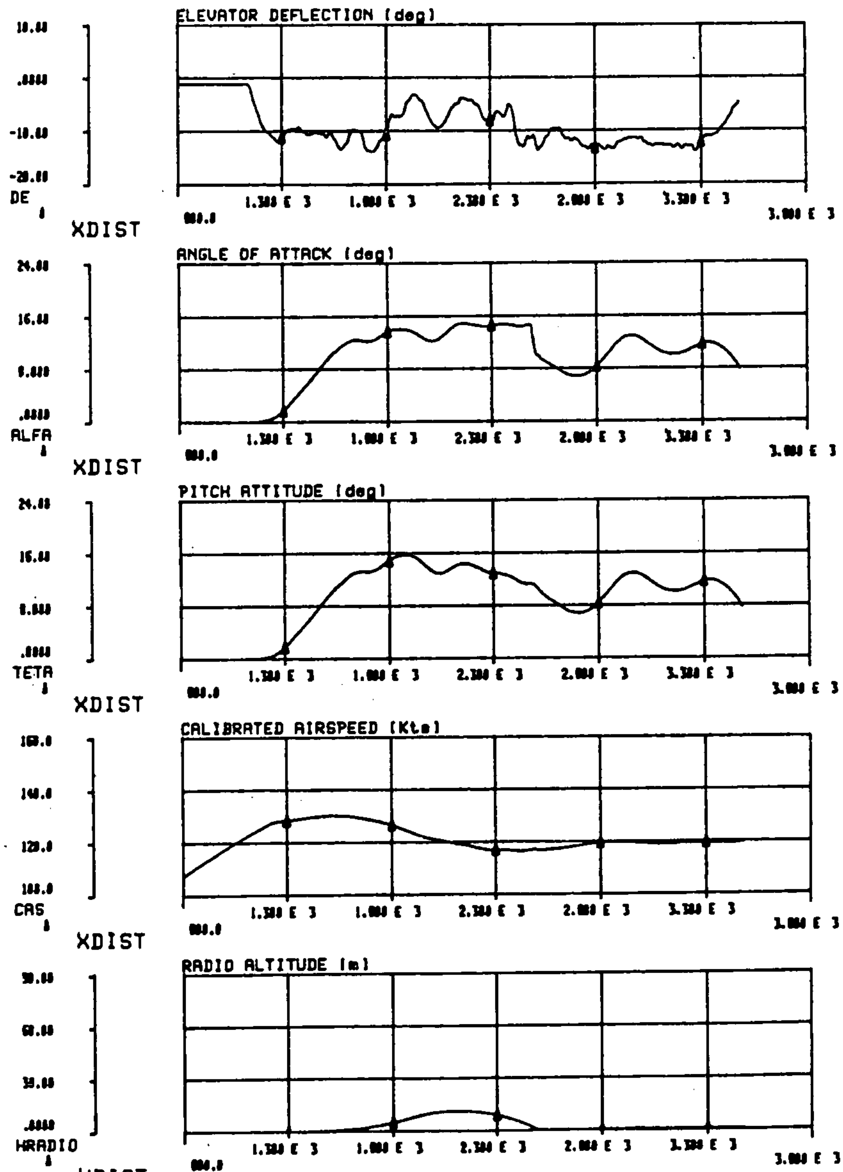


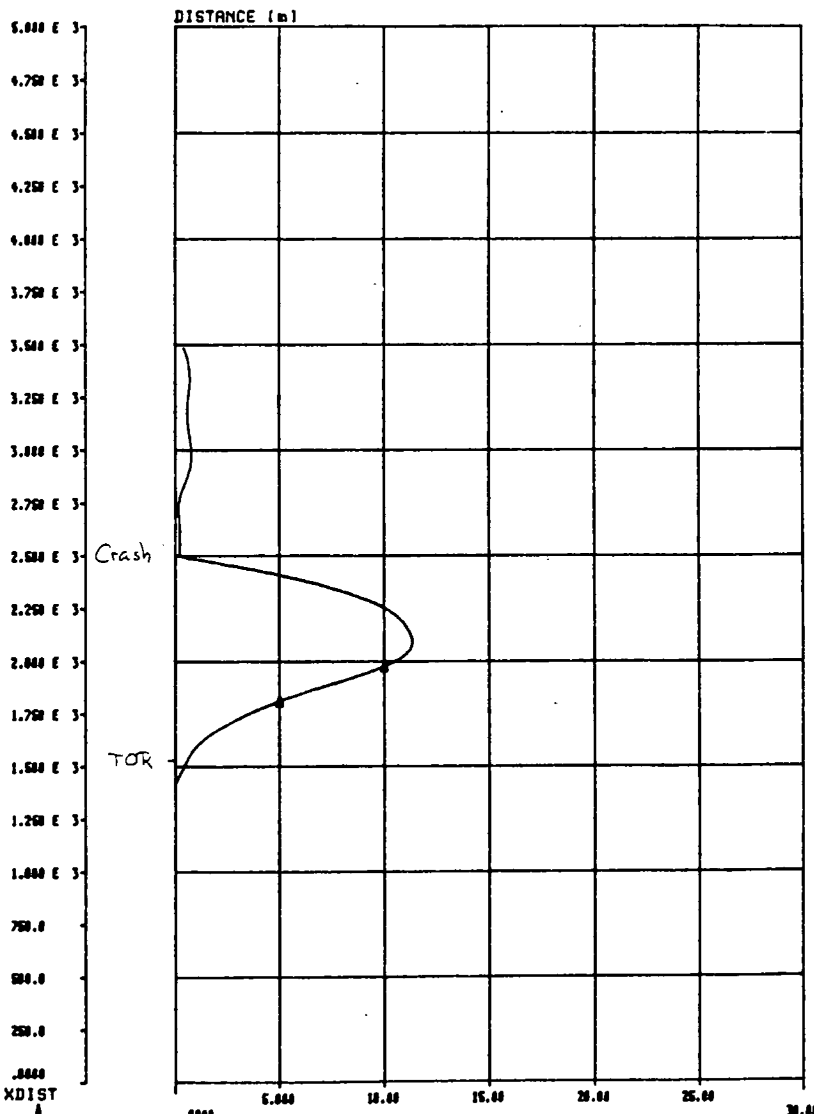
Fig 21A

REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

issue date: JUNE 1989 issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

Fokker 100 / TAY620 Condition 19: Ice = 0.25 Slush = 0.15

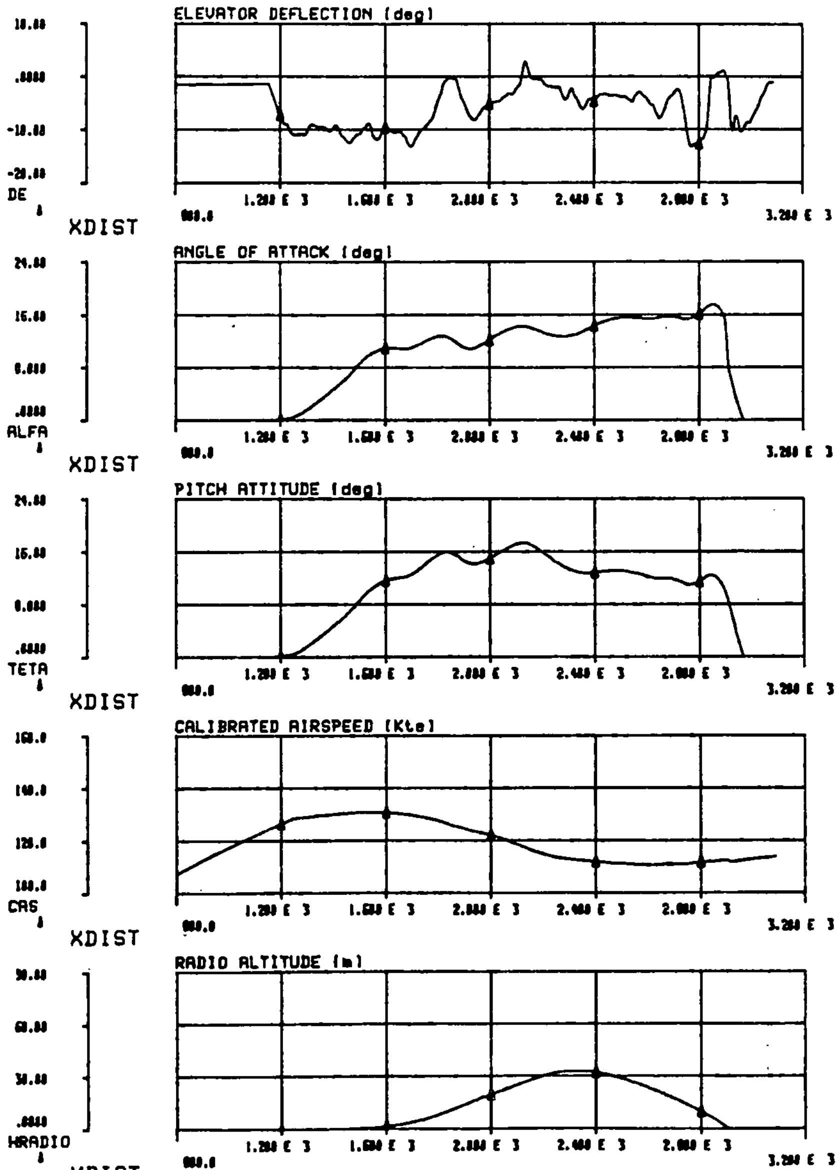


REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

Issue date: JUNE 1989 Issue no.: 01

security class	report no.:
RESTRICTED	VS-28-25

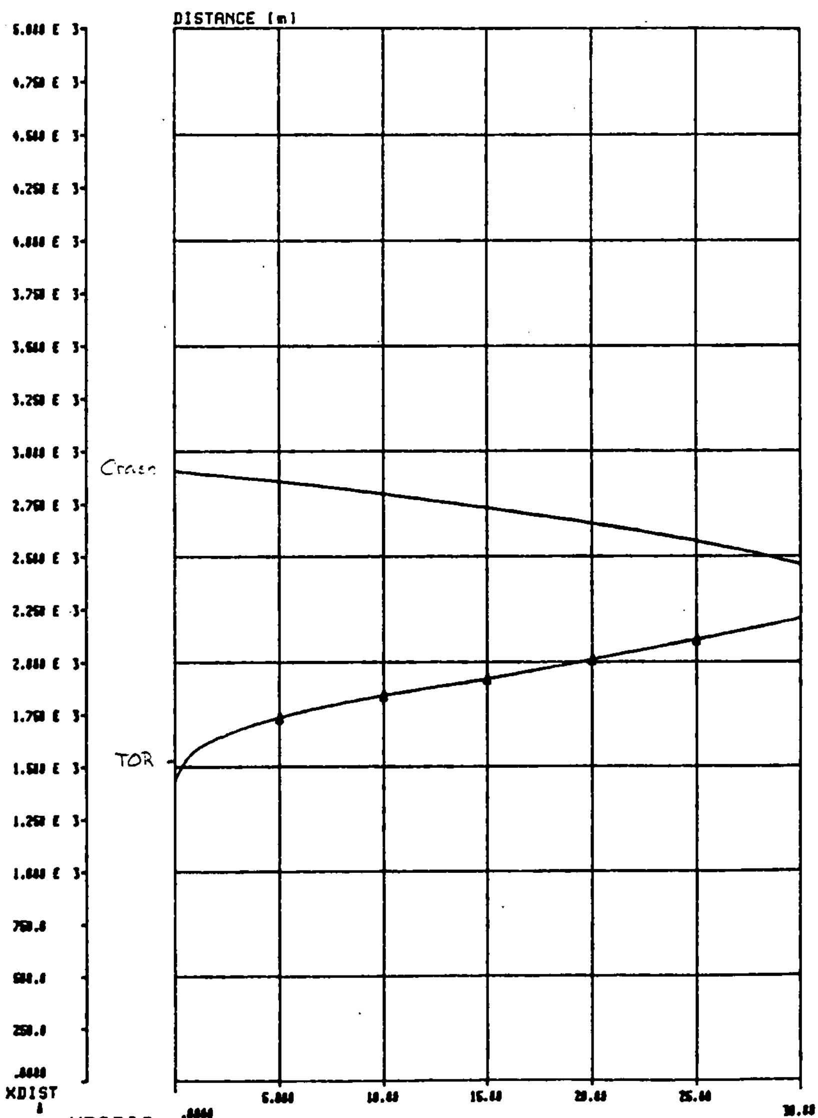
Fokker 100 / TAY620 Condition 20: Ice = 0.1 Slush = 0.15



REPORT
Fokker Aircraft B.V.
Amsterdam The Netherlands

	issue date: JUNE 1989 issue no.: 01
security class: RESTRICTED	report no.: VS-28-25

Fokker 100 / TAY620 Condition 20: Ice = 0.1 Slush = 0.15



REPORT
Fokker B.V.
Amsterdam
Holland

issue date: AUGUST 1989 issue no.: 2

security class: RESTRICTED

report no.: VS-28-25

Ident: 100A4.02 TAY620 File : DMP.SLUSH.1A1 Date : 1- 8-1989
FOKKER 100 / TAY620
ICE=0.0
SLUSH=0.0

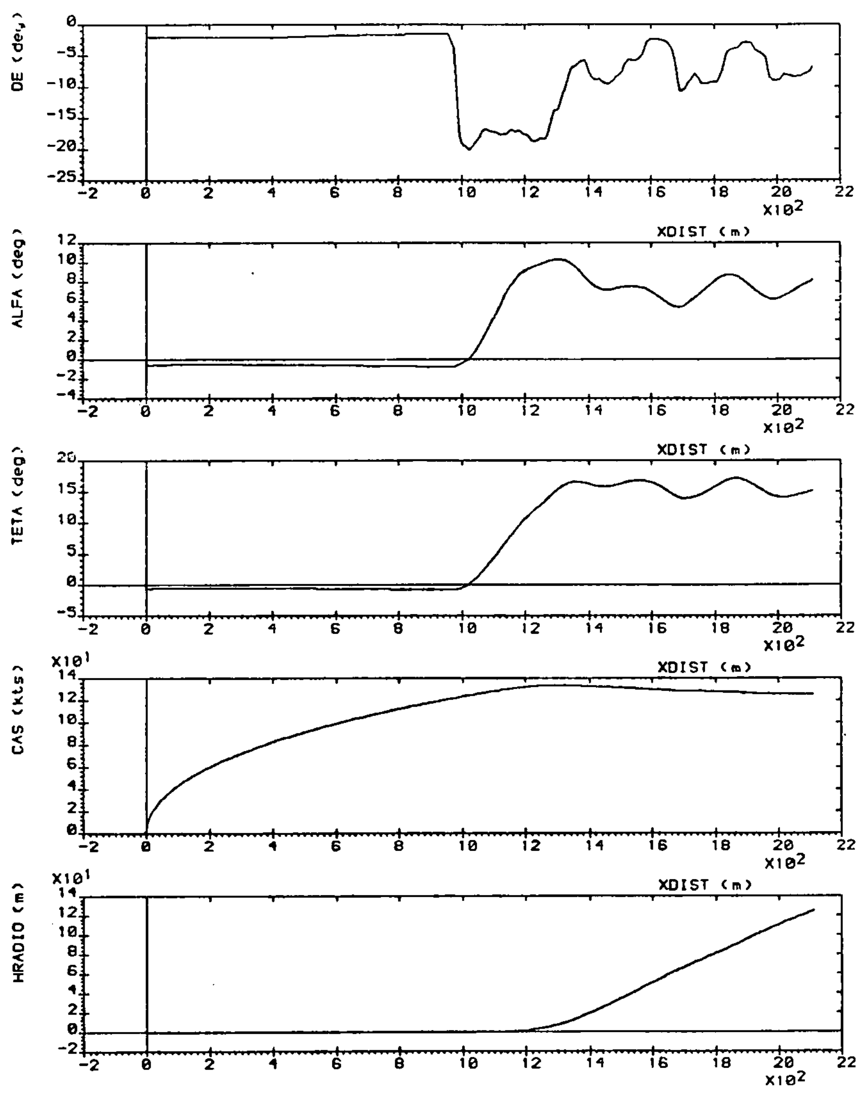


FIGURE 23

REPORT
Fokker B.V.
Amsterdam
Holland

issue date: AUGUST 1989 issue no.: 2

security class RESTRICTED | report no.: VS-28-25

Ident: 100A4.02 TAY620 File : DMP.SLUSH.2A2 Date : 1- 8-1989
FOKKER 100 / TAY620
ICE=.5
SLUSH=0.15

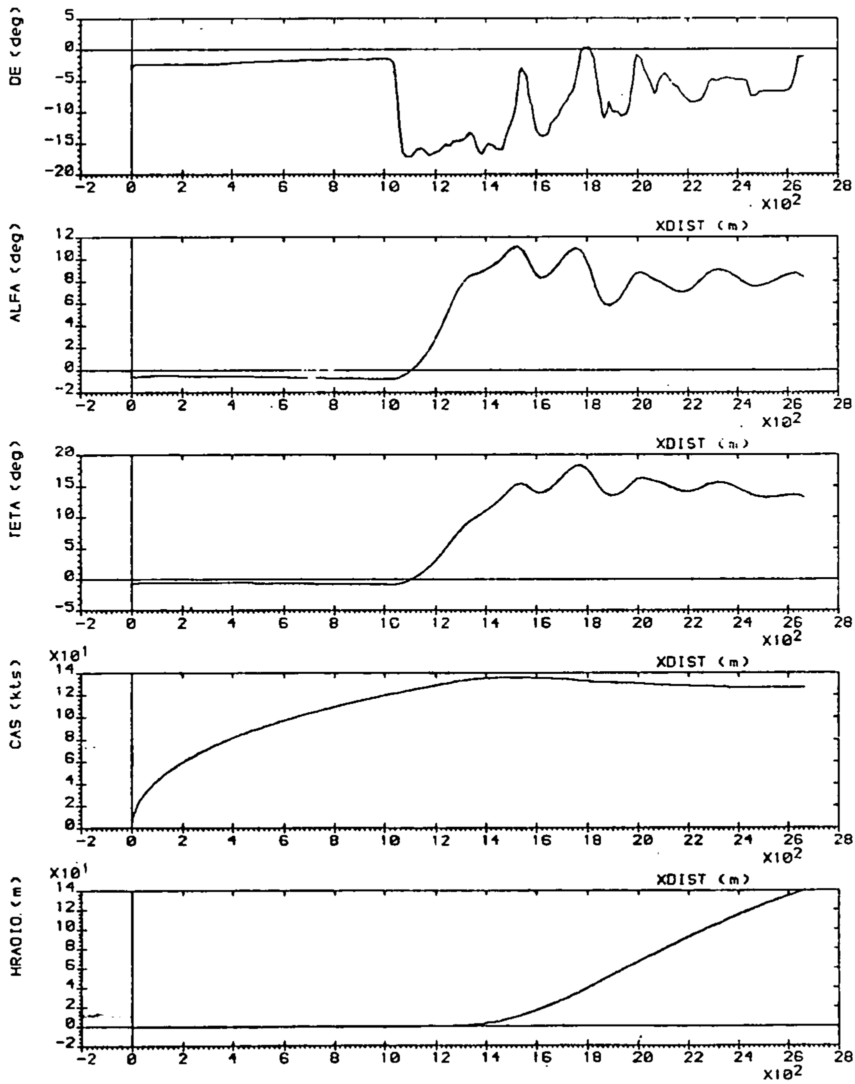


 FIGURE 24

REPORT
Fokker B.V.
Amsterdam
Holland

issue date: AUGUST 1989 issue no.: 2

security class **RESTRICTED** report no.: **VS-28-25**

Ident: 100A4.02 TAY620 File : DMP.SLUSH.3A1 Date : 1- 8-1989
FOKKER 100 / TAY620
ICE=0.6
SLUSH=0.15

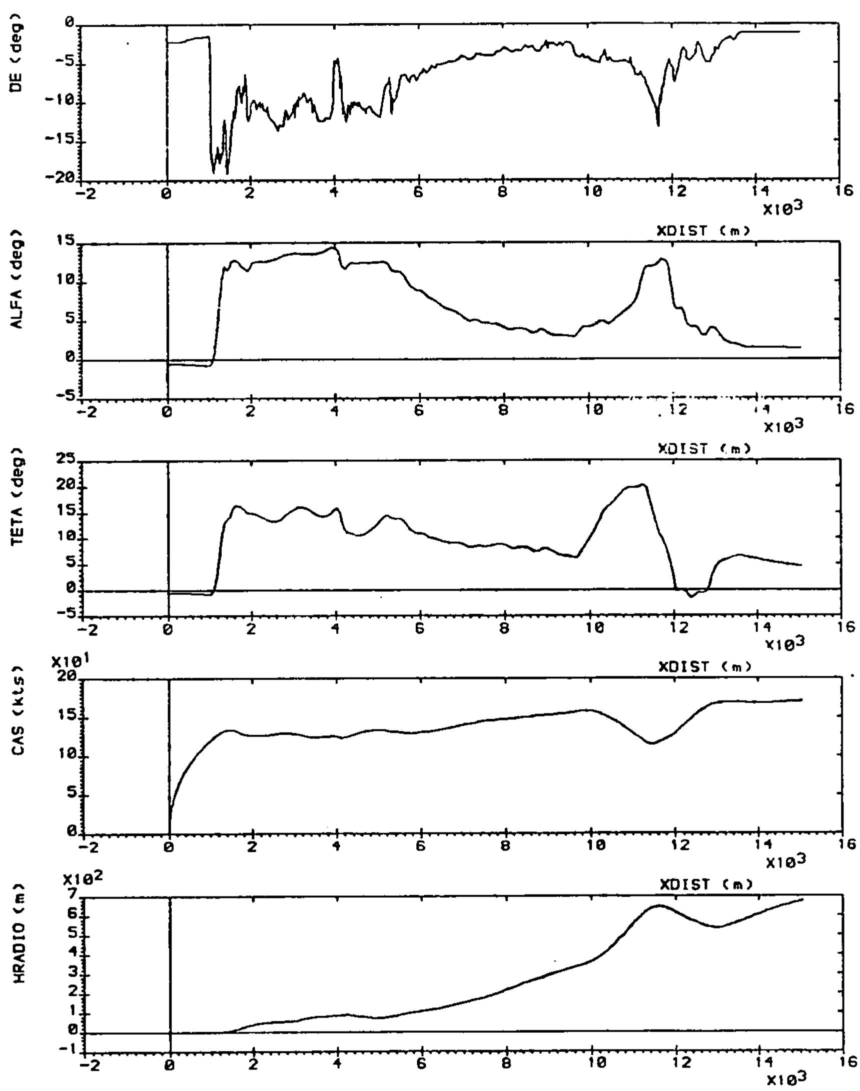


 FIGURE 25

REPORT
Fokker B.V.
Amsterdam
Holland

security class	RESTRICTED	report no.:	VS-28-25
issue date:	AUGUST 1989	issue no.:	2

Ident: 100A4.02 TAY620 File : DMP.SLUSH.3A3 Date : 1- 8-1989
FOKKER 100 / TAY620
ICE=0.75
SLUSH=0.15

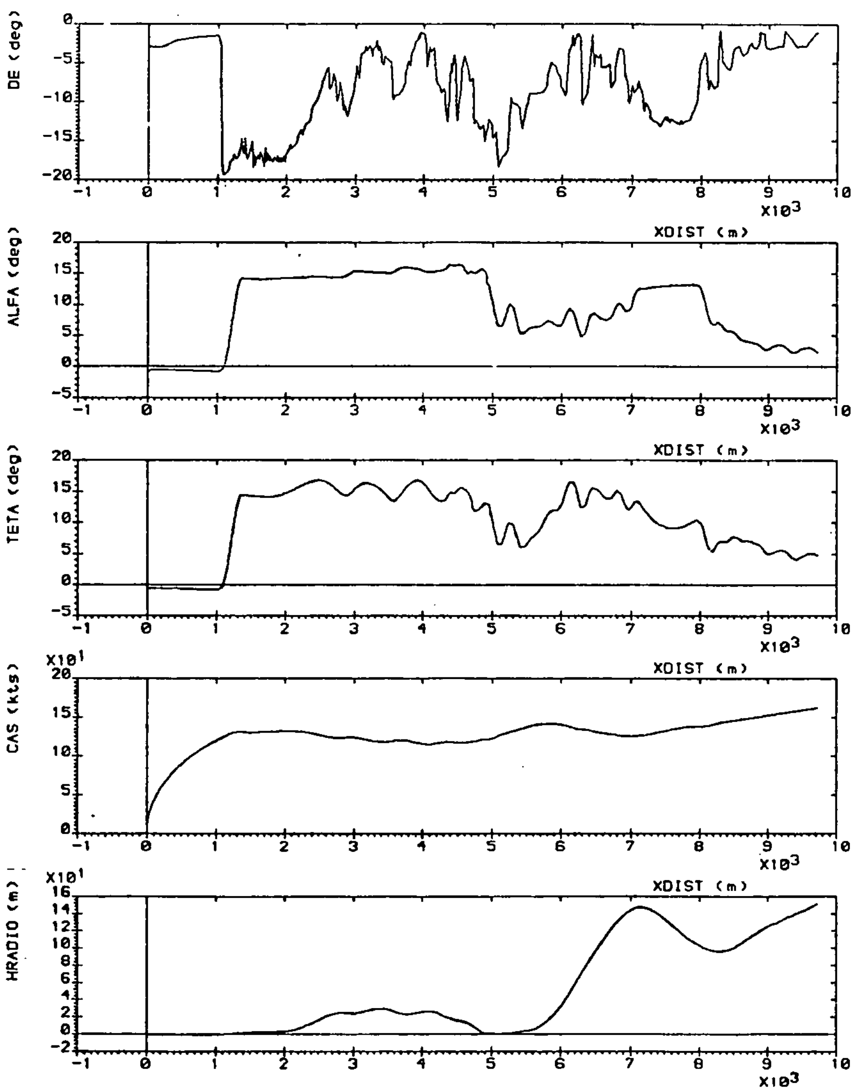
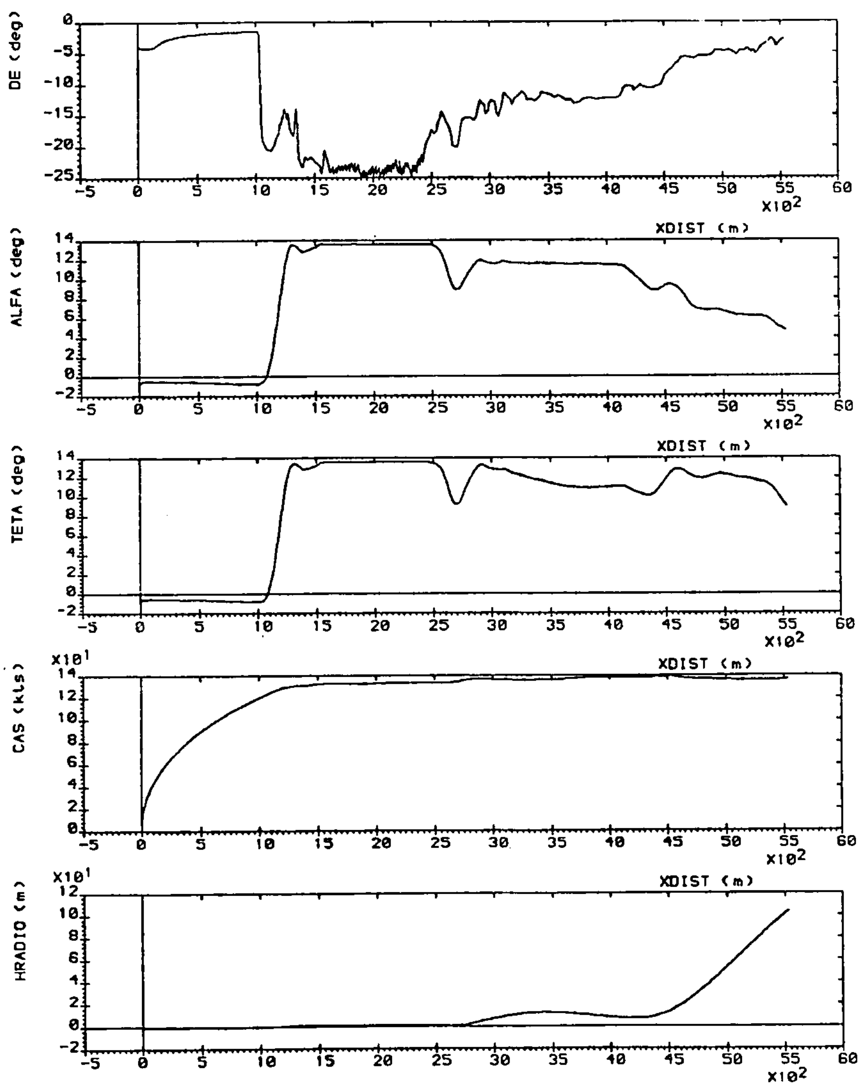


 FIGURE 27

REPORT
Fokker B.V.
Amsterdam
Holland

security class	issue date: AUGUST 1989 / report no.:	issue no.: 2
RESTRICTED	VS-28-25	

Ident: 100A4.02 TAY620 File : DMP.SLUSH.3A7 Date : 1- 8-1989
FOKKER 100 / TAY620
ICE=0.8
SLUSH=0.15



REPORT
Fokker B.V.
Amsterdam
Holland

issue date: AUGUST 1989 issue no.: 2

security class RESTRICTED

report no.: VS-28-25

Ident: 100A4.02 TAY620 File : DMP.SLUSH.3A5 Date : 1- 8-1989
FOKKER 100 / TAY620
ICE=0.9
SLUSH=0.15

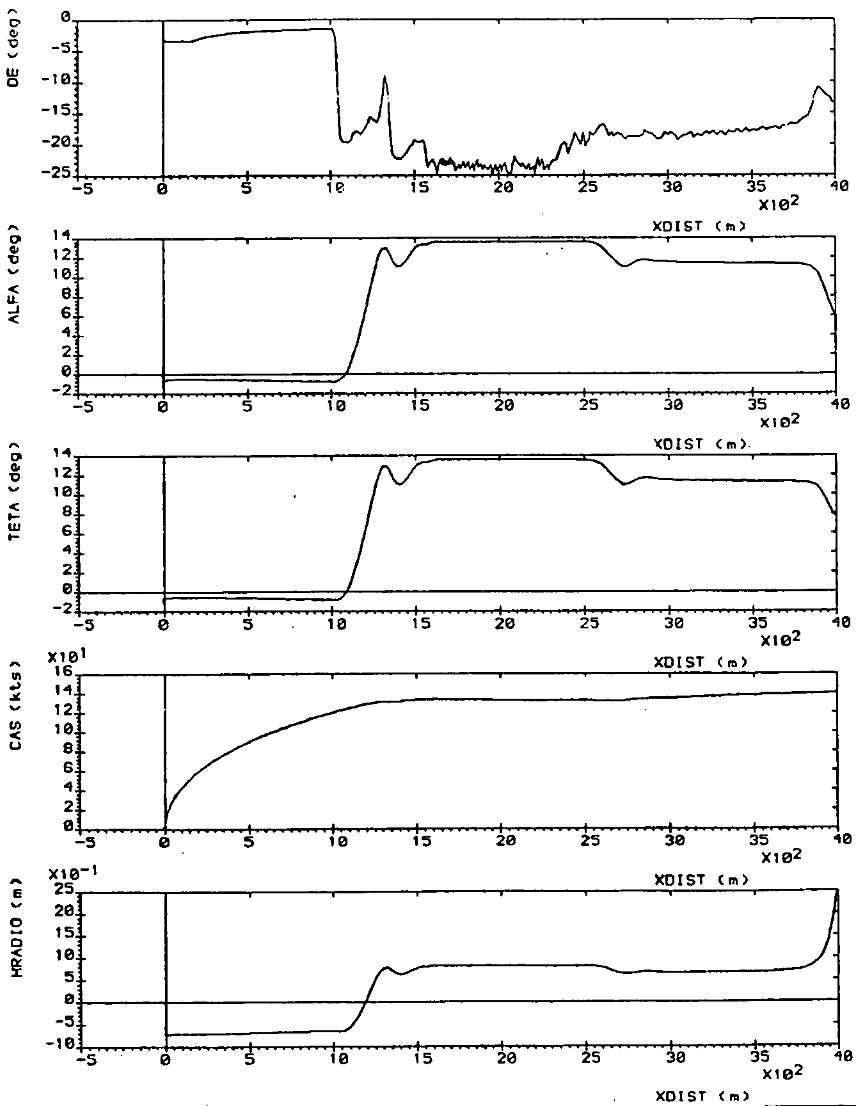


 FIGURE 29

REPORT
Fokker B.V.
Amsterdam
Holland

issue date: AUGUST 1989 issue no.: 2

security class RESTRICTED

report no.: VS-28-25

Ident: 100A4.02 TAY620 File : DMP.SLUSH.4A2 Date : 1- 8-1989
FOKKER 100 / TAY620
ICE=0.5
SLUSH=0.15
900 KG WEIGHT INCREMENT DUE TO ICE ON AIRCRAFT

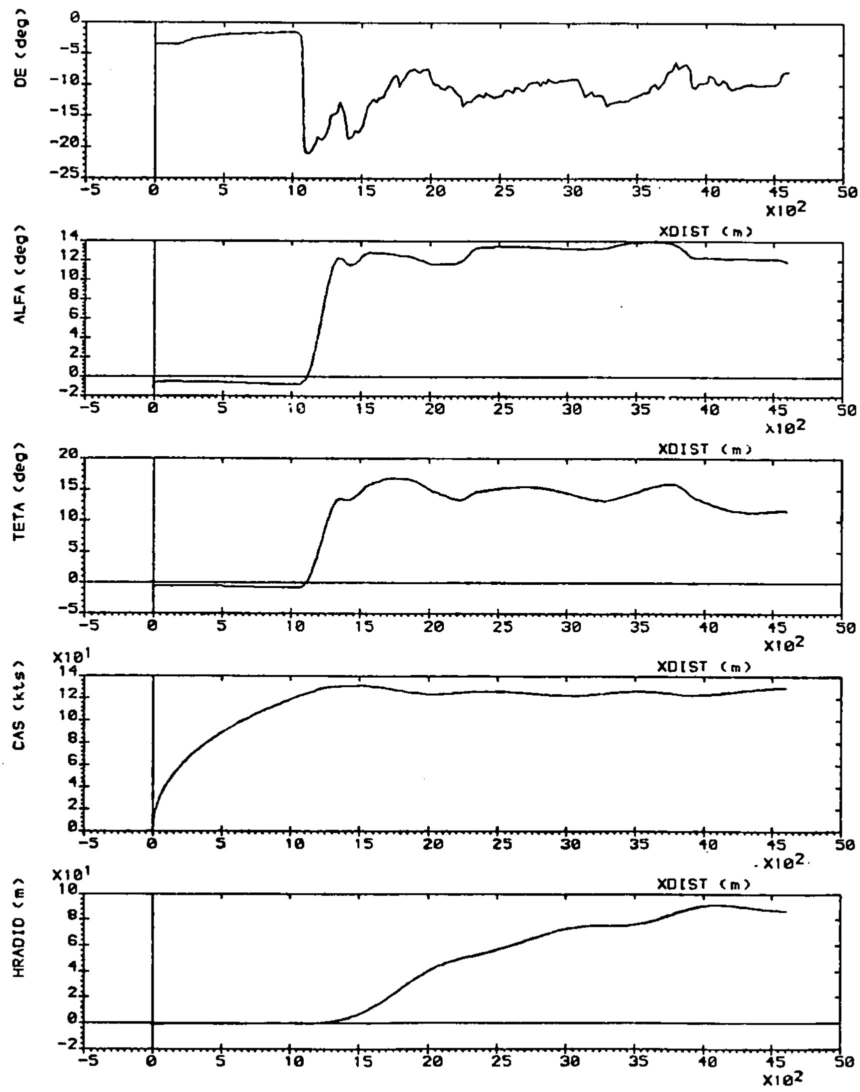


 FIGURE 30

REPORT
Fokker B.V.
Amsterdam
Holland

issue date: AUGUST 1989 issue no.: 2

security class: RESTRICTED

report no.: VS-28-25

Ident: 100A4.02 TAY620 File : DMP.SLUSH.4A3 Date : 1- 8-1989
FOKKER 100 / TAY620
ICE=0.6
SLUSH=0.15
900 KG WEIGHT INCREMENT DUE TO ICE ON AIRCRAFT

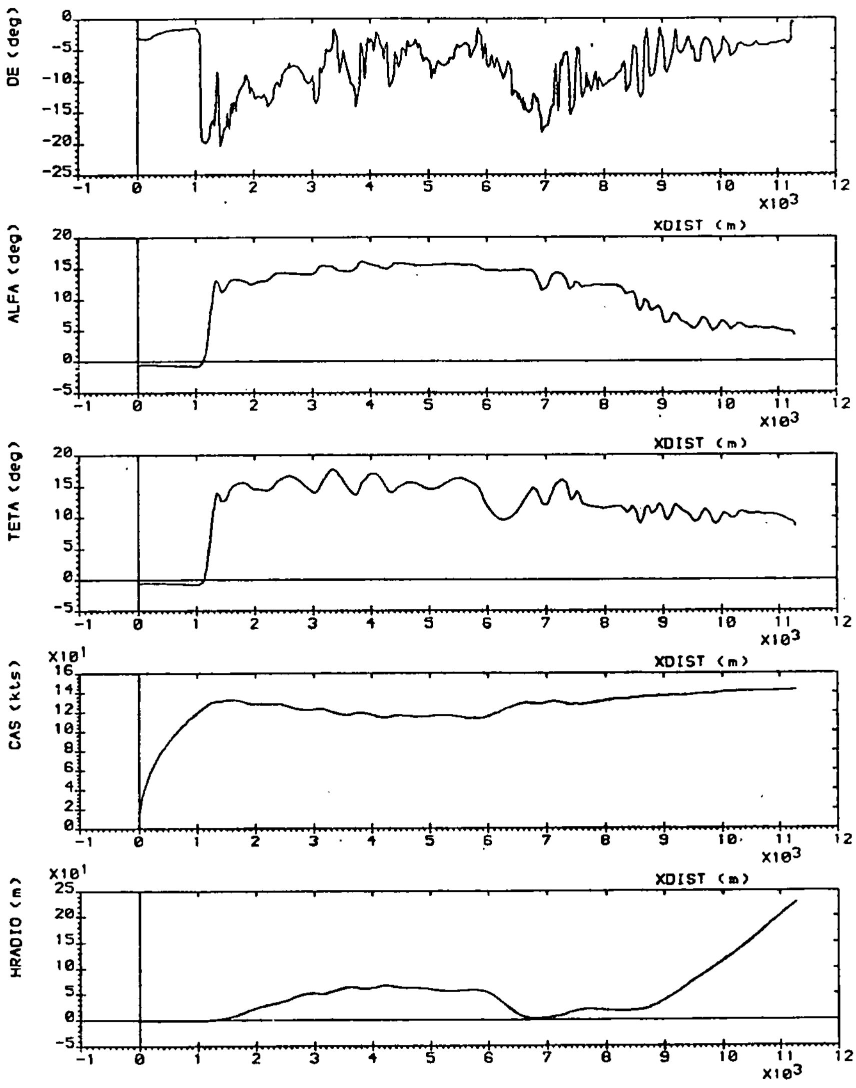


 FIGURE 31

REPORT
Fokker B.V.
Amsterdam
Holland

issue date: AUGUST 1989 issue no.: 2

security class	report no.:
RESTRICTED	VS-28-25

Ident: 100A4.02 TAY620 File : DMP.SLUSH.4A4 Date : 1- 8-1989
FOKKER 100 / TAY620
ICE=0.7
SLUSH=0.15
900 KG WEIGHT INCREMENT DUE TO ICE ON AIRCRAFT

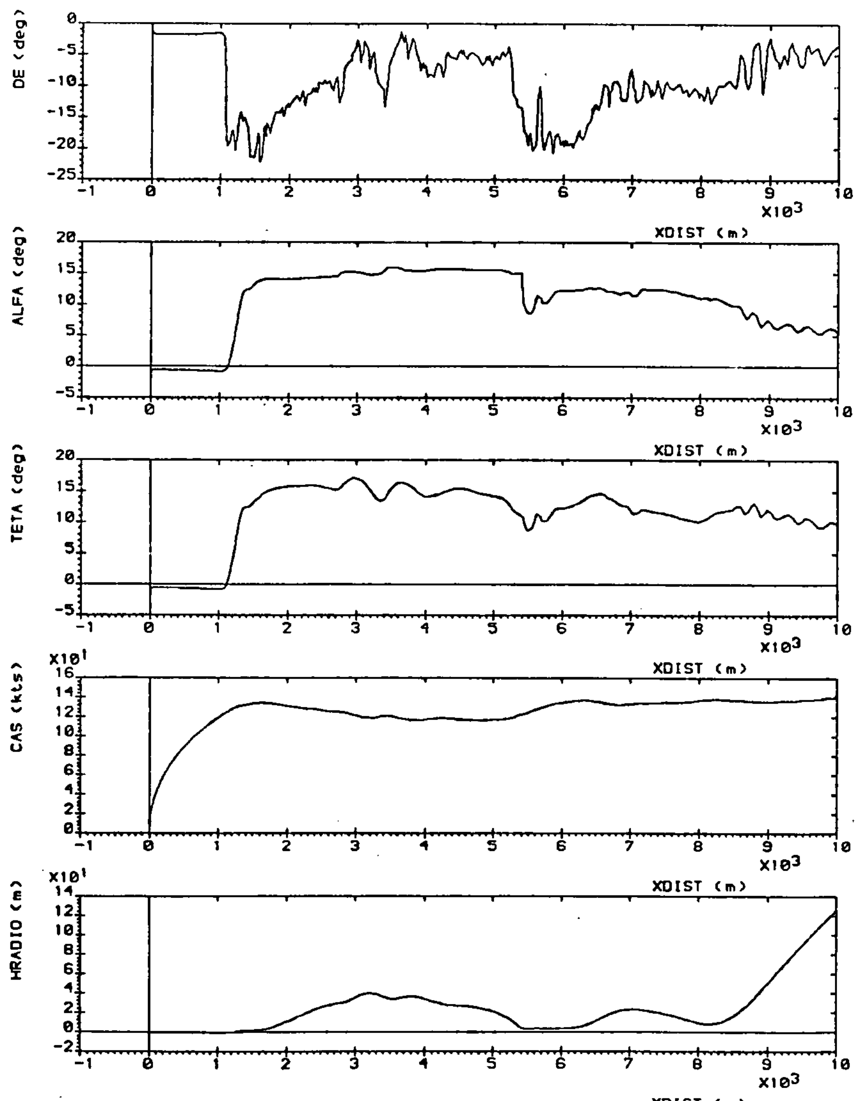


 FIGURE 32

REPORT
Fokker B.V.
Amsterdam
Holland

issue date: AUGUST 1989 issue no.: 2

security class	report no.:
RESTRICTED	VS-28-25

Ident: 100A4.02 TAY620 File : DMP.SLUSH.4A5 Date : 1- 8-1989
FOKKER 100 / TAY620
ICE=0.75
SLUSH=0.15
900 KG WEIGHT INCREMENT DUE TO ICE ON AIRCRAFT

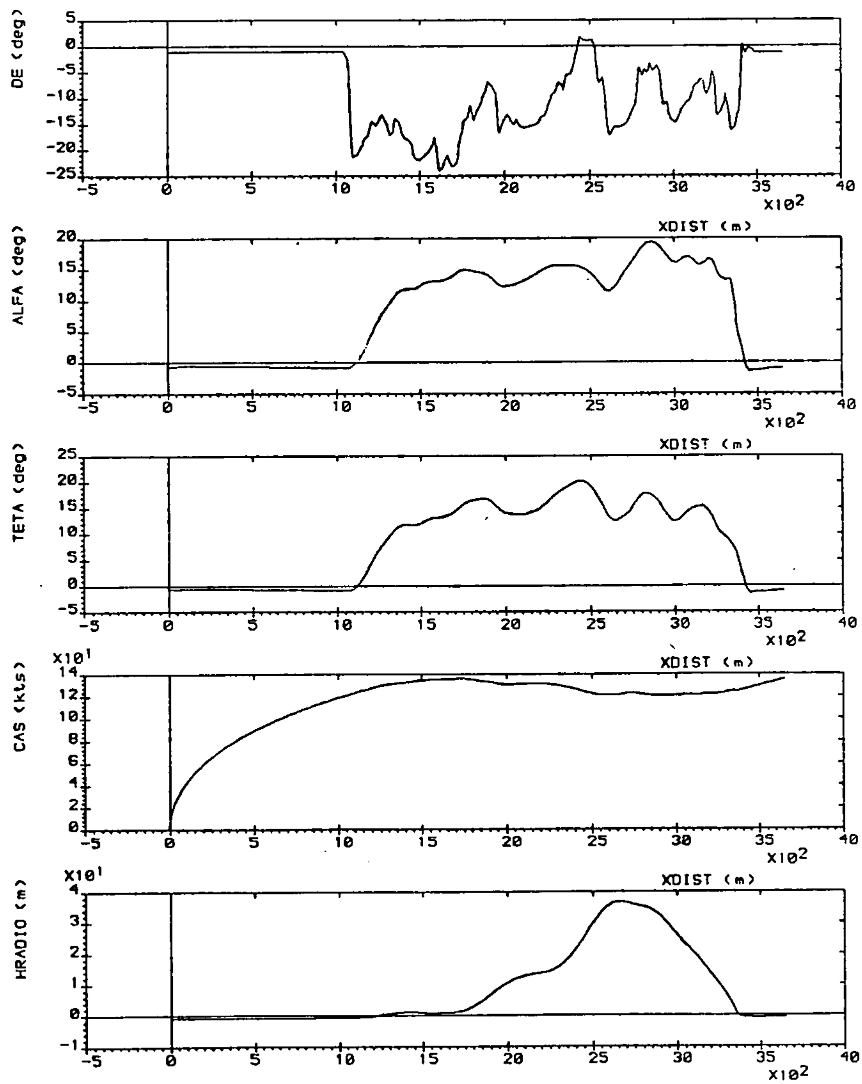


 FIGURE 33

REPORT
Fokker B.V.
Amsterdam
Holland

issue date: AUGUST 1989 issue no.: 2

security class RESTRICTED

report no.: VS-28-25

Ident: 100A4.02 TAY620 File : DMP.SLUSH.4A6 Date : 1- 8-1989
FOKKER 100 / TAY620
ICE=0.8
SLUSH=0.15
900 KG WEIGHT INCREMENT DUE TO ICE ON AIRCRAFT

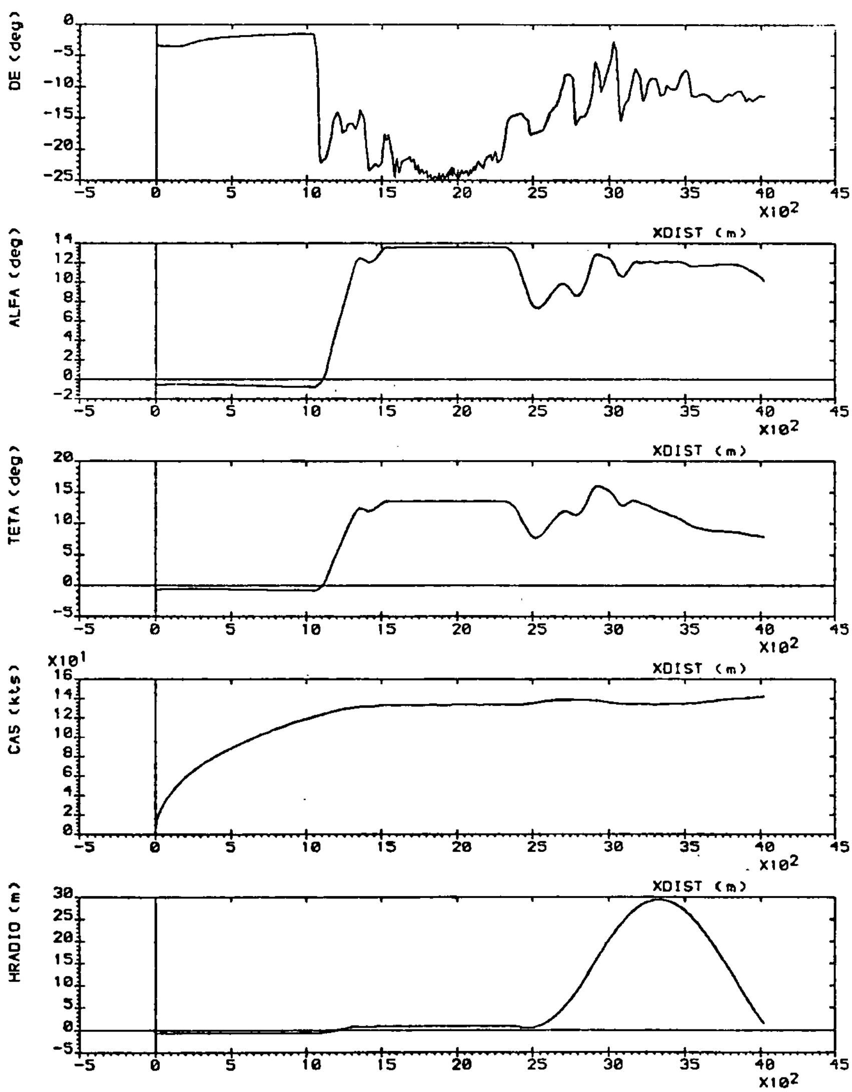


 FIGURE 34

REPORT

issue date: June 1989 | issue no. 1

security class: Restricted | report no. VS-28-25

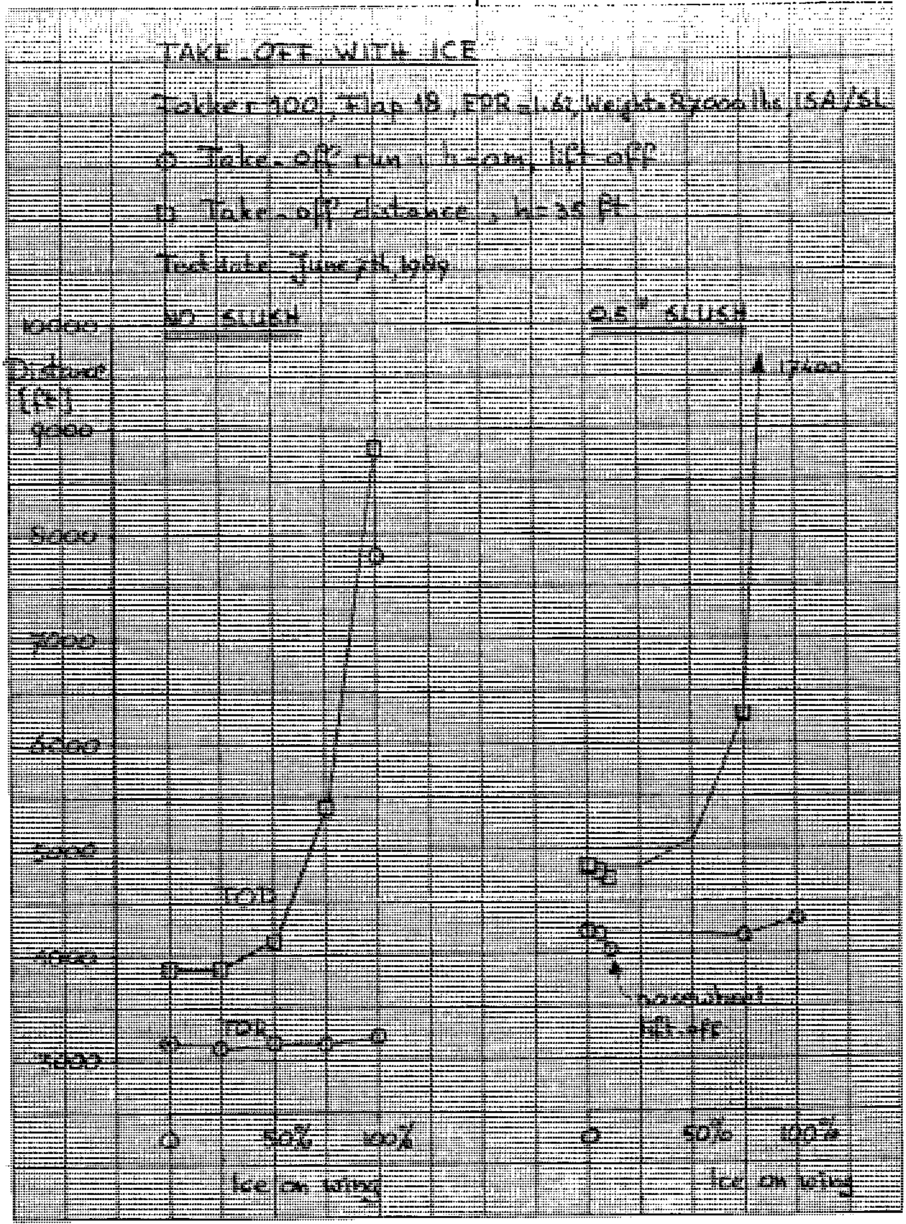


Figure 35

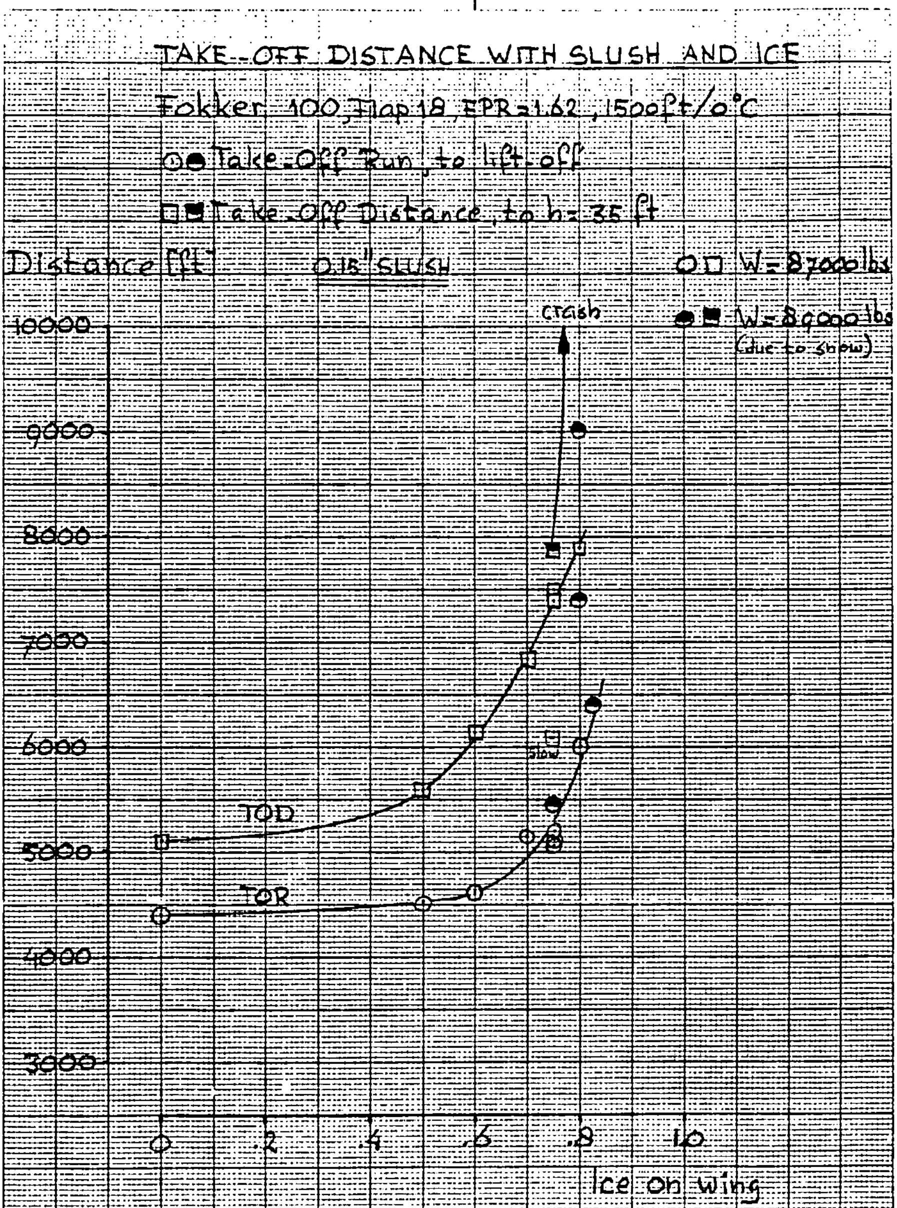
form 9715 05-88 12 01

REPORT

issue date. June 1989 issue no 1

security class Restricted

report no VS-28-25



page 51 of pages

Figure 36

REPORT

issue date: AUGUST 1989 issue no.: 2

security class: RESTRICTED

report no.: VS-28-25

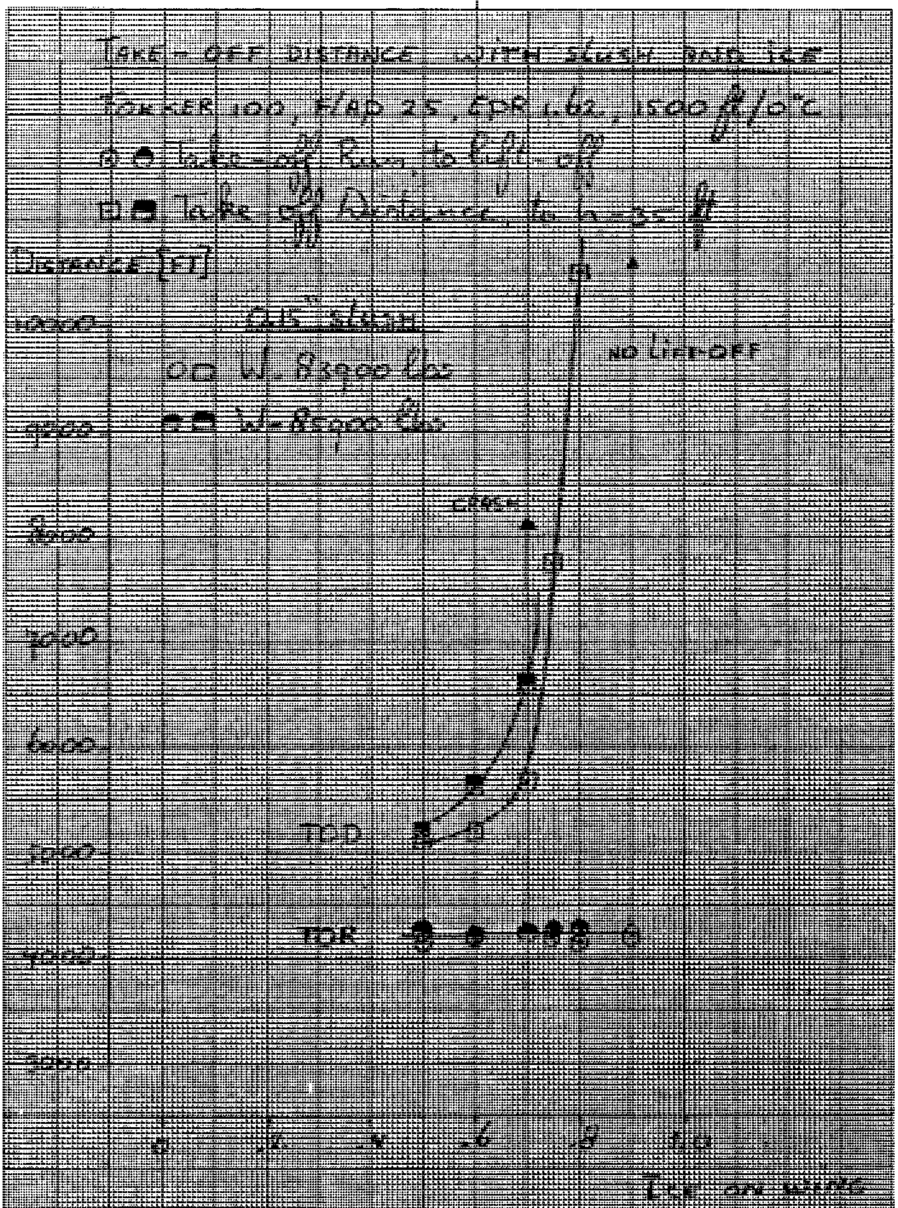


FIGURE 37

form 9/15 05-86 ĸ201

Appendix 4

A Report on the Flight Dynamics of the Fokker F-28 Mk 1000 as They Pertain to the Accident at Dryden, Ontario, March 1989

J.M. Morgan
G.A. Wagner
R.H. Wickens

November 22, 1989

LIMITED
UNCLASSIFIED

Canadä

A REPORT ON THE FLIGHT DYNAMICS OF THE FOKKER F-28 Mk 1000 AS THEY PERTAIN TO THE ACCIDENT AT DRYDEN, ONTARIO, MARCH 1989

Prepared by

J.M. Morgan
Flight Research Laboratory
National Aeronautical Establishment

G.A. Wagner
Air Canada and CALPA

R.H. Wickens
Low Speed Aerodynamics Laboratory
National Aeronautical Establishment

OTTAWA
NOVEMBER 22, 1989

NAE MISC 64

National Research Council Canada
Conseil national de recherches Canada

Copy # 12

Copy #..12..........

A REPORT ON THE FLIGHT DYNAMICS OF THE FOKKER F-28 Mk 1000 AS THEY PERTAIN TO THE ACCIDENT AT DRYDEN, ONTARIO, MARCH 1989

Prepared by

J.M.Morgan
Flight Research Laboratory
National Aeronautical Establishment

G.A.Wagner
Air Canada and CALPA

R.H.Wickens
Low Speed Aerodynamics Laboratory
National Aeronautical Establishment

Ottawa
November 22, 1989

STATEMENT OF OWNERSHIP

F-28 FLIGHT DYNAMICS
TABLE OF CONTENTS

SECTION 1 - GENERAL INTRODUCTION

SECTION 2 - AERODYNAMICS

F-28 FLIGHT DYNAMICS
SECTION 1

OVERVIEW AND GENERAL INTRODUCTION

INTRODUCTION

In March 1989 a Fokker F-28 Mk1000, C-FONF, operated by Air Ontario crashed while attempting a take-off at Dryden, Ontario, under adverse weather conditions. The accident investigation is taking the form of a Judicial Enquiry and as such persons not normally a part of the Canadian aviation accident investigative group are assisting or participating in the enquiry. A sub committee of the full fact gathering team has been designated the Performance Sub Committee or the Performance Steering Group and has been charged with investigating the take off performance of the F-28 aircraft and the effects thereon of the environmental conditions existing at the time of the accident. This paper is a distillation of the work of three members of this Steering Group, namely:

J.M.Morgan	National Aeronautical Establishment
G.A.Wagner	Air Canada and CALPA
R.H.Wickens	National Aeronautical Establishment

The three authors represent considerable expertise in a variety of appropriate disciplines. Mr Wickens is a specialist in low speed aerodynamics, Mr Wagner is a practising airline pilot who is also a qualified aeronautical engineer and assistant university professor, while Mr Morgan is a physics graduate and an engineering test pilot with extensive experience in real-time software and mathematical modelling techniques.

DOCUMENT ORGANISATION

The document has been divided up into Sections describing the various aspects of the work conducted, namely:

Section 1. This section is a general introduction and gives a brief overview of information available to the group and the kinds of investigations carried out in support of the enquiry.

Section 2. This section provides in depth background information into the aerodynamics of lift and drag, the effects of surface roughness (contamination) on the performance of an aerofoil and some detailed analysis of the F-28 wing.

Section 3. In Section 3 dynamic man-in-the-loop simulations carried out during a visit to the Fokker plant are described together with tentative conclusion drawn from them.

Section 4. Here analytical mathematical modelling of the F-28 is described in detail and sample trajectories for a F-28 aircraft attempting take off in the presence of flying surface and runway contamination are presented. The results are interpreted and conclusions based on the off-line modelling are discussed.

Section 5. This section deals with validation of the mathematical models described in Section 4.

Section 6. This section completes the document with a brief discussion of the results and offers conclusions as to the engineering reasons for the trajectory observed at the Dryden accident.

OBJECTIVES

The objective of the simulation work was to develop a range of possible flight path scenarios which were similar to that flown by the crew of the F28-MK1000 in the Dryden accident and from that determine a range of conditions which could have caused such a trajectory. The aerodynamic analyses were performed to support the simulation efforts and to provide enhanced background for the accident analysis and investigation.

THE INVESTIGATIVE PROCESS

For some decades now, civil transport aircraft have been required to carry Flight Data Recorders (FDR) and Cockpit Voice Recorders (CVR), devices that record a variety of aircraft state, configuration, power plant and crew activity parameters. These devices are built to withstand high levels of impact and certain exposure to fire while retaining their data in a recoverable fashion. When these recorders are recovered intact and useable after a crash, flight path re-construction is usually possible with a high level of confidence and such re-constructions can be invaluable in determining possible or probable causes of the accident.

Unfortunately the FDR aboard the Dryden aircraft did not survive in a readable state due to an intense post-crash fire. This meant that the group had only the accounts of eye witnesses on which to base any assumptions as to the aircraft's pre-crash behaviour. Luckily there were a comparatively large number of witnesses, including survivors and amongst the latter were several professional pilots, whose recollections have proved very valuable. There was also reasonable agreement among the witness reports as to the trajectory of the aircraft prior to crash, while analysis of tree impacts conducted by personnel of the Canadian Aviation Safety Board (CASB) shed some light on the flight path just prior to the final impact.

GENERAL CONDITIONS OF ACCIDENT

From witness's statements or interviews and the impact swath through the trees, there are some general prima facie conclusions which can be drawn, these are:

The aircraft's wing was, to some extent or other contaminated with snow and or slush at the start of the take-off run, and was at least partially contaminated up to the point of rotation.

The wing trailing-edge flaps were set to 18 degrees at the start of the take-off run and were at or near 25 degrees at the point of impact.

The engines functioned normally throughout the take-off attempt.

The aircraft rotated for the first time rather later than normal, either became briefly airborne or partially so, un-rotated temporarily, re-rotated and became airborne at very low level at or close to the end of the runway. It remained at very low level (failed to climb) until impact.

There is a very high probability that the runway was contaminated with snow or slush at the time of the take off attempt.

ASSUMPTIONS

In this case due to the lack of factual numerical data, the only way to attempt to re-create the flight path was by assuming certain details about the aircraft's mechanical and operational status, and then using a mathematical simulation and varying parameters which were possibly related to the reason the aircraft failed to fly.

The resulting flight paths were then compared with witness reports and other analyses of the aircraft's trajectory. These simulator studies were set up to produce the same forms of numerical and graphical output as would be obtained from a FDR analysis. Simulator studies were conducted both in a real-time dynamic engineering simulator at Fokker in Holland and by the use of mathematical flight path simulations based on aircraft performance data supplied by the manufacturer. The off-line simulations were written and developed by members of the sub-committee on performance.

These studies assume, based on information provided to us by other groups involved in this investigation, that:

- The aircraft powerplants generated normal thrust throughout the takeoff (although we do consider a single powerplant failure for completeness).
- There were no structural failures prior to impact.
- There were no brake failures or seizures, or tire failures which would have extended the ground roll portion of the takeoff or rendered the aircraft incapable of achieving Vus (unstick speed).
- There were no flight control system failures.
- There was no interference in the flight control system from any source.
- The flight crew handled the aircraft with normal handling techniques.

- o There were no system/instrument failures such that the flight crew was unable to fly the aircraft with the precision required for instrument flight. (An example would be failure of pitot heat so that the pilots would not have airspeed information available).

- o There were no adverse wind conditions which would have affected the aircraft's performance.

Based on the above assumptions, these simulations attempt to recreate the flight profile of the aircraft by assuming a range of wing snow/ice contamination levels and runway water/slush/wet snow contamination. These simulations and the results should NOT be interpreted as defining what actually happened to the accident aircraft. Rather, the material presented in this study should be interpreted as follows:

If the aircraft suffered no other operational or technical problems other than wing contamination combined with a certain degree of rolling resistance contamination on the runway, then the results of this simulation are possibly representative of the Dryden accident flight profile. In effect, this simulation and analysis is examining a subset (primarily aerodynamic and handling parameters) of all possible factors which may have been related to this accident.

CONTAMINATED WING TAKE OFFS

There is a long history of aircraft accidents related to flight in icing conditions. Specifically, there have been a number of accidents of aircraft which took off with ice/snow contaminants adhering to the wings and other parts of the aircraft. In these cases, either the aircraft were not de-iced prior to takeoff or the time between de-icing and departure was so long that the aircraft wings were again contaminated at takeoff time.

Additionally, there have been a number of events with F28-1000 aircraft which indicated that this aircraft was no different than others of similar configuration; it is sensitive to ice and snow contaminants on the wing, especially on the first 15% of chord. Experience with the F28 indicated that early flow separation and stalling was a characteristic effect of ice and snow contaminants on the wings. Furthermore, the premature separation on F28 aircraft typically caused wing drop as a result of outer panel flow separation and wing tip stall prior to inboard wing stall. (See Section 2 for details on this characteristic). There were two F28 accidents a number of years ago, one in Turkey and the other in Hanover, Germany, which are similar in a number of characteristics to the Dryden accident.

In the Dryden accident, the witness reports of contaminant on the wings of the aircraft during the takeoff roll, combined with descriptions of the aircraft's flight characteristics during takeoff roll, rotation, liftoff, and the short airborne segment were, in general terms, similar to reports of other ice/snow related accidents. This is true of events involving both the F28 and other aircraft.

These facts, combined with the lack of FDR data, provided the rationale for a requirement to simulate the flight path of the F28-MK1000 while considering significant amounts of wing contaminant and runway contamination. The engine failure case considered in this section was studied not because we had any indication to date that one of the powerplants had failed, but rather for completeness.

GENERAL APPLICABILITY

In this study, great care has been taken to model specifically the performance of the Fokker F-28 in the presence of contamination of both the flying surfaces and the runway. The results obtained, though, should never be interpreted in any way as indicating that this specific aircraft has shortcomings in this respect to any greater or lesser extent than any other aircraft in this class. Such sensitivity to contamination as has been demonstrated in this exercise might reasonably be expected to pertain in any aircraft of this class (ie, swept wing, jet propelled) in far greater measure than is seen in other classes of aeroplane. This is vividly portrayed in Figure 1, taken directly from a Fokker publication [1], which shows the markedly more severe penalties paid for contamination by a jet as opposed to a propeller powered aircraft. Not only does the shallower lift curve slope and reduced $C_{L_{max}}$ of the swept wing make the performance more readily degradable, but the jet powered machine does not have the advantage of a relatively large area of its wing being immersed in high velocity air from the propeller slipstream, its only lift producing capability being a result of its motion relative to the air.

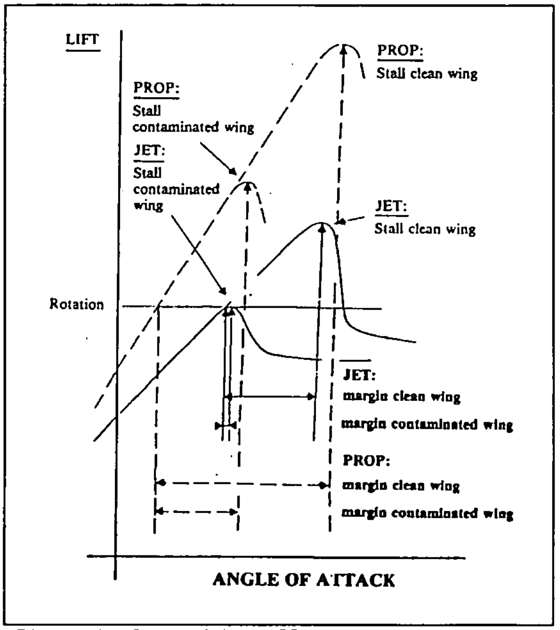


Figure 1 :Jet and Propeller Comparison

F-28 FLIGHT DYNAMICS
SECTION 2

AERODYNAMIC NOTES AND A DISCUSSION OF THE STALL AND POST STALL BEHAVIOUR

INTRODUCTION

This section of the report on flight dynamics presents a brief survey of the aerodynamic principles which are relevant to the Fokker F-28 transport aircraft, during ground roll and initial climb phase, and to degrees of wing contamination which affect that portion of the flight envelope.

Icing contamination of the lifting and control surfaces is not specifically addressed in this discussion, except in the context of roughness-induced changes to the wing characteristics, including stall and trim changes.

LIFT

The production of lift and drag on a conventional wing is a consequence of the streamline flow around the aerofoil and its smooth departure from the trailing edge. The lift force originates from the circulation and curvature of the flow over the profile and drag is a result of fluid viscosity and span loading.

The flow accelerates over the top and bottom of the aerofoil, especially near the leading edge. The pressures on both surfaces fall below ambient static pressure and the differential between these values, taken over the entire wing surface, results in a net lifting force.

The lift force is the product of flow dynamic pressure, wing area and lift coefficient, it expressed as follows:

$$L = (\tfrac{1}{2}\rho V^2) \times (S) \times (C_L) \qquad (1)$$

The lift coefficient, C_L depends on the angle of attack of the wing or aerofoil, where angle of attack is defined as the inclination of the aerofoil chord line to the oncoming flow. A similar expression for drag is:

$$D = (\tfrac{1}{2}\rho V^2) \times (S) \times (C_D) \qquad (2)$$

Lift is always at right angles to the direction of flight and drag is directed rearwards along the direction of flight. Figure 1 shows the forces on an aerofoil section in conditions of attached flow and also for separated flow, or stall. For normal attached flow the lift force can be decomposed into two components: a normal force and a force in the plane of the chord line, directed upwind. This latter force is known as leading edge suction and is caused by the curvature and acceleration of the flow around the leading edge. Achieving the full value of leading edge suction is crucial to the efficient operation of the aerofoil. If the value of the leading edge suction is reduced, or lost completely (as may be the case when the wing is stalled) then the main force on the aerofoil, in addition to friction drag, is the normal force, whose components are a reduced lift and a significant drag component (Figure 1b).

The basic characteristics of an aerofoil can be altered by the use of camber and high lift devices.The effect of camber is to change the relationship between lift coefficient, C_L, and angle of attack (α), see Figure 2. With a cambered aerofoil, C_L has a finite value when α is zero; however, the slope of the lift curve remains unchanged. High lift devices consist of trailing edge flaps, which extend rearwards and downwards and may have complex geometries, and leading edge slats, which extend forwards and downwards and enable the flow at the leading edge to remain attached at higher angles of attack than would otherwise be the case.

The main effect of flaps is to displace the lift curve upwards by an amount which depends on flap angle and geometry (Figure 3a). Maximum C_L is increased but still occurs at an angle of attack similar to that of the unflapped wing. Flap deflection also results in a sizeable drag increment (Figure 3b).

The increment in lift achieved by flap defection results in increased flow acceleration and suction on the nose of the aerofoil. To avoid leading edge separation and to achieve the potential gains in maximum lift, special attention must be paid to the leading edge design. This is done by the use of a generous nose radius (as in the case of the F-28 wing) or by the use of a leading edge slat. Figure 3a shows the effect of the extension of leading edge devices on the lift characteristics of the basic and flapped wing. Maximum C_L is increased significantly and occurs at a greater angle of attack than with the device retracted. Drag also increases as a result of slat extension but not as much as for the extension of flaps.

The pitching moment on the aerofoil is also affected by camber and the deflection of flaps. As angle of attack increases the aerofoil pitching moment is approximately constant until the stall. After the stall the tendency is to pitch nose down. Flap extension produces a further nose down increment in the pitching moment. Pitching moment is expressed as:

$$M = (\tfrac{1}{2}\rho V^2) \times (S) \times (c) \times (C_M) \qquad (3)$$

where (c) is the characteristic length, (ie the chord length for an aerofoil) and C_M the pitching moment coefficient.

The foregoing discussion relates to the origins of lift on the wing section, or aerofoil. The lift of the complete wing is more complex, and depends upon the shape of the planform, principally the aspect ratio, (span squared/area). The vortex flow that is a fundamental characteristic of the aerofoil section, extends along the span, and leaves the wing tips in the form of wing tip vortices which stream downwind. Actually, vorticity is shed along the entire wing span in the form of a vortex sheet that subsequently rolls up at the side edges into concentrated free vortices.

For the purpose of analysis the wing can be replaced by a vortex system consisting of a bound vortex travelling with the wing, and free vortices that emanate from the wing tips and stream down wind. A schematic representation of this flow model is shown in Figure (4).

This simple concept has allowed all conventional lifting surfaces to be compared on the same basis; aerodynamic theory shows that aspect ratio is the governing physical parameter that determines lifting performance and induced drag. The slope of the lift curve is linear over the operating range of the wing, and decreases as wing aspect ratio decreases. The upper bound of the relationship is the lift curve slope of the airfoil section, corresponding to an infinite aspect ratio and it is evident from Figure 4b that a high aspect ratio is desirable for efficient flight. Conversely, a disturbance in the distribution of spanwise load, such as that caused by the deflection of trailing edge controls, or a partial stall, corresponds to a lower equivalent aspect ratio, lower lifting effectiveness and higher induced drag as compared to the undisturbed span loading.

The free vortex system behind the wing gives rise to an induced flow, the vertical component of which is termed "downwash". The momentum of this flow is imparted to the undisturbed air per unit time as the wing advances, and is directly related to lift. The energy of the complete downwash field represents the price to be paid for the generation of lift. The downwash flow in the region immediately behind the wing is important for the operation of the tail plane, and the longitudinal stability of the aircraft. Thus if aspect ratio changes, or if a local disturbance occurs on the wing surface, the downwash will be altered, the load on the tail plane will change, and the aircraft trim equilibrium will be disturbed.

DRAG

Drag forces acting on an aircraft consist of two components: pressure drag and friction drag. Pressure drag, which is parallel to the direction of motion, results from the pressure forces acting on the body. Friction drag is the sum of all the tangential forces taken in the same direction, and is the viscous component.

Pressure drag has two components: induced drag, which is dependent upon lift and wing aspect ratio; and wake or form drag, which is dependent upon the shape of the wing section, and the growth of the unseparated boundary layer. Form drag originates from a balance of the pressures over the front and rear portions of the airfoil section, and can be thought of as a buoyancy force directed rearwards.

Form or wake drag is zero if the flow is frictionless, and the external flow closes around the wing (ie. no separation). This is known as D'Alembert's paradox. In a real flow, however, where viscosity consumes the momentum next to the wing surface, the pressure over the rear portion of the airfoil is altered, and therefore no longer balances the forward pressure force. The resulting imbalance is a pressure drag and depends upon the form or profile of the airfoil. If separation, or any other disturbance occurs on the rear portion of the airfoil, this imbalance becomes very large and constitutes a significant increase in drag. Form drag and friction drag, taken together, are called profile drag, and depend on the local cross-section or profile of the wing.

The induced drag of the lifting system arises from the bound and streamwise arrangement of vorticity. In its simplest form, the wing can be thought of as a device which advances into still air, and continuously deflects downwards, a finite mass of air in the wake. This idealization, known as the streamtube concept, suggests that the trailing wake and its circulating flows are contained within a circular tube spanning the wing tips, that contains all of the momentum associated with the production of lift.

Similarly, the work done in producing this deflected streamtube, its internal flows and its downward motion, results in a drag which is dependent upon lift, and is termed induced drag.

A simple formula for total drag is as follows:

$$C_D = C_{D_0} + C_L^2/\pi(Ae) \qquad (4)$$

C_{D_0} is the viscous drag coefficient, and (Ae) is the effective aspect ratio. Lift/drag ratio, a measure of wing performance, depends upon effective aspect ratio, and profile drag.

A secondary, but important parameter in the relationship between lift and induced drag, is the distribution of aerodynamic load along the span of the wing. Induced drag is a minimum when the distribution of lift over the span is elliptic in shape and the value of the wing efficiency factor e is 1.0. Any departure from this shape, due to local separation, or deflection of controls, results in a non-optimum load distribution, a value of e less than 1.0, and higher induced drag for the same lift.

SKIN FRICTION AND THE BOUNDARY LAYER

Viscous drag resulting from the frictional force on the wing arises from the loss of momentum of the fluid that has passed over the surface. This phenomenon is confined to a thin layer adjacent to the surface, in which intense shearing takes place. The shearing stress, or frictional force per unit area, is measured by the product of the coefficient of viscosity and the velocity gradient next to the surface. Thus a gas of low viscosity can produce significant frictional drag on a smooth surface. The boundary layer, as this thin region is called, may be composed of either laminar or turbulent flow and its behaviour determines the limits of efficiency and stability of the airflow over the range of operation of the aircraft.

The initial flow in the boundary layer on a smooth surface will be smooth and orderly (ie. laminar), and the velocity increases from zero to its full value across the thin layer of the viscous region. This layer, in which momentum loss occurs, increases in thickness with distance from the leading edge; the frictional force, which depends upon the velocity gradient, diminishes in the same distance. Figure 5 shows, schematically, the main elements of the laminar and turbulent boundary layer.

Viscous drag is the sum of the frictional force over the length of the surface. Thickening of the laminar boundary layer with distance implies a continuous loss of kinetic energy dissipated by viscosity, and at some point separation will occur when the kinetic energy of the flow is sufficiently reduced. This will occur more rapidly if the flow is advancing into an adverse (positive) pressure gradient.

Transition from laminar to turbulent flow in the natural boundary layer is inevitable, and has both beneficial and adverse effects. As is known for the dimpled golf ball, a turbulent flow resists the tendency to separate with a corresponding reduction of form drag. The same observation can be made for the airfoil in which the boundary layer flow is turbulent. The tendency to separate is resisted, and the maximum lift coefficient at which the airfoil will stall is increased. The negative effect is that as far as viscous forces are concerned, the turbulent boundary layer will have a higher skin friction, and hence a higher drag than the laminar layer, even on a smooth surface.

The main criterion which determines whether or not the boundary layer is turbulent is a parameter which expresses the ratio of fluid inertial and friction forces. The parameter is the Reynold's Number[1] and it determines the relationship between the flows on similar bodies, such as the wing boundary layer flow on a full size aircraft, and its scaled-down model counterpart. Reynold's Number also determines, in both cases, when the boundary layer makes the transition from laminar to turbulent flow. Research has shown that for flow on a smooth flat plate, transition to turbulence will occur at a Reynold's number of about one million. This is well below the value for typical transport aircraft on take off, so unless the aircraft wing is designed specifically to have extensive laminar flow, it will be fully turbulent over most of its length, and therefore its flight envelope.

The turbulent boundary layer is characterized by a thick layer of turbulent mixing and dissipation. Embedded below the turbulent region is a thin laminar layer next to the surface, called the laminar sub-layer. It is in this sub-layer where the velocity gradients are high, and the frictional drag originates (Figure 5b). The flow on the airfoil at full scale Reynold's numbers is turbulent except at the nose, near the leading edge attachment point, where the boundary layer is initially laminar. Transition to turbulence occurs within a short distance, however, due to local pressure gradients and the condition of the surface.

The laminar sub-layer over the forward portion of the aerofoil chord has high levels of frictional drag, but its thickness is gradually reduced by the turbulent region adjacent to it, as the flow progresses along the chord. The initial thickness of the sub-layer is important in determining whether or not the surface can be considered aerodynamically "smooth", or "rough". This is especially critical near the nose of the airfoil, where any protuberances or roughness elements will have a serious effect further downstream: further aft on the chord

---

[1] Reynold's Number is defined as:

R_e = (velocity)x(chord)/(kinematic viscosity) the rising turbulence intrudes into the sub-layer, the surface is always considered "rough", and the energy loss is due mainly to turbulent dissipation.

Because the flow at the trailing edge is theoretically a stagnation point, the external flow must decelerate before coming to rest, resulting in an adverse pressure gradient. If upstream roughness or excessive turbulent dissipation has consumed momentum in the boundary layer, it may separate, and the stall begins. As the wing incidence increases, separation becomes more wide spread until the wing is said to have stalled.

If the surface contamination elements (rivet heads, frost etc.) lie within the laminar sublayer they have virtually no effect on the total resistance. If, however, the roughness elements protrude beyond the laminar sublayer, the result is a noticeable increase in skin friction, and production of more turbulence. An increase of Reynold's number aggravates this problem since the laminar sub-layer becomes thinner at high Reynold's numbers. If the roughness height is large in comparison with the laminar sub-layer, then the frontal drag of these elements determines the average skin friction, and their shape, orientation and distribution become important. The increased turbulence and dissipation in the roughened boundary layer also leads to a premature flow separation and stall for Reynold's numbers above one million. At high Reynold's numbers nearly all of the loss of energy is due to wake formation; the resistance is independent of viscosity, and proportional to the square of the velocity. Figure 5c shows the effect of Reynold's number on drag coefficient in laminar and turbulent flow. If the surface is rough, the curve representing turbulent flow indicates an increase in skin friction drag.

Figure 6a shows the critical roughness size (in terms of percent chord) below which there is no increase in drag on a flat surface. The working range of Reynold's number for the F-28 is also indicated in this Figure. For distributed roughness greater than the critical size, Figure 6b shows the drag increase experienced by both wings and bodies, for a range of Reynold's numbers.

CHARACTERISTICS OF THE STALL OF AEROFOILS

Separation of the turbulent boundary layer is followed by partial or complete detachment of flow over the airfoil, a dramatic decrease in lift, and an increase in drag. The trailing edge no longer completely governs the strength of the circulation and vorticity is shed downwind as a turbulent wake. The chordwise distribution of pressure is greatly altered, and the resulting change in airfoil pitching moment will disturb the aircraft trim conditions. Since the pressure distribution of the stalled airfoil no longer conforms to that of attached flow, form drag will increase. Friction drag is indeterminate over the separated region, but will be active on the lower surface of the airfoil. For the complete wing, induced or vortex drag will be less, since lift is lower.

There are basically three types of aerofoil stall (illustrated in Figure B-1), and the characteristics of each are governed mainly by airfoil geometry and Reynold's number.

Type 1: Trailing Edge Stall

The trailing edge stall is the most common and desirable type of stall for airfoils with thickness/chord ratios 15% and above. At high angles of attack, flow on the upper surface is characterized by a thickening of the turbulent boundary layer, followed by an initial separation at the trailing edge. The separation gradually moves forward, with a corresponding decrease in lift. Maximum lift occurs when the separation reaches mid-chord. The resulting collapse of lift is gradual, drag continues to rise rapidly, and pitching moment becomes less nose down. Flow at the leading edge remains attached, and the leading edge suction force is active to a high angle of attack.

Type II: Leading Edge Stall

As thickness/chord ratio decreases below about 10%, the airfoil experiences an abrupt separation of flow near the leading edge. Separation of the laminar portion of the boundary layer occurs well before maximum lift, and transition to turbulent flow will occur in the separated shear layer. The flow will reattach in the form of a small bubble just aft of the airfoil nose. At moderate angles of attack, the pressure distribution is not seriously altered, and the lift, drag and moment characteristics of the airfoil are not greatly changed.

As angle of attack increases, however, the bubble enlarges and moves aft until reattachment of the turbulent shear layer is no longer possible.The flow then separates over the entire airfoil surface, the leading edge suction collapses, and the pressure distribution along the chord remains nearly constant with low negative values. Lift drops abruptly with no gradual transition; pitching moment becomes significantly less nose down.

Type III: Thin Aerofoil Stall

Separation and stall on very thin sections (<6% t/c) consists mainly of the gradual lengthening and ultimate breakdown of the upper surface short bubble. The breakdown of the bubble with resulting flow separation occurs at moderate angles of attack. The lift curve is characterized by a gradual reduction in lift slope, and a stall which occurs at a low maximum lift coefficient, but with a gradual decline. Pitching moment undergoes a large but gradual negative change. The pressure distribution exhibits negative values, which extend over the length of the bubble, as long as it is attached to the surface. When flow breakdown occurs the long bubble detaches from the trailing edge, and a trailing wake is shed from the leading edge.

In general, modern airfoils do not conform precisely to these three distinct categories of stalling behaviour; rather, combinations of the different stall characteristics may be exhibited, and may be sensitive to minor variations of shape, Reynold's number, leading and trailing edge devices etc. For Reynold's numbers appropriate to the operation of typical transport aircraft, a large nose radius is desirable to delay the breakdown of leading edge suction and to achieve the trailing edge separation (type I) and high maximum lift. Conversely, as Reynold's number diminishes, all airfoils tend to stall from the leading edge (type III). Observations from both wind tunnel and flight test indicate that the aerofoil section of the F-28 wing lies well within the region for TYPE I (Trailing Edge) stalls and, as such, may be considered a conservative design. The reason for this may be attributed mainly to the generous nose radius of the aerofoil.

STALLING CHARACTERISTICS OF ROUGHENED AIRFOILS

The previous remarks regarding airfoil stall relate to flow over a smooth surface. When the airfoil has a roughened surface, transition to turbulence occurs earlier, friction drag increases, and flow separates prematurely from the upper surface.

The effect of distributed roughness on the premature stall of airfoils is shown in Figures 7 and 8 which are from Reference [2]. The roughness was distributed uniformly over part or all of the airfoil, and Reynold's number was varied from about 10^5 to 10^7. Maximum lift coefficient is considerably reduced by roughness for the two airfoils which were tested, and the critical Reynold's number at which this occurs decreases as the magnitude of the roughness increases. The results of Reference [1], for the higher Reynold's numbers, indicate that roughening of the entire wing upper surface results in a loss of maximum lift of as much as 50%. Drag under conditions of premature stall would be due mainly to form drag, and would be high. The size of the distributed roughness in these experiments corresponded to 0.01 in. and 0.004 in. on a wing the size of that of the F-28. Most studies of the effect of roughness on the performance of airfoils deal with the uniform distribution of contamination over the entire upper surface. The importance of preserving smooth attached flow around the nose is important; if the nose contamination is removed, the wing is restored to its original unstalled state. Conversely, the contamination may take the form of a single roughness element, or ridge which extends across the span on the upper surface. The drag of such a protuberance depends upon the degree to which it extends above the sub-layer, and the sharpness of its edges. Maximum lift will be reduced and if the flow over the nose is critical, separation will occur abruptly from the leading edge. Figure 7b shows a comparison of the loss of lift due to uniformly distributed roughness to that due to a single, spanwise ridge extending along the wing upper surface.

STALLING OF COMPLETE WING

Stall characteristics of the complete wing depend upon which portion stalls first, and how the separation spreads along the span. Initial stalling at the wing tip is undesirable since it may induce a violent roll, and a loss of aileron control.

If the boundary layer is encouraged to stall first at the wing root, then the tendency to wing drop is lessened, but the turbulence and low total pressure which results from the separation may result in buffeting of the tailplane and poor quality flow in the engine intakes for fuselage-mounted fan engines. Stall management on wings of current transport aircraft is usually achieved by precipitating the separation at a particular spanwise location. This may be accomplished by the use of various devices at the leading edge, eg; kinks in the leading edge, notches, fences or vortilons. These devices not only result in stall at a particular lift coefficient, but ensure a symmetric stall.

GROUND EFFECT

Ground effect is perceived as a cushioning of the aircraft when landing with a resulting tendency to "float" before touchdown. Ground effect also has a significant effect during take-off, although the physical sensation may not be as obvious.

The phenomenon originates from the interaction of the wing and fuselage with the ground plane and is composed of three different phenomena, which affect both lift and drag. They are usually applied as corrections to design and performance data.

The first effect is due to the volume or displacement of the airplane and the low pressures that will be induced between it and its image. These negative pressures act to suck the aircraft on to the ground, and therefore constitute an effective loss of lift.

The second effect occurs only when the wing is lifting and the resulting interaction results in an increase in lift per unit angle of attack. The sensation experienced on landing is due to this increase of lifting effectiveness. This increase is, in some cases, cancelled or reduced by the displacement effect of the aircraft volume, already described.

The third ground effect results from the interaction of the trailing wake behind the wing with the ground plane. The most important result of this is that the upwash at the wing diminishes, so that the effective angle of attack is lower. This causes a significant reduction of induced drag, thereby lengthening the final flight path before touch down.

The beneficial value of ground effect during take-off is reduced drag and increased lift, however these benefits diminish rapidly as the aircraft climbs. At approximately one wing span above the ground, the ground effect has essentially vanished.

AERODYNAMIC CHARACTERISTICS OF THE FOKKER F-28, MK. - 1000

FOKKER F-28 MK. - 1000 - SPECIFICATIONS

The Fokker F-28 (Mk.1000) is a twin-turbofan short range airliner. It is a swept, low-wing configuration, with a T-tail, and rear mounted engines. The version of the present investigation seats 65 passengers, and cruises at a maximum speed of 455 kt at 23000 ft (a Mach number of 0.75).

A full technical specification of the Fokker F-28, (MK.-1000) can be had from Reference [3] and is presented in Appendix A. Some of the geometric, weight and performance parameters relevant to the present investigation are listed as follows. A general arrangement of the aircraft is shown in Appendix A.

TABLE I

Wing Span	77'-4 1/2"
Wing Area	822 ft^2
Aspect Ratio	7.27
Mean Aerodynamic Chord (MAC)	11.5 ft.
Engine Thrust[2]	9850 lb.
Max. take-off weight	65000 lb.
Operating weight empty	35,464 lb.
Max cruise speed (23000')	455 kt.

Rotation speed for the F-28 ranges from 100 to 130 kt. depending on weight and environmental factors.

The flow on the wing changes from a high lift condition at lift off using slotted Fowler flaps, to low transonic flow at cruise. The lift coefficients of the mean chord section based on maximum weight and the above speeds are 1.38 and 0.24 at lift-off and cruise respectively. The maximum lift coefficient for the F-28 wing is about 2.1. The wing is not equipped with leading edge devices (Slats, Kreuger Flaps etc.)

The Reynold's number of the flow at the mean chord ranges from 12 million at sea level (lift off at 130 kt) to 29 million at 23000 ft. (455 kt.). The boundary layer flow is turbulent over the main wing component under normal operating conditions.

AERODYNAMIC DATA FOR THE FOKKER F-28, MK.-1000

Relevant aerodynamic data which was made available by Fokker comes from several sources:

[2] Sea Level Static, ICAO Standard Day

1) Results of a wind tunnel test at the NLR[3] in which the effects of simulated ice contamination of the wing were measured.

2) A description of the aerodynamics of wing stall, including flight experience with the airplane.

3) Computed values of pressure distribution, skin friction and displacement thickness of the boundary layer, for the F-28 airfoil section.

4) An official database from which the F-28 simulator model was assembled.

F-28 WIND TUNNEL TEST DATA

Figure 9 shows the results of wind tunnel tests on a complete model of the Fokker F-28. The test Reynold's number of the Mean Aerodynamic Chord (MAC) was 2.85 million, and the wing flaps were set at 30 degrees. The model angle of attack range was from -2 to +20 degrees. The test was conducted in the NLR wind tunnel and the model was positioned on a mounting which allowed a range of pitch angles to be used.

Data are also shown in which the upper surface of the main wing component is treated uniformly distributed carborundum roughness elements. The wing roughness was intended to simulate ice deposits of 1 and 2 mm thickness full scale, uniformly distributed on the upper wing surface at one element per sq cm. Tests were also done with the first 15% of the wing component cleaned off. Figure 9 presents C_L and C_M plotted against angle of attack, and also C_L against C_D.

The lift slope in the linear part of the lift curve is 0.100. For angles above about 8 degrees, the lift curve becomes non-linear, due to a thickening and deceleration of the trailing edge boundary layer. Maximum lift occurs at 14 degrees, and has a value of $C_L = 2.13$. The top of the stall is rounded, but lift falls rapidly to a value of 1.55 as the wing pitches to 16.5 degrees. Lift continues to diminish to a value of $C_L = 1.46$ at 20 degrees angle of attack.

The wing exhibits a characteristic hysteresis in lift, as the angle of attack reverses. Maximum lift is not achieved, and the data returns to the linear part of the lift curve at an angle of attack of 7.5 degrees and at a lift coefficient of 1.75. Hysteresis is an entirely viscous phenomenon, and is a common occurrence on wings and airfoils. It is associated with flow fluctuations, particulary during reattachment at the stall. Hysteresis does not occur when the wing upper surface is roughened; the maximum lift coefficient under these conditions is 1.6.

[3] Nationaal Lucht- en Ruimsevaartlaboratorium, the Dutch National Aerospace Laboratory.

Pitching moment C_M, is nose down relative to the quarter chord of the MAC, for values of lift before and after the stall. There is little hysteresis.

Drag rises slowly with lift until maximum lift is reached, as is shown in the drag polar Figure 9. Drag at C_{LMax} is about triple the drag for small values of lift, and is attributed to induced or vortex drag.

As lift falls, after flow separation, the drag rise is due mainly to form drag from the altered wing pressure distributions. Hysteresis also occurs in drag, since the pressure distribution is also affected by the flow separations. As with the lift curve, roughness reduces the hysteresis effect.

The effect of roughness on the wing upper surface is dramatic. Maximum lift occurs some 7 degrees earlier at an angle of attack of 7.5 degrees, and reaches a value of 1.6. At higher angles lift diminishes to $C_L = 1.4$, and thereafter remains constant.

With roughness applied, pitching moment begins to decrease rapidly beyond 8.5 degrees, and thereafter becomes strongly nose down at maximum lift.

Drag at maximum lift for the roughened wing is less than that for the clean wing, but lift is also less: the drag continues to rise rapidly as lift falls. At angles of attack above 11 degrees, there is a rapid rise in drag, to a value of $C_D = 0.6$, with essentially no change in lift.

With the entire wing upper surface roughened, the levels of turbulence in the boundary layer that is developing on the nose are higher than normal and kinetic energy is being exchanged for pressure at a higher rate than for the clean surface. If the roughness elements are large enough the result is higher local drag and turbulence; the sublayer itself is annihilated by the wake turbulence of the roughness elements. This factor and also the fact that the flow is subjected to a rising pressure aft of the nose suction peak, provide the potential for early boundary layer separation and wing stall.

Conversely, if the wing nose is clean over the first 15% of chord, the boundary layer, and particularly the laminar sublayer, develops naturally and is able to negotiate the adverse pressure gradient on the rear half of the wing successfully. If roughness is present on the rear portion of the wing surface only, the potential for flow separation is modified by a weakening of the adverse pressure gradient and the additional roughness-induced turbulence plays a more active role in resisting the tendency to separation. Friction drag, however, will be higher, due mainly to the drag of the roughness elements themselves.

EFFECT OF ROUGHNESS ON DRAG IN UNSEPARATED FLOW

Roughness elements on a smooth surface will affect skin friction drag and if the local flow is still laminar, roughness will cause an immediate transition to turbulent flow. The resistance formulae of Reference [4] can be used to estimate drag theoretically, resulting from simulated roughness contamination, assuming separation does not occur. For a chord Reynold's number of 12 million, and a smooth surface of the same length as the F-28 mean chord, the total skin friction drag coefficient is estimated to be 0.0029. When roughened, the drag coefficient rises to 0.0065 and 0.0079 for roughness heights of 1 mm and 2 mm respectively. The wind tunnel results obtained by Fokker indicate that, for angles of attack below the stall, roughness causes a drag rise of about 6% in the complete airframe model compared to the smooth wing configuration.

The wind tunnel data for the F-28 model show very clearly the effects of wing contamination on aerodynamic characteristics. They do not, however, conform precisely to the airplane configuration in the present investigation, since the flap setting on the model was 30 degrees, compared to the 18 to 25 degree settings which the actual aeroplane was thought to have had during the takeoff run. The test Reynold's number was 2.85×10^6, compared with 12×10^6 for the aircraft at take-off. The main effect of these differences will be on maximum lift. The lift curve to C_{LMax} for attached flow for a flap angle of 18 degrees is available from the Fokker data base, and it can be assumed that appropriate Reynold's number corrections have been made. Similar information is available for C_D and C_M beyond stall; the correction process is more uncertain, but it is assumed that the incremental changes in the aerodynamic characteristics due to both stall and contamination can be applied from the wind tunnel data directly to the data base.

STALLING CHARACTERISTICS OF THE F-28 WING

The Fokker F-28 has a wing of aspect ratio 7.27, swept 16 degrees at the quarter-chord line. The leading edge profile has a kink at wing station 4700 (40.7% semi-wing span), and a leading edge fence at station 3784 (32.8% semi-wing span). The mean aerodynamic chord, to which Reynold's numbers are referred, is at wing station 4940 (43.8% of wing semi-span). Investigations by Fokker of the maximum lift, and wing stall aerodynamic characteristics using wind tunnel investigations and flight test, are presented in Reference [5].

An important design objective for the F-28 was the achievement of a high maximum lift coefficient, and satisfactory stall characteristics. The wing sections are characterized by a large nose radius in order to improve maximum lift capabilities. Further improvements were achieved by the use of Fowler flaps, which are single slotted at the 18 degree take off position, and double slotted at higher extensions.

In addition to attaining high values of C_{LMax}, it was desirable to produce airplane stall characteristics that resulted in definite nose down pitching. This avoids large attitude changes, high drag levels and losses in height when the aircraft stalls. The pitching moment curve in Figure 9 for the clean wing attests to the fact that this goal was achieved.

Initial wind tunnel testing of the F-28 prototype was performed on both full and half models at Reynold's number 3 and 5 million respectively. Wing stall was characterized by a rapid spanwise spread of the separation. Initiation of the stall at a particular point along the wing was done using a small leading edge fence. The stall progresses in a wedge-shaped configuration in both outboard and inboard directions. The outer portions of the wing, and the wing root junction stall last, thus enabling full retention of lateral control, and avoidance of flow distortion into the engine intakes until after maximum lift has been achieved. Flight test observations confirmed the wind tunnel test results with regard to stall progression and maximum lift, but also disclosed an initial, strong buffeting which preceded the fully stalled condition. Figure B-2 shows the main features of the stall patterns and vortex wake of the F-28 wing, inferred from wind tunnel and flight test data.

Observations were also made, during flight test of the F-28, of differences in the stall in free air (at altitude) and in ground effect. It was observed that in free air the stall progresses along the wing in the manner already described, while in ground effect however and with the mainwheels in contact with the surface, it was noted that separation occurred on the inboard wing panels only (Reference [3]): the outer wing panels did not stall. Maximum lift was essentially unchanged, but occurred at an angle of attack some 4 degrees lower than in free air. These observations conform to the results of other research into ground effect (Reference [6]). Similar observations are not available for the effect of ground proximity on the stall characteristics of a roughened wing.

The rate and progression of the stall over the artificially roughened wing surface is not precisely known, although the measured lift and drag coefficients supplied by Fokker indicate a complete breakdown of the flow. Since the entire upper wing upper surface of the wind tunnel model, including the leading edge, was roughened, and recalling the basic research on the effects of roughness on lift (Reference [1]), it is likely that separation occurs simultaneously along the entire span. In this situation, the leading edge fences may be less effective in fixing the initial spanwise location of the stall, and also in ensuring a symmetrical stall across the span. Even when complete stall has not occurred on the outer wing panels, the aileron effectiveness may be adversely affected by roughness. No data were available on this point. Figure B-3 shows a representation of the stall pattern and wake on a contaminated wing.

COMPUTED DATA FOR FOKKER F-28 AIRFOIL

The airfoil section of the Fokker F-28 is a modified NACA 4-digit profile, with a large nose radius. The design cruise Mach number of the Mean Aerodynamic Chord is 0.75, and the dive Mach number is 0.83. Airfoil thickness at the M.A.C. is 14%. The generous nose radius, although a limiting factor in high sub-sonic flight, enables flow around the leading edge to remain attached, and the suction force to reach its full value when trailing edge flaps are used during take-off and landing. The graphs shown in Figure 10 give the top and bottom surface pressures, and boundary layer parameters for a flap angle of 18 degrees, and angles of attack of -2 degrees and 5 degrees. The computation method included viscous effects, and used the code VSWAKE.

The maximum nose suction peak at these angles is about -1.2 for α=-2 degrees; and -5.34 at α=+5 degrees. Reynold's number in both cases was 15 million. The lift coefficients were 0.6515 and 1.5100 respectively, and the moment is nose-down.

Calculations include local values of skin friction C_F and boundary layer displacement thickness δ^*. The displacement thickness represents the distance by which the outer streamlines have been displaced by viscous retardation of the fluid in the inner streamlines. It is a measure of viscous drag.

AERODYNAMIC DATA BASE

The performance group was supplied with a complete data base of aerodynamic, stability and control information. This data base was originally used by Fokker to construct their F-28 dynamic simulator. It is corrected for the variable effects of Reynold's number, Mach number and altitude; so that the data, when applied to the complete equations of motion, produces the real airplane performance in the simulator. The utility of these data in the context of the present investigation is that it is standardized and credible, and can be used to create a realistic scenario for take off and initial climb.

The data which are of initial interest are lift, drag and moment for the aircraft in free flight and also in ground effect. The data do not go beyond C_{LMax} into the post-stall regime. The effects of wing contamination are presented in the form of incremental changes of lift, and it is believed that these are derived from the single wind tunnel test which has already been described Figure 9 for uniform roughness heights of 1 and 2 mm. Incremental corrections for roughness heights smaller than these values were not available in experimental form, although arbitrary factors could be applied to the data (Figure 14).

The aerodynamic effect of the ground cushion during take off and climb, particularly at high lift coefficients, acts to change the angle of attack necessary to produce a certain lift coefficient. With flaps extended, below a lift coefficient of about 1.5, ground proximity increases lift; particularly when the trailing edge approaches the ground. This is particularly relevant to swept-wing aircraft, where the tips may come close to the ground during rotation. An additional phenomenon, which reduces lift and induced drag, arises from a reduction of the wing upwash and induced angle of attack. This is due to the presence of the ground plane, which does not allow vertical velocities.

The F-28 data base also includes the effects of ice accretion on the leading edges of the wings, tailplane and fin, to a thickness of 2 in. Graphs in Figure (12) show the incremental changes in lift, drag and pitching moment which would occur during flight operations in icing conditions.

In the context of the present investigation, these data may not represent precisely the type of uniform contamination which was simulated in the NLR wind tunnel, nor ice that is deposited by freezing rain or snow.

CONCLUSIONS

The following conclusions are based on the various F-28 aerodynamic data which were given by Fokker to the performance group. They do not specifically address or explain the circumstances of the Dryden accident at this time.

The F-28 wing section is designed for a cruise mach number of 0.75, and a high maximum lift coefficient at low speeds. A generous nose radius minimizes the likelihood of separation under high lift conditions and promotes stall from the trailing edge.

Stalling of the basic smooth wing is from the trailing edge. It then spreads outward from the leading edge fence location in a fan-shaped manner toward the tip and wing root regions. These regions separate last, allowing lateral control and engine intake flow to remain effective to high angles of attack.

In ground effect, with the main wheels on the ground, stalling occurs 4 degrees earlier, but only the inner portion of the wing stalls. C_{LMax} is unchanged.

Artificial roughness on the upper surface of the wing of a wind tunnel model caused a premature stall in which boundary layer separation may have occurred all along the leading edge. The roughness corresponded to an element size of about 1 to 2 mm on the full scale F-28 wing while the distribution corresponded to approximately one element per square centimetre on the same wing. With flaps set to 30 degrees on the model the wing stalled at an angle of attack 7 degrees lower than for the clean wing. There was a 33% loss of maximum lift compared to the clean wing.

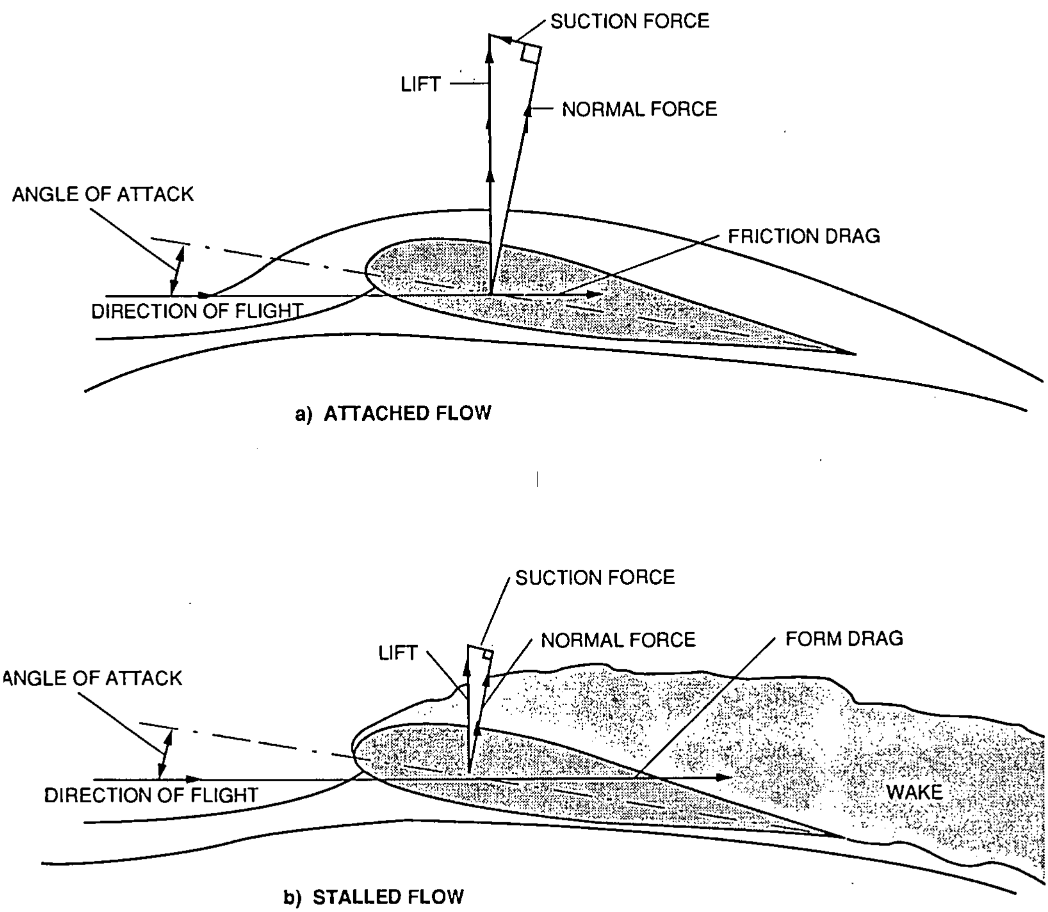
Research on wing sections at Reynold's numbers ranging from 100,000 to 10,000,000 shows that roughness not only increases drag below the stall but also increases the likelihood of a premature stall, particularly if the nose is roughened. As Reynold's number increases towards the values experienced by the F-28 wing during take-off (greater than 10,000,000) the loss in maximum lift can be as high as 50% compared to a clean surface (Reference [1]).

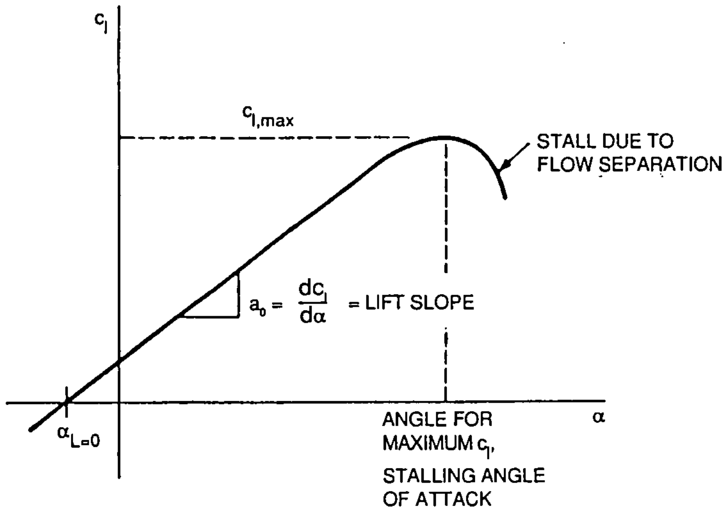
In some cases the aerofoil is sensitive to the size of the roughness elements; the loss of maximum lift being less for very small roughness heights. Most aerofoil sections, however, respond to roughness of any scale by stalling prematurely and incurring the maximum loss of lift. Removal of roughness on the nose and over the first 15% of chord restores the aerofoil close to its original performance.

LIST OF SYMBOLS

A	Aspect Ratio
b	Wing Span
c	Wing Chord
c (MAC)	Mean Aerodynamic Chord
D	Drag
e	Wing Efficiency Factor
L	Lift
M	Moment
Re	Reynold's Number (Vc/ν)
S	Wing Area
V	Flight Velocity
α	Angle of Attack
ρ	Air Density
ν	Kinematic Viscosity
C_L	Lift Coefficient
C_D	Drag Coefficient
C_M	Moment Coefficient
C_P	Wing Surface Pressure Coefficient
C_F	Boundary Layer Friction Coefficient
δ^*	Boundary Layer Displacement Thickness
SLS	Sea Level Standard Conditions

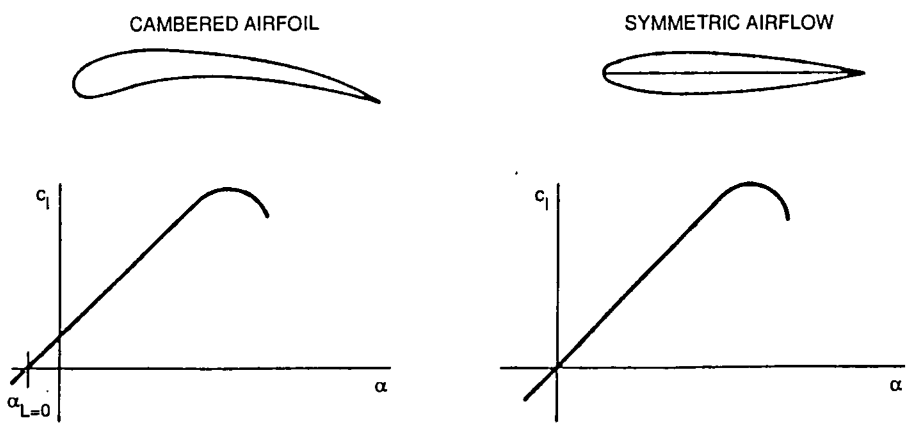
AERODYNAMIC FORCES ACTING ON A WING SECTION





SKETCH OF A TYPICAL LIFT CURVE

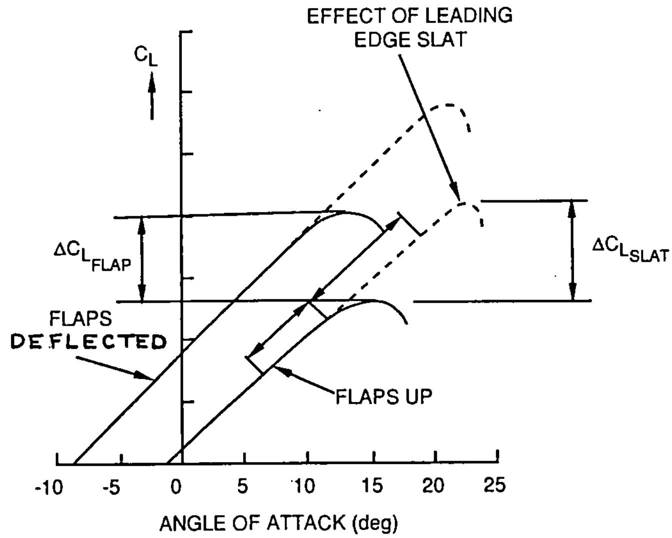
(a)



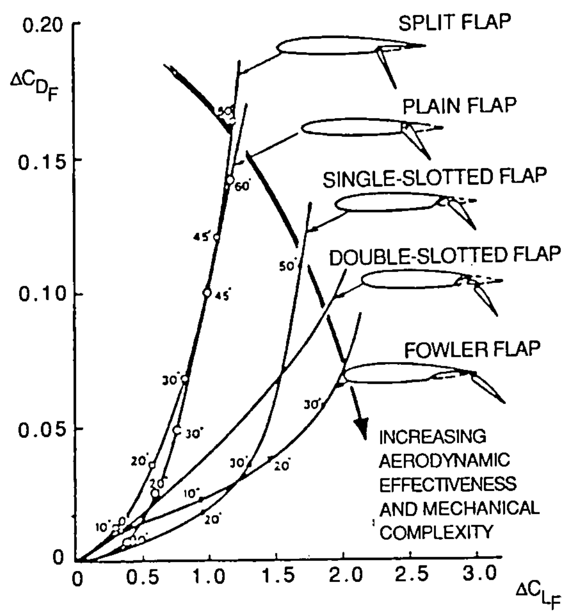
COMPARISON OF LIFTS CURVES FOR CAMBERED AND SYMMETRIC AIRFLOWS

(b)

AIRFOIL LIFT AND DRAG CHARACTERISTICS WITH HIGH-LIFT DEVICES

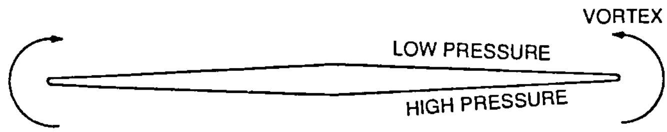


LIFT CURVES WITH AND WITHOUT HIGH-LIFT DEVICES (REF. 3)



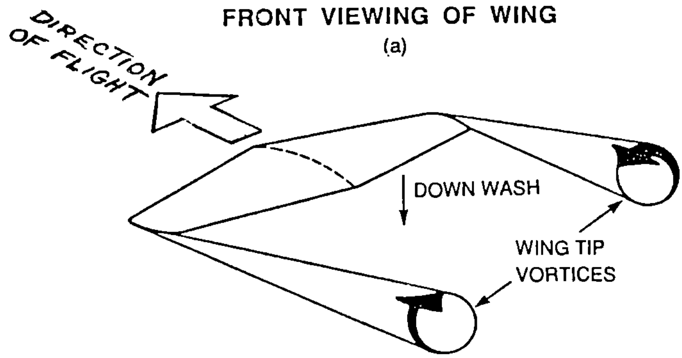
TRENDS IN PERFORMANCE OF TRAILING-EDGE FLAPS (REF. 3)

TRAILING VORTEX SYSTEM AND LIFT FOR FINITE WINGS



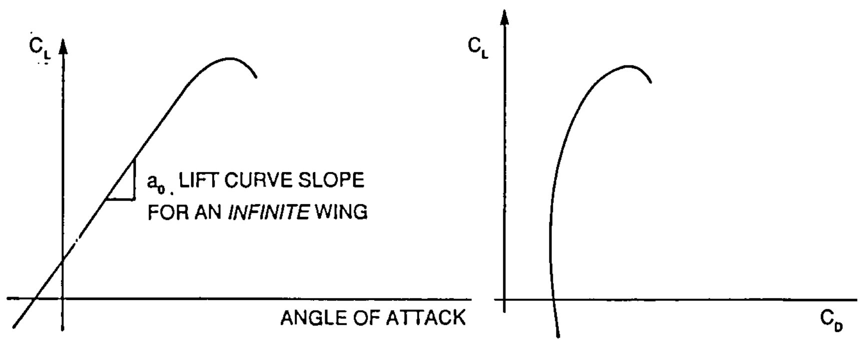
FRONT VIEWING OF WING

(a)

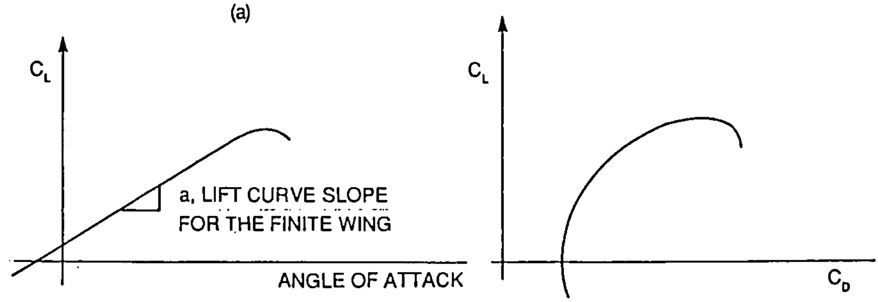


(b)

ORIGIN OF WING TIP VORTICES
ON A FINITE WING



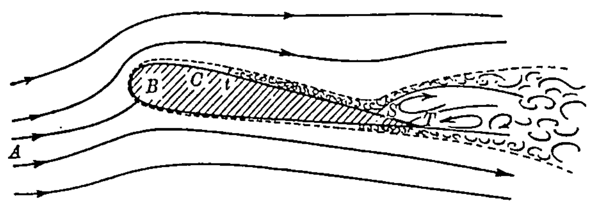
(a)



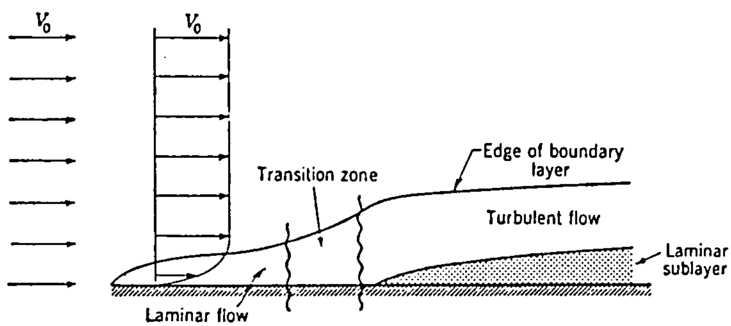
(b)

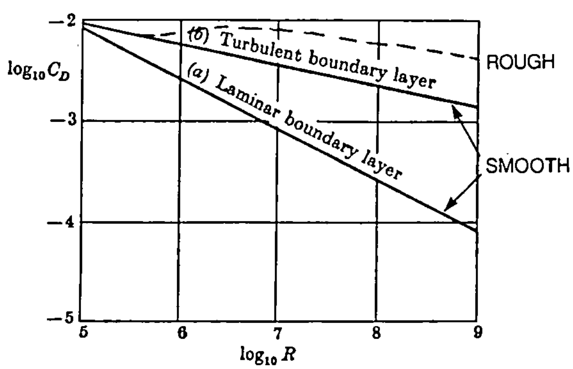
DISTINCTION BETWEEN THE LIFT CURVE SLOPES
FOR INFINITE AND FINITE WINGS

CHARACTERISTICS OF BOUNDARY LAYER FLOW



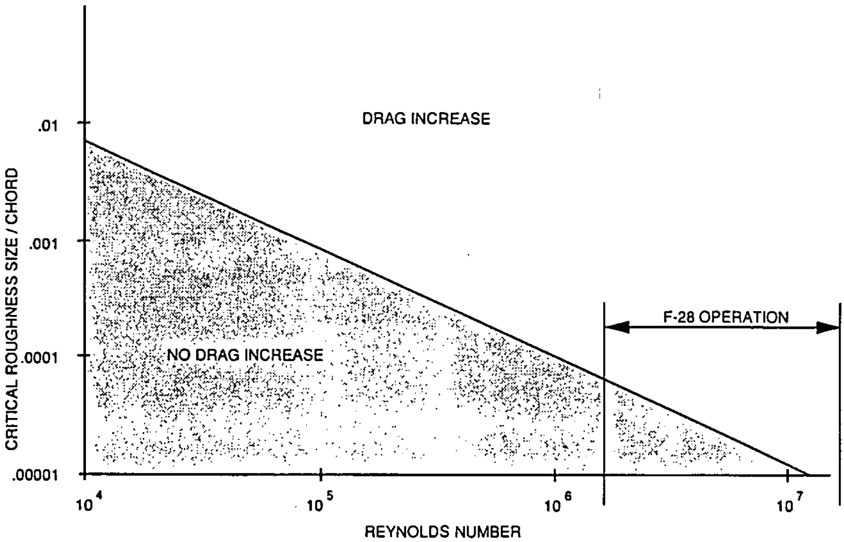
A SKETCH (not to scale) ILLUSTRATING THE NATURE OF THE FLOW OF A UNIFORM STREAM PAST AN AEROFOIL WHEN SEPARATION OCCURS NEAR THE TRAILING EDGE.

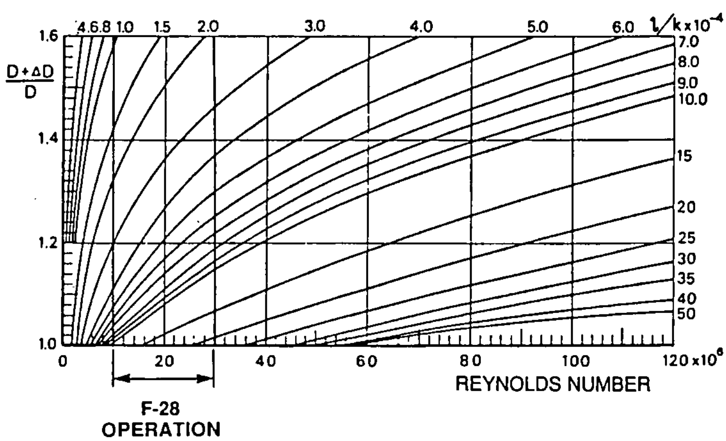




THE SCALE EFFECT ON THE DRAG COEFFICIENT OF A FLAT PLATE IN A UNIFORM STREAM WITH (a) A LAMINAR AND (b) A TURBULENT BOUNDRY LAYER OVER THE WHOLE SURFACE.

EFFECT OF ROUGHNESS ON DRAG

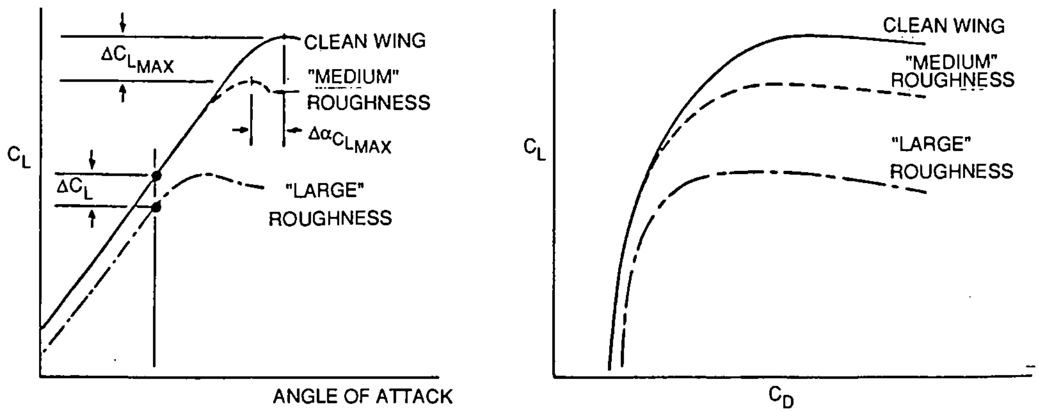




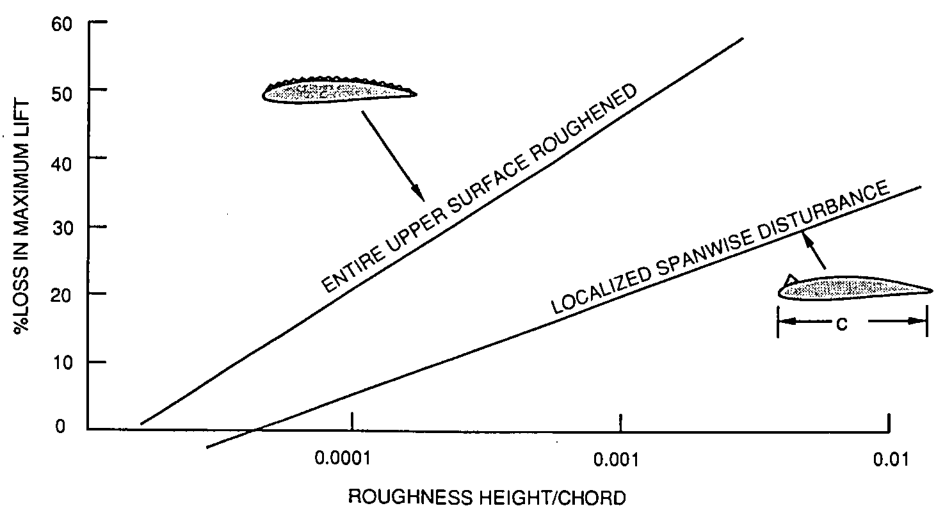
(b) WING OR BODY DRAG DUE TO SURFACE ROUGHNESS (REF 3)

F-28 FLIGHT DYNAMICS **Section 2 - Aerodynamics** Figure 7 **Page 29**

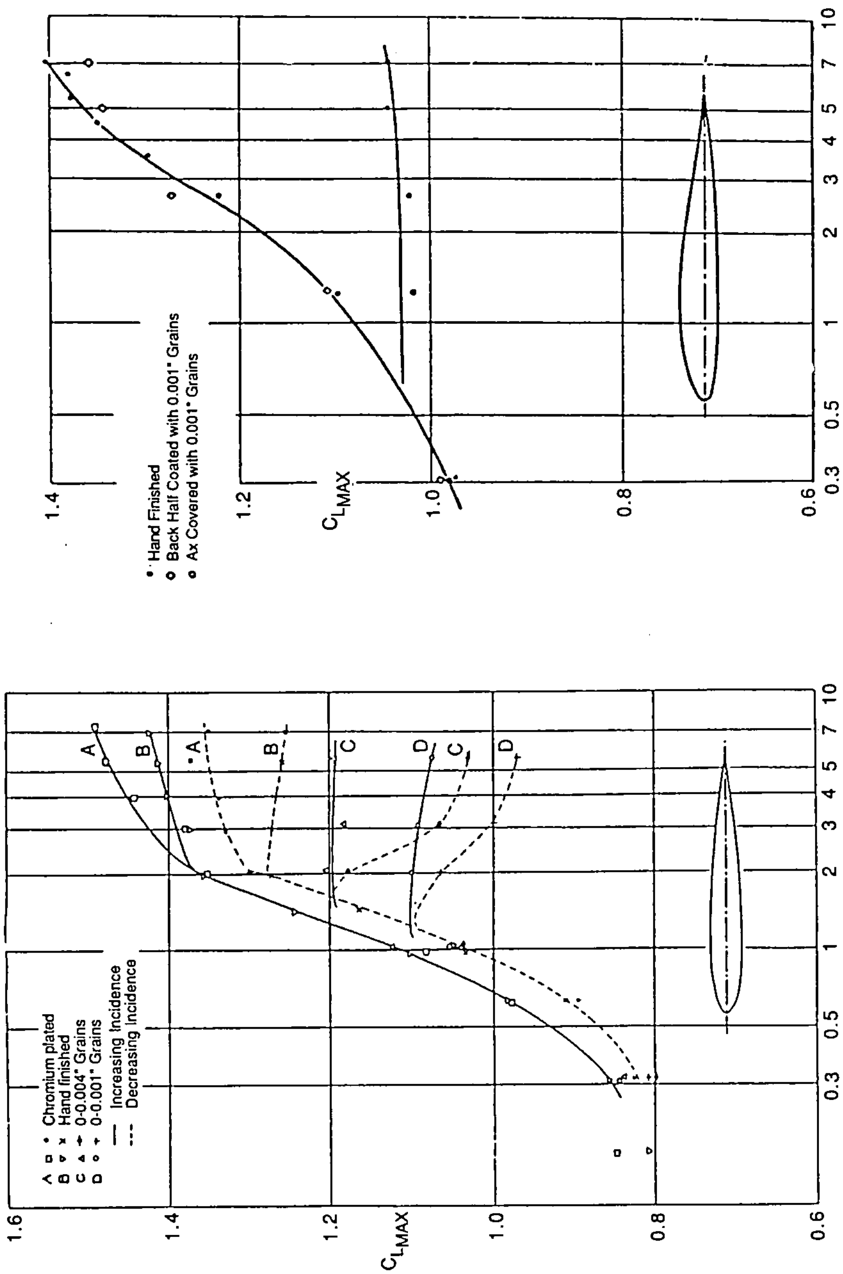
ROUGHNESS EFFECTS ON WING CHARACTERISTICS



TYPICAL EFFECT OF SURFACE ROUGHNESS AT THE LEADING EDGE ON AERODYNAMIC CHARACTERISTICS (REF. 12)



b) EFFECT OF DISTRIBUTED AND ISOLATED ROUGHNESS ON MAXIMUM LIFT LOSS (REF. 12)



HAND FINISHED AEROFOIL AND AEROFOIL COATED WITH CARBORUNDUM POWDER

MAXIMUM LIFT ON R.A.F. 34. (8 in. CHORD)

HAND FINISHED AEROFOIL AND AEROFOIL COATED WITH CARBORUNDUM POWDER

MAXIMUM LIFT ON N.A.C.A. 0012. (8 in. CHORD)

EFFECT OF UNIFORM ROUGHNESS DISTRIBUTION ON THE MAXIMUM LIFT OF WINGS (REF. 9)

F-28 FLIGHT DYNAMICS **Section 2 - Aerodynamics** Figure 9 **Page 31**

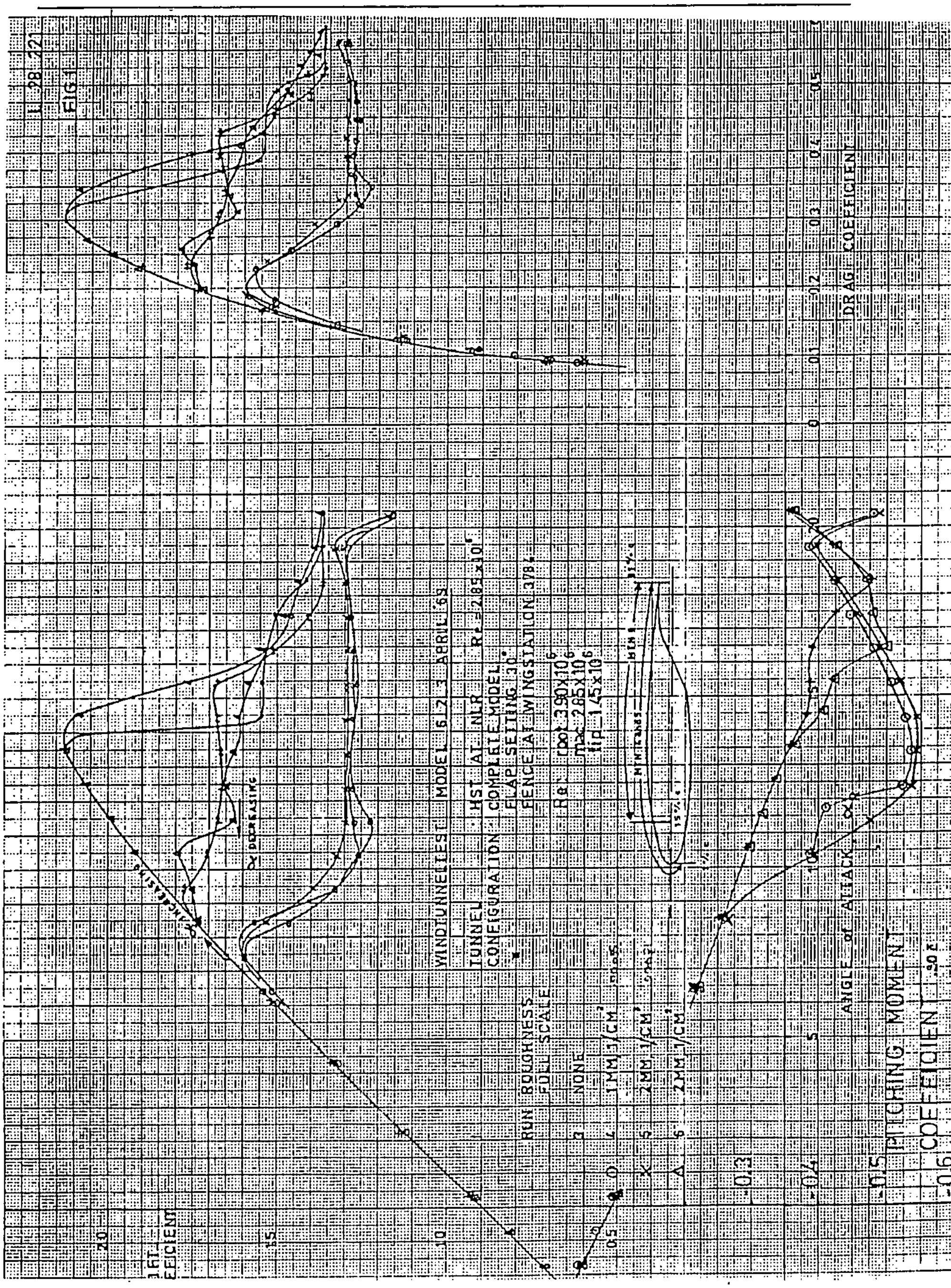
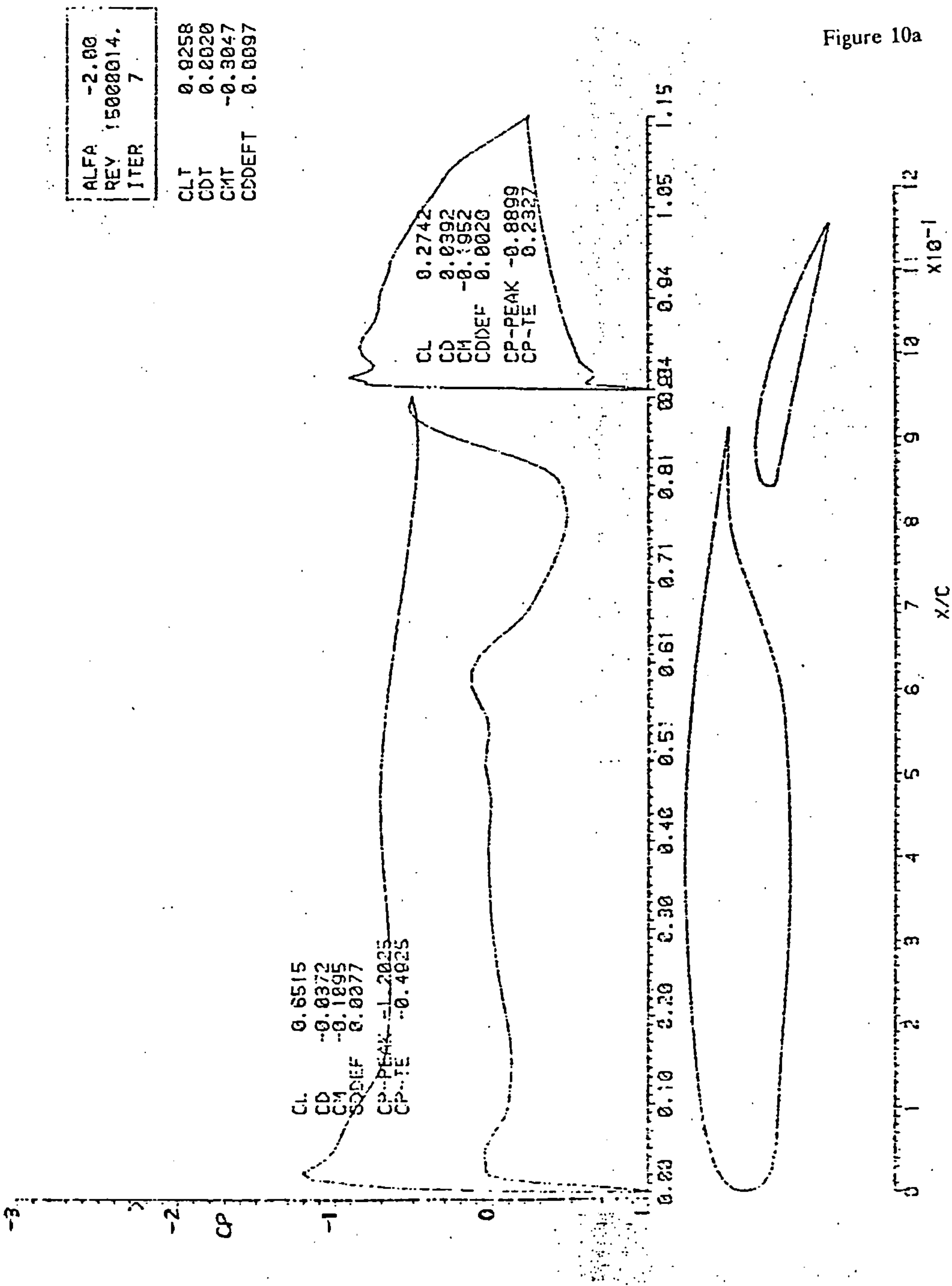


Figure 10a



Section 2 FIGURE 10a Theoretical Flow and Pressure Data for F-28 Aerofoil

Section 2 FIGURE 10b

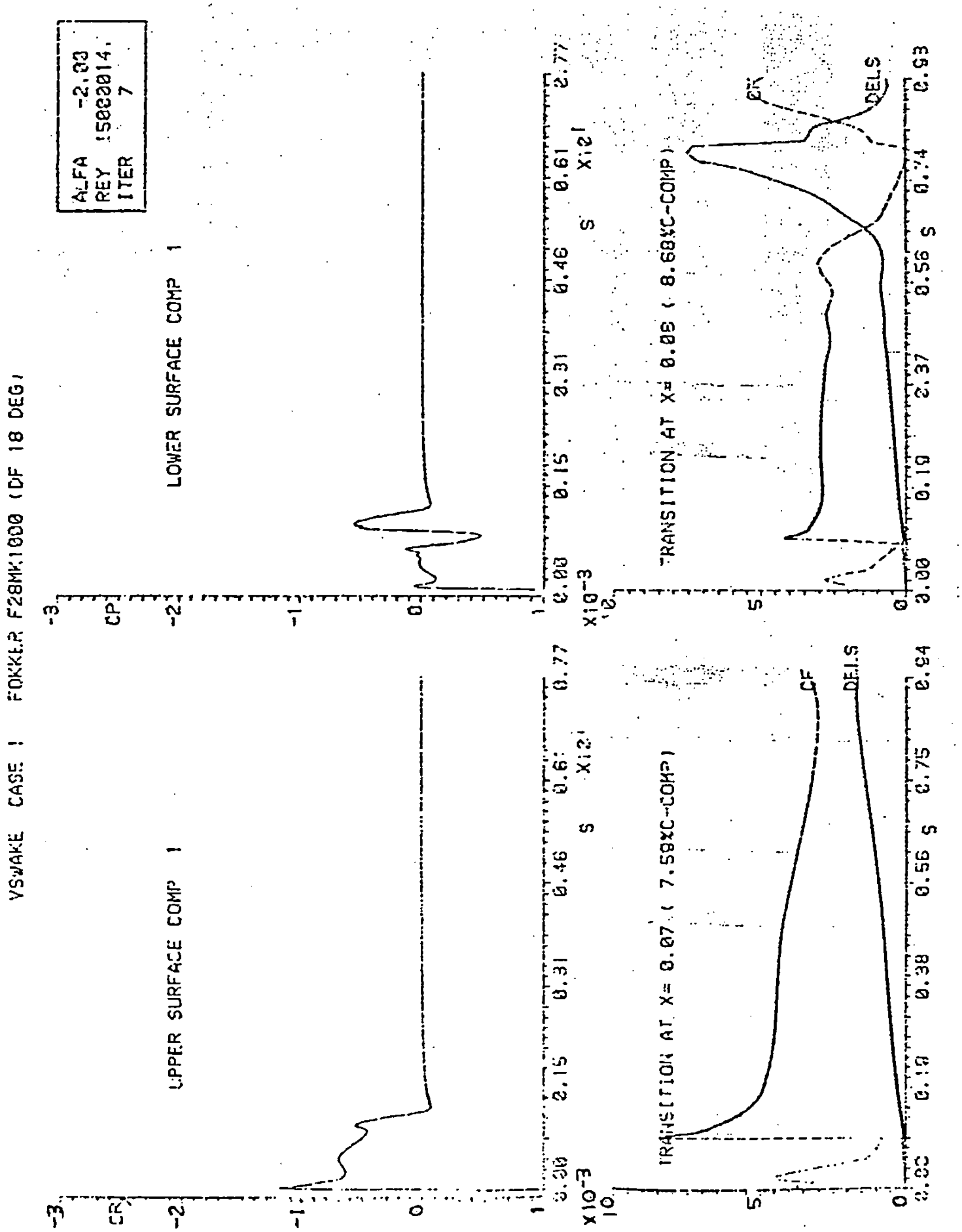


FIGURE 10c

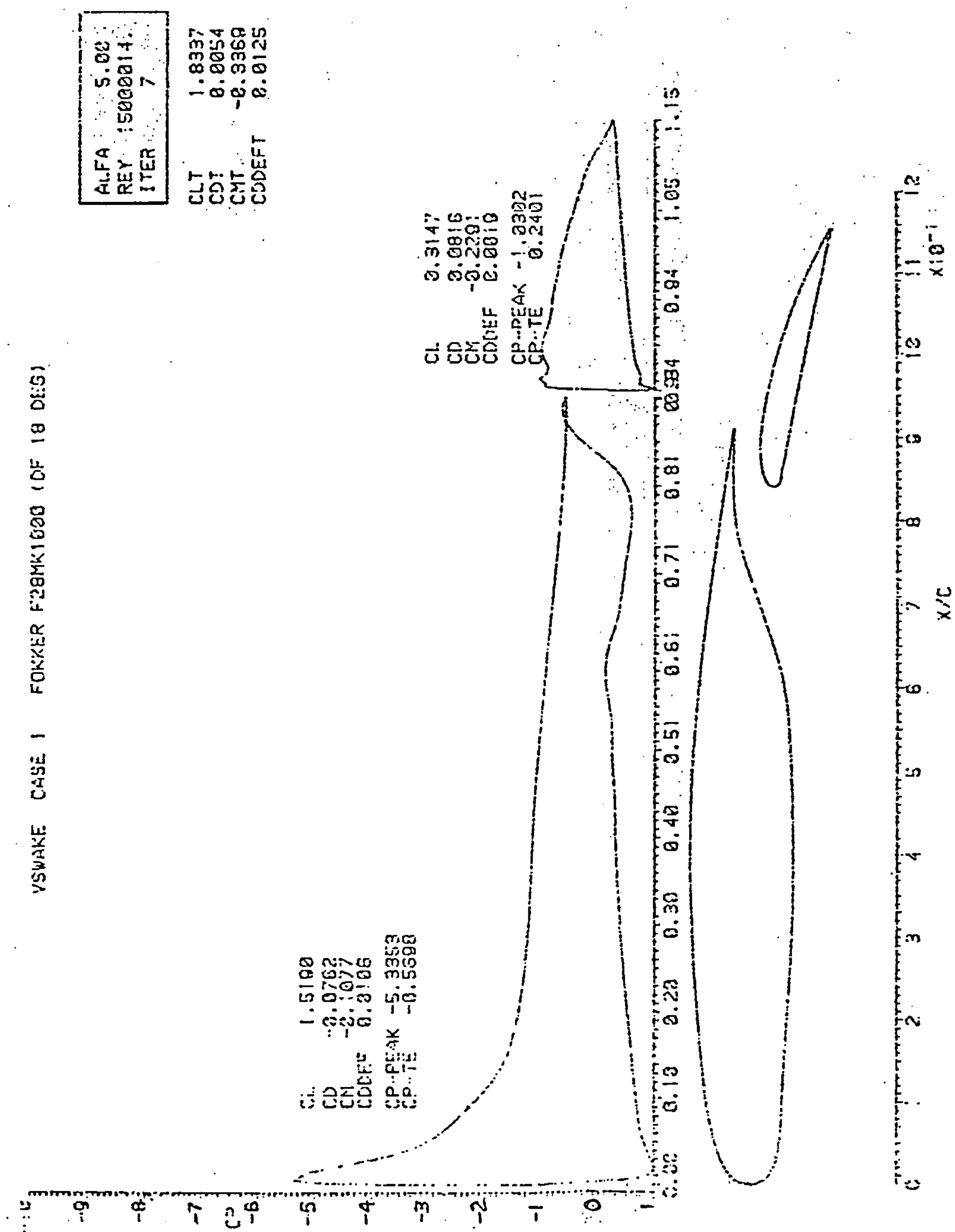
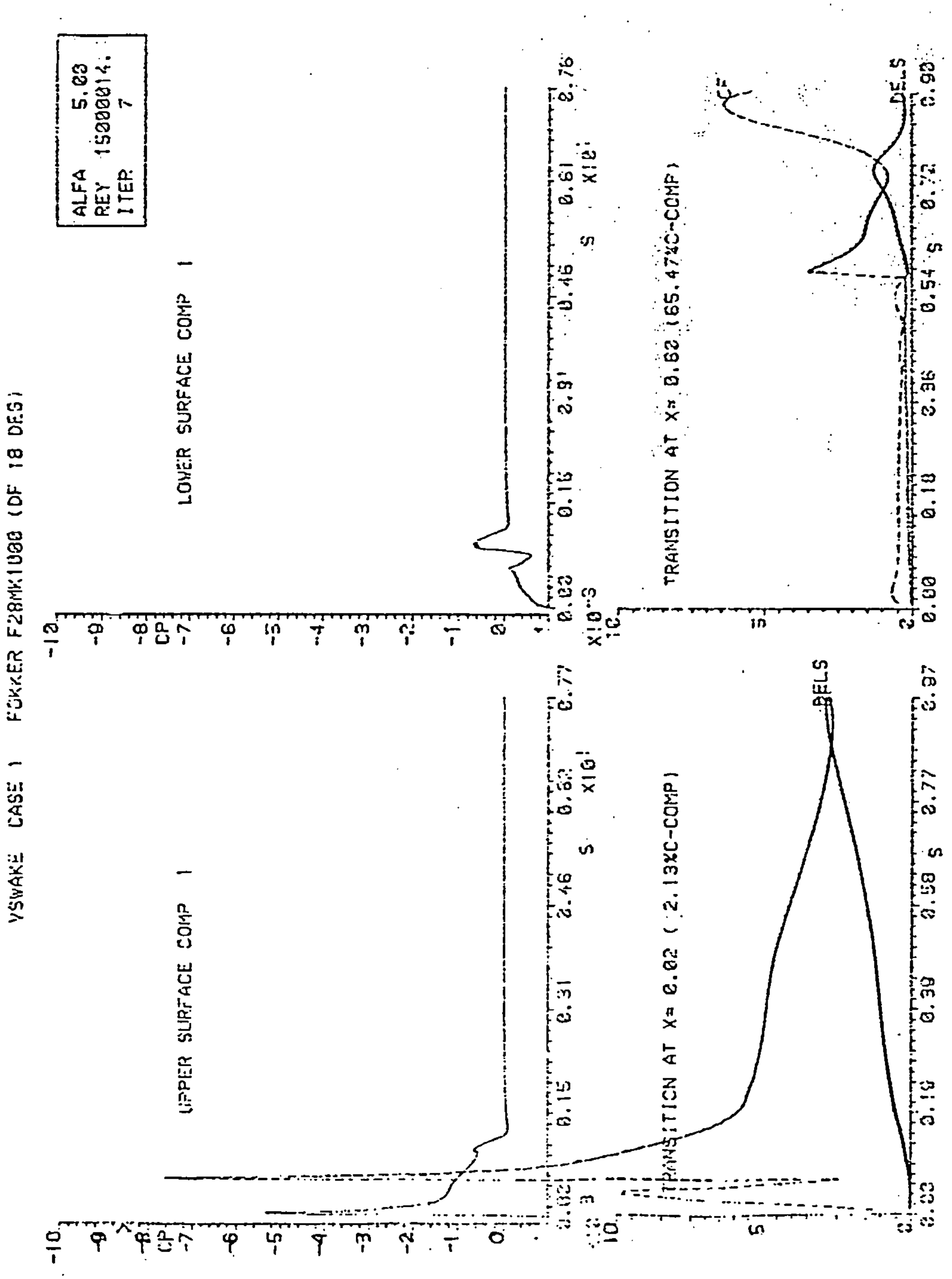

VSWAKE CASE 1 FOKKER F28MK1000 (DF 10 DEG)
ALFA 5.00
REY 15000014.
ITER 7
CLT 1.8337
CDT 0.0054
CMT -0.3369
CDDEFT 0.0125
CL 1.5100
CP-PEAK -5.3353
CL 0.3147
CP-PEAK -1.3302
CP-TE 0.2401
CP
X/C

FIGURE 10d


VSWAKE CASE 1 FOKKER F28MK1000 (DF 18 DEG)
UPPER SURFACE COMP 1
LOWER SURFACE COMP 1
ALFA 5.00
REY 15000014.
ITER 7
TRANSITION AT X= 0.02 (2.13%C-COMP)
TRANSITION AT X= 0.62 (65.47%C-COMP)

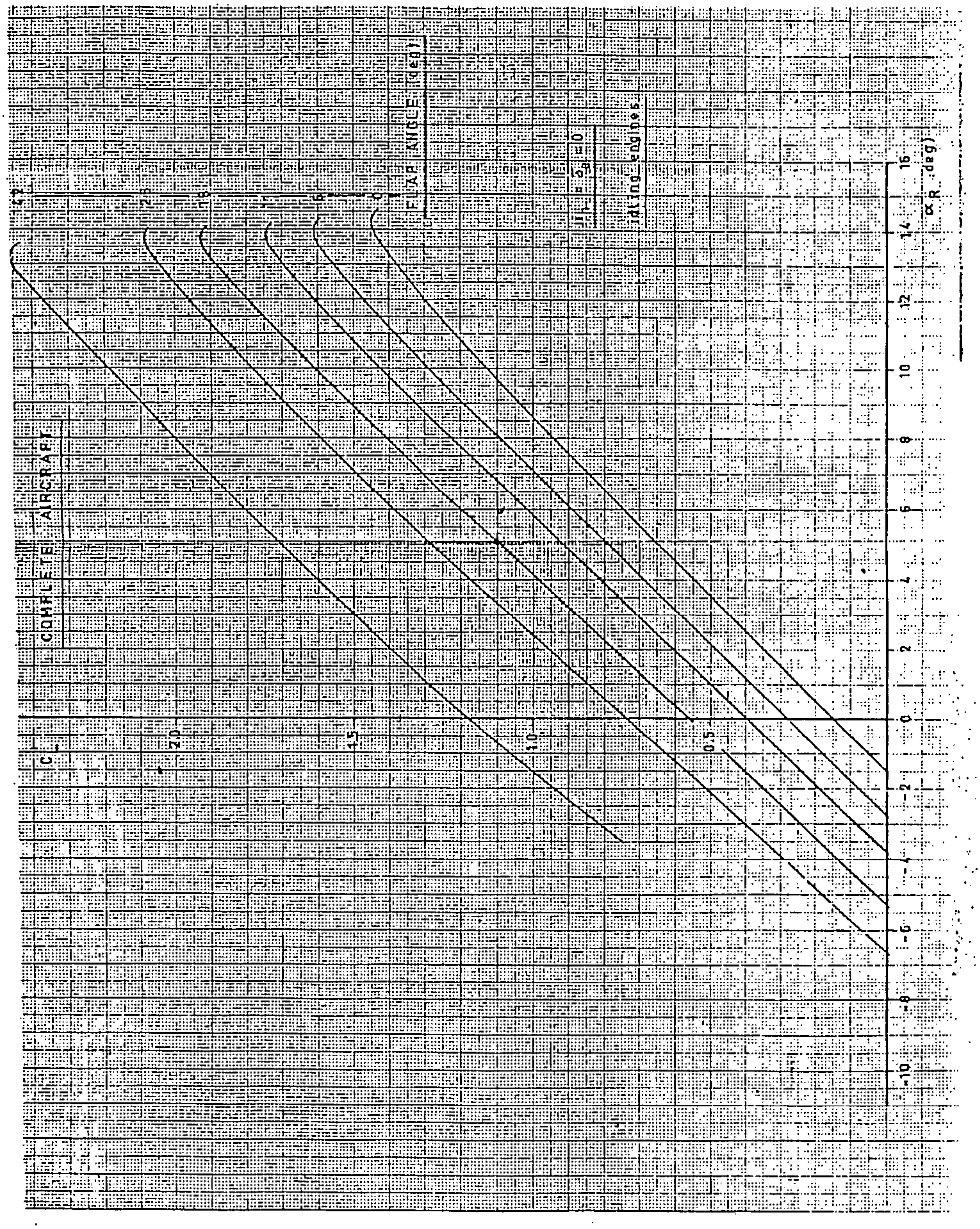


FIGURE 11 F-28 LIFT COEFFICIENT vs ANGLE OF ATTACK (FREE AIR)

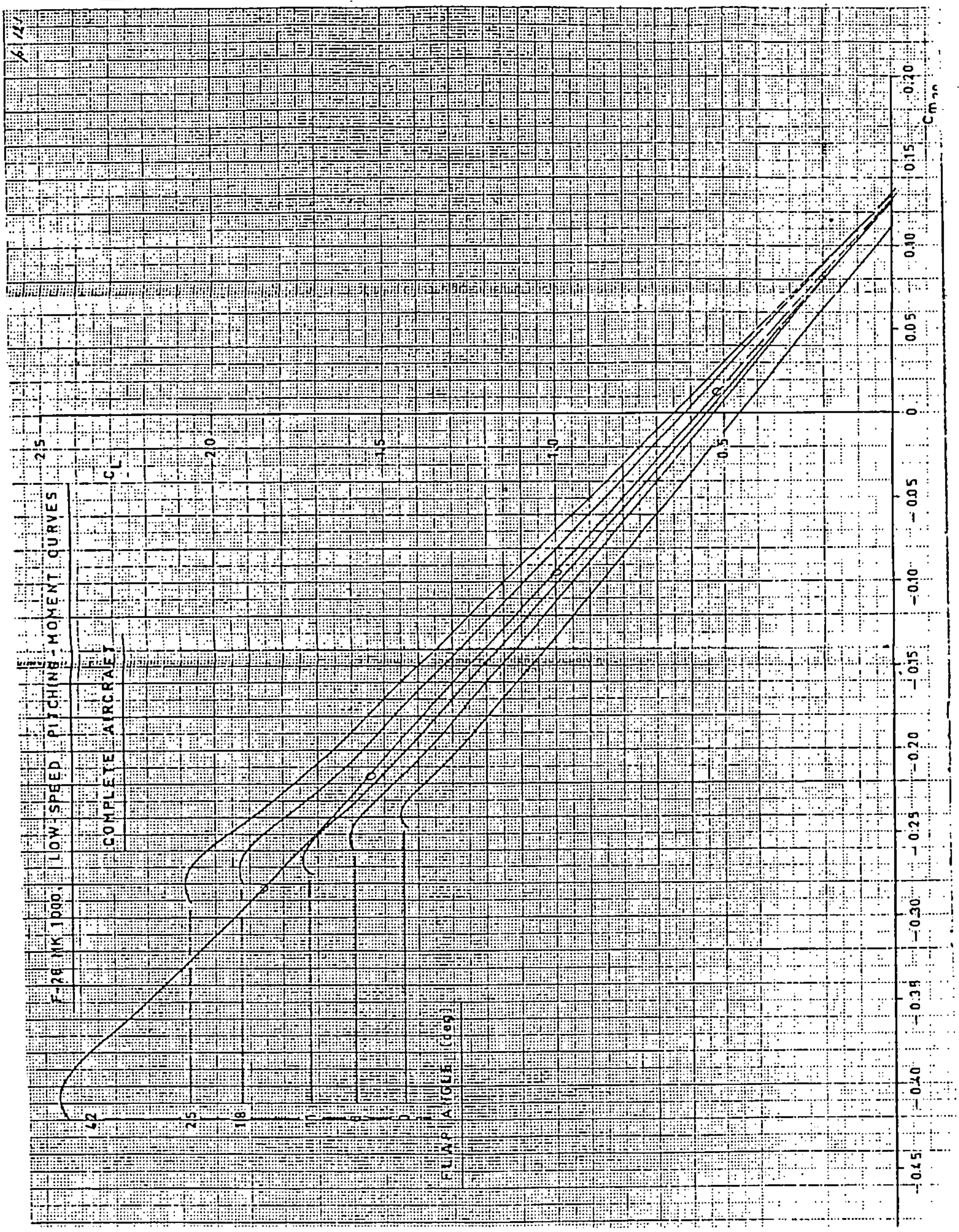


FIGURE 12 F-28 MOMENT COEFFICIENT vs LIFT COEFFICIENT (FREE AIR)

FOKKER-VFW B.V.

NETHERLANDS AIRCRAFT FACTORIES FOKKER-VFW

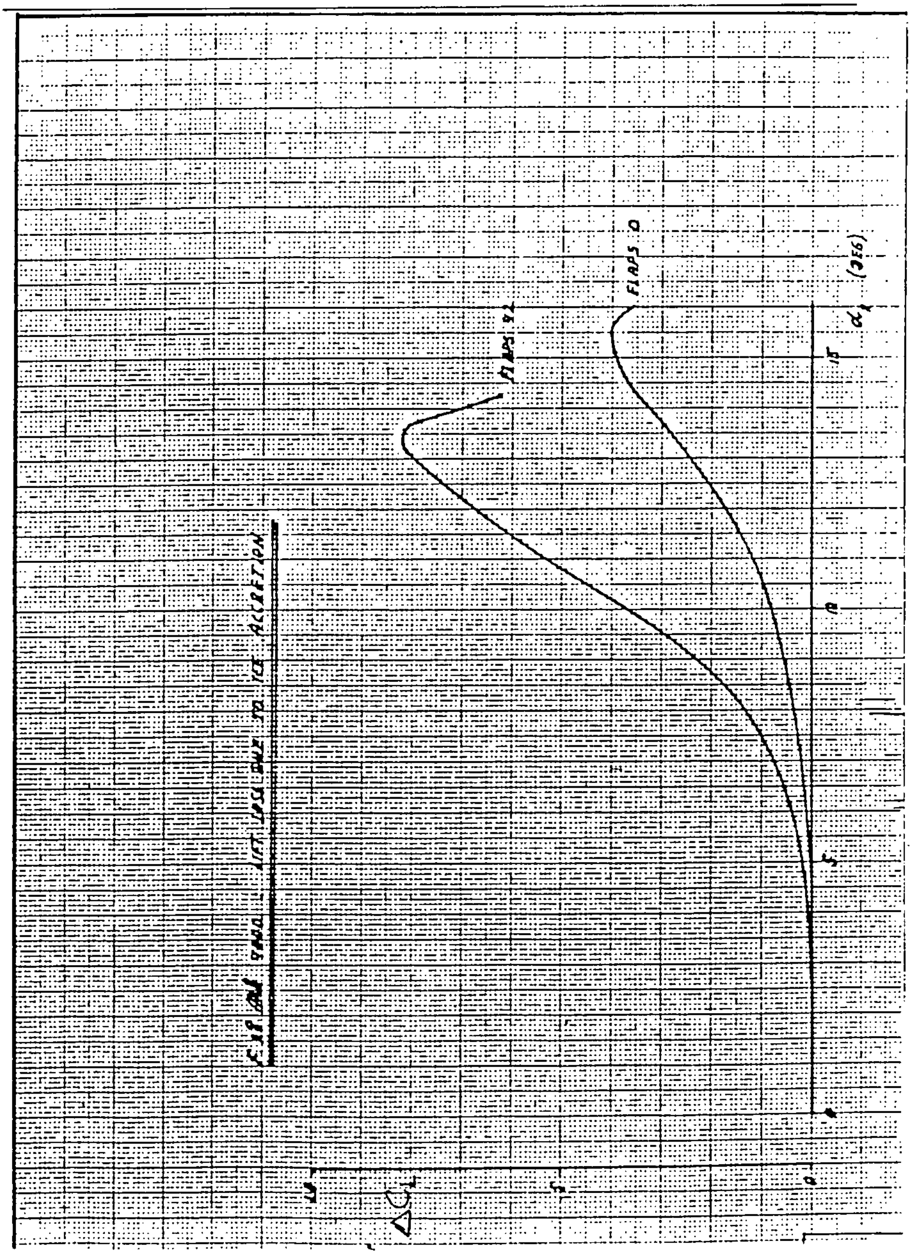
RAPPORT NR.+REPORT NR. L-28-269

BLAD,PAGE 107

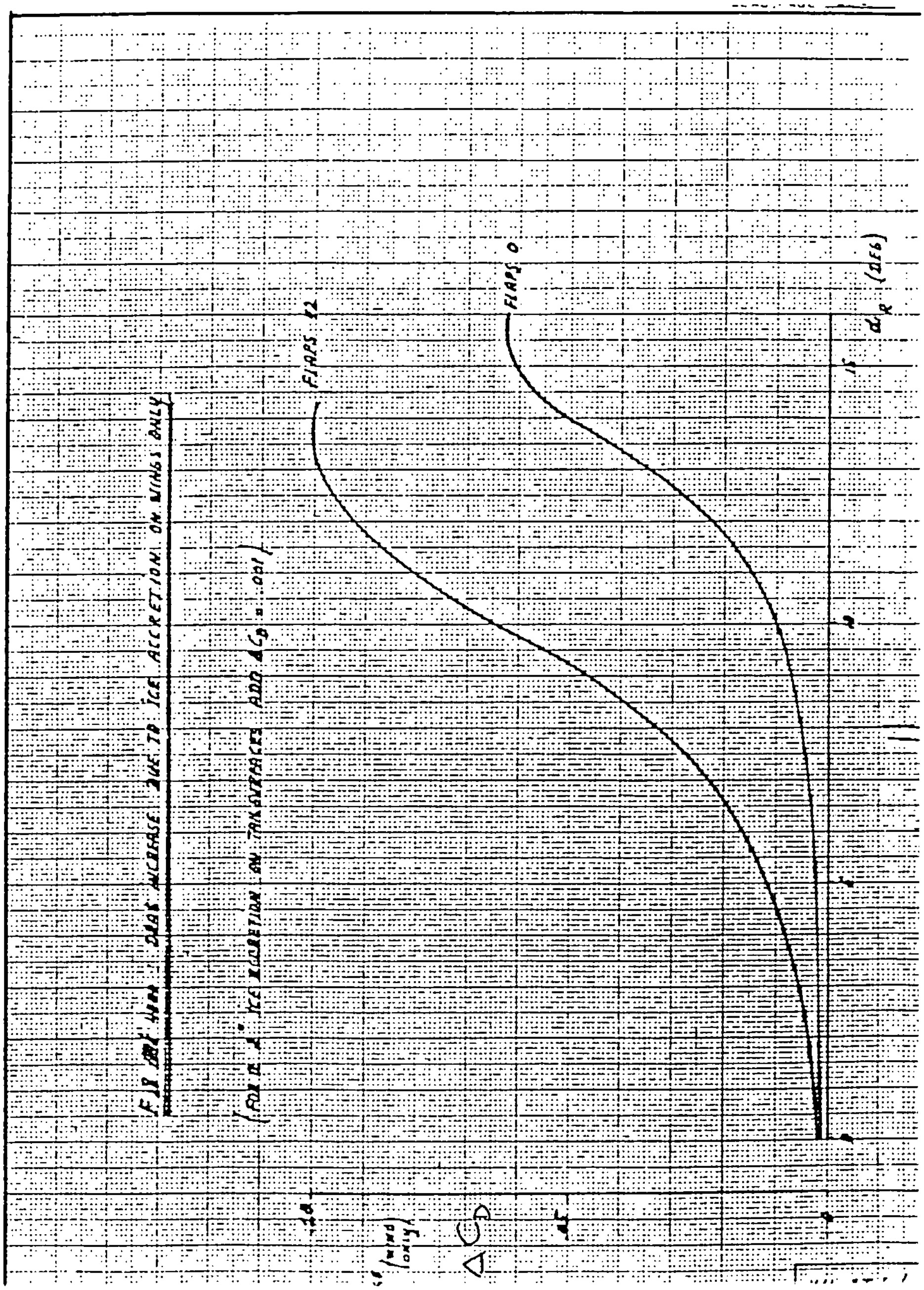
F-28 Mk.1000 Basic low speed drag polars (FREE AIR)

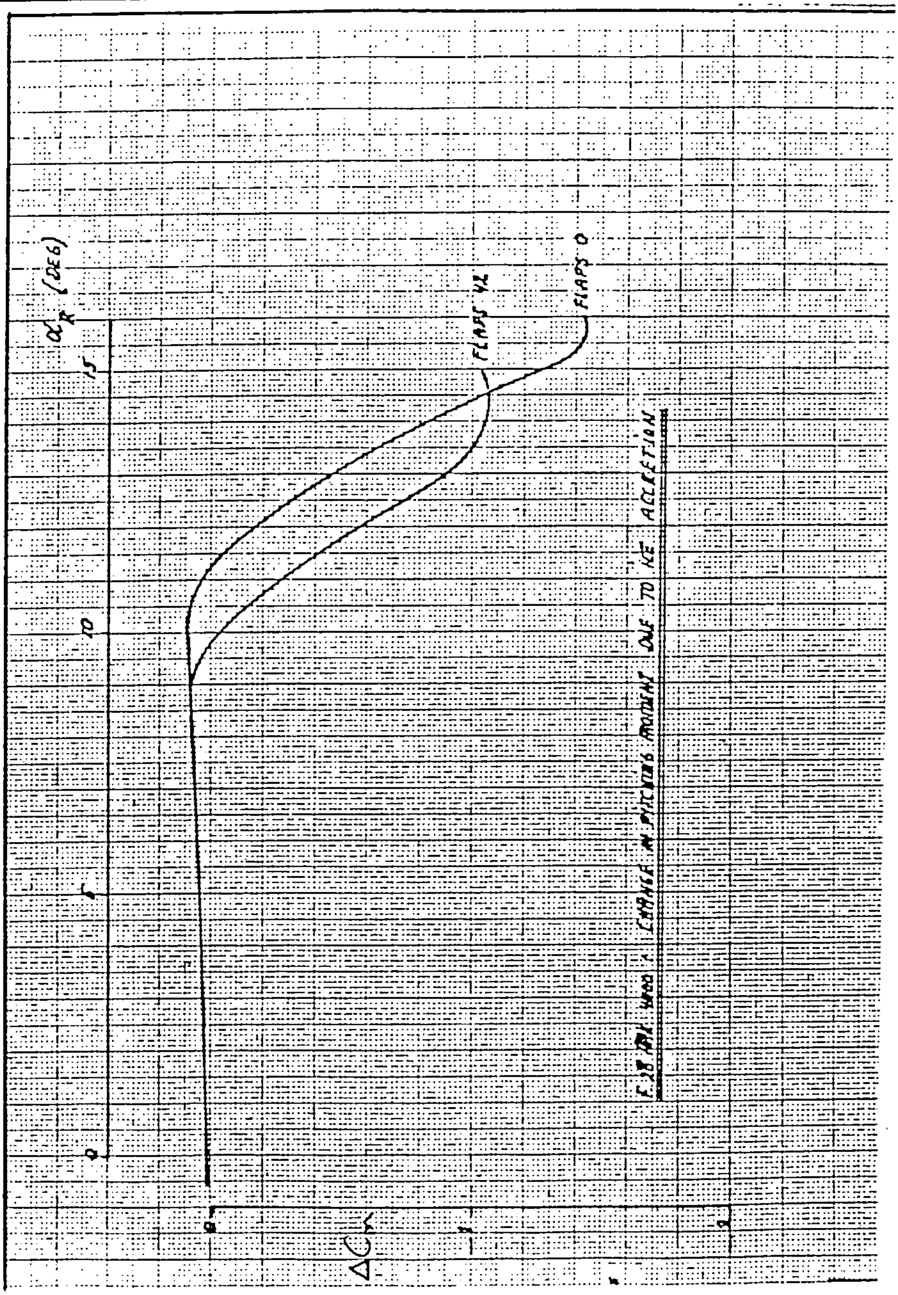
Flap angle (deg.)	Drag polar
0	$C_D = 0.0195 + 0.0535\ C_L^2$
6	$C_D = 0.0270 + 0.0515\ C_L^2$
11	$C_D = 0.0325 + 0.0486\ C_L^2$
18	$C_D = 0.0405 + 0.0470\ C_L^2$
25	$C_D = 0.0600 + 0.0470\ C_L^2$
42	$C_D = 0.1340 + 0.0400\ C_L^2$

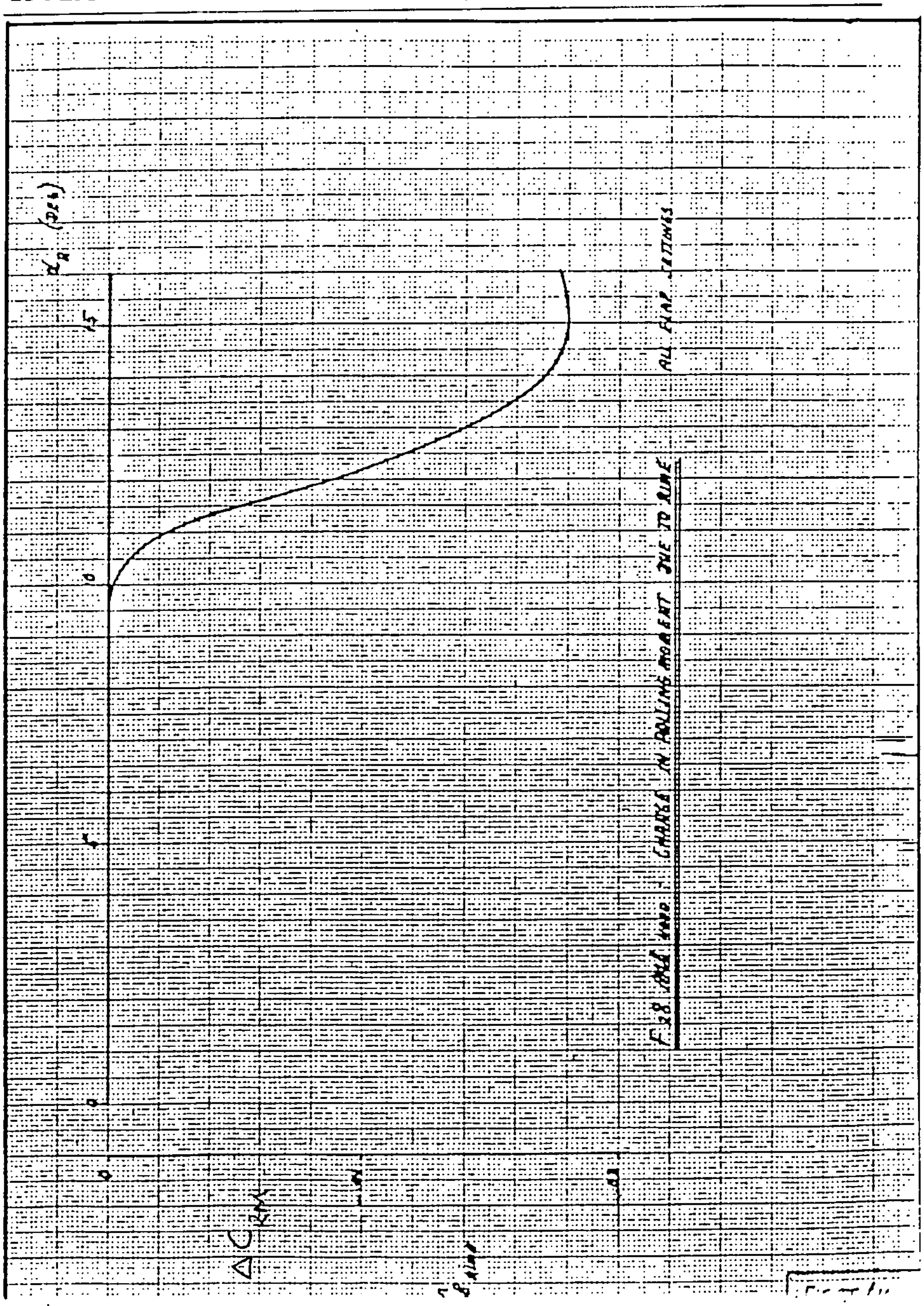
Section 2 FIGURE 13 Low Speed Drag Polars, Free Air


FLAPS 42
FLAPS 0
ΔCL

F-28 FLIGHT DYNAMICS **Section 2 - Aerodynamics** Figure 14b **Page 40**




FLAPS 42
FLAPS 0
CHANGE IN PITCHING MOMENT DUE TO ICE ACCRETION



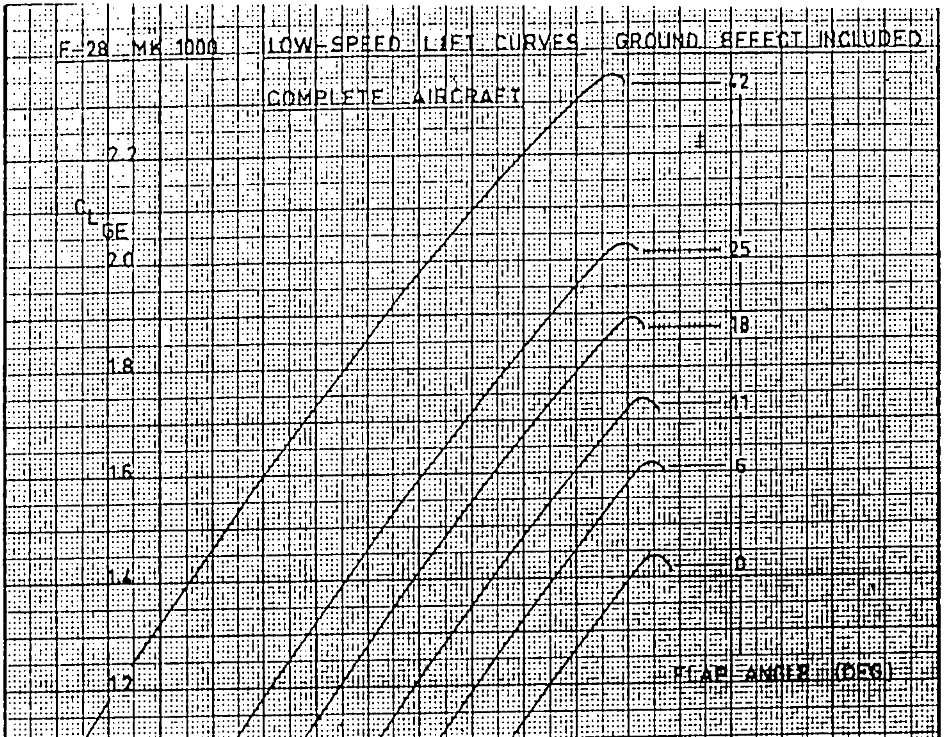


FIGURE 15 LIFT COEFFICIENT vs ALPHA - IN GROUND EFFECT

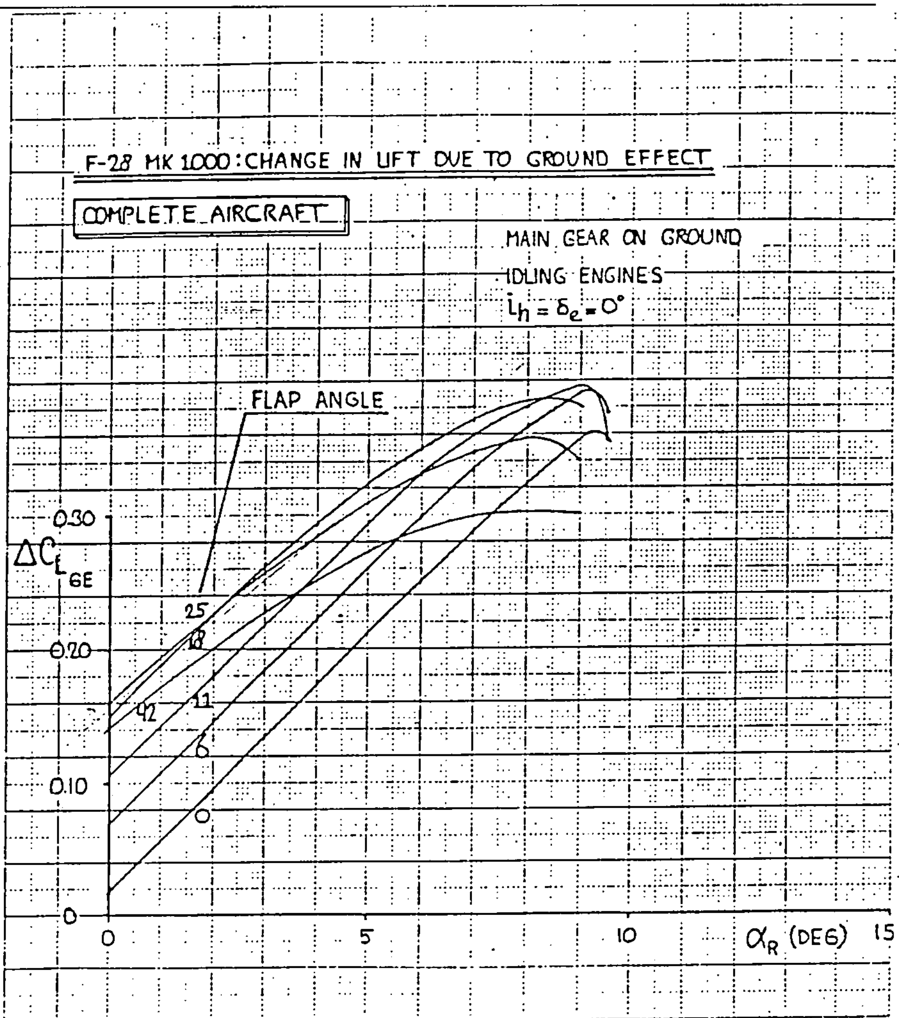


FIGURE 16 CHANGE IN LIFT DUE TO GROUND EFFECT

3.1/20^A

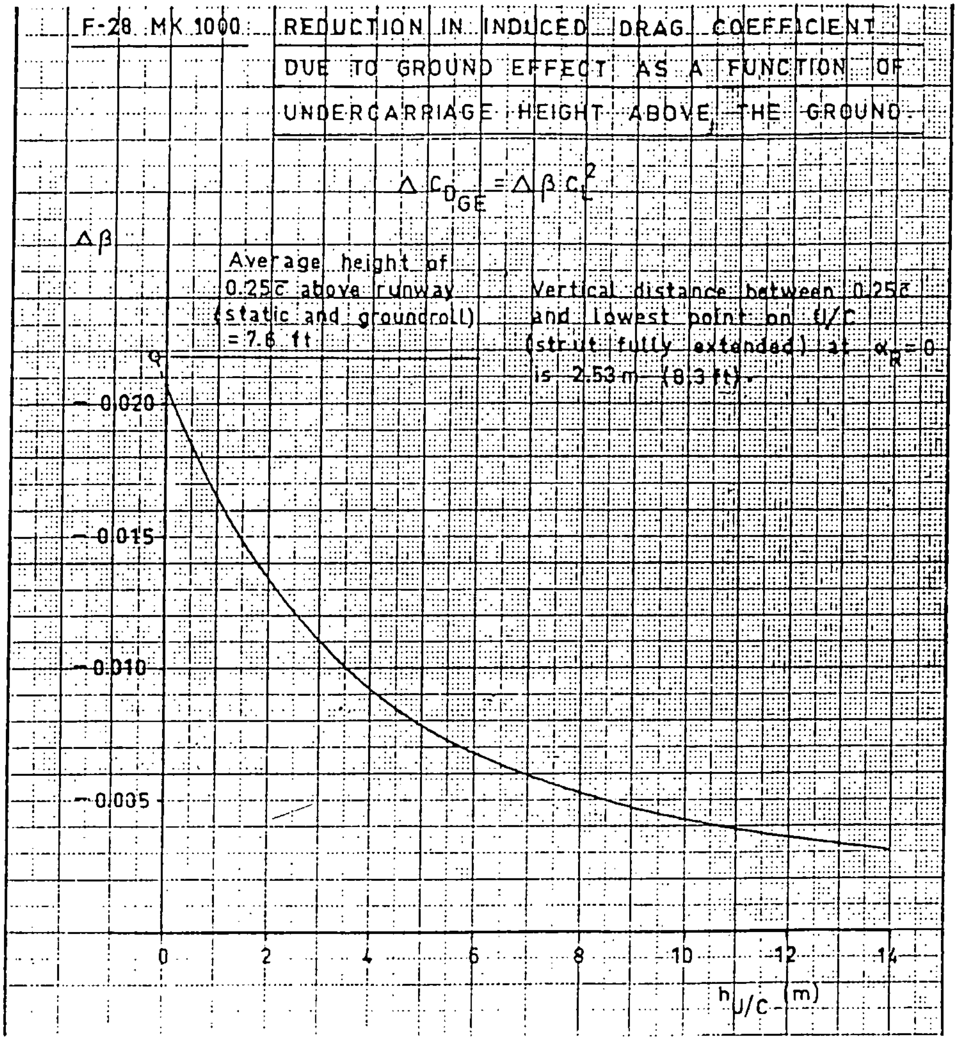


FIGURE 17 CHANGE IN INDUCED DRAG DUE TO GROUND EFFECT

APPENDIX A TO SECTION 2

TECHNICAL DETAILS OF THE
FOKKER F-28 AIRCRAFT

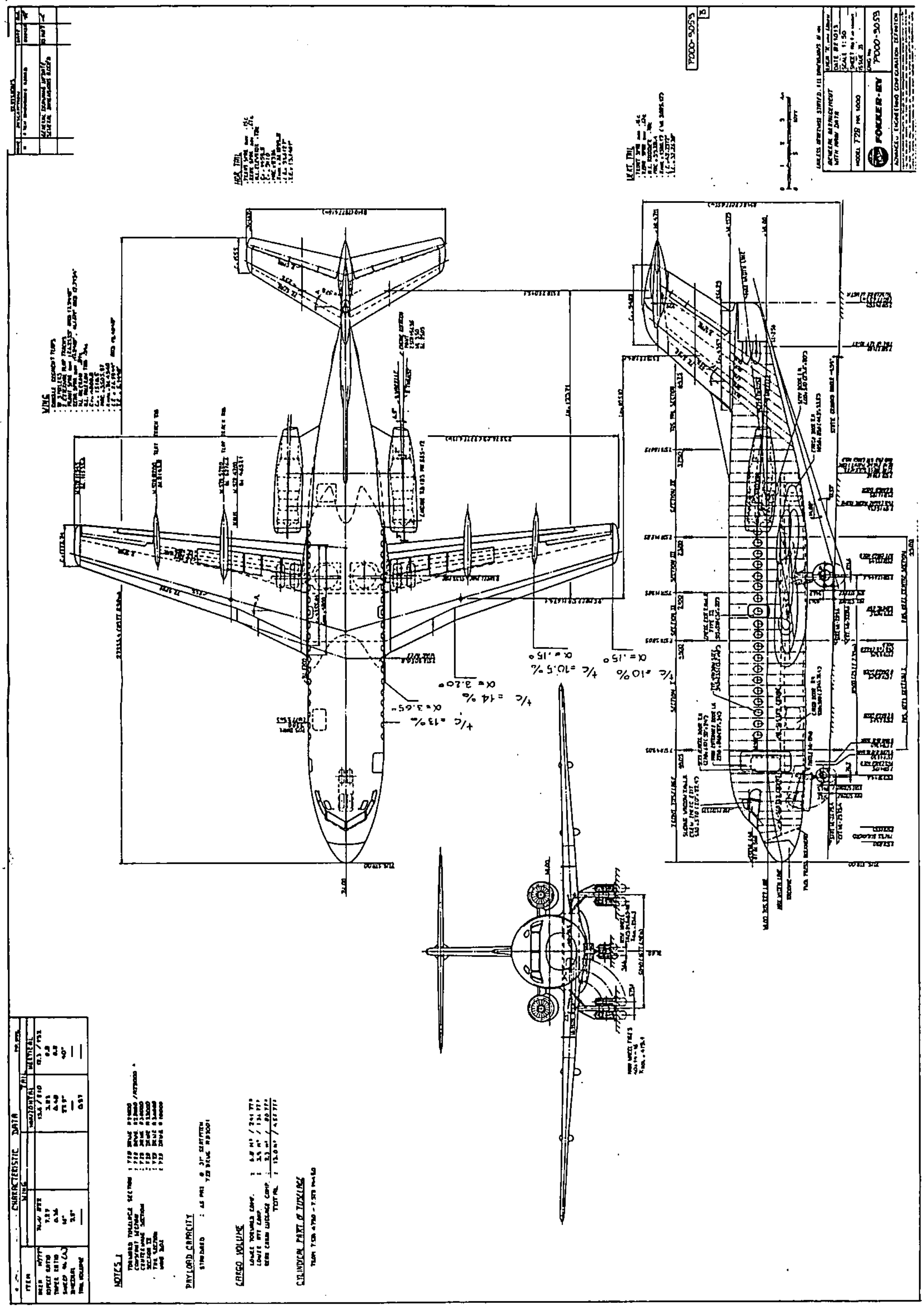


FIGURE A-1

but a basic layout is available. In this, the cabin is divided into three sections: a conference room with six seats, a rest room with settee and divan, and a lounge with four seats. Toilet, galley, wardrobe, baggage space and seat for attendant in forward fuselage. Second toilet and baggage space at rear.

ACCOMMODATION (Mk 400 Combiplane): Principal features of this version are a large cargo loading door forward of the wings on the port side, with the sill at truck-bed height, and a reinforced cargo floor with tiedown rings. Typical layouts include 40 passengers four abreast at 35·5 in (90 cm) seat pitch, plus 218 cu ft (6·17 m³) of cargo space; 28 passengers at same seat pitch in rear of cabin, plus 588 cu ft (16·65 m³) cargo space; or all-cargo version with 1,727 cu ft (48·9 m³) of cargo space. Alternative layouts for up to 48 passengers.

ACCOMMODATION (Mk 400M): Folding canvas seats, with safety harnesses, along cabin sides for up to 45 paratroops. Toilet and provision for medical supply box or pantry unit at rear. Ambulance version can accommodate 24 USAF-type stretchers, in eight tiers of three, with seats at front and rear for up to nine medical attendants or sitting casualties. All-cargo version fitted with skid strips, tie-down fittings, protection plates and hinged hatracks. Despatch door on each side of fuselage at rear for dropping supplies and personnel.

ACCOMMODATION (Mk 500): Main cabin has standard seating for 52 passengers four abreast at 35·25 in (89·5 cm) seat pitch; alternative layouts enable up to 56 passengers to be carried at 28·5 in (72 cm) pitch.

SYSTEMS: Pressurisation and air-conditioning system utilises two Rootes-type engine-driven blowers. Choke heating and air-to-air heat exchanger; optional bootstrap cooling system. Pressure differential 4·16 lb/sq in (0·29 kg/cm²) in Mks 400, 500 and 600; 5·5 lb/sq in (0·39 kg/cm²) in Mk 200. No hydraulic system. Pneumatic system, pressure 3,400 lb/sq in (230 kg/cm²), for landing gear retraction, nosewheel steering and brakes. Emergency pneumatic circuits for landing gear extension and brakes. Primary 28V electrical system supplied by two 375A 28V DC engine-driven generators. Secondary system supplied via two 115V 400Hz AC constant-frequency inverters. Variable-frequency AC power supply, from 120/208V 15kVA engine-driven alternators, for anti-icing and heating. Two 24V 40Ah nickel-cadmium batteries. 39·4 cu ft (1·12 m³) oxygen system for pilots.

ELECTRONICS AND EQUIPMENT: Standard provisions for VHF and HF transceivers, VHF navigation system (including glideslope), ADF, ILS, marker beacon, dual gyrosyn compass system and intercom system. Provision for weather radar, autopilot etc.

DIMENSIONS, EXTERNAL:
Wing span 95 ft 2 in (29·00 m)
Wing chord at root 11 ft 4 in (3·45 m)
Wing chord at tip 4 ft 7 in (1·40 m)
Wing aspect ratio 12
Length overall:
except Mk 500 77 ft 3½ in (23·56 m)
Mk 500 82 ft 2½ in (25·06 m)
Fuselage: Max width 8 ft 10½ in (2·70 m)
Max height 9 ft 1½ in (2·79 m)
Height overall, standard landing gear:
except Mk 500 27 ft 11 in (8·50 m)
Mk 500 28 ft 7½ in (8·71 m)
Height overall, rough-field landing gear:
except Mk 500 28 ft 2 in (8·59 m)
Tailplane span 32 ft 0 in (9·75 m)
Wheel track (c/l shock struts) 23 ft 7½ in (7·20 m)
Wheelbase:
except Mk 500 28 ft 8 in (8·74 m)
Mk 500 31 ft 11½ in (9·74 m)
Propeller diameter 11 ft 6 in (3·50 m)
Propeller ground clearance:
standard landing gear:
except Mk 500 3 ft 1 in (0·94 m)
Mk 500 3 ft 3 in (0·99 m)
rough-field landing gear:
except Mk 500 3 ft 4½ in (1·02 m)
Passenger door (aft, port):
Height 5 ft 5 in (1·65 m)
Width 2 ft 5 in (0·74 m)
Height to sill 4 ft 0 in (1·22 m)
Service/emergency door (aft, stbd):
Height 3 ft 8 in (1·12 m)
Width 2 ft 5 in (0·74 m)
Height to sill 3 ft 3 in (0·99 m)
Standard cargo door (Mk 200 only):
Height 3 ft 11 in (1·19 m)
Width 3 ft 5 in (1·04 m)
Height to sill 3 ft 3 in (0·99 m)
Large cargo door (Mks 400, 500 and 600):
Height 5 ft 10 in (1·78 m)
Width 7 ft 7½ in (2·32 m)
Height to sill:
except Mk 500 3 ft 3 in (0·99 m)
Mk 500 3 ft 4½ in (1·03 m)
Despatch doors (Mk 400M only, aft, port and stbd, each):
Height 5 ft 5 in (1·65 m)
Width 3 ft 11 in (1·19 m)
Height to sill 4 ft 0 in (1·22 m)

DIMENSIONS, INTERNAL:
Cabin, excl flight deck:
Length:
except Mk 500 47 ft 5 in (14·46 m)
Mk 500 52 ft 4 in (15·96 m)
Max width 8 ft 4½ in (2·55 m)
Max height 6 ft 7½ in (2·02 m)
Volume:
except Mk 500 2,136 cu ft (60·5 m³)
Mk 500 2,360 cu ft (66·8 m³)
Freight hold (fwd) max:
Mk 200 169 cu ft (4·78 m³)
Mks 400, 500, 600 197 cu ft (5·58 m³)
Freight hold (aft) max:
all versions 100 cu ft (2·83 m³)

AREAS:
Wings, gross 753·5 sq ft (70·0 m²)
Ailerons (total) 37·80 sq ft (3·51 m²)
Trailing-edge flaps (total) 136·90 sq ft (12·72 m²)
Vertical tail surfaces (total) 153 sq ft (14·20 m²)
Horizontal tail surfaces (total) 172 sq ft (16·00 m²)

WEIGHTS AND LOADINGS:
Manufacturer's weight, empty:
Mk 200, 44 seats 22,436 lb (10,177 kg)
Mk 400, 40 seats 23,290 lb (10,564 kg)
Mk 400M 23,360 lb (10,596 kg)
Mk 500, 52-56 seats 23,578 lb (10,695 kg)
Mk 500M 24,325 lb (11,034 kg)
Mk 600, 44 seats 22,786 lb (10,336 kg)
Operating weight, empty:
Mk 200, 44 seats 24,612 lb (11,164 kg)
Mk 400, 40 seats 24,875 lb (11,283 kg)
Mk 400M, all-cargo 23,947 lb (10,862 kg)
Mk 400M, medical evacuation 24,880 lb (11,286 kg)
Mk 400M, paratrooper 24,336 lb (11,039 kg)
Mk 500, 52-56 seats 25,915 lb (11,755 kg)
Mk 500M, all-cargo 24,912 lb (11,300 kg)
Mk 500M, medical evacuation 26,023 lb (11,804 kg)
Mk 500M, paratrooper 25,332 lb (11,491 kg)
Mk 600, 44 seats 24,962 lb (11,323 kg)
Max payload (weight limited):
Mk 200, 44 seats 12,888 lb (5,846 kg)
Mk 400, 40 seats 12,625 lb (5,727 kg)
Mk 400M, all-cargo 13,553 lb (6,148 kg)
Mk 400M, medical evacuation 12,612 lb (5,721 kg)
Mk 400M, paratrooper 13,164 lb (5,971 kg)
Mk 500, 52-56 seats 13,585 lb (6,162 kg)
Mk 500M, all-cargo 14,588 lb (6,617 kg)
Mk 500M, medical evacuation 13,477 lb (6,113 kg)
Mk 500M, paratrooper 14,168 lb (6,427 kg)
Mk 600, 44 seats 12,538 lb (5,687 kg)
Max T-O weight:
all versions 45,000 lb (20,410 kg)
Max landing weight:
Mks 200, 400, 400M and 600 41,000 lb (18,600 kg)
Mks 500 and 500M 42,000 lb (19,050 kg)
Max zero-fuel weight:
Mks 200, 400, 400M and 600 37,500 lb (17,010 kg)
Mks 500 and 500M 39,500 lb (17,900 kg)
Max wing loading:
all versions 59·7 lb/sq ft (291·5 kg/m²)
Max power loading:
all versions 10·5 lb/shp (4·76 kg/shp)

PERFORMANCE (at weights indicated):
Normal cruising speed at 20,000 ft (6,100 m) and AUW of 38,000 lb (17,237 kg):
all versions 259 knots (298 mph; 480 km/h)
Rate of climb at S/L, AUW of 40,000 lb (18,143 kg):
all civil versions 1,480 ft (451 m)/min
both military versions 1,620 ft (494 m)/min
Service ceiling at AUW of 38,000 lb (17,237 kg):
all civil versions 29,500 ft (8,990 m)
both military versions 30,000 ft (9,145 m)
Service ceiling, one engine out, at AUW of 38,000 lb (17,237 kg):
all civil versions 11,700 ft (3,565 m)
both military versions 13,300 ft (4,055 m)
Runway LCN at max T-O weight, standard landing gear 16
Required T-O field length (ICAO-PAMC) at AUW of 40,000 lb (18,143 kg), all civil versions:
S/L, ISA 3,250 ft (991 m)
S/L, ISA +15°C 3,560 ft (1,085 m)
3,000 ft (914 m), ISA 3,980 ft (1,213 m)
Required T-O field length (military) at AUW of 40,000 lb (18,143 kg), both military versions:
S/L, ISA 2,310 ft (704 m)
S/L, ISA +15°C 2,510 ft (765 m)
3,000 ft (914 m), ISA 2,750 ft (838 m)
Required landing field length (ICAO-PAMC) at AUW of 37,500 lb (17,010 kg), all civil versions:
S/L 3,160 ft (963 m)
3,000 ft (914 m) 3,390 ft (1,033 m)
Required landing field length (military) at AUW of 37,500 lb (17,010 kg), both military versions:
S/L 1,900 ft (579 m)
3,000 ft (914 m) 2,040 ft (622 m)
Range (ISA, zero wind conditions) with FAR 121.645 reserves for diversion, 30 min hold at 10,000 ft (3,050 m) and 10% flight fuel:
Mks 200 and 600, 44 passengers 1,020 nm (1,197 miles; 1,920 km)
Mk 400, 40 passengers 1,025 nm (1,203 miles; 1,935 km)
Mk 500, 52 passengers 935 nm (1,082 miles; 1,741 km)
Military transport range (ISA, zero wind conditions) at max T-O weight, reserves for 30 min hold at S/L and 5% initial fuel:
Mks 400M and 500M, all-cargo, max standard fuel 1,195 nm (1,375 miles; 2,213 km)
Mks 400M and 500M, all-cargo, max possible fuel 2,370 nm (2,727 miles; 4,390 km)
Military combat radius, conditions as above:
Mks 400M and 500M, all-cargo, max standard fuel 625 nm (719 miles; 1,158 km)
Mks 400M and 500M, all-cargo, max possible fuel 1,230 nm (1,416 miles; 2,278 km)
Max endurance at 20,000 ft (6,100 m):
Mk 400M, max standard fuel 7 hr 25 min
Mk 400M, max possible fuel 12 hr 47 min
Mk 500M, max standard fuel 7 hr 14 min
Mk 500M, max possible fuel 12 hr 26 min

OPERATIONAL NOISE CHARACTERISTICS (FAR Pt 36):
T-O noise level 89 EPNdB
Approach noise level 99 EPNdB
Sideline noise level 92·5 EPNdB

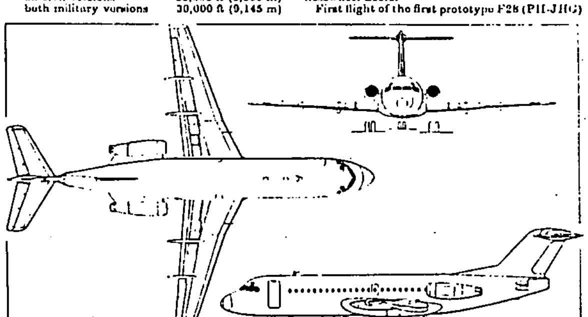
FOKKER-VFW F28 FELLOWSHIP

Announced in April 1962, the F28 Fellowship twin-turbofan short-haul transport was developed in collaboration with other European aircraft manufacturers and with the financial support of the Netherlands government. One half of the Dutch share of the development cost was supplied through the Netherlands Aircraft Development Board, the other half through a loan guaranteed by the government.

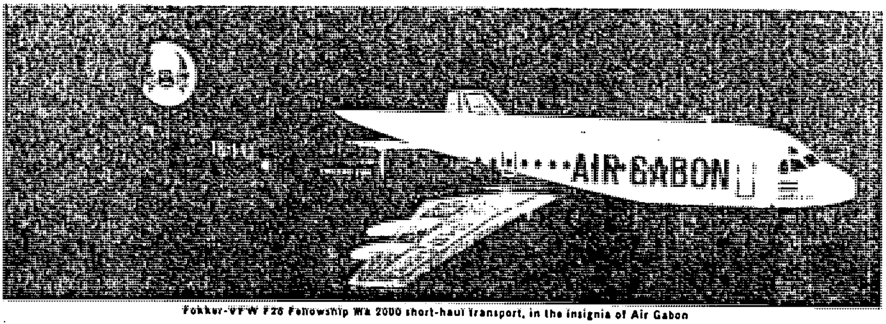
Under agreements signed in the Summer of 1964, production is undertaken by Fokker-VFW in association with MBB and VFW-Fokker in Germany and Short Bros and Harland in the UK.

Fokker-VFW is responsible for the front fuselage, to a point just aft of the flight deck, the centre fuselage and wing-root fairings. MBB builds the fuselage, from the wing trailing-edge to the rear pressure bulkhead, and the engine nacelles and support stubs. VFW-Fokker is responsible for the rear fuselage and tail unit, and for the cylindrical fuselage section between the wing leading-edge and flight deck. Shorts are responsible for the wings (including the slatted wings for the Mks 5000 and 6000), and other components, including the main-wheel and nosewheel doors.

First flight of the first prototype F28 (PH-JHG)



Fokker-VFW F28 Fellowship Mk 6000 twin-turbofan short-range airliner (*Pilot Press*)



Fokker-VFW F28 Fellowship Mk 2000 short-haul transport, in the insignia of Air Gabon

was made on 9 May 1967, and the second prototype, PH-WEV, flew on 3 August 1967. The third F28 (PH-MOL) flew for the first time on 20 October 1967 and was brought up to production standard in the early Summer of 1968.

The Dutch RLD granted a C of A to the F28 on 24 February 1969, and the first delivery (of the fourth aircraft, to LTU) was made on the same day. The aircraft received FAA Type Approval on 24 March 1969 and German certification on 30 March 1969. RLD certification for operation from unpaved runways was granted in mid-1972. The Mk 1000 was granted FAA-approved noise certification on 31 December 1971.

A total of 107 Fellowships (85 Mk 1000, 7 Mk 1000C, 10 Mk 2000 and 5 Mk 4000) had been ordered by 3 June 1975, as follows:

Mk 1000/1000C	
Aerolineas Argentinas	3
AeroPeru	3
Air Gabon (1 Mk 1000VIP, 1 Mk 1000C)	2
Air Nauru	2
Ansett Transport Industries (Airlines of NSW and MacRobertson-Miller)	6
Argentine Air Force (Mk 1000C)	6
Argentine government	1
Australian Dept of Transport (Air)	3
Aviaction (Germany)	3
Braathens (Norway)	5
Colombian Air Force	1
Congo (Brazzaville)	1
Eastex (USA)	1
Fairchild Industries	1
Garuda Indonesian Airways	18
Germanair	4
Iberia	3
Itavia (Italy)	3
Ivory Coast (1 Mk 1000, 1 Mk 1000C)	2
Linjeflyg (Sweden)	3
LTU (Germany)	4
Malaysian government	2
Martinair-Holland	1
Netherlands government	1
Nigeria Airways	2
Nigerian government	1
Pelita/Pertamina	2
Peruvian government	1
THY (Turkey)	5
Togo government	1
Touraine Air Transport	1
Transair (Canada)	2
Mk 2000	
Air Gabon	2
Ghana Airways	2
Nigeria Airways	6
Mk 4000	
Undisclosed	5

Six versions have been announced, as follows:

Mk 1000. Initial version, in production and service, with seating for up to 65 passengers. First F28 commercial service was flown by Braathens on 28 March 1969. Available optionally, for all-cargo or mixed passenger/cargo operations, with large freight door at front on port side, aft of passenger door, in which form it is designated **Mk 1000C**.

Mk 2000. Similar to Mk 1000 except for lengthened fuselage, permitting an increase in accommodation for up to 79 passengers in all-tourist layout. F28 first prototype modified to Mk 2000 standard and flown for first time on 28 April 1971. Dutch certification awarded on 30 August 1972. In production and service.

Mk 3000. See Addenda.

Mk 4000. High-density version, announced in early 1975, to seat up to 85 passengers at 29 in (74 cm) pitch. Airframe basically that of Mk 6000, except for omission of leading-edge slats; uprated Spey Mk 555-15H is retained as power plant. Intended for use over stage lengths of about 890 nm (1,025 miles; 1,650 km), using a T-O field length of 5,740 ft (1,750 m). Two additional overwing emergency exits (making a total of four). Design criteria, due to be finalised by April 1975, include a max T-O weight of 70,990 lb (32,200 kg), max landing weight of 63,935 lb (29,000 kg) and max zero-fuel weight of 57,540 lb (26,100 kg).

Mk 5000. Similar to Mk 1000 except for slatted, long-span wings and improved Spey engines. Available with large cargo door.

Mk 6000. Similar to Mk 2000 except for slatted, long-span wings and improved Spey engines. Prototype, modified from F28 first prototype (previously used for Mk 2000 certification flying) and fitted with modified wings from the second prototype, made its first flight on 27 September 1973. Certification expected by mid-1975.

The following details apply generally to all versions, except where a specific model is indicated:

Type: Twin-turbofan short-range airliner.

Wings: Cantilever low/mid-wing monoplane. Wing section NACA 0000-X 40Y series with camber varying along span. Thickness/chord ratio up to 14% on inner wing, 10% at tip. Dihedral 2° 30′. Sweepback at quarter-chord 16°. Single-cell two-spar light alloy torsion-box structure, comprising centre-section, integral with fuselage, and two outer wings. Fail-safe construction. Lower skin made of three planks. Taper-rolled top skin. Forged ribs in centre-section, built-up ribs in outer panels. Double-skin leading-edge with ducts for hot-air de-icing. Irreversible hydraulically-operated ailerons. Emergency manual operation of ailerons, through tabs. Hydraulically-operated Fowler double-slotted flaps over 70% of each half-span with electrical emergency extension. Five-section hydraulically-operated lift dumpers in front of flaps on each wing. Trim tab in each aileron. Mks 5000 and 6000 have extended-span wings with full-span hydraulically-operated leading-edge slats.

Fuselage: Circular-section semi-monocoque light alloy fail-safe structure, made up of skin panels with Redux-bonded Z-stringers. Bonded doubler plates at door and window cut-outs. Quickly-detachable sandwich (metal/end grain balsa) floor panels. Hydraulically-operated petal airbrakes form aft end of fuselage.

Tail Unit: Cantilever light alloy structure, with hydraulically-actuated variable-incidence T tailplane. Electrical emergency actuation of tailplane. Hydraulically-boosted elevators. Hydraulically-operated rudder with duplicated actuators and emergency manual operation. Honeycomb sandwich skin panels used extensively, in conjunction with multiple spars. Double-skin leading-edges for hot-air de-icing.

Landing Gear: Retractable tricycle type of Dowty-Rotol manufacture, with twin wheels on each unit. Hydraulic retraction, nosewheels forward, main units inward into fuselage. Oleo-pneumatic shock-absorbers. Goodyear wheels, tyres and electronically-controlled braking system. Steerable nosewheel. Mainwheel tyres size 39 × 13, 16-ply rating, pressure 100 lb/sq in (7·0 kg/cm²) on Mk 1000, 102 lb/sq in (7·1 kg/cm²) on Mk 2000, 110 lb/sq in (7·7 kg/cm²) on Mks 5000 and 6000. Nosewheel tyres size 24·5 × 8·5, 10-ply rating, pressure 85 lb/sq in (5·98 kg/cm²) on Mk 1000, 78 lb/sq in (5·5 kg/cm²) on Mk 2000, 80 lb/sq in (5·6 kg/cm²) on Mk 5000 and 75 lb/sq in (5·3 kg/cm²) on Mk 6000. Low-pressure tyres optional on all units.

Power Plant (Mks 1000 and 2000): Two Rolls-Royce RB.183-2 Spey Mk 555-15 turbofan engines with blade-cooling (each 9,850 lb; 4,468 kg st), mounted in pod on each side of rear fuselage. No water injection or thrust reversers. Thermal anti-icing for air intakes. For Mks 5000 and 6000, a Mk 555-15H version of the Spey engine is under development. This will retain the existing nominal thrust rating of the Mk 555-15, but at ambient temperatures up to 28°C, and will be fitted with a five-chute silencing nozzle. Integral fuel tank in each outer wing panel with total usable capacity of 2,143 Imp gallons (9,740 litres) in Mks 1000/2000; 2,130 Imp gallons (9,682 litres) in Mks 5000/6000. Optional seven bladder-type tank units in wing centre-section with total usable capacity of 726 Imp gallons (3,300 litres). Single refuelling point under starboard wing, near root.

Accommodation: Crew of two side by side on flight deck, with jump-seat for third crew member. Electrically-heated windscreen. Pantry/baggage space immediately aft of flight deck on starboard side, followed by entrance lobby with hydraulically-operated airstair door on port side, service and emergency door on starboard side, and seat for stewardess. On Mks 1000 and 5000, an optional upward-opening cargo door, to permit all-cargo or all-passenger operation, can be added aft of the passenger airstair door. Additional emergency door on each side of main cabin, over wing. Main cabin layout of Mks 1000/5000 can be varied to accommodate 55, 60 or 65 passengers five abreast at 37, 32/33 or 31 in (94, 81/84 or 79 cm) seat pitch respectively. In Mks 2000/6000, layout can be varied to accommodate 79 passengers at 31 in (79 cm) seat pitch. Aft of cabin are a wardrobe (port), baggage compartment (port) and toilet compartment (starboard). Underfloor cargo compartments fore and aft of wing, with single door on starboard side of forward hold, with one door on rear hold of each version.

Systems: AiResearch air-conditioning system, using engine bleed air. Max pressure differential 7·45 lb/sq in (0·52 kg/cm²). Two independent hydraulic systems, pressure 3,000 lb/sq in (210 kg/cm²). Primary system for flight controls, landing gear, nosewheel steering and brakes, secondary system for duplication of certain essential flight controls. Flying control hydraulic components supplied by Jarry Hydraulics. All-AC electrical system utilises two 20kVA Westinghouse engine-driven generators to supply three-phase constant-frequency 115/200V 400Hz power. One 20Ah battery for starting APU and for emergency power. AiResearch GTCP 36-4A APU, mounted aft of rear pressure bulkhead, for engine starting, ground air-conditioning and ground electrical power, and to drive a third AC generator for standby use on essential services in flight.

Electronics and Equipment: Standard equipment includes VHF transceivers, VHF navigation system (with glideslope), DME, marker beacon, weather radar, ADF, ATC transponder, dual compass system, interphone and public address systems, Smiths SEP6 autopilot, Collins FD 108 flight director, flight guidance caution system, flight data recorder and voice recorder. Thermal bleed air system for wing leading-edges (slats on Mks 5000/6000), tailplane leading-edge and engine air intakes. Stick pusher system on Mks 5000/6000. Optional equipment to customer's requirements, including equipment for operation in Cat. 2 weather minima.

Dimensions, external:

Wing span:	
1000, 2000	77 ft 4¼ in (23·58 m)
5000, 6000	82 ft 3 in (25·07 m)
Wing chord at root:	
all versions	15 ft 9 in (4·80 m)
Wing chord at tip:	
1000, 2000	5 ft 9¾ in (1·77 m)
Wing aspect ratio:	
1000, 2000	7·27
Length overall:	
1000, 5000	89 ft 10¾ in (27·40 m)
2000, 6000	97 ft 1¾ in (29·61 m)
Length of fuselage:	
1000, 5000	80 ft 6¼ in (24·55 m)
2000, 6000	87 ft 9¾ in (26·76 m)

…/NEW ZEALAND: AIRCRAFT—FOKKER-VFW/AEROSPACE

Fuselage: Max width 10 ft 10 in (3·30 m)
Height overall 27 ft 9¼ in (8·47 m)
Tailplane span 28 ft 4½ in (8·64 m)
Wheel track (c/l of shock struts) 16 ft 6½ in (5·04 m)

Wheelbase:
1000, 5000 29 ft 2½ in (8·90 m)
2000, 6000 33 ft 11½ in (10·35 m)

Passenger door (fwd, port):
Height 6 ft 4 in (1·93 m)
Width 2 ft 10 in (0·86 m)

Service/emergency door (fwd, stbd):
Height 4 ft 2 in (1·27 m)
Width 2 ft 0 in (0·61 m)

Emergency exits (centre, each):
Height 3 ft 0 in (0·91 m)
Width 1 ft 8 in (0·51 m)

Freight hold doors (each):
Height (fwd, each) 2 ft 11½ in (0·90 m)
Height (aft) 2 ft 7½ in (0·80 m)
Width (fwd, each) 3 ft 1½ in (0·95 m)
Width (aft) 2 ft 11 in (0·89 m)
Height to sill (fwd, each) 4 ft 10 in (1·47 m)
Height to sill (aft) 5 ft 2½ in (1·59 m)

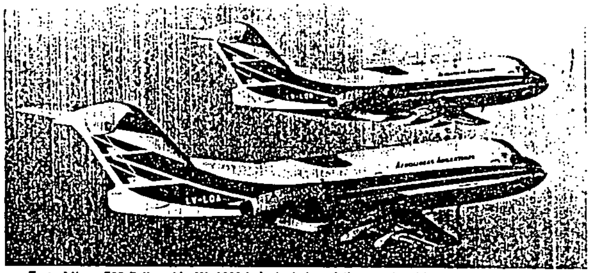
Baggage door (rear, port, optional):
Height 1 ft 11½ in (0·60 m)
Width 1 ft 8 in (0·51 m)

Optional cargo door (fwd, port):
Height 6 ft 1½ in (1·87 m)
Width 8 ft 2 in (2·49 m)
Height to sill 7 ft 4¼ in (2·24 m)

DIMENSIONS, INTERNAL:
Cabin, excl flight deck:
Length:
1000, 5000 43 ft 0 in (13·10 m)
2000, 6000 50 ft 3 in (15·31 m)
Max length of seating area:
1000, 5000 35 ft 2¾ in (10·74 m)
2000, 6000 42 ft 6¾ in (12·95 m)
Max width 10 ft 2 in (3·10 m)
Max height 6 ft 7½ in (2·02 m)
Floor area:
1000, 5000 413·3 sq ft (38·4 m²)
2000, 6000 482·2 sq ft (44·8 m²)
Volume:
1000, 5000 2,525 cu ft (71·5 m³)
2000, 6000 2,931 cu ft (83·0 m³)
Freight hold (underfloor, fwd):
1000, 5000 245 cu ft (6·90 m³)
2000, 6000 308 cu ft (8·70 m³)
Freight hold (underfloor, rear):
1000, 5000 135 cu ft (3·80 m³)
2000, 6000 169 cu ft (4·80 m³)
Baggage hold (aft of cabin), max 80 cu ft (2·265 m³)

AREAS:
Wings, gross:
1000, 2000 822 sq ft (76·40 m²)
5000, 6000 850 sq ft (78·97 m²)
Ailerons (total) 28·74 sq ft (2·67 m²)
Trailing-edge flaps (total) 150·7 sq ft (14·00 m²)
Fuselage airbrakes (total) 38·97 sq ft (3·62 m²)
Fin (incl dorsal fin) 132·4 sq ft (12·30 m²)
Rudder 24·76 sq ft (2·30 m²)
Tailplane 209·9 sq ft (19·50 m²)
Elevators (total) 41·33 sq ft (3·84 m²)

WEIGHTS AND LOADINGS:
Manufacturer's weight empty:
1000, 65 seats 31,954 lb (14,492 kg)
1000C 31,954 lb (14,492 kg)
2000, 70 seats 32,929 lb (14,936 kg)
5000, 65 seats 33,504 lb (15,198 kg)
6000, 79 seats 34,477 lb (15,638 kg)
Operating weight empty:
1000, 65 seats 35,464 lb (16,084 kg)
1000C 35,853 lb (16,263 kg)
2000, 70 seats 36,705 lb (16,600 kg)
5000, 65 seats 37,014 lb (16,790 kg)
6000, 79 seats 38,345 lb (17,393 kg)
Max weight-limited payload:
1000 19,036 lb (8,636 kg)
1000C 18,647 lb (8,457 kg)
2000 17,705 lb (8,030 kg)
5000 17,486 lb (7,930 kg)
6000 17,655 lb (8,007 kg)



Two of three F28 Fellowship Mk 1000 twin-turbofan airliners ordered by Aerolineas Argentinas in early 1975

Max T-O weight:
1000, 2000 65,000 lb (29,485 kg)
5000, 6000 70,800 lb (32,115 kg)
Max zero-fuel weight:
1000, 2000, 5000 54,500 lb (24,720 kg)
6000 56,000 lb (25,400 kg)
Max landing weight:
1000, 2000 59,000 lb (26,760 kg)
5000, 6000 64,000 lb (29,030 kg)
Max wing loading:
1000, 2000 79·1 lb/sq ft (386 kg/m²)
5000, 6000 83·3 lb/sq ft (406 kg/m²)
Max cabin floor loading:
all passenger versions 75 lb/sq ft (366 kg/m²)
1000, 5000, with large cargo door 125 lb/sq ft (610 kg/m²)
Max power loading:
1000, 2000 3·3 lb/lb st (3·3 kg/kg st)
5000, 6000 3·6 lb/lb st (3·6 kg/kg st)

PERFORMANCE (ISA, except where indicated):
Max never-exceed speed (all versions) 390 knots (449 mph; 723 km/h) EAS or Mach 0·83
Max permissible operating speed (all versions) 330 knots (380 mph; 611 km/h) EAS or Mach 0·75
Max cruising speed at 23,000 ft (7,000 m) (all versions) 456 knots (523 mph; 843 km/h) TAS
Econ cruising speed at 30,000 ft (9,150 m), AUW of 50,000 lb (26,760 kg):
1000, 2000 362 knots (416 mph; 670 km/h) TAS
5000, 6000 366 knots (421 mph; 678 km/h) TAS
Threshold speed at max landing weight:
1000, 2000 119 knots (137 mph; 220 km/h) EAS
5000, 6000 110 knots (127 mph; 204 km/h) EAS
Max cruising altitude:
all versions 35,000 ft (10,675 m)
Min ground turning radius:
1000, 5000 31 ft 6 in (9·60 m)
2000, 6000 35 ft 9 in (10·90 m)
Runway LCN at max T-O weight (hard runway):
1000, standard tyres 26·5
1000, low-pressure tyres 22
2000, standard tyres 27
2000, low-pressure tyres 22·5
5000, standard tyres 31
5000, low-pressure tyres 27
6000, standard tyres 30
6000, low-pressure tyres 26
Runway LCN at max T-O weight (flexible runway):
1000, standard tyres 21
2000, standard tyres 21·5
5000, standard tyres 25
5000, low-pressure tyres 21
6000, standard tyres 24
6000, low-pressure tyres 20
FAR T-O field length at max T-O weight (1000, 2000):
S/L 5,490 ft (1,673 m)
S/L, ISA + 10°C 5,820 ft (1,774 m)
S/L, ISA + 15°C 6,160 ft (1,878 m)
2,000 ft (610 m) 5,970 ft (1,820 m)
3,000 ft (915 m) 6,320 ft (1,926 m)
FAR T-O field length at max T-O weight (5000, 6000):
S/L 5,860 ft (1,786 m)
S/L, ISA + 10°C 6,046 ft (1,843 m)
S/L, ISA + 15°C 6,168 ft (1,880 m)
2,000 ft (610 m) 6,120 ft (1,865 m)
3,000 ft (915 m) 6,530 ft (1,990 m)
FAR landing field length at max landing weight (1000, 2000):
S/L 3,540 ft (1,079 m)
5,000 ft (1,525 m) 4,010 ft (1,222 m)
FAR landing field length at max landing weight (5000, 6000):
S/L 3,120 ft (951 m)
5,000 ft (1,525 m) 3,527 ft (1,075 m)
Range, high-speed schedule, FAR 121.654 reserves:
1000, 65 passengers 1,020 nm (1,174 miles; 1,889 km)
2000, 70 passengers 630 nm (725 miles; 1,167 km)
*5000, 65 passengers 1,210 nm (1,392 miles; 2,240 km)
6000, 79 passengers 900 nm (1,036 miles; 1,667 km)
Range, long-range schedule, FAR 121.654 reserves:
1000, 65 passengers 1,130 nm (1,300 miles; 2,093 km)
2000, 70 passengers 700 nm (806 miles; 1,296 km)
*5000, 65 passengers 1,400 nm (1,611 miles; 2,593 km)
6000, 79 passengers 1,030 nm (1,185 miles; 1,908 km)

*With wing centre-section tanks

OPERATIONAL NOISE CHARACTERISTICS (FAR Pt 36):
T-O noise level:
1000, 2000 90 EPNdB
5000, 6000 (estimated) 88 EPNdB
Approach noise level:
1000 101·2 EPNdB
2000 101·8 EPNdB
5000, 6000 (estimated) 97·5 EPNdB
Sideline noise level:
1000, 2000 90·5 EPNdB
5000, 6000 (estimated) 97 EPNdB

Fuselage: Max width 10 ft 10 in (3·30 m)
Height overall 27 ft 9½ in (8·47 m)
Tailplane span 28 ft 4¼ in (8·64 m)
Wheel track (c/l of shock struts) 16 ft 6¼ in (5·04 m)
Wheelbase:
1000, 5000 29 ft 2¼ in (8·90 m)
2000, 6000 33 ft 11½ in (10·35 m)
Passenger door (fwd, port):
Height 6 ft 4 in (1·93 m)
Width 2 ft 10 in (0·86 m)
Service/emergency door (fwd, stbd):
Height 4 ft 2 in (1·27 m)
Width 2 ft 0 in (0·61 m)
Emergency exits (centre, each):
Height 3 ft 0 in (0·91 m)
Width 1 ft 8 in (0·51 m)
Freight hold doors (each):
Height (fwd, each) 2 ft 11½ in (0·90 m)
Height (aft) 2 ft 7½ in (0·80 m)
Width (fwd, each) 3 ft 1½ in (0·95 m)
Width (aft) 2 ft 11 in (0·89 m)
Height to sill (fwd, each) 4 ft 10 in (1·47 m)
Height to sill (aft) 5 ft 2½ in (1·59 m)
Baggage door (rear, port, optional):
Height 1 ft 11½ in (0·60 m)
Width 1 ft 8 in (0·51 m)
Optional cargo door (fwd, port):
Height 6 ft 1¾ in (1·87 m)
Width 8 ft 2 in (2·49 m)
Height to sill 7 ft 4¼ in (2·24 m)

DIMENSIONS, INTERNAL:
Cabin, excl flight deck:
Length:
1000, 5000 43 ft 0 in (13·10 m)
2000, 6000 50 ft 3 in (15·31 m)
Max length of seating area:
1000, 5000 35 ft 2¾ in (10·74 m)
2000, 6000 42 ft 6¼ in (12·95 m)
Max width 10 ft 2 in (3·10 m)
Max height 6 ft 7½ in (2·02 m)
Floor area:
1000, 5000 413·3 sq ft (38·4 m²)
2000, 6000 482·2 sq ft (44·8 m²)
Volume:
1000, 5000 2,525 cu ft (71·5 m³)
2000, 6000 2,931 cu ft (83·0 m³)
Freight hold (underfloor, fwd):
1000, 5000 245 cu ft (6·90 m³)
2000, 6000 308 cu ft (8·70 m³)
Freight hold (underfloor, rear):
1000, 5000 135 cu ft (3·80 m³)
2000, 6000 169 cu ft (4·80 m³)
Baggage hold (aft of cabin), max 80 cu ft (2·265 m³)

AREAS:
Wings, gross:
1000, 2000 822 sq ft (76·40 m²)
5000, 6000 850 sq ft (78·97 m²)
Ailerons (total) 28·74 sq ft (2·67 m²)
Trailing-edge flaps (total) 150·7 sq ft (14·00 m²)
Fuselage airbrakes (total) 38·97 sq ft (3·62 m²)
Fin (incl dorsal fin) 132·4 sq ft (12·30 m²)
Rudder 24·76 sq ft (2·30 m²)
Tailplane 209·9 sq ft (19·50 m²)
Elevators (total) 41·33 sq ft (3·84 m²)

WEIGHTS AND LOADINGS:
Manufacturer's weight empty:
1000, 65 seats 31,954 lb (14,492 kg)
1000C 31,954 lb (14,492 kg)
2000, 79 seats 32,929 lb (14,936 kg)
5000, 65 seats 33,504 lb (15,198 kg)
6000, 79 seats 34,477 lb (15,638 kg)
Operating weight empty:
1000, 65 seats 35,464 lb (16,084 kg)
1000C 35,853 lb (16,263 kg)
2000, 79 seats 36,795 lb (16,690 kg)
5000, 65 seats 37,014 lb (16,790 kg)
6000, 79 seats 38,345 lb (17,393 kg)
Max weight-limited payload:
1000 19,036 lb (8,630 kg)
1000C 18,647 lb (8,457 kg)
2000 17,705 lb (8,030 kg)
5000 17,496 lb (7,936 kg)
6000 17,655 lb (8,007 kg)
Max T-O weight:
1000, 2000 65,000 lb (29,485 kg)
5000, 6000 70,800 lb (32,115 kg)
Max zero-fuel weight:
1000, 2000, 5000 54,500 lb (24,720 kg)
6000 56,000 lb (25,400 kg)
Max landing weight:
1000, 2000 59,000 lb (26,760 kg)
5000, 6000 64,000 lb (29,030 kg)
Max wing loading:
1000, 2000 79·1 lb/sq ft (386 kg/m²)
5000, 6000 83·3 lb/sq ft (406 kg/m²)
Max cabin floor loading:
all passenger versions 75 lb/sq ft (366 kg/m²)
1000, 5000, with large cargo door 125 lb/sq ft (610 kg/m²)
Max power loading:
1000, 2000 3·3 lb/lb st (3·3 kg/kg st)
5000, 6000 3·6 lb/lb st (3·6 kg/kg st)

PERFORMANCE (ISA, except where indicated):
Max never-exceed speed (all versions) 390 knots (449 mph; 723 km/h) EAS or Mach 0·83
Max permissible operating speed (all versions) 330 knots (380 mph; 611 km/h) EAS or Mach 0·75
Max cruising speed at 23,000 ft (7,000 m) (all versions) 455 knots (523 mph; 843 km/h) TAS
Econ cruising speed at 30,000 ft (9,150 m), AUW of 59,000 lb (26,760 kg):
1000, 2000 362 knots (416 mph; 670 km/h) TAS
5000, 6000 366 knots (421 mph; 678 km/h) TAS
Threshold speed at max landing weight:
1000, 2000 119 knots (137 mph; 220 km/h) EAS
5000, 6000 110 knots (127 mph; 204 km/h) EAS
Max cruising altitude:
all versions 35,000 ft (10,675 m)
Min ground turning radius:
1000, 5000 31 ft 6 in (9·60 m)
2000, 6000 35 ft 9 in (10·90 m)
Runway LCN at max T-O weight (hard runway):
1000, standard tyres 26·5
1000, low-pressure tyres 22
2000, standard tyres 27
2000, low-pressure tyres 22·5
5000, standard tyres 31
5000, low-pressure tyres 27
6000, standard tyres 30
6000, low-pressure tyres 26
Runway LCN at max T-O weight (flexible runway):
1000, standard tyres 21
2000, standard tyres 21·5
5000, standard tyres 25
5000, low-pressure tyres 21
6000, standard tyres 24
6000, low-pressure tyres 20
FAR T-O field length at max T-O weight (1000, 2000):
S/L 5,490 ft (1,673 m)
S/L, ISA + 10°C 5,820 ft (1,774 m)
S/L, ISA + 15°C 6,160 ft (1,878 m)
2,000 ft (610 m) 5,970 ft (1,820 m)
3,000 ft (915 m) 6,320 ft (1,926 m)
FAR T-O field length at max T-O weight (5000, 6000):
S/L 5,860 ft (1,786 m)
S/L, ISA + 10°C 6,046 ft (1,843 m)
S/L, ISA + 15°C 6,168 ft (1,880 m)
2,000 ft (610 m) 6,120 ft (1,865 m)
3,000 ft (915 m) 6,530 ft (1,990 m)
FAR landing field length at max landing weight (1000, 2000):
S/L 3,540 ft (1,079 m)
5,000 ft (1,525 m) 4,010 ft (1,222 m)
FAR landing field length at max landing weight (5000, 6000):
S/L 3,120 ft (951 m)
5,000 ft (1,525 m) 3,527 ft (1,075 m)
Range, high-speed schedule, FAR 121.654 reserves:
1000, 65 passengers 1,020 nm (1,174 miles; 1,889 km)
2000, 70 passengers 630 nm (725 miles; 1,167 km)
*5000, 65 passengers 1,210 nm (1,392 miles; 2,240 km)
6000, 70 passengers 900 nm (1,036 miles; 1,667 km)
Range, long-range schedule, FAR 121.654 reserves:
1000, 65 passengers 1,130 nm (1,300 miles; 2,093 km)
2000, 70 passengers 700 nm (806 miles; 1,296 km)
*5000, 65 passengers 1,400 nm (1,611 miles; 2,593 km)
6000, 70 passengers 1,030 nm (1,185 miles; 1,908 km)

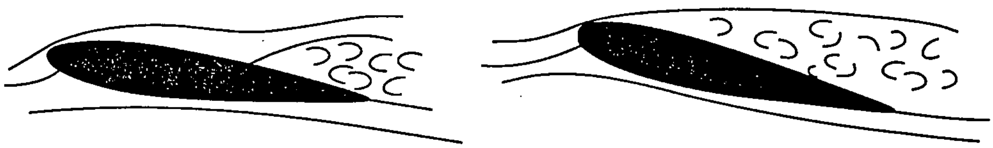
* *With wing centre-section tanks*

OPERATIONAL NOISE CHARACTERISTICS (FAR Pt 36):
T-O noise level:
1000, 2000 90 EPNdB
5000, 6000 (estimated) 88 EPNdB
Approach noise level:
1000 101·2 EPNdB
2000 101·8 EPNdB
5000, 6000 (estimated) 97·5 EPNdB
Sideline noise level:
1000, 2000 99·5 EPNdB
5000, 6000 (estimated) 97 EPNdB

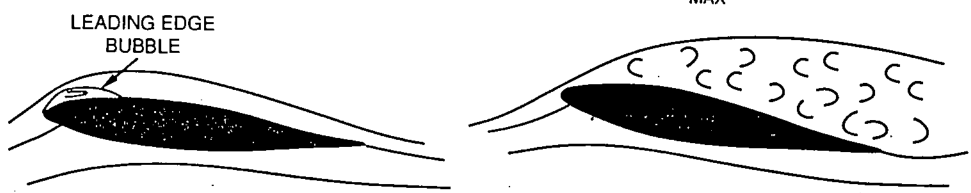
APPENDIX B TO SECTION 2

ILLUSTRATIONS OF STALL TYPES AND
VORTEX FLOW ABOUT A WING

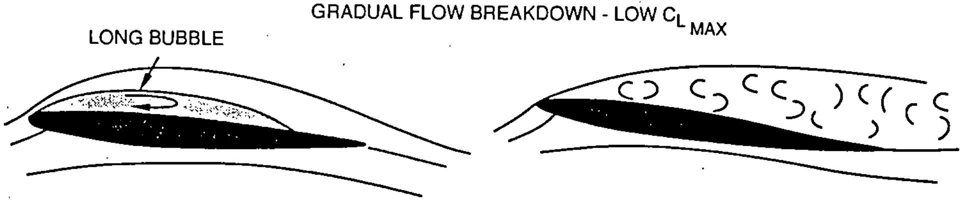
TYPE I - TRAILING EDGE STALL
GRADUAL FLOW BREAKDOWN - HIGH $C_{L_{MAX}}$



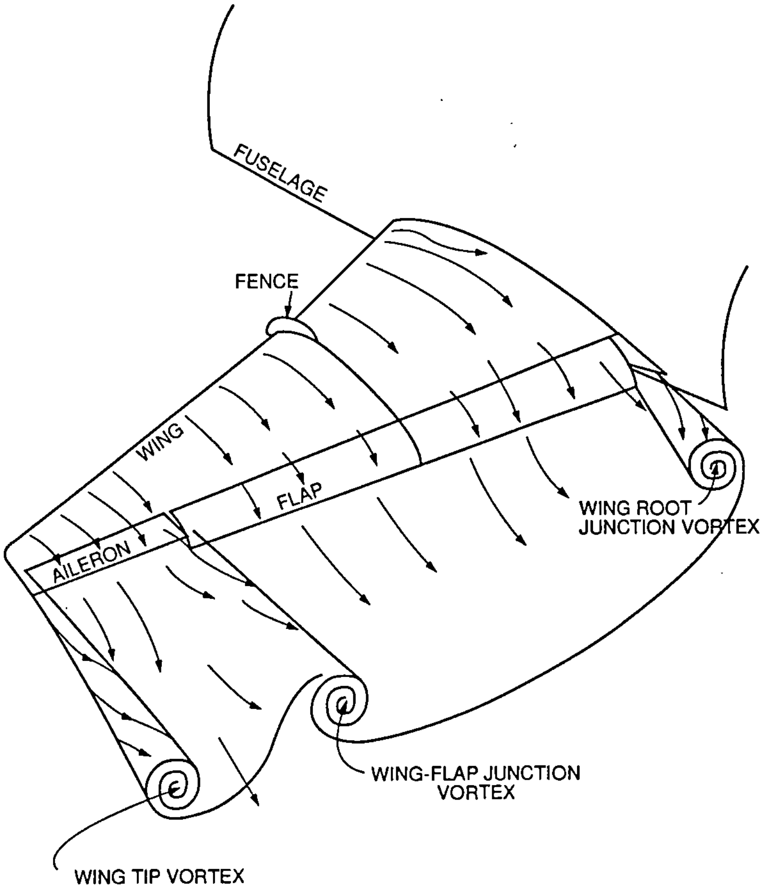
TYPE II - LEADING EDGE STALL
ABRUPT FLOW BREAKDOWN - HIGH $C_{L_{MAX}}$



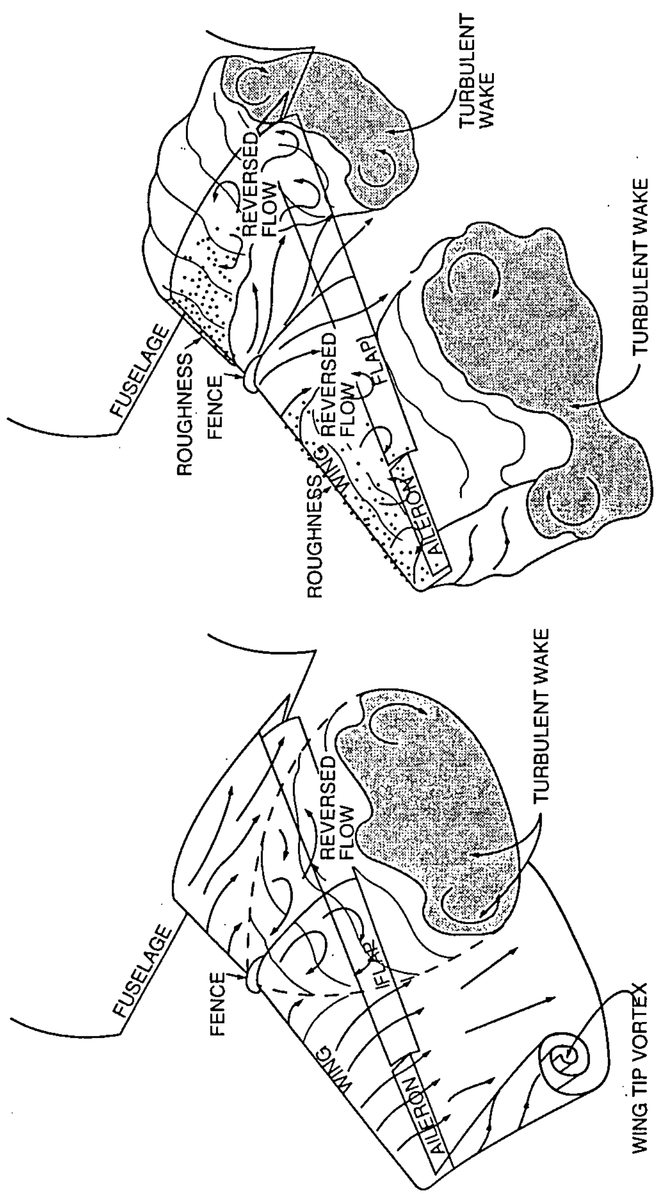
TYPE III - THIN AIRFOIL STALL
GRADUAL FLOW BREAKDOWN - LOW $C_{L\,MAX}$



STALLING CHARACTERISTICS OF AIRFOILS



NORMAL FLOW AND WAKE FROM CLEAN WING



REGIONS OF SEPARATED FLOW FROM OUTER WING PANELS AND WING ROOT; CONTAMINATED WING

STALL AND TURBULENT WAKE FROM CLEAN WING

SKETCH OF TYPICAL VORTEX AND TURBULENT WAKE FROM A PARTIALLY-STALLED WING.

F-28 FLIGHT DYNAMICS
SECTION 3
REAL-TIME SIMULATION STUDIES AND ANALYSES

INTRODUCTION

As noted in the introductory section, the destruction of the FDR tape in this accident meant that there were no numerical data on which to base any analysis of the aircraft's trajectory at any point during the attempted take-off: the only guidance available to the investigators was embodied in various witness reports. This meant that simulation, either analytical or real-time, man-in-the-loop, was the only tool available to assist the performance steering group in studying the circumstances of the Dryden accident. Both forms of simulation were used: a visit by the group to the manufacturer's facility in Amsterdam, Netherlands, yielded the opportunity to use the company's engineering dynamic simulator, while extensive mathematical modelling (analytical simulation) was conducted to check and validate the observations made at Fokker Aircraft. This section describes and comments on the results of the dynamic simulations.

DYNAMIC SIMULATION IN THE FOKKER ENGINEERING SIMULATOR

At the time that these dynamic simulations were conducted in the Fokker engineering simulator[4], it was configured as a Fokker F100 aircraft, a somewhat larger derivative of the F-28 with appreciable aerodynamic differences. This aircraft is a new Fokker aircraft and the F28 is no longer produced. Since there was insufficient time to reprogram the engineering simulator with F28 data, it was decided to use the simulator in its existing form, approximating the F28 aircraft by selecting thrust/weight values so that the performance of the machine would be similar to that of the F28. The simulator is a single seat development simulator equipped with a full set of electronic flight instruments at the captain's station, full engine instruments and standard flight controls. It was also equipped with a visual system which provided a night runway scene.

The mathematical model of the F100 used in the engineering simulator included icing performance characteristics for a variety of levels of wing ice. Also, the ground model included the capability to introduce various levels of slush on the runway to provide rolling resistance contamination for the simulation. It was decided to fly the dynamic simulations using a variety of different wing and runway contaminant levels. The data from these simulations were saved and plotted to present pictorially and numerically the flight profiles and changes in the aircraft performance which would be experienced.

[4] An engineering simulation is one of great technical detail often used by aircraft designers as a development and research tool.

SIMULATOR APPROXIMATIONS FOR F28-1000 REPRESENTATION

Scaling the Fokker 100 to an F28 MK1000

The objective of the dynamic simulation was to obtain flight profiles which would have been achieved by an F28 MK1000 for various sets of conditions. To accomplish this task, it was necessary to choose a number of parameters carefully.

A weight was selected for the F100 so that the stall speeds and other reference speeds (V_1, V_R and V_2) were the same as those of a F-28 at 63,500 lb weight. This would provide for the same rotation and V_2 speeds and allow for take off roll comparisons to be made for dry and contaminated runways with the thrust level appropriately selected. Also, use of the same speeds resulted in achieving roughly the same wing Reynold's number (a non dimensional ratio of dynamic to viscous forces used in aerodynamics) at rotation. This would ensure that the aerodynamic characteristics of the wing would simulate as closely as possible to those of the F28 in the same conditions.

With the weight so selected, it was necessary to select a thrust level less than full takeoff thrust for the F100 so that the thrust to weight (T/W) ratio was equivalent to that of the accident F28. The T/W ratios were matched for zero velocity. Fokker engineers indicated that thrust decay with speed of the F100 engine was similar to that of the F-28 engine. Thus, the acceleration of the dynamic model should have been similar to the F28.

The aerodynamic drag profiles of the aircraft were similar enough that it was felt that the data the dynamic simulation would provide would be representative since:

- Aerodynamic drag did not become a significant factor until roughly 80 knots during the takeoff roll.
- The exact characteristics of the icing contaminant being modelled were unknown but adjustment to the contaminant level would compensate for minor differences in the drag profiles.

An obvious concern was the use of the F100 wing in icing studies where wing profile was critical to the results. The Fokker F-100 wing has the same wing box section as the F-28 wing, however, the aerofoil section forward of the front spar has been redesigned. The wing planform has been changed and the wing tips extended and redesigned. The trailing edge flaps have a different camber to change the wing load distribution.

Although differences in wing section characteristics may have some effects as regards this study, the magnitude and nature of the effects due to severe ice/frost contaminant does not seem to be strongly dependent on the wing section in this class of jet transport aircraft. (See Section 1 - Aerodynamics)

The centre of gravity position of the F100 was set at 30% MAC to give the F100 the same rotation response to control as the F28 at 22%, the setting for the Dryden takeoff.

The F28 involved in the Dryden accident took off at a weight of approximately 63,500 lb plus the accumulated weight of the snow/ice. The aircraft had a static takeoff thrust level of 19,700 lb. total, assuming that the engines were functioning normally. The T/W ratio equalled 0.30 at this full takeoff thrust. The F100 in the simulation had a weight of 87,000 lb and a thrust level of 26,100 lb was selected so that the T/W ratio also equalled 0.30. The F100 weight was selected so that the stall speeds for clean wings were the same in both cases, 107 kt. In both cases, flap settings of 18 degrees were used.

Baseline Conditions

The baseline conditions for the dynamic simulation were established with clean wings and a dry runway. Takeoffs were accomplished in these conditions and the rotation point checked against witness reports of the accident to validate, roughly, the modelling of the F28.

The baseline simulation results correlated well, in general terms, with the F28 characteristics. In addition, these baseline runs gave the simulation pilot time to develop a feel for the simulator so that consistent rotation and handling techniques could be applied to all takeoffs.

Slush Modelling

The slush model depth was varied to determine the level of slush contaminant required to extend the takeoff roll to the distance reported by the witnesses.

Slush depth was varied from 0 to 0.45 inches in small steps. The additional takeoff distance was noted in each case and a slush depth of 0.15 inches selected as a baseline value for the simulation. This slush depth resulted in an increase in takeoff distance of approximately 500 feet, that is, of the same order as the excess take-off run reported by witnesses to the Dryden accident. It should be noted, however, that there is an additional component of extended takeoff roll which results from the icing contaminant on the wings requiring rotation to a higher pitch attitude prior to liftoff. This factor was considered later in the simulation.

Wing Contaminant Modelling

The wing contaminant was modeled by using the Fokker rough ice/snow simulation for the entire wing. The contaminant factor could be varied between 0 and 1.0. It should be carefully noted, however, that this factor is <u>not</u> equivalent to contaminant depth although it is so labelled on the plots provided by Fokker. The reason is that wing contaminants with different characteristics will result in very different performance of the wing at the same depth. In other words, a very thin layer of a very rough contaminant can result in a far greater performance loss than a thick layer of very smooth contaminant which follows the wing contour. It is sufficiently important a point that despite repetition it must be restated that *the FORM and POSITION of a wing contaminant is much more important than its thickness in considering wing performance.*

Hence, a better description of the contaminant factor would be to say that at levels above approximately 0.8, the aircraft would not fly off the runway at the speeds and in the conditions of the test. As a result, we worked with a variety of contaminant levels in the range of 0.5 to 0.80 which resulted in flight profiles which matched, in general terms, the accident profile.

The runs which most closely matched the profile described by witnesses at Dryden were achieved with a slush depth of 0.15 inches and a contaminant level of about 0.8.

Fokker's description of the wing ice simulation is quoted from page 3 of Warrink[7].

> *Ice on the wing is simulated as a change in lift-, drag- and pitching moment coefficient. The magnitude of it has been determined in the wind tunnel, in which one inch thick horn shaped ice on the leading edge was simulated. From tests with different ice shapes and from literature it is known that these effects are also valid for rime ice or frozen slush in the leading edge region. Through calculations in which static equilibrium conditions are determined the effect of 1 inch ice (in ground-effect) on lift, flight path angle and elevator deflection has been assessed. See figures 1, 2 and 3. In the simulation the effect of ice on the wing could be varied linearly between 0 and 1.0.*

Engine Failure On Take-off

A few take offs were flown during which an engine was failed just after rotation. Regardless of the contaminant level on the aircraft, directional control was not a problem. However, the contaminant level at which the aircraft was still able to liftoff and climb was significantly reduced. Successful takeoffs were accomplished at a contaminant factor of less than 0.5, and that level provided for minimal performance. It should be noted that the relationship between contaminant *level* and contaminant *thickness* is highly nonlinear, so that this should not be interpreted as meaning that the aircraft is able to carry half the contaminant load with an engine failure.

However, it was clear that the reduced thrust at rotation severely reduced the available performance margin and thus limited the aircraft's capability to carry any contaminant through a successful takeoff.

DYNAMIC SIMULATION HANDLING TECHNIQUES

Overview

A fundamental assumption made during the simulation exercise was that the pilots of the accident aircraft would have believed that their aircraft was flyable and would, therefore, have employed normal handling techniques. Therefore, for 'Dryden' simulations no special procedures or techniques were allowed which would have provided a better flight profile due to the simulator pilots' a priori knowledge of the external conditions being applied. Ad hoc experiments with off nominal techniques left no doubt that handling technique greatly affects the resulting flight profile in the presence of contamination. This observation was later confirmed by the off-line numerical modelling.

Handling technique in the context of this exercise includes the following:

- o Selection of rotation speed. A pilot who applied a speed increment above V_r prior to rotation would have a higher probability of a successful takeoff. The converse is also true.

- o Use of a lower rotation rate. A pilot who used a slower rotation rate would also have a higher probability of a successful takeoff.

- o Use of a partial rotation. A pilot who rotated the aircraft to the usual liftoff attitude and held it there rather than rotating further would also have a higher probability of a successful takeoff.

It is important to note that the above comments should not be interpreted as recommendations for aircraft handling in adverse conditions. The reason is that there are many other trade-off factors which are balanced out in any takeoff which these techniques may degrade. The only parameter being examined in this case is the specific question of whether, for the selected conditions at the planned speeds, this aircraft would fly.

The dynamic simulations were all flown by Mr. Wagner, a current B767 first officer with Air Canada, to preserve consistency in the handling of the simulation. The simulator flying was monitored by Mr. Morgan, an engineering test pilot with National Aeronautical Establishment. Techniques for flight control handling during different phases of the simulation were reviewed by the two pilots during the exercise to attempt to ensure that reasonable procedures were used at all times.

Flying Techniques and Methods

Each takeoff run was started from the threshold of the runway at zero velocity with the thrust already at planned takeoff power. The brakes were released and the takeoff roll commenced. No wind was simulated because in the Dryden accident, the wind was effectively calm.

The aircraft was accelerated to rotation speed with a very slight push force on the control wheel to ensure positive nosewheel steering. As rotation speed was reached, the rotation was initiated by use of nominal wheel pull force to achieve a rotation rate of approximately 3 degrees per second. The rotation attitude was limited to 18 degrees, somewhat higher than that for the F28, but appropriate for the Fokker 100 aircraft.

After the aircraft became airborne, the aircraft was accelerated to the reference V_2 speed plus a speed increment, depending on the configuration and conditions for the test run. The run was terminated at an altitude of about 400 feet above airport altitude or when the aircraft impacted with the ground during unsuccessful takeoff runs. Some takeoffs were also terminated after extended flight just above the terrain in ground effect where a successful climb-out could not be achieved.

All the data from each run were recorded by the simulation computer.

Flying Techniques During Contaminated Runway Takeoffs

For the contaminated runway takeoffs, normal control wheel inputs were used except for a few runs where the nose was raised about 2 to 3 degrees at about 80 knots to get the nosewheel out of the slush. This is a procedure specified in the F28 manual and was flown to determine what effect use of the technique could have had on the takeoff in this case.

The data from the runs were analyzed and it was found that raising the nosewheel to reduce slush drag had a measurable, but rather small effect, on takeoff distance. The difference was on the order of 100 feet.

Flying Techniques During Contaminated Wing Takeoffs

For contaminated wing takeoffs, normal control wheel rotation forces were used, even though the rotation rate that resulted was somewhat slower than with the clean wing model. This is because the contaminant had the effect of
increasing the nose down pitching moment of the wing therefore there was less excess nose up moment from the elevator to cause rotation.

As the contaminant levels were increased, numerous takeoff runs were flown where the stick shaker[5] actuated immediately on or just after liftoff. This was due to the significantly greater angles of attack achieved in these cases. It was judged that normal pilot technique would be to attempt to reduce the angle of attack to stop the stick shaker and nose down control wheel inputs were made accordingly. However, an attempt was made to maintain

---

[5] A 'stick shaker' is a warning device which vibrates the pilot's control column if the wing reaches a pre-determined angle of attack. Under normal operations this device warns against impending stall, and its onset is generally used to indicate the prudent limit of useable lift.

an aircraft attitude right at the edge of stick shaker activation. This is because it is believed that most pilots, in view of current training with respect to wind shear escape manoeuvres and ground school training, would expect to achieve close to maximum available lift at the point of stick shaker activation.

It should be noted that in cases of significant wing contamination, the wing can be well beyond the stalling angle of attack by the time the stick shaker activates. In essence, the stick shaker is responding to the normally expected maximum angle of attack of the clean wing. The stall warning system is not actually measuring stall and flow separation from the wing. Rather, it infers the onset of stall from the known performance of the wing and is programmed to activate at a fixed geometric angle of attack based on that knowledge.

Thus, the pilot flew many contaminated airfoil simulations in or near stick shaker. The simulation pilot worked hard to try to keep the aircraft at the edge of stick shaker and that is the reason that there is noticeable pitch oscillation on the recordings from those runs.

Flying Techniques During Engine Out Takeoffs

Normal pitch handling of the aircraft was used for the engine out takeoffs. In these cases, an engine was failed just at Vr and appropriate rudder inputs made by the pilot to ensure that the aircraft continued to track straight. Small roll inputs were required to correct any incipient rolling tendency in the aircraft due to any remaining yaw from the engine failure. The climb-out characteristics of the aircraft were conventional with the engine failure, except that, as described, only a limited wing contaminant load could be carried in these cases.

Summary of Dynamic Simulation Experience

The Dynamic Simulation data is presented in Fokker Report VS-28-25, Order Number 22192. This report summarizes the work done in the Fokker simulator between June 7th and June 8th, 1989.

The effect of varying runway slush depth was primarily reflected in increased takeoff run. There were some additional effects seen related to the ability of the aircraft to accelerate after rotation with the wing significantly contaminated. However, the slush effect was limited in its effect, in general terms, to increasing the takeoff run.

The effect of the wing contamination was to degrade the performance of the wing, the degree of degradation being a nonlinear function of the contaminant level.

A few principal effects were noted in this simulation.

1. As the wing contaminant level increased from zero, the aircraft's performance immediately reflected the fact by a reduction in climb performance.

2. At moderate levels of contaminant, the aircraft experienced stick shaker shortly after unstick and the profile after that point was related to the simulation pilot attempting to keep the aircraft right at the edge of stick shaker, 13 degrees angle of attack. It should be pointed out that for the contaminated wing, that angle of attack was already post stall in most of those cases. Climbing out of ground effect became impossible in many instances.

3. At critical levels of wing contaminant between 0.75 and 0.825, the aircraft was able to unstick and sometimes fly. However, as the aircraft climbed out of ground effect, the performance loss resulted in the aircraft descending, touching down again or crashing off the end of the runway.

4. In summary, as the contaminant level increased, the liftoff pitch attitude and airspeed (not rotation airspeed) had to be increased to provide adequate lift to unstick. Also, since increasing levels of contaminant decreased the stalling angle of attack, liftoff occurred closer and then beyond the true stalling angle of attack. Eventually, liftoff was occurring post stall (contaminated wing) or the aircraft stalled shortly after liftoff as it climbed out of ground effect. Successful flight with the wing contaminated at levels between 0.7 and 0.825 was effectively impossible using normal techniques. The profiles resulting from flight at these contaminant levels were, in general terms, close to the profile which is representative of the Dryden accident. (See figures 17 to 19 in the Fokker Report)

5. In cases where an engine was failed, the aircraft was not flyable with even moderate levels of contaminant. The drag increase due to the contaminant is so great that the thrust of only one powerplant is inadequate to carry even these moderate ice levels. The reason is that the high angles of attack required to generate adequate lift with the contaminated wing produces much higher drag levels. Post stall drag also is extremely high. The only way to get the aircraft to fly with the contaminant is to have enough thrust to accelerate to a high enough speed. However, the thrust level with one engine is inadequate to provide that acceleration.

F-28 FLIGHT DYNAMICS
SECTION 4

OFF-LINE MODELLING
INTRODUCTION

Subsequent to a visit to the manufacturer of the aircraft and man-in-the-loop ground based simulations carried out there (Section 2), off line modelling of the F-28 during take off was performed to examine both the normal take-off performance and the effects of runway and flying surface contamination. The purpose of the numerical simulations was to confirm observations made at the Fokker Establishment using a modified engineering simulation of the Fokker 100, a similar but not identical vehicle. This report outlines the methods used, approximations and extrapolations made and provides appropriate samples of the model output. Two models were developed simultaneously by Wagner in Montreal and Morgan in Ottawa. Their outputs were periodically checked one against the other and where differences were found the source was isolated and either corrected or, if conceptual or algorithmic, modified after consultation.

A secondary, but important, purpose of this section is to provide accountability for the theoretical engineering used in modelling the F-28 take-off. To that extent, the language used is, at times, quite technical and there is an extensive use of descriptive mathematics. For this, the author apologises to the lay reader, but it was felt to be imperative that the work which led to the conclusions presented here should be available for scrutiny by his peers.

DATA SOURCES

Three primary and two secondary data sources were used in building the off-line simulation. Aerodynamic and performance data were taken from the F-28 simulation data base provided by Fokker Aircraft[8] and from an internal Fokker wind tunnel study of the F-28 lift and drag characteristics when the flying surfaces were contaminated with artificial roughness. For cognitive pilot modelling through the rotation and immediately post lift-off, flight data were extracted from time histories of 21 previous take-offs flown in the actual aircraft involved in the Dryden accident (C-FONF), which were provided by the Engineering Branch of the CASB. Runway contamination was modelled using information published by NASA[9] and the Royal Aeronautical Establishment (UK)[10].

SITUATION OVERVIEW

Fokker F-28 C-FONF crashed into a treed area some 750 or so meters from the end of the runway at Dryden immediately after a take-off attempt. The aircraft struck trees at a height about one meter above the runway height at the lift-off end and subsequently cut a swath through the trees for a further 240 meters before coming to rest. The flight data recorder (FDR) suffered fire damage to the extent that no data were recoverable and eye witness reports are the only available source of information regarding the trajectory of the aircraft during the take-off run and prior to the crash. There was a general trend in the witness reports suggesting that the aircraft's wings were at least partially contaminated with slush or ice during the take-off attempt and there is additional information suggesting that the runway was to some extent or other contaminated with slush or wet snow at the time of the accident. The general tenor of the witness reports, together with the absence of ground markingsground markings between the runway end and the first point of impact suggests a sequence of events approximately thus:

> The aircraft, in an 18 degree flap configuration, commenced its take-off run from a normal position on the runway, achieved rotation speed somewhat further down than was normal and commenced a rotation. During the initial rotation the machine either became briefly airborne, or simply extended the oleos, and then settled back onto the runway, reducing its body angle somewhat. A second rotation very close to the end of the runway resulted in the aircraft becoming airborne but maintaining a very low altitude until striking the trees. Subsequent technical investigation has shown that at some time during the take-off attempt the wing flaps were extended from 18 to 25 degrees and that at the time of impact the undercarriage was in transit (neither fully down nor fully up).

The above general concept has, for modelling purposes been termed the 'Dryden Scenario'.

SCOPE OF MODELLING

Since it is clear that the aircraft did not gain significant altitude, the modelling task was greatly simplified. The change of flap setting was accounted for after the first rotation, while the change on overall drag coefficient due to in-transit undercarriage was so small that it was ignored. The take-off was treated as a three phase task, ground run, rotation and post lift-off, these being defined as follows:

> a: **Ground Run.** This was taken to be the phase from the start of the take-off, with the aircraft stationary at the end of the runway to the point at which the pilot commenced rotation into the pre-planned take-off attitude. Pilot intervention at this stage is not significant: with aircraft of this class it usually consists of maintaining a continuous forward pressure on the control column to ensure good nosewheel contact with the runway and hence good directional control by use of nosewheel steering.

> b: **Rotation.** This phase covers the time from the end of the ground run during which the aircraft is rotated in pitch with the object of permitting the wing to generate sufficient lift to raise the aircraft from the surface so that it becomes completely airborne. While the technique may vary somewhat between aircraft types, it is usual to rotate to a pre-set attitude and at a given rate, the aircraft generally becoming airborne as or shortly after the target attitude is achieved. Here pilot technique becomes of significance if the best performance of the wing is to be realised. The pitch rate used and the precision with which the target attitude is achieved can both influence the realisation of the optimum performance of the wing.

c: **Post Lift-Off.** This phase is here taken to mean the time between the aircraft becoming completely airborne from rotation to its either climbing out of ground-effect or settling back to the surface as the case may be. In developing the numerical model it became apparent that pilot technique was a vital ingredient during this phase of flight.

The aircraft has been continuously modelled through these three phases, however the rudimentary pilot cognitive model changes in reaction to the phase condition.

PILOT MODELLING AND AIRCRAFT DYNAMICS

Early experience during model development indicated that the results of the simulations were likely to be critically dependent on pilot technique, which supported observations made during the dynamic simulations. It was also thought desirable to explore alternate pilot control strategies in the case of badly contaminated flying surfaces. To these ends a rudimentary pilot cognitive model was built. That is, no attempt was made to model pilot compensatory or physiological characteristics, but provision was made for a variety of pilot behaviours, each resulting in a commanded pitch rate for the aircraft. The output from this section of the simulation was fed to a simple first order low-pass filter with a break point set at 1.5 radians/sec, roughly representative of the expected pitching response of an aircraft of this class at typical take-off speeds.

Pilot behaviour was modelled during two of the take-off phases, the rotation and the immediate post lift-off regime, as described below.

ROTATION

For the rotation, four representative behaviours were considered, these being:

a. **Normal.** A study of the time histories of 21 take-offs provided by the CASB indicated that the 'normal' or customary take-off rotation consisted of a fairly rapid rotation to about 10 degrees of pitch attitude, followed a short time later (about 1.5 seconds or so) by a further rotation to between 13 and 15 degrees of pitch. The latter increment in pitch attitude appears to be 'open loop' in nature as on a significant number of the take-offs recorded it was accompanied by a slight transient reduction in airspeed. This procedure was taken as the initial model. The take-off data available showed a mean pitch rate during the first stage of rotation of 3.81 deg/sec with a standard deviation of 0.76 deg/sec, the maximum value noted was 5.1 deg/sec and the minimum 2.9. The mean value was used in the model as a commanded pitch rate limit.

b. **Slow Rotation.** The structure of the rotation manoeuvre here is exactly the same as that described in paragraph a., with the exception that the limit on commanded pitch rate was set to 1.9 deg/sec, a half of the nominal value.

c. **Over-rotation.** This strategy was based on a consideration of typical pilot response when the aircraft unexpectedly fails to become airborne after the normal rotation to 10 degrees of pitch attitude. After a slight delay (1.5 seconds) the aircraft is further rotated in pitch to 12.0 degrees. Under normal circumstances, that is with an uncontaminated aircraft such a failure to fly at the normal attitude might be experienced if, say, the weight of the vehicle had been underestimated or an error had developed in the airspeed measuring system. In this case an increment in attitude *could* cause sufficient lift to be developed to achieve lift-off. In the case of the uncontaminated F28 the wing would still be operating below the maximum C_L and the drag penalty for the additional rotation would be small.

d. **The 'Dryden' Scenario.** Eye witness reports generally agree that the aircraft at Dryden was rotated twice, though whether or not it became temporarily airborne after the first rotation is uncertain. A significant number of the passenger witnesses remarked on a final power surge shortly before the machine became airborne close to the end of the runway. A basic scenario which answers to the preponderance of the witness reports was described on pages 1 and 2. For modelling purposes this was treated as a dynamic sequence with the aircraft being pitched nose down after the initial rotation either at a fixed rate or to an arbitrary attitude. The further flap extension to 25 degrees was modelled assuming that the crew selected the extension after having failed to become fully airborne at the first rotation: the extension was modelled at 1 degree per second with a linear interpolation of both lift and drag between the 18 degree and 25 degree conditions. While this set of motions meets the described aircraft motions and is, to an experienced pilot, a plausible set of pilot actions under these circumstances, *it can not be too strongly emphasised that this is conjecture, based, in the absence of factual knowledge, on an informed but judgemental interpretation of witness descriptions.*

POST LIFT-OFF

Following lift-off, three piloting options are provided, these being:

a. **Increment Pitch Attitude.** This mode was derived from a study of the time-histories of take-offs previously performed in the actual crash aircraft which suggest that an increase in pitch attitude immediately after lift-off is usual. Whether or not this is an habitual procedure or whether the pilot is at that time attempting to track airspeed is uncertain. For the majority of samples the airspeed is stagnant during this manoeuvre, but there were several cases where an airspeed loss was noted during the secondary rotation. The increment in pitch attitude by 3 degrees is again based on a survey of the data mentioned above. This procedure follows closely the approved procedure contained in the Fokker flight manual for the F-28.

b. **Constant Airspeed.** This is akin to a frequently used procedure for aircraft of this class, wherein the pilot, during initial climb, attempts to maintain the speed at which he broke ground plus a certain increment, the 10 knots used in the model being typical.

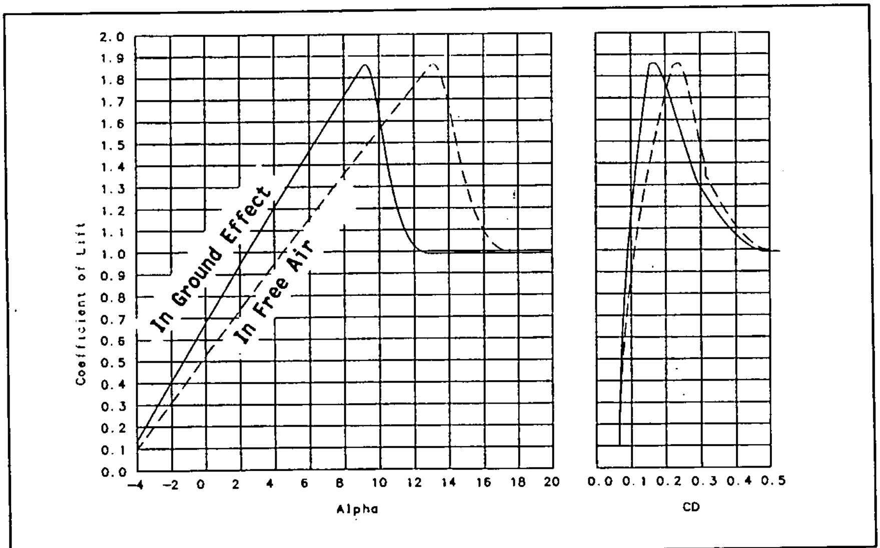


Figure 2: C_L and C_D for Clean Wing

c. **Constant Angle of Attack.** While not in the normal piloting repertoire, since the required information is not generally available in the cockpit, this probably represents the most efficient way of establishing an initial climb. It was included for performance limit comparisons only and is not intended to represent real pilot behaviour.

AERODYNAMIC MODELLING

Since, by its very nature, this investigation had to concentrate on stall and post-stall behaviour of the aircraft, great care was taken to achieve good modelling of the aircraft's characteristics in this region. Additionally it was necessary to model ground effect with some precision and to derive an intelligent estimate of the effects on both lift and drag of a wing contaminant. The model was developed using data from both Reference 1 and the Fokker wind-tunnel experiments. The procedure used in determining the clean wing characteristics in and out of ground effect was first to use curve fitting techniques to obtain the C_L/α curve for the 18 flap wing out of ground effect (OGE) and then to enter this curve using not the reference angle of attack, but an effective angle of attack based on the aircraft's height and a ground effect interpolation curve provided in Reference 1. The curve for angles lower than 13 degrees was taken directly from Reference 1, while the extended range was derived by interpolation from the wind tunnel data, maintaining the

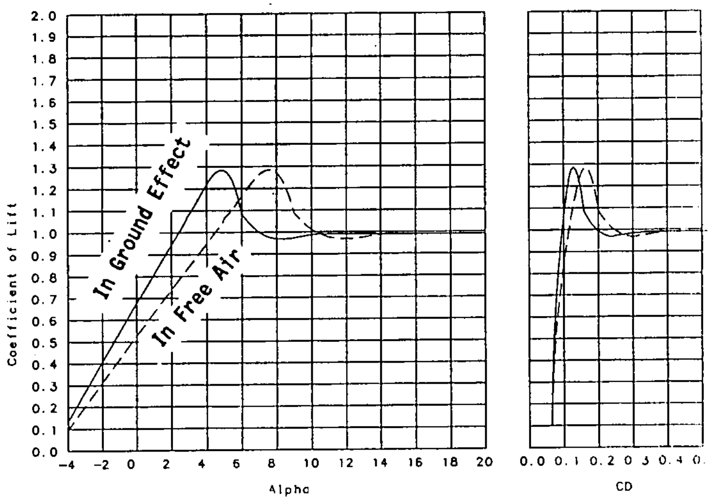


Figure 3: C_L and C_D for Contaminated Wing

form of the curve while reducing its magnitude to that anticipated for the 18 flap case. The resulting curves for the uncontaminated wing are shown in Figure 1. In modelling flap extensions to 25 a simple increment, again based on the data in Reference 1 was used.

The contaminated wing curve was derived from three sources, the clean wing curve for very low angles of attack, a plot of lift loss due to rime ice as given in Reference 1 and the wind tunnel data, using the same techniques as described above. The final curves used are at Figure 2. While this may appear to be a rather sparse data set on which to model a regime critical to the study, it has the merit of being fact based and applying specifically to the F-28 wing. Additionally, there is ample theoretical support for the form of the curves used and even their magnitude, particularly following Jones and Williams[11] and Cebeci[12]. Additional information derived from both wind tunnel and flight test was obtained from Zierten and Hill[13], although the research reported here referred to aircraft with leading edge high lift devices, the general trend and the specific references to stick shaker activation were of use.

Drag

An initial examination of the available F28 data indicated that drag would be critical to these simulations. Provided the wing is producing a reasonable value of C_L even when contaminated, then if the aircraft accelerates to a sufficiently high speed it will fly. If, however, the drag becomes so great that there is insufficient engine thrust to accelerate the aircraft after rotation, then such an event becomes impossible. For the take-off to be successful it is also necessary for the aircraft to accelerate when airborne to compensate for the reduction in C_L at a given angle of attack as the machine climbs out of ground effect. Drag curve estimates were again derived from a combination of data from the Fokker data base and the company's wind tunnel data. The effects of wing contamination came from the same sources. Figures 1 and 2 also show the drag polar plots used in the simulation and their relationship to C_L and α.

Degree of Wing Contamination

Since it is impossible to determine the exact form of the wing contamination present during the Dryden accident, it is taken that the wing is either contaminated beyond the critical condition or not. The evidence for this type of binary approach to critical contamination is strong. It was implied by Jones[14] 53 years ago and is amply supported by Abbott and Von Doenhoff[15] and Hoerner[16]. However, to permit gradations of contamination, it may be considered that part of the wing was contaminated and part was not. There is some witness support for this approach. This being accepted, the contamination coefficient used in the simulations simply interpolates the lifting capability of the wing on a proportional basis between the clean and contaminated conditions. This approach leads to a C_L/α curve with two distinct peaks for intermediate contamination conditions, which may or may not occur in reality but does indicate a reduced performance capability commensurate with that described by Wolters[17] and the previously cited works of Cebici and Zierten and Hill: this is considered to provide an adequate and realistic representation of performance degradation due to wing contamination.

Engine Failure

The Wagner model accounts for possible engine failure during the take off attempt, this is done for the sake of completeness, *not because there is any suspicion that the power plants behaved abnormally during this accident.* While there is a general agreement in the witness reports that there was a power increase shortly before the final lift off, very few suggest that a power reduction occurred during the take off. The professional pilot who was seated adjacent to the engine intakes did not report any power reduction. Engine failure was modelled by reducing the thrust instantly to approximately half of nominal, while adding the drag term corresponding to the ram drag of the failed engine and the required deflection of the rudder to maintain directional control.

MODEL RUN MATRIX

Once the modelling had been completed and validated (Section 5), a matrix of cases to be run was determined empirically. For all cases, the baseline configuration was a weight of 63,500 lb, full rated thrust, 18 degrees of flap and a V_r of 122.5 kt. The nominal rotation was an initial pitch rate of 3 deg/sec towards a target attitude of 10 degrees followed by a further rotation at 1 deg/sec to 13 degrees of pitch attitude after unstick, ie, following the preferred Fokker procedure. Thereafter, three parameters were varied as being of prime interest in this study, the depth of slush, the proportion of wing contamination and the selection of V_r. These runs were completed using both the nominal rotation technique described above and the 'Dryden Scenario' described at length earlier. Nominal (3 deg/sec) and a reduced (2 deg/sec) rotation rates were used for the initial rotation. The full set of conditions tested was:

a. **Slush Depth.** 0,0.1,0.2,0.3 and 0.4 inches.

b. **Contaminant Ratio.** 0 and 50 to 100 % in steps of 1%. When this resolution produced ambiguous results boundaries were defined by making special runs at finer resolution

c. **Rotate Speeds.** 117.5, 122.5 (nominal) and 127.5 kt.

d. **Rotation Rates.** 3 and 2 degrees/second.

PRESENTATION OF RESULTS

Initial plots, Figures 4 to 6 are presented to clarify some of the effects of flying surface and runway contamination described earlier. Figure 4 shows the effect of runway slush and wing contamination on the take-off distances to both rotation and lift-off. It can be seen that while the presence of slush changes the distance required to reach V_r significantly, wing contamination has very little effect, almost all the traces for distance to rotation overlay each other. This is definitely not so for the distance to lift off. As the level of wing contamination increases, the distance penalty to unstick increases quite rapidly due to the marked increase in drag produced by the contaminated wing at high angles of attack. This characteristic represents a situation in which the full extent of performance loss may not be apparent until the aircraft is rotated; prior to this the reduction in acceleration is little more than could be attributed to a slush layer. Figure 5 is presented to indicate the reasons for this effect. It shows that as contamination level increases, even in the absence of slush, the distance the aircraft has to travel between V_r and the unstick point increases only slowly until a dramatic 'knee' is reached (numerically at just over 0.6 contamination ratio). This is coincident with the aircraft being at or beyond C_{Lmax} for the contaminated wing at its rotation angle of 10 degrees and having to generate the necessary lift by increasing speed rather than C_L. The low acceleration rates available once the drag rise caused by wing contamination has been encountered mean that excessive distance has to be consumed for this to occur. A secondary effect can be seen in the same figure by examining the trace of Theta (body angle). At first moderate increases for Theta at lift off are enough to compensate for the loss of C_L due to contamination, but a point is reached, at about 0.58 contamination ratio, when the rate of increase in theta steepens noticeably. This is related to the reduced lifting capability of the wing as indicated earlier in Figure 2.

The next two plots in this section represent the crux of this investigation. They show that it is possible to define two boundary conditions in terms of combinations of slush depth and contamination factor which can both lead to catastrophic results of attempted take-offs. A *boundary condition* here means a continuous relationship between level of contamination and runway slush depth which represents the dividing line between a successful take-off or not, as illustrated in Figure 3. In both Figures 6 and 7, several boundaries are shown for varying conditions of V_r and rotation rate, these should be individually interpreted according to Figure 3.

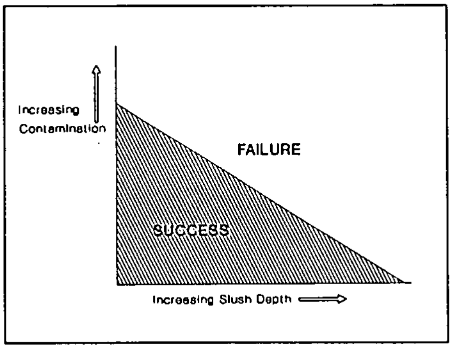


Figure 3: A Boundary Condition Plot

Figure 6 indicates a boundaries for a condition in which the aircraft will simply fail, in the distance available, to leave the ground and will run off the end of the runway. It also shows that any reduction in the rotation speed will have an adverse effect on the available performance. At somewhat lesser levels of both factors, another boundary was found to exist, defining a condition wherein the aircraft would at first leave the runway, but fail to climb out of ground effect and settle back to the surface (Figure 7). This boundary existed for all conditions of rotation speed and rotation rate tested, and is annotated to indicate the effects of varying the various aircraft handling parameters on the placement of the boundary. When this condition was met it was possible, by making subtle changes in the assumed pilot control strategy after the initial lift off (eg, rate of pitch, response to stick shaker) to cause the model to fly for considerable distances at very low altitudes, but it was not possible to make it fly except by assuming extremes in pilot behaviour.

The final sets of Figures provided with this section are intended to illustrate the effects and observations made earlier in the text. Figure 8, a,b and c shows the overall effects of increasing contamination factor in a gross way. The rotation speed here was 122.5 kt and slush depth 0.25 in. At 65% contamination the aircraft flies away normally, at 68% the machine sinks following the initial lift off, due both to the loss of lift with height and the pilot's reaction to stick shaker, but then climb away. Note that the scale of the height trace is such that at 6500 feet (500 feet beyond the end of the runway) the aircraft is still only at 10 feet. In 7c, contamination now being set at 69% the aircraft returns to the runway and subsequently runs off the end. The series in Figure 9 a,b and c shows that fine graduation of the contaminant level creates subtle differences in the aircraft responses. This set of plots refers to a much shallower slush layer (0.1 in) and an incremented rotation speed of 127.5 kt. Figure 9a indicates that at 82.3% contamination the aircraft flies away despite two bursts of stick shaker, while by the time contamination is at 82.4% the machine never exceeds about 5 ft, eventually returning to the surface some 1100 feet beyond the end of the runway. When there is 0.1% additional contamination the result is a short hop and an over-run. Finally, Figure 10 a and b demonstrate the remarkable sensitivity to assumed pilot behaviour noted earlier. The only difference in these two runs is that the angle to which the aircraft is un-rotated following the initial hop is two degrees lower in 9b than 9a, the latter strategy resulting in a second lift-off and climb out and this at a very high level of contamination.

The implication of the results presented here, especially the two sets of boundary conditions, is that there exist a combination of values of slush depth and wing contamination which can cause aircraft trajectories of the type described by witnesses to the Dryden accident.

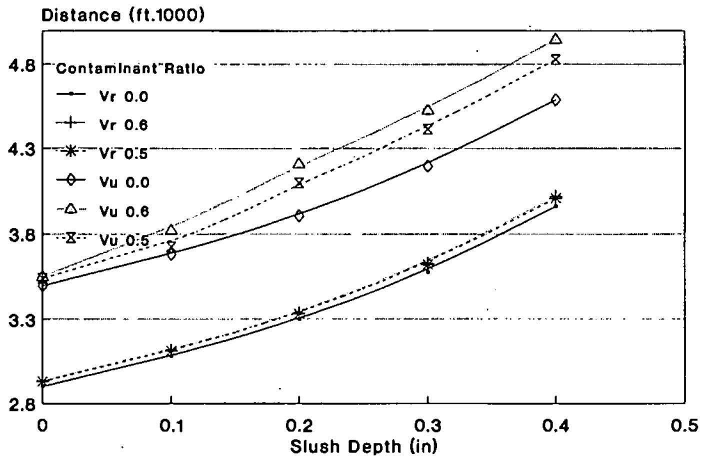


Figure 4 Effect of Contamination and Slush on the Distance Required to Reach V_r and V_u

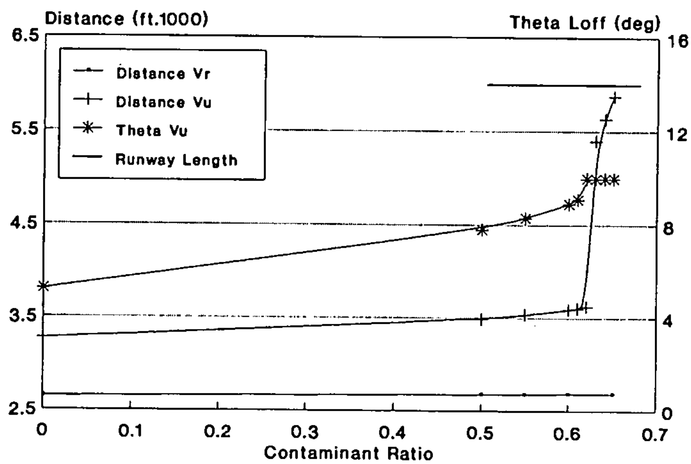


Figure 5 Effect of Wing Contamination on Distance Required To Reach V_r and V_u Illustrating the 'Knee' Effect at Limiting Body Angle

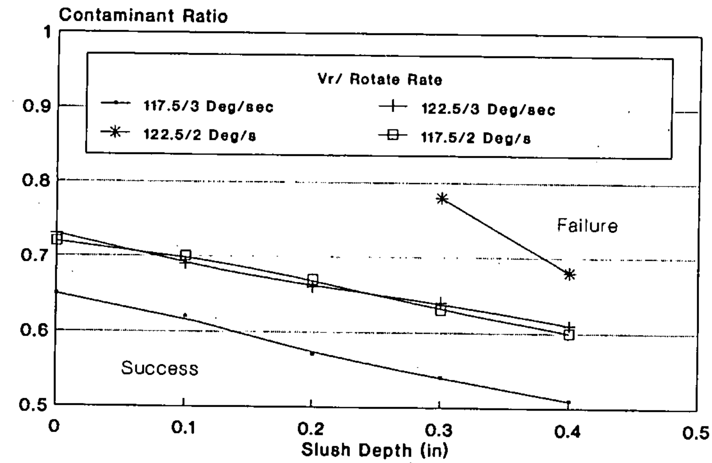


Figure 6 Various Boundary Plots at Different Values of V_r and Rotation Rate for Overrun Case

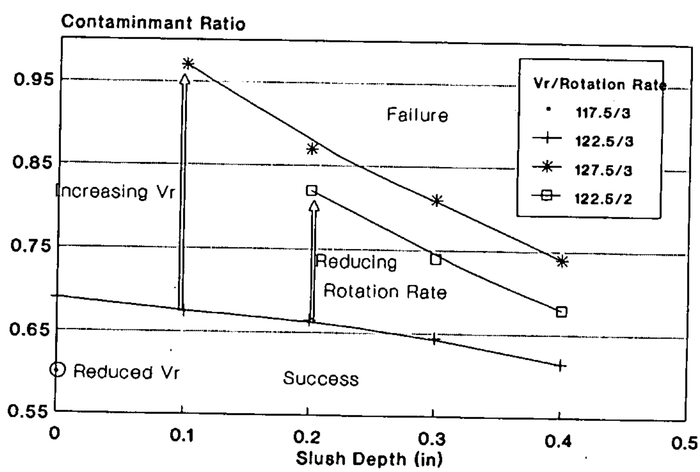


Figure 7 Various Boundary Plots for the 'Bounce' Case

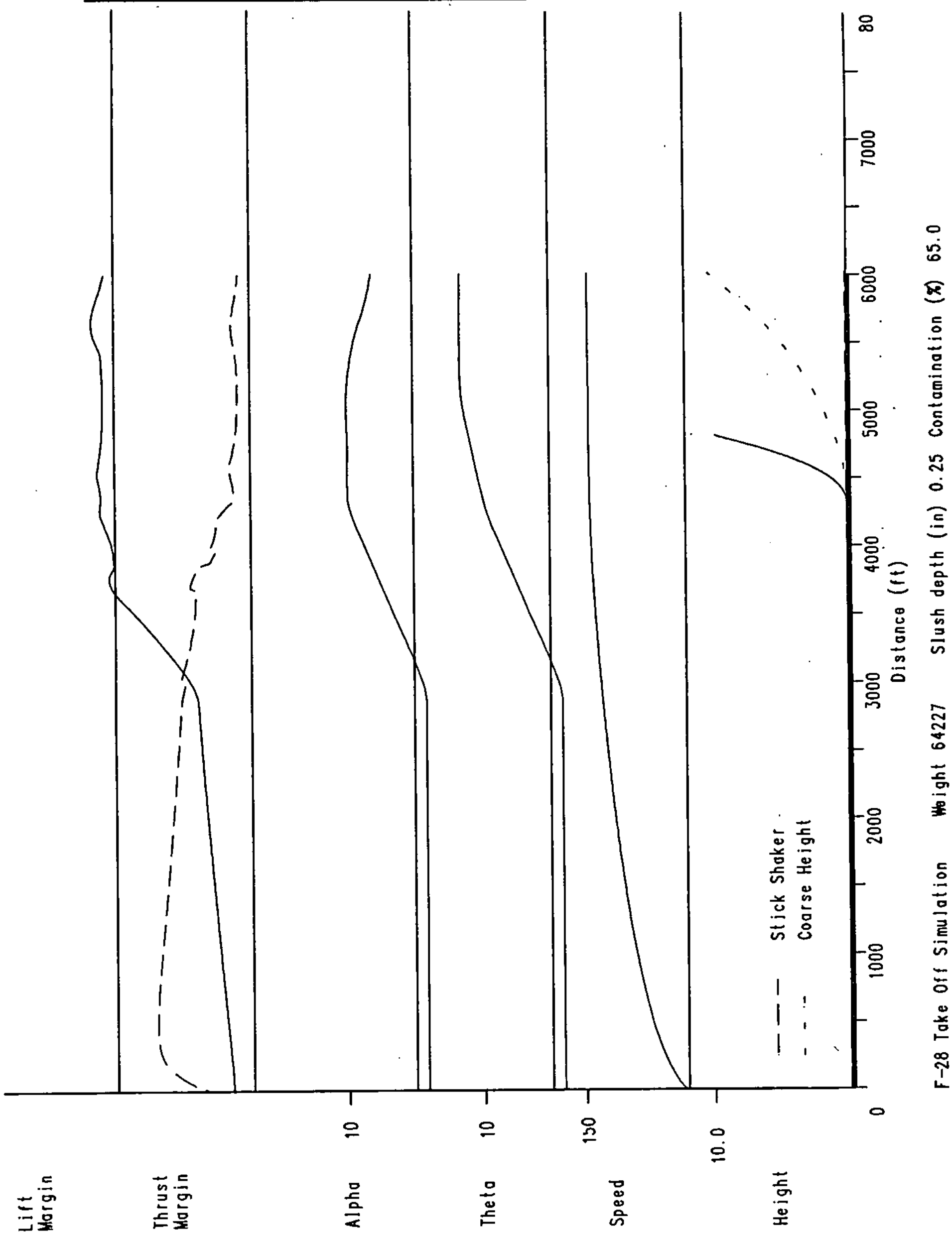


Figure 8a Successful Take-Off

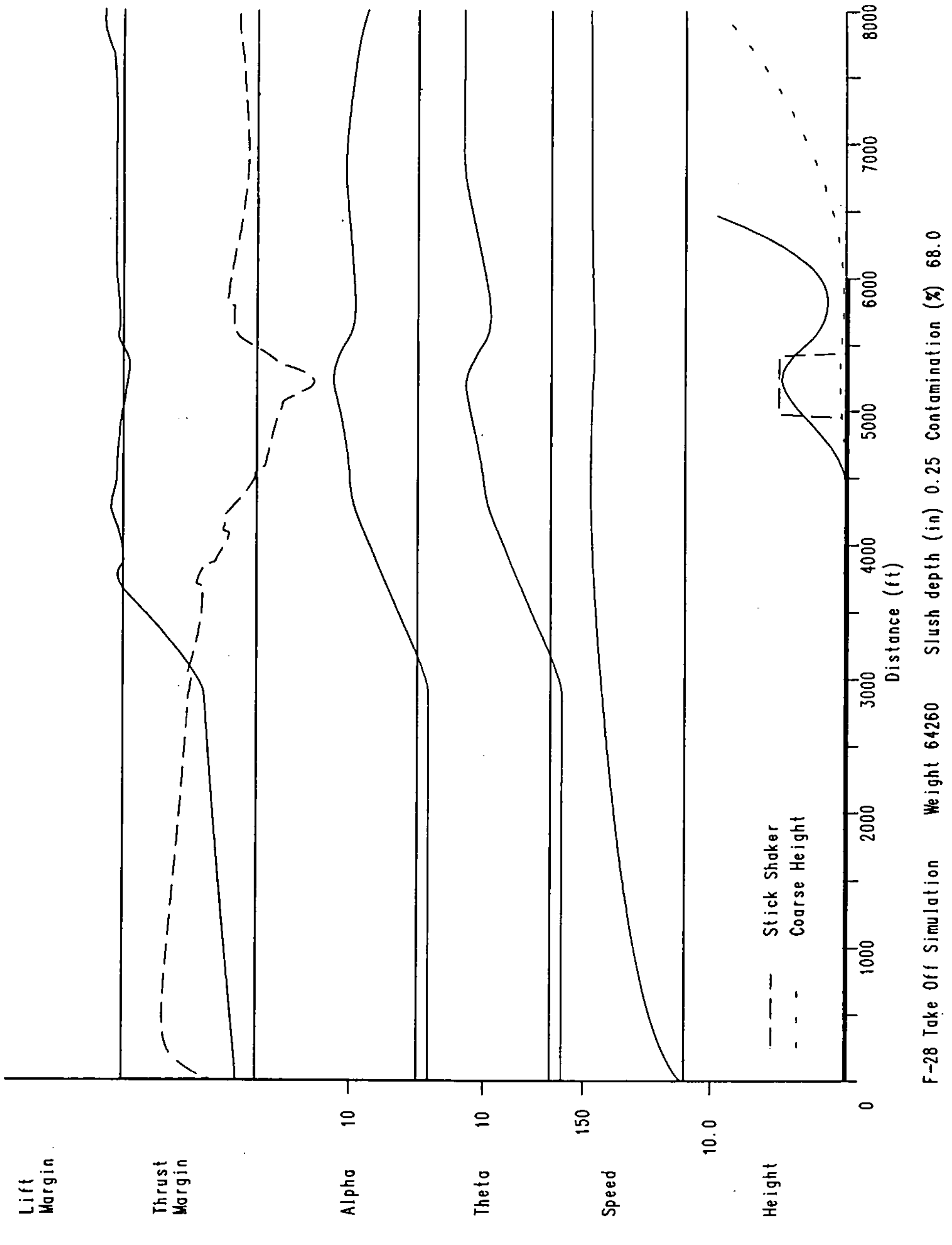


Figure 8b Marginal Take-Off

F-28 FLIGHT DYNAMICS Section 4 - Mathematical Modelling Page 80

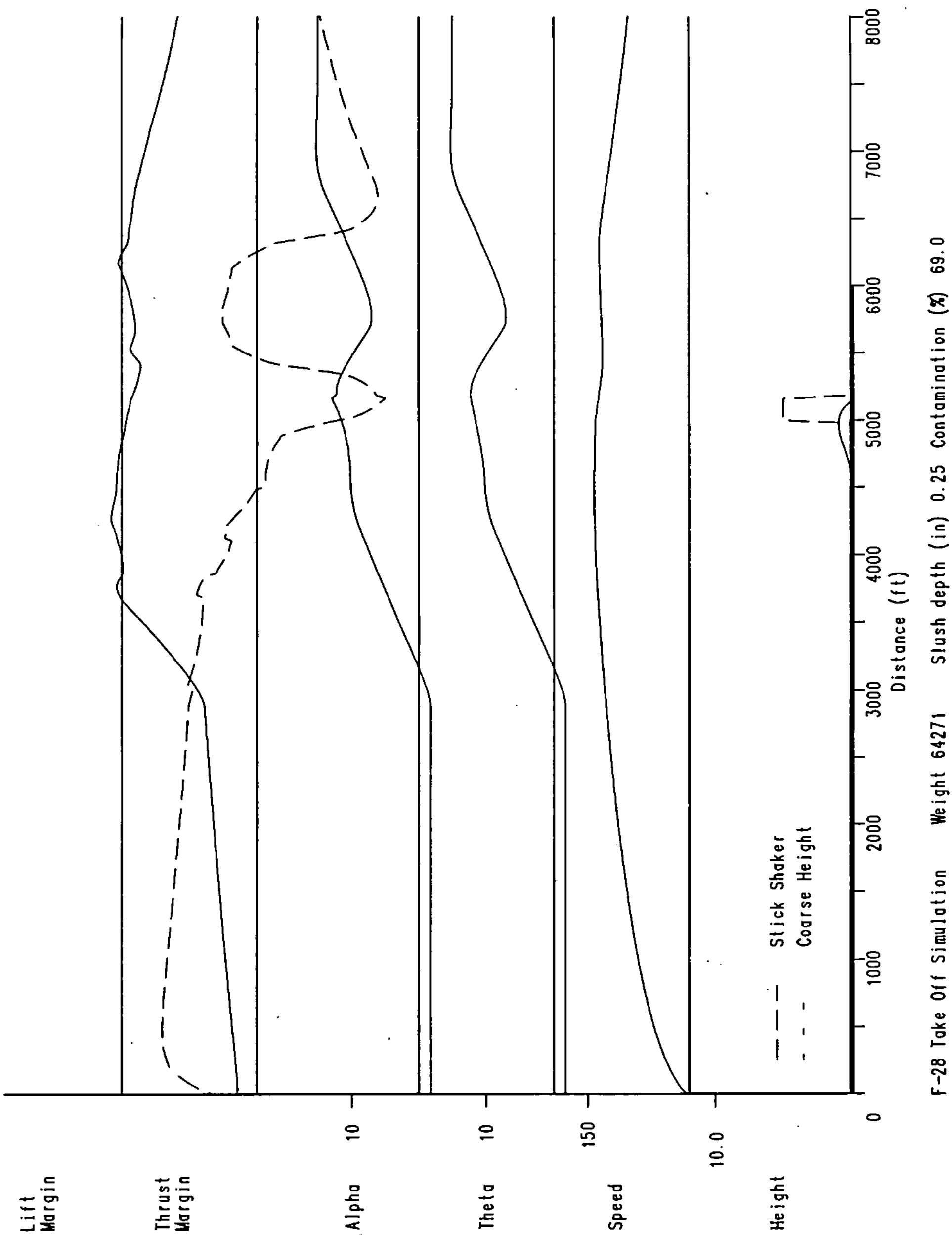


Figure 8c Unsuccessful Take-Off

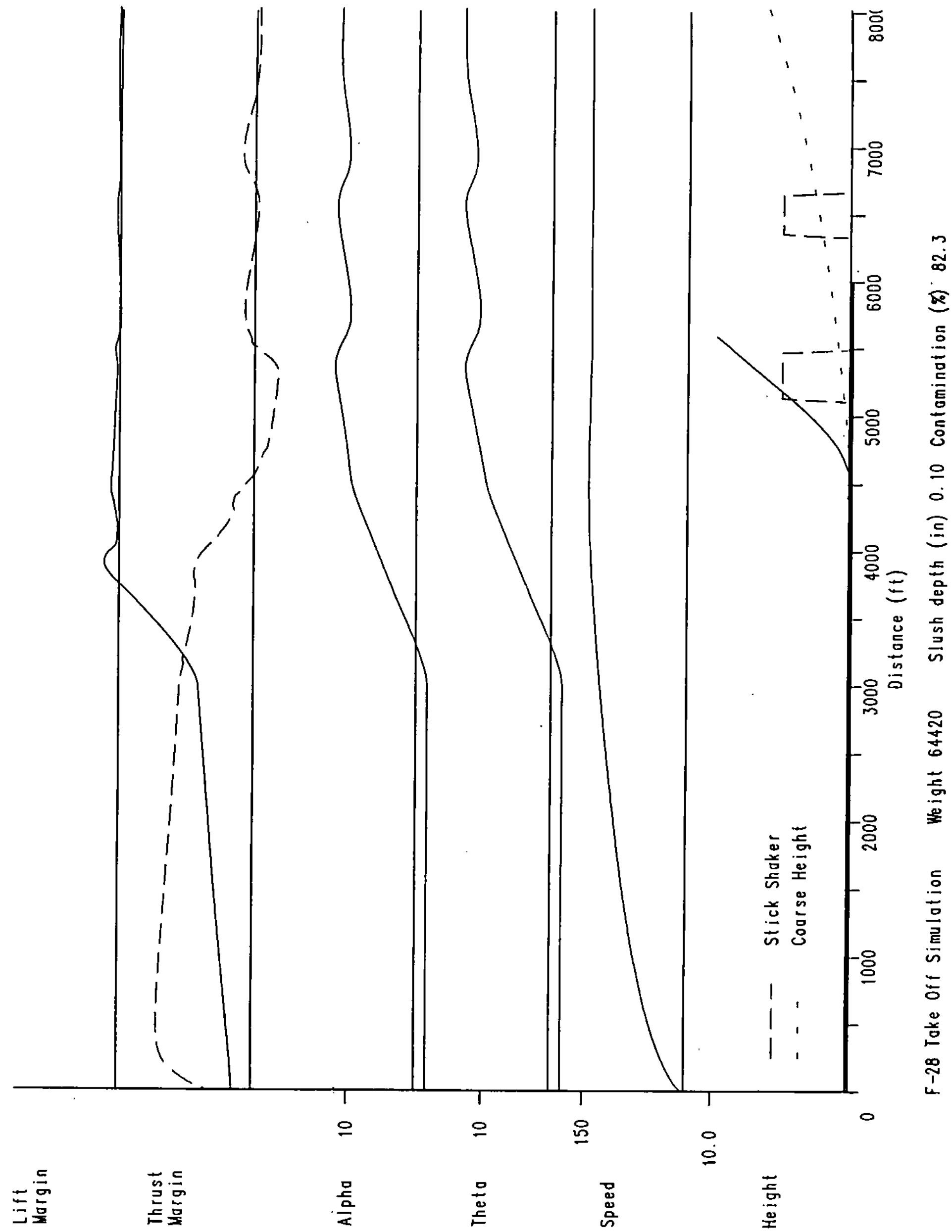


Figure 9a Successful Take-Off at 82.3% Contamination

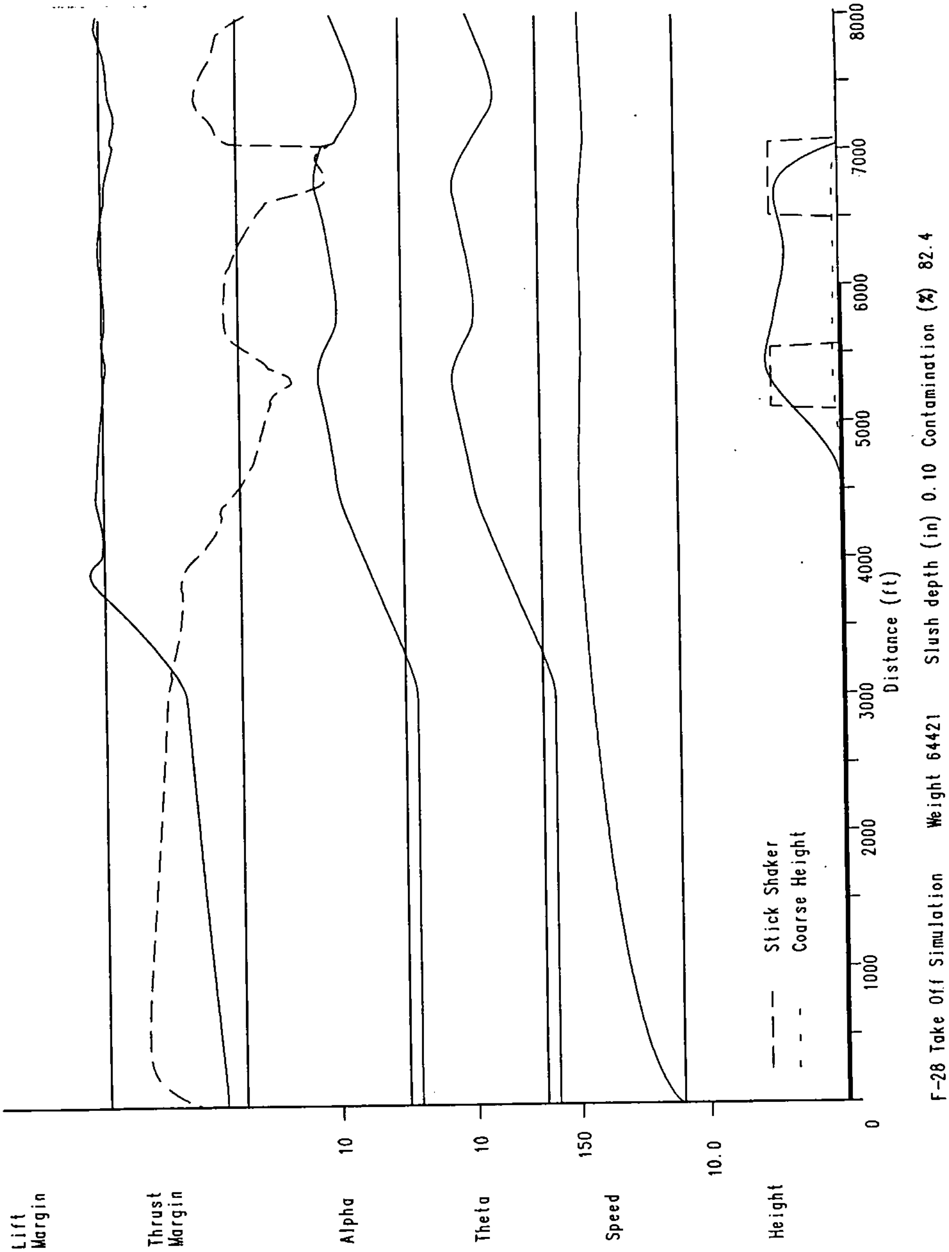


Figure 9b Unsuccessful Take-Off at 82.4 % Contamination, Identical Technique The Aircraft Flew over 2400 feet before Crash

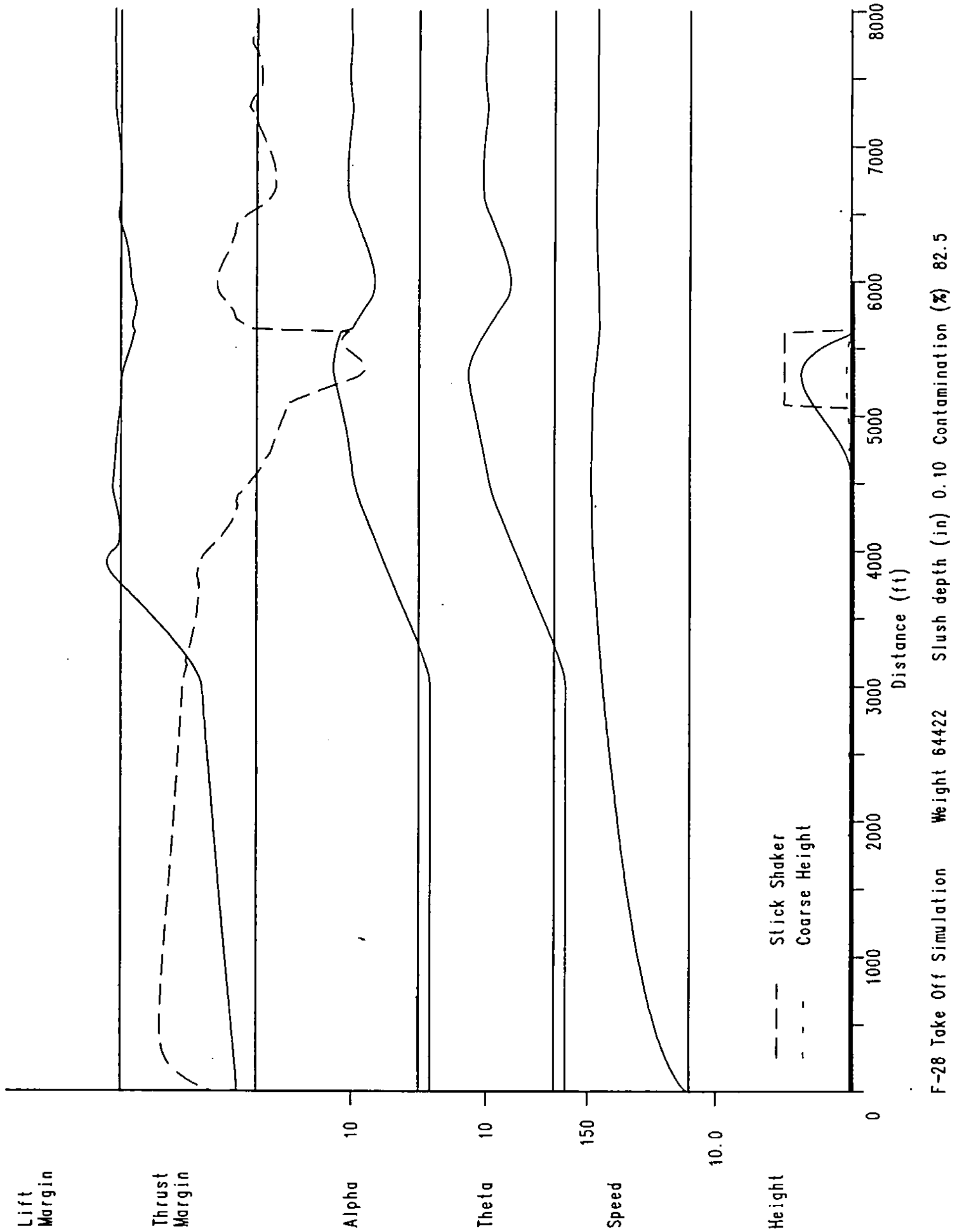


Figure 9c At 82.5% Contamination the Take-Off Becomes a Short Hop and Runway Overrun

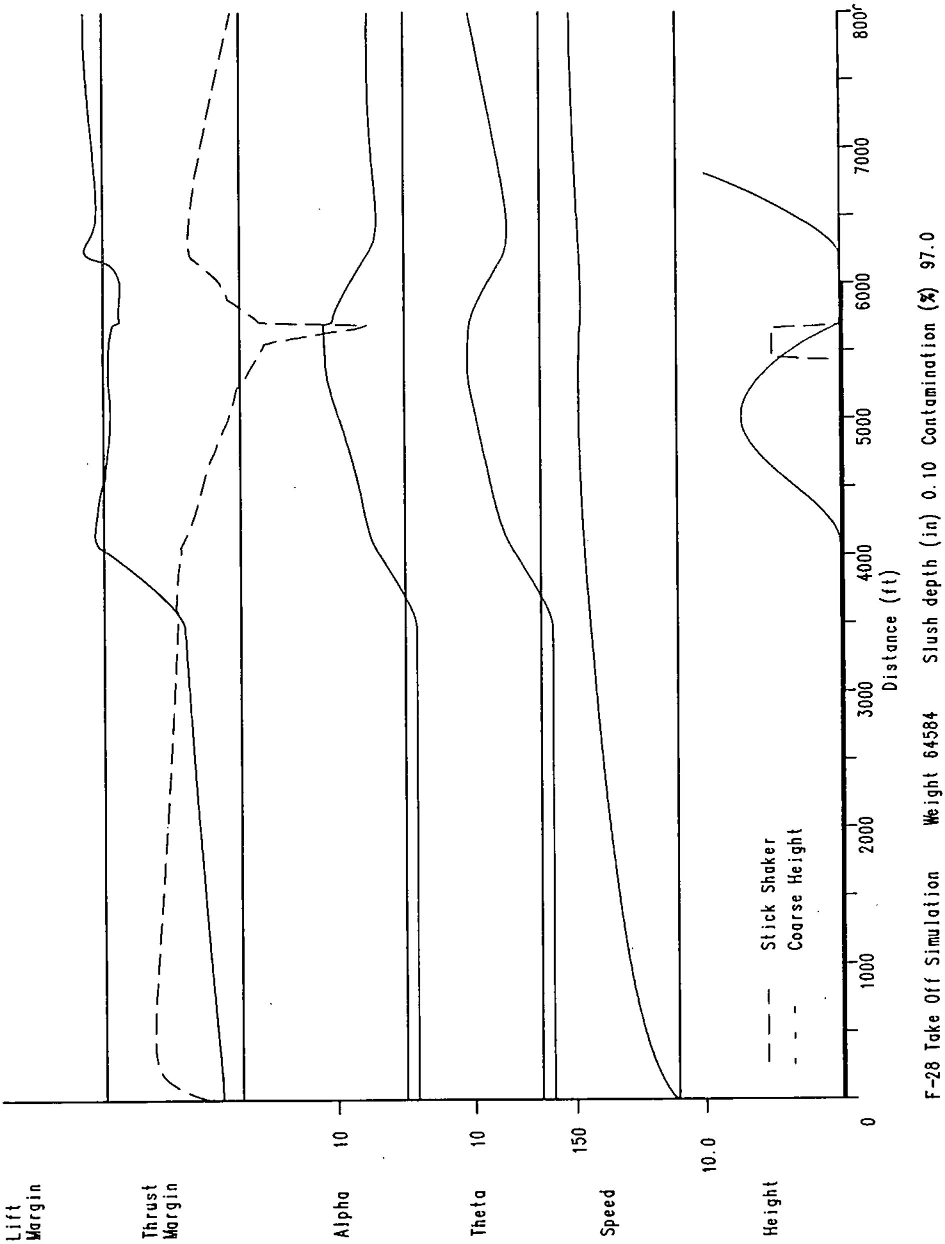


Figure 10a Second Lift-Off Following Hop

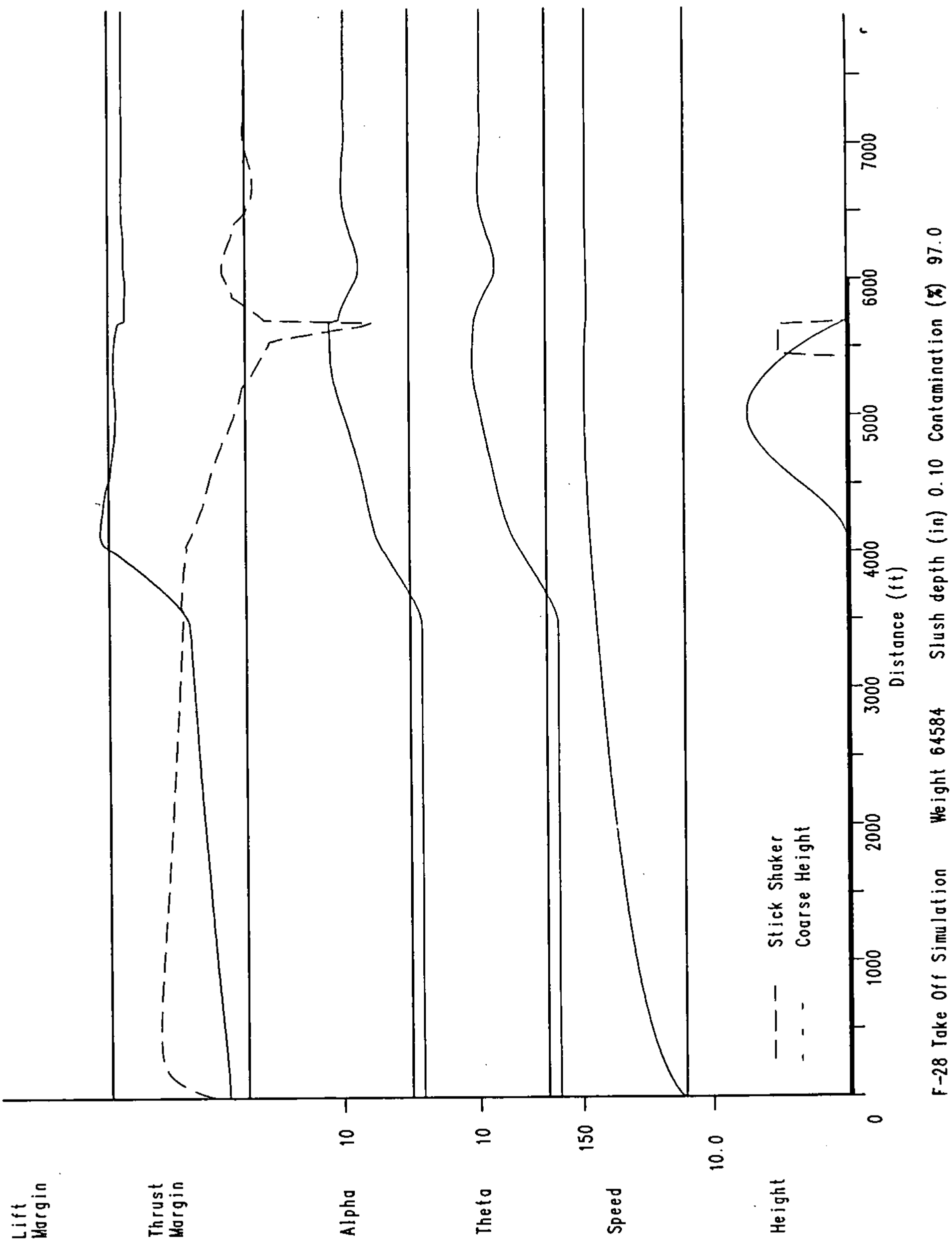


Figure 10b Slight Change in Technique Causes Overrun

APPENDIX A TO SECTION 4
NUMERICAL MODEL STATEMENTS

SYMBOL TABLE

C_L	Coefficient of Lift, complete aircraft, flap 18
C_{Lc}	As above for fully contaminated wing
C_{Lw}	Effective C_L sample wing with contaminant
C_D	Coefficient of drag uncontaminated wing
δC_D	Increment in C_D due to wing contamination
C_{Dw}	Effective C_D for sample wing with contaminant
c	Wing contamination factor (0 to 1.0)
d	Depth of runway contaminant (in)
D	Drag (lb force)
e	The Naperian constant
h	height (feet)
K_{ge}	Ground effect interpolation parameter
L	Lift (lb force)
m	mass (lb)
q_a	dynamic pressure of atmosphere ($\frac{1}{2}\rho V^2$ psf)
q_s	dynamic pressure of slush (psf)
q	body pitch rate (deg/sec)
s	the Laplace operator
t	time
t_0	reference time
T	Engine thrust (lb force)
u	velocity along body axis X
V	total velocity (ft/sec)
V_r	Planned rotation speed
W	Weight (lb force)
δW	Weight increase due to contaminant
w	velocity along body axis Z
w	width of wheel tyre
α	angle of attack (referenced to fuselage) degrees
λ	flight path angle (degrees)
δ	static depression of tires
ϵ	error
Θ	pitch attitude (degrees)
ρ	Air density

Subscripts

a	aerodynamic
b	body
c	commanded
e	effective

n	iteration cycle
max	maximum value
main	pertaining to mainwheel
nose	pertaining to nosewheel
ref	reference value at moment of lift-off
s	slush
T	true
tot	total
0	reference value (in context)

ADJUST WEIGHT FOR CONTAMINANT

(This assumes an even coating of contaminant of specific gravity 0.85 covering the contaminated proportion of all horizontal surfaces to a depth of 0.3 in. Contaminant on the fuselage is not considered.)

$$\delta W = 1117c$$

$$W = W + \delta W$$

AERODYNAMIC COEFFICIENTS

Obtain C_L and C_D for pertaining conditions

Note: C_L and C_D are computed by curve fitting from data provided in the Fokker simulation data base for the 18 degrees of flap Out of Ground Effect (OGE) case. The curves for In Ground Effect are computed by calculating an α_e (alpha effective) based on the displacement of C_{Lmax} in and out of ground effect and noting that C_{L0} for the F28 is at -5.3 degrees, α_e is a function of the ground effect interpolation parameter thus:

$$K_{ge} = e^{-0.11h} \quad \text{(Approximation of Fokker parameter)}$$

$$\alpha_e = (\alpha + 5.3)(1 + 0.27K_{ge}) - 5.3 \quad | \quad \alpha_e \le 19.9 \text{ (arbitrary limit)}$$

Compute C_L

1.1 $\alpha_e < 13.0$

$$C_L = 0.52508 + 0.10672\alpha_e - 0.0003387\alpha_e^2$$

1.2 $13.0 \le \alpha_e < 15.0$

$$C_L = -235.18 + 50.024\alpha_e - 3.4957\alpha_e^2 + 0.08097\alpha_e^3$$

1.3 $\alpha_e \ge 15.0$

$$C_L = 60.6598 - 9.7969\alpha_e + 0.53588\alpha_e^2 - 0.0097648\alpha_e^3$$

1.4 $\alpha_e > 17.5$

$$C_L = 0.99$$

For the fully contaminated wing, a parameter C_{Lc} is computed thus:

2.1 $\alpha_e < 5.0$

$$C_{Lc} = C_L$$

2.2 $5.0 \leq \alpha_e < 9.0$

$$C_{Lc} = 3.8156 - 1.5516\alpha_e + 0.27697\alpha_e^2$$

2.3 $9.0 \leq \alpha_e < 15.0$

$$C_{Lc} = 5.5399 - 1.0486\alpha_e + 0.079142\alpha_e^2 - 0.0019817\alpha_e^3$$

2.4 $\alpha_e \geq 15.0$

$$CLc = 0.99$$

Combining these two coefficients:

$$C_{Lw} = C_L - c(C_L - C_{Lc})$$

To evaluated C_{Dw} the procedure to compute C_D is:

3.1 $\alpha_e \leq 13.0$

$$C_D = 0.0405 + 0.0235 + (0.04760 - 0.2K_{ge})C_{Lw}^2$$

3.2 $13.0 < \alpha_e \leq 14.9$

$$C_D = 0.46097 - 0.072393\alpha_e + 0.0042269\alpha_e^2$$

3.3 $\alpha_e > 14.9$

$$C_D = -3.5630 + 0.42198\alpha_e - 0.01086\alpha_e^2$$

For the contaminated wing a value for δC_D is computed by table look-up and linear interpolation and the value

$$C_{Dw} = C_D + c\delta C_D$$

is evaluated

FLUID DYNAMIC FORCES

$L = C_{Lw} q_a S$

$D_a = C_{Dw} q_a S$

$D_W = 0.2(L - W)$

if $h > 0.0$ $D_W = 0.0$

Compute Slush Drag

$D_S = C_{DS} q_s d f(w)$

$f(w) = 2w\surd[(\delta + d)/w - ((\delta + d)/w)^2]$

$\delta nose = 2.1(W - L)/W$

$\delta_{main} = 2.4(W - L)/W$

$D_{Stot} = 4D_{Smain} + 2D_{Snose}$

if $\Theta > \Theta_0 + 1$

$D_{Stot} = 4D_{Smain}$

Total drag

$D_{tot} = D_a + D_W + D_S$

Engine Thrust

$T = 19592. - 17.75(V_T/1.69)$

PILOT MODELLING

GROUND RUN

$q_b = q_c = 0.0$

$\Theta_0 = -2.0$

ROTATION (Commences when $V_T > V_r$)

Normal

$\theta_c = 10.0$

$\epsilon_\theta = \theta_c - \theta$

$q_c = \epsilon_\theta \mid 3.81 \geq q_c$

Slow

$q_c = \epsilon_\theta \mid 1.9 \geq q_c$

Overrotate

if $(\theta \geq 10.0).(q_c = 0.0)$ $t_0 = t$

rotate as normal

if $(t - t_0) \geq 1.5$ $\theta_c = 12.0$

POST UNSTICK

if $(h_n > 0.0).(h_{n-1} = 0.0)$

$\alpha_{ref} = \alpha$

$V_{ref} = V_T$

Constant alpha

$\epsilon_\theta = \alpha_{ref} - \alpha$

$q_c = \epsilon_\theta$

Normal (increment Theta)

$\theta_c = 13.0$

$q_c = \theta_c - \theta$

Constant Speed

$\epsilon_\theta = V_T - V_{ref}$

$$q_c = 0.5\epsilon_\Theta$$

RESPONSE TO STICK SHAKER

The stick shaker response assumes a 0.8 second delay in reaction to onset (assuming 0.5 second recognition time and 0.3 seconds neuromuscular delay) but only 0.4 seconds delay to termination, assuming a 0.1 second recognition delay for an alerted pilot.

if $\alpha \geq 11.4$ ssk TRUE

if $(ssk_n = \text{TRUE}).(ssk_{n\text{-}9} = \text{TRUE})\ q_c = -2.0$

if $(ssk_{n\text{-}5} = \text{FALSE})\ q_c = q_c$

ALL CASES (The aircraft is not permitted to decelerate without pilot intervention)

if $(V_{i(n)} < V_{i(n-1)})\cdot(q_c > 0.0)\ q_c = -0.5$

ROTATIONAL EQUATIONS

$$\frac{q_b}{q_c} = \frac{1.5}{(s + 1.5)}$$

$$\Theta = \int q_b dt + \Theta_0$$

$$\lambda = \mathrm{Tan}^{-1}(\dot{h}/\dot{x})$$

$$\alpha = \Theta - \lambda$$

KINEMATIC EQUATIONS IN BODY AXES

$$m = W/32.18$$

$$\dot{u} = (T + L\mathrm{Sin}(\alpha) - D\mathrm{Cos}(\alpha) - W\mathrm{Sin}(\Theta))/m - qw$$

$$\dot{w} = (L\mathrm{Cos}(\alpha) + D\mathrm{sin}(\alpha) - W\mathrm{Cos}(\Theta))/m + qu$$

$$u = \int \dot{u} dt$$

$$w = \int \dot{w} dt$$

$$V_T = \sqrt{(u^2 + w^2)}$$

$$\dot{x} = u\mathrm{Cos}(\Theta) + w\mathrm{Sin}(\Theta)$$

$$d = \int \dot{x} dt$$

$$\dot{z} = w\mathrm{Cos}(\Theta) - u\mathrm{Sin}(\Theta)$$

$$\dot{h} = -\dot{z}$$

$$h = \int \dot{h}dt$$

Note: in all cases

$\int xdt$ is approximated as $\Sigma(x_{(n-1)} + x_{(n)})/2 \ \delta t$

where $\delta t = 0.1$ secs

F-28 FLIGHT DYNAMICS
SECTION 5

FOKKER F-28 MODELLING VALIDATION

INTRODUCTION

As a part of the investigation into the accident involving Fokker F-28 C-FONF at Dryden airport, an off-line computer model was constructed to investigate the effects of aircraft and runway contaminants on the take-off performance of this aircraft. The model was based on a simulation data base provided by the manufacturer. At the same time, actual Flight Data Recorder (FDR) records were available covering some 21 take-offs of this specific aircraft during the month of February 1989 (the accident occurred in March).

Since the FDR was destroyed in the crash and there are, therefore no numerical data available concerning the aircraft's trajectory prior to impact, it was felt to be of prime importance that the model used in the investigation be validated as rigorously as possible. To this end, the existing FDR records were analysed and compared with the model outputs for the same sets of conditions. Generally there was very close agreement once one minor adjustment to the model had been made; this will be described in detail in a following section.

FLIGHT DATA RECORDER DATA

To use the existing FDR data to validate the simulation, it was first necessary to confirm the internal consistency of the FDR records and then to develop a sense of their quality or accuracy. Four of the FDR parameters were of prime interest in determining the runway performance of the aircraft, these being:

Indicated Airspeed (IAS) [kt]
Thrust [%]
Pitch Attitude (Θ)[deg]
Longitudinal Acceleration (A_x) ['g' units]

For each take-off, the aircraft weight, airport elevation, ambient temperature and prevailing wind were known.

The Relationships

The relationships among the above parameters can be quite complex if the aircraft is permitted to enjoy all of its degrees of freedom so to simplify the analytical processes only the take-off ground roll up to, but not including rotation, was used in this exercise. This effectively constrains the aircraft in the pitch, roll and yaw rotational freedoms and permits simpler linear comparisons to be used in testing for mutual consistency. In this condition, the relationships may be expressed thus:

$$\ddot{x} = (A_x - \mathrm{Sin}(\Theta))g \qquad (1)$$

$$V = \int \ddot{x}\, dt \qquad (2)$$

$$V_i = V\sqrt{\sigma} + V_w \qquad (3)$$

$$V = (V_i - V_w)/\sqrt{\sigma} \qquad (4)$$

$$\ddot{x} = T_{net}/\mathrm{Weight} \qquad (5)$$

$$T_{net} = \mathrm{Thrust} - \mathrm{Drag} \qquad (6)$$

Where $\ddot{x}$ is the acceleration along the runway, 'g' the acceleration due to gravity, V_i the equivalent airspeed (closely related to, but not identical with IAS), V is true inertial speed relative to the earth, V_w the component of wind along the aircraft's longitudinal axis, positive for a headwind, σ the relative density of the atmosphere and T_{net} the net thrust. These equations offer sufficient redundancy to permit a recursive approach towards validation to be effective. It is accepted that Equation (1) is an approximation, and should read, in its full form

$$\ddot{x}/g = (A_x - \mathrm{Sin}(\Theta))\cdot\mathrm{Cos}(\Theta) - (A_z + \mathrm{Cos}(\Theta)\mathrm{Cos}(\Phi))\cdot\mathrm{Sin}(\Theta)$$

(where A_z is the body axis vertical acceleration and Φ the angle of bank) the restricted range of Θ while on the runway (from -2 to .5 degrees) makes the second term so small, and Cos(Θ) so close to unity that the approximation is justified in the interests of simplicity.

Interpreting FDR Records

The most difficult of the FDR parameters with which to deal was the one named Thrust, which was expressed as a percentage, but for which we had no a priori relationship to the thrust being developed by the engines. Since during normal take-offs the thrust was applied slowly (up to 10 seconds at times) it was critical not only to understand the relationship between the recorded parameter and actual thrust, but also to make the model capable of accepting the same schedules of thrust application as the aircraft for each take-off. It was also noted that the Thrust parameter reached different maximum values for each take-off.

To obtain a relationship between the Thrust parameter and actual thrust, an assumption was made that each take-off was performed using normal take-off thrust, ie, 19,500 lb force. The FDR print-outs were examined for maximum values of acceleration (using Eqn (1) to compute $\ddot{X}$) the value of V_i at this point was estimated by the use of Equations (2) and (3) and the total aircraft drag estimated from

$$\text{Drag} = C_d q S + (\text{Weight} - \text{Lift})\mu$$

Where C_d, the coefficient of drag, was derived from the Fokker data base, (q) was the dynamic pressure at V_i, (S) the reference wing area and μ the assumed coefficient of rolling friction for the aircraft. This permitted the use of Equations (5) and (6) to estimate a value for thrust at that point. The value of V_i was also used to calculate the thrust decrement due to speed (approximately 17 lb per knot) which was applied to the model thrust output at the same point. Since the point of maximum acceleration was always met at very low speeds, such that the aerodynamic drag was always low (of the order of 150 lb, compared to normal engine thrust of 19500 lb), the sensitivity of this procedure to errors in the aerodynamic model is very weak. Differences between the values for thrust developed from the FDR data and the model could therefore be assumed to be dominated by other factors, off-nominal engine performance in the aircraft, erroneous estimations of μ, discrepancies in the recorded values of A_x or Θ or an incorrect initial assumption that full rated power was being used. In fact, agreement was generally quite close, and a minor adjustment to μ from .02 to .022[6] was sufficient to produce agreement within reasonable scatter.

Having gained some measure of confidence in the FDR recordings by this method, the same technique was now used to compute actual thrust from the start of throttle advance to maximum Thrust parameter value for a selection of take-offs chosen from the full set. The selection criterion was that a time-history of airspeed (once the IAS sensor had become fully functional) should show as little wind effect as possible, thereby reducing errors in the application of Equations (3) and (4) due to indeterminate variations in V_w. The resulting data showed a remarkably good linear correlation between thrust and the Thrust parameter, regression analysis yielding the relationship:

$$T = T_{max}(-.55464 + 1.56045 T_{irel})$$

Where T_{max} is the full rated thrust and T_{irel} is the ratio between the value of the recorded Thrust parameter and its maximum value for that specific take-off. This value for thrust (T) was used for the remaining validations.

Speed Profile Comparisons

Since the whole object of the modelling exercise was to examine the effects of contamination on both the take-off run and post lift-off behaviour of the F-28, it was felt that the final stage of validation of the model should be a full comparison of the speed

[6] The literature on rolling friction was very sparse, giving such generalities as "μ can vary from .02 on a runway or deck to .05 on a well kept grass field", so this adjustment is by no means excessive.

profiles between the FDR data and the model. However, prior to this a final check on the modelling was made by comparing model indicated airspeed with that of the FDR for a variety of weights and ambient wind conditions. Two short segment plots, Figures 1 and 2, show the FDR IAS, and integrations of the corrected FDR longitudinal acceleration and the model output of IAS. It can be seen from these that a very close match has been achieved, and it should be noted that the model on which this is based did not vary in any way from the data provided by the manufacturer, while model thrust was based on the standard engine model. The extremely close agreement noted provides adequate confidence to complete the final comparisons.

Figures 3,4,5 and 6 show the full airspeed correlations between FDR IAS, FDR accelerations integrated and model output. It can be seen that the airspeed trace displays considerable non-linearity below 100 kt, but that in all cases there is a terminal confluence of all three parameters. Figure 6 is of considerable interest. This take-off case was reported to have taken place in zero wind, yet the curves did not overlay but, as can be seen from Figures 6,10 and 15, both the speed, thrust and acceleration traces diverged as time increased. This indicated an error in some function of speed rather than in the thrust estimation. The assumption of a rolling take off for this case produced curves which overlay very closely as can be seen in Figures 6 (diamond symbol),11 and 15(Filled square symbol). The rolling take-off assumption is analytically attractive since it has exactly the desired effect of removing the speed dependent divergence between FDR and model, since it serves simply to displace the inertial velocity to time curve without changing its form, while it changes the slope of the V^2 to time relationship, as illustrated in Figure 16.

Acceleration and Thrust Comparisons

Figures 12 to 15 for acceleration and 7 to 11 for thrust estimates also show agreements which are probably as close as can be reasonably hoped for using data of this kind.

SUMMARY

The plots provided with this document are sufficient to indicate that very close agreement between the recorded performance of C-FONF and the math model has been achieved. This being so, the author has very high confidence that the model outputs will fairly and accurately represent the basic behaviour of the subject aircraft in its normal state.

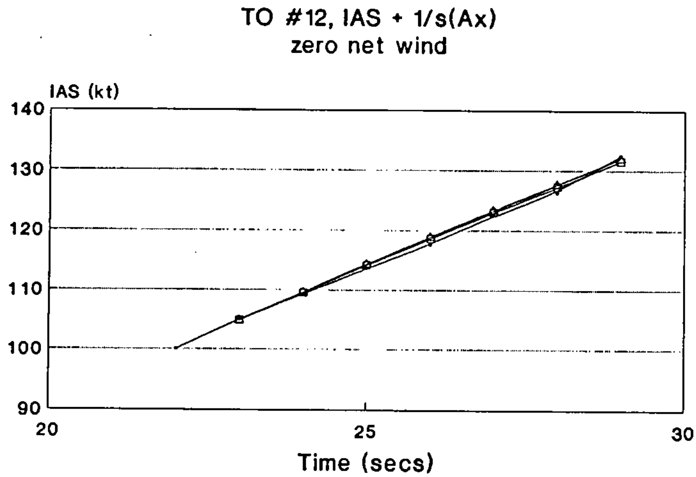


Figure 1 Airspeed, FDR Ax and Model Correlation

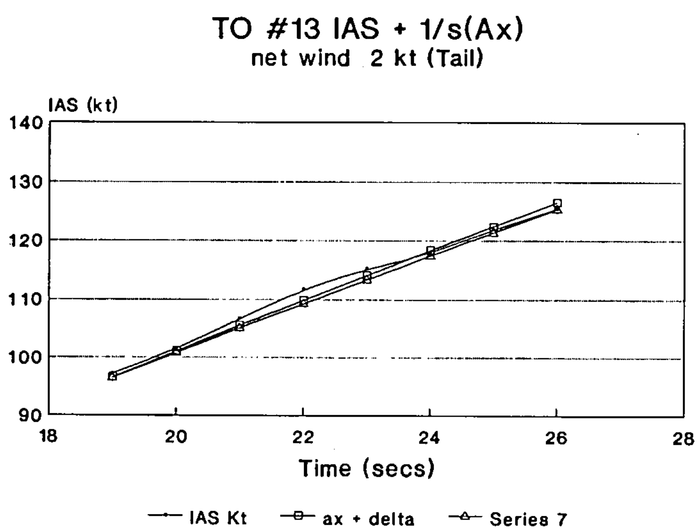


Figure 2 Airspeed, FDR Ax and Model Correlation

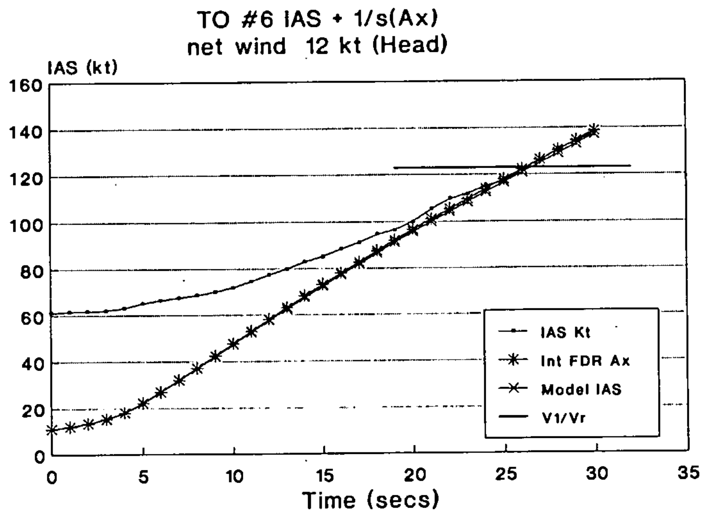


Figure 3 FDR and Model Comparison, Speeds

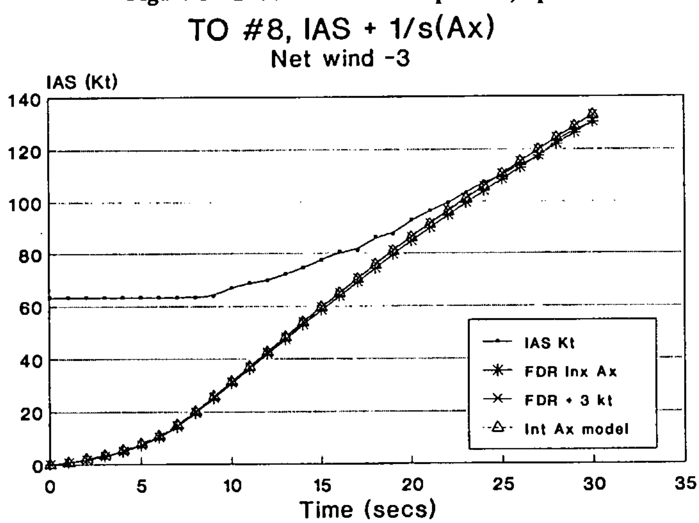


Figure 4 FDR and Model Comparisons, Speeds

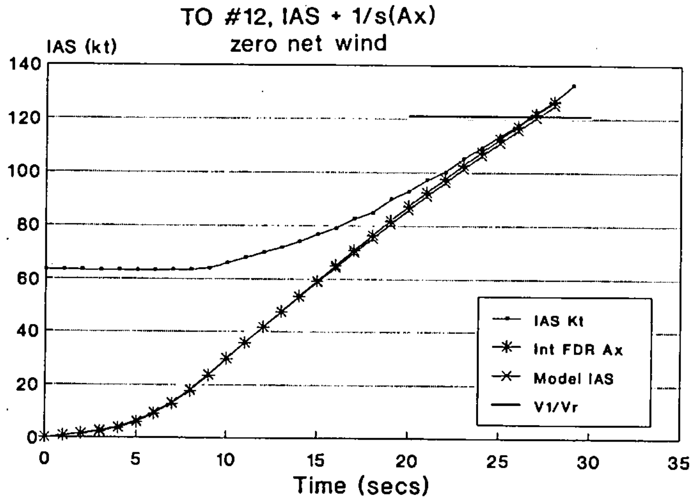


Figure 5 FDR and Model Comparisons, Speeds

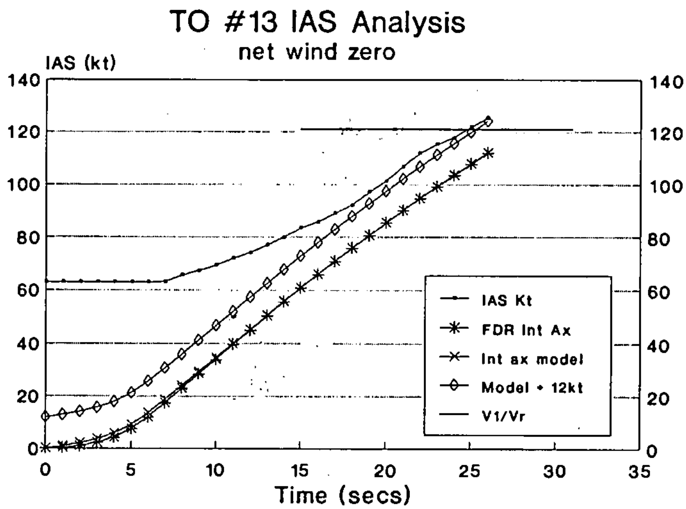


Figure 6 FDR and Model Comparisons, Speeds

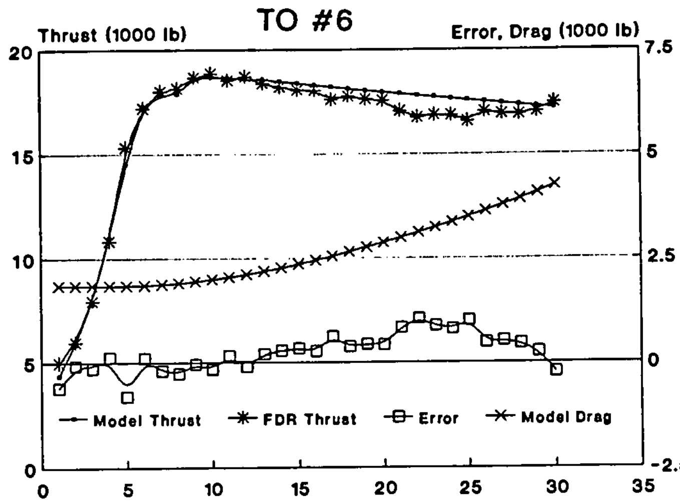


Figure 7 FDR and Model Comparisons, Thrust

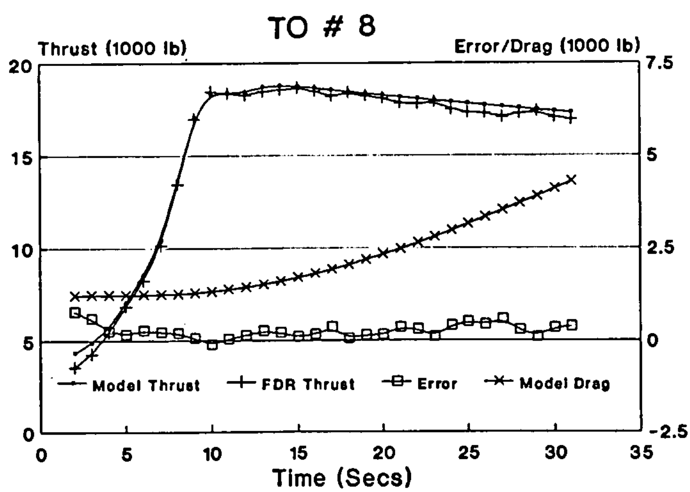


Figure 8 FDR and Model Comparisons, Thrust

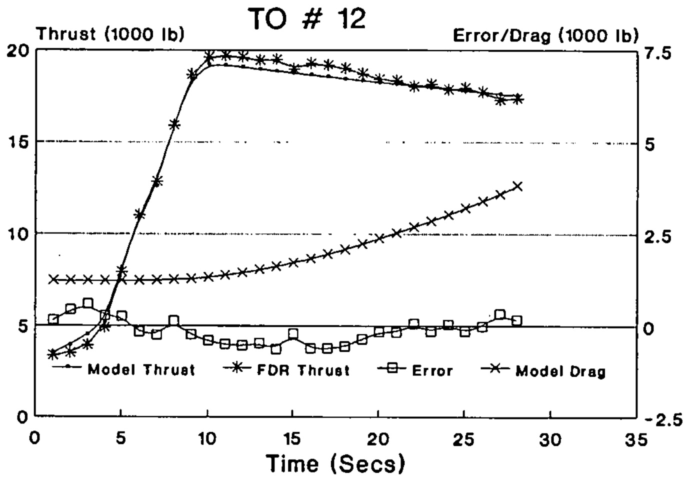


Figure 9 FDR and Model Comparisons, Thrust

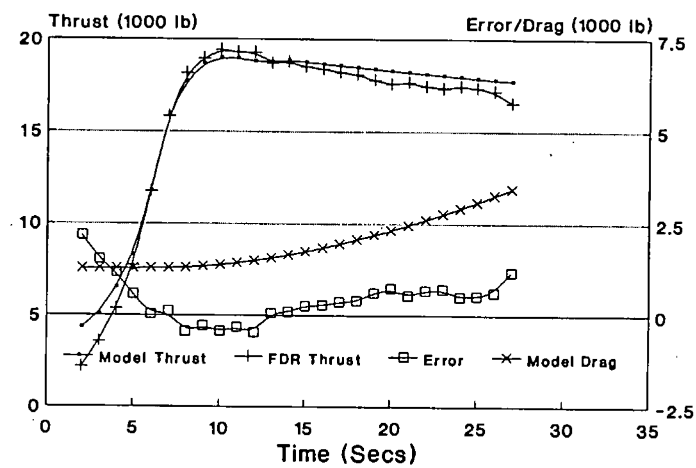


Figure 10 FDR and Model Thrusts, TO #13, Standing Start

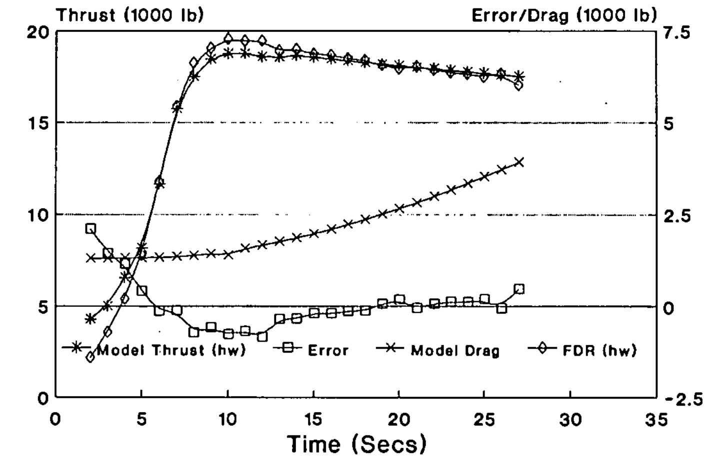


Figure 11 FDR and Model Thrusts, TO #13, Rolling Start

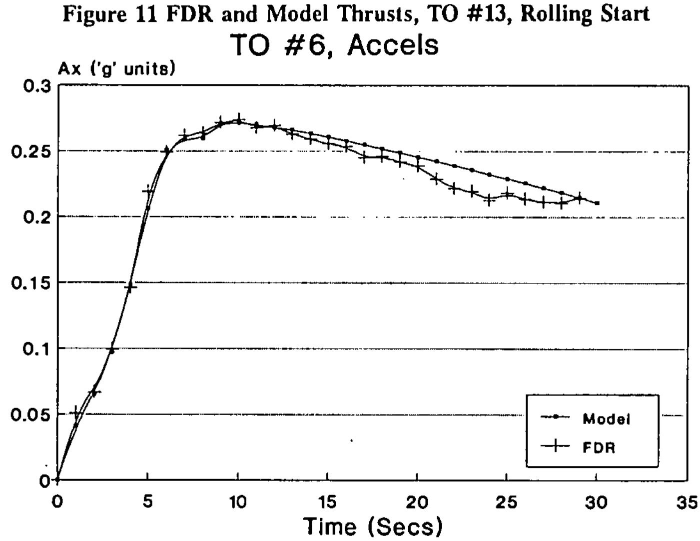


Figure 12 FDR and Model Comparisons, Acceleration

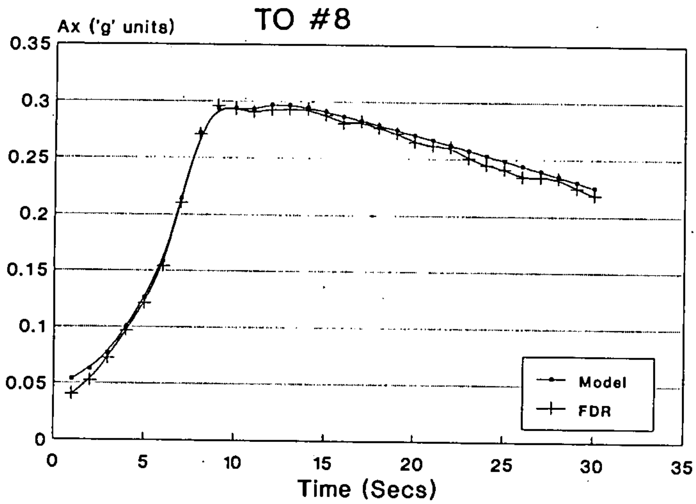


Figure 13 FDR and Model Comparisons, Acceleration

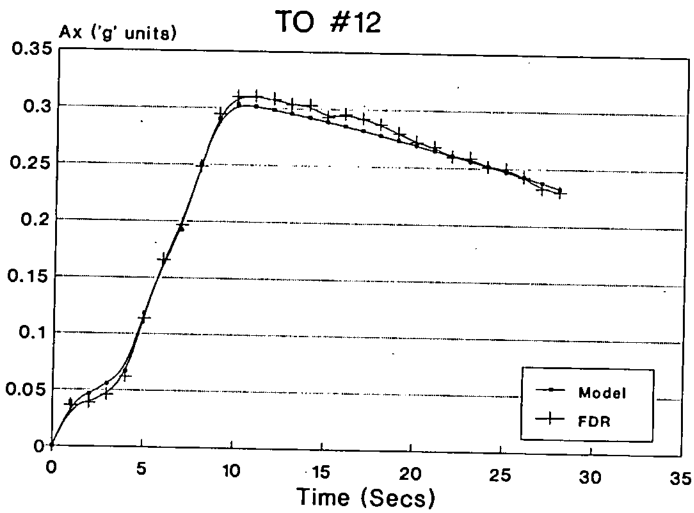


Figure 14 FDR and Model Comparisons, Acceleration

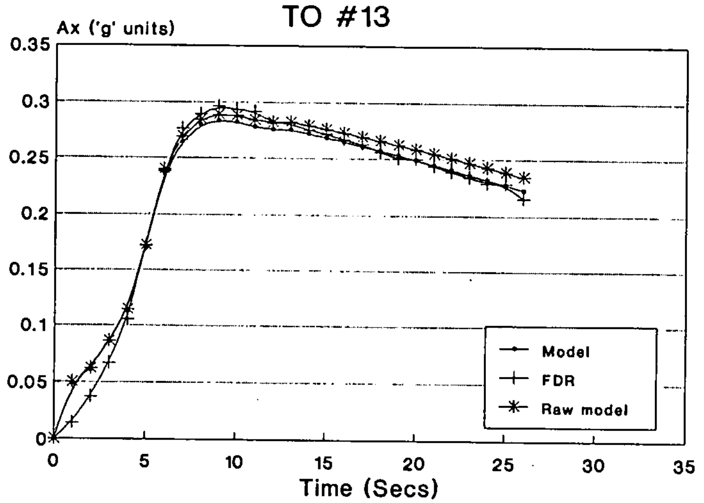


Figure 15 FDR and Model Comparisons, Acceleration Showing Raw Model and Model with Assumed Rolling Start

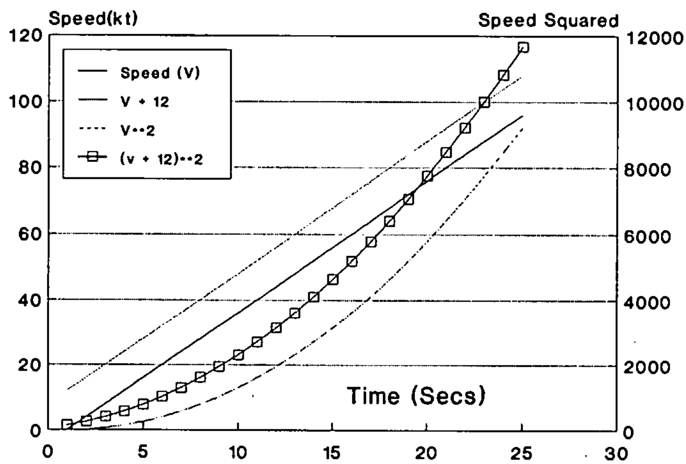


Figure 16 Effects of Rolling Take-off

F-28 FLIGHT DYNAMICS
SECTION 6

DISCUSSION AND CONCLUSIONS

DYNAMIC SIMULATIONS

The dynamic simulations demonstrated that the increased takeoff roll and short airborne segment could have been the result of the conditions tested in these simulations.

An increase in takeoff run on the order of 500 to 700 feet will result from slush accumulation on the takeoff runway on the order of 0.15 inches for the F28-1000 aircraft in those conditions, combined with the additional time to rotate the aircraft to the higher required liftoff attitude.

The airborne segment is more difficult to clearly define because there is a lack of a clearly defined flight path, nor do we have any knowledge of the pilot's control strategies as he attempted to complete the take-off. However, witness reports indicate that airborne segment was limited in absolute altitude to less than one wingspan, suggesting that the aircraft never climbed out of ground effect. The horizontal trajectory is defined by tree cut and wreckage location information after the first tree strike. Based on those data, simulations with moderate wing contaminant factors resulted in airborne segments which, in general terms, matched the witnesses' descriptions of the Dryden trajectory.

It is probably of significance that in those runs during which moderate to high levels of wing contamination were represented, stick shaker activation was a constant feature. The onset of this warning will usually trigger a highly trained response on the part of the pilot, who has been taught to use this indication as a means of achieving close to the maximum lifting performance of his wing when so needed. With the wing performance degraded by roughness this device can be misleading if used in an attempt to optimise lift since at stick shaker activation the wing may already be past the maximum C_L achievable in the presence of the contaminant. It should also be noted that the use of stick shaker triggering as an indication of maximum lifting capability must be essentially a *short term* procedure, even with the clean wing this operating point is well removed from the optimum lift/drag ratio for the aircraft and is not, therefore, a suitable operating condition for sustained climb. However, a pilot generally[7] has no other indication available to him and it is only to be expected that he would respond as trained.

NUMERICAL SIMULATIONS

The numerical simulations described in detail in Section 4 supported very strongly the observations made in the Fokker simulator. This indicates that the behaviour of that simulation may be taken, with some confidence, to represent closely the behaviour to be expected of an F-28 aircraft in actual flight.

---

[7] Note, however, that unlike the majority of current transport aircraft, the Fokker F-28 is equipped with an angle of attack indicator

Additionally, the off-line modelling complemented the dynamic simulations in that it permitted the investigators to examine a wide range of conditions in a very clinical manner and in a relatively short time. In particular it permitted the definition of two critical boundary conditions for contaminated take-off attempts, either of which would result in a catastrophic occurrence. Specifically, the region between the boundaries represents an entire range of slush and wing contamination conditions which could give rise to a trajectory of the kind described by witnesses to the Dryden accident.

A general observation based on the results of the numerical simulations is that the higher the rotation speed and the slower the rotation rate, the greater was the probability that the take off attempt would be successful. This is exactly what would be expected from an engineering evaluation of the effects of contamination on the aircraft's characteristics. Advice given in the F-28 handbook supports this observation.

GENERAL DISCUSSION

This statement immediately above raises two issues pertinent to this accident and worthy of comment here inasmuch as they bear on the act of attempting a take-off under the conditions pertaining at the time. It is not in the least likely that the average airline pilot would have sufficient theoretical knowledge to be able to assess in detail the effect on his aircraft's performance of these forms of contamination. Indeed, it is not possible to make such an assessment on the spur of the moment while already in the cockpit. The second issue concerns the pilot's awareness of his aircraft's external state under these kinds of conditions. Again, in some ways this is a function of the size and shape of aircraft of this class. By and large direct observation of the flying surfaces by the crew is either very difficult or impossible, once strapped in for take-off. In the F-28 approximately 50% of the wing can be viewed obliquely from the cockpit window with special effort, while by opening the window and leaning out the entire wing can be viewed. The automatic ice detection systems that presently exist are designed to detect and warn against the accretion of ice in flight rather than that due to the exposure of the aircraft to precipitation or frost formation while on the ground: the effects of the two types of airframe icing are quite different.

OTHER FACTORS

Wing Leading Edge Paint Deterioration

There have been reports that the wing leading edge of the F28 involved in this accident had a significant degree of paint cracking and deterioration. The paint thickness on the aircraft leading edge was measured at 0.016 inches, consisting of 3 or 4 layers of paint. This issue was brought up with Fokker's aerodynamics group who indicated that while the cracked paint certainly did not enhance performance, its effect on the maximum lift coefficient and stalling angle of attack was not judged to be significant.

There is a question of whether the deteriorated leading edge paint condition could have contributed to the degree that any contaminant would adhere to the wing. To date, there is no clear answer to that.

CONCLUSIONS

It is difficult when writing a report of this nature to be adequately mindful of the semantics or etymology of the words used. This is often the case when persons working in a specific discipline assign to a common word a precise or special meaning more limiting than that which applies in the vernacular. We have several times used the word 'cause' and phrases such as 'the cause of the accident'. It must be remembered that we use that word in a very technical sense to indicate a sequence of events which would or could give rise to a flightpath similar to the one reported at Dryden. The 'cause' to which we refer means a set of physical or engineering conditions which have a direct and predictable result (that is, we are describing a causal relationship). These are not of themselves the cause of the accident in the general sense, simply the result of a pilot attempting to take-off in a significantly contaminated aircraft.

It must be remembered that the conclusions of this subgroup report present possible causes of the flight path for the Dryden accident. It is critically important to remember that the assumptions listed in the beginning of this report must be clearly borne in mind in the final analysis of this accident. This report treats only the aerodynamics and aircraft handling aspects of this accident and assumes that there were NO other factors which could have been the related to the accident. There is no doubt that major failures of aircraft systems or other factors not mentioned in this report and not considered in this simulation could also have resulted in the accident flight profile, alone or in conjunction with the known wing contaminant.

With these caveats in mind, we are prepared to state:

1. The witness reported flight paths and "Dryden Scenario" which was based on those reports is physically possible from an engineering viewpoint.

2. The aerodynamic performance of the F28 in the Dryden accident was definitely degraded by the wing contamination which was reported by the witnesses on board the aircraft. This conclusion is based on knowledge of the sensitivity of aircraft lifting surfaces to contaminant and our analysis of the degree of contamination of the wings described by the witnesses. The work done by Fokker in their wind tunnel, general knowledge of aircraft aerodynamics and analyses of other accidents with F28's and similar aircraft clearly support the conclusion that the contaminants on the wings degraded the lifting capability and increased the drag on the accident aircraft.

3. The increased ground distance to the reported liftoff point could have been due to the following factors, individually or in combination:

   a) Small slush accumulations on the runway

   b) Selection of higher than normal rotation speed

4. An additional contributing factor to the increased ground distance to liftoff was the higher speed and/or pitch attitude required for liftoff as a result of wing

contaminant. This would have increased the takeoff run to the liftoff point, irrespective of any other factor. This was due to the additional time required to reach the required speed and/or to rotate the aircraft to the higher liftoff attitude. At the liftoff speed for the F28 in the Dryden case on the order of 130 knots, each additional second during rotation increased the ground run by approximately 200 feet.

5. The deteriorated condition of the paint on the wing leading edge probably did not affect the aerodynamic characteristics of the aircraft directly. However, the effect of the deteriorated paint on the adherence characteristics of contaminants at the leading edge is unknown, but could potentially have been a minor factor in the amount of contaminant that remained on the wing.

6. Simulation and analytical work done by this group has defined a range of conditions in terms of wing and runway contaminant levels which, alone, <u>could</u> have resulted in the accident profile.

7. Without FDR data, CVR data, the pilots themselves, and a mathematical description of the wing and runway contaminant levels, it can <u>NOT</u> be conclusively stated that wing or runway contamination <u>alone</u> caused the aircraft to crash.

REFERENCES

1. Wolters, S.R., Watch it in Winter, Operation and Maintenance of Fokker Aircraft, NO 3, Feb 1984

2. Jones, R., and Williams, D.H., The Effect of Surface Roughness on the Characteriestics of the Aerofoils NACA 0012 and RAF 34. NPL(UK) Reports and Memoranda No 1708, Feb 1936

3. Jane's All the World's Aircraft, 1975-76, p. 144

4. Schlichting, Boundary Layer Theory Pergamon Press, 1955

5. Schuringa, Tj., Aerodynamics of the Wing Stall of the Fokker F-28. AGARD CP-102, #20

6. Torenbeek, E., Synthesis of Subsonic Airplane Design Delft University Press

7. Warrink B.J., Simulation Report vs-28-25, Fokker Aircraft, June 1989, Order 22192

8. Anon F28 Simulation Data Base, Master File

9. Walter B. Horne et al. Studies of the Retarding Force Developed on an Aircraft Tire Rolling in Slush or Water. NASA TN D-552, September 1960

10. Slatter N.V. and Maltby R.L.,The Measurement of the Effects of Slush and Water on Aircraft During Take-Off. RAE R&M 3604, 1969.

11. loq. cit.

12. Cebeci, T., Effects of Environmentally Imposed Roughness on Airfoil [sic] Performance, Paper delivered at the Von Karman Institute for Fluid Dynamics, February 1987.

13. Zierten, T.A. and Hill E.G.,Effects of Wing Simulated Ground Frost on Airplane Performance. von Karman Institute Lecture Series on "Influence of Environmental Factors on Aircraft Perfromance", 1987.

14. loq. cit.

15. Abbott Ira H. and Von Doenhoff Albert E. The Theory of Wing Sections Dover Publications Inc. New York 1959, Ch 7, 7.5c pp157 et seq

16. Hoerner Dr-Ing S.F. Fluid-Dynamic Drag Published by the Author, 1965 Library of Congress No 64-19666 Ch 5.1

17. loq. cit.

Appendix 5

Wind Tunnel Investigation of a Wing-Propeller Model Performance Degradation due to Distributed Upper-Surface Roughness and Leading Edge Shape Modification

R.H. Wickens
V.D. Nguyen

April 1991

WIND TUNNEL INVESTIGATION OF A WING-PROPELLER MODEL PERFORMANCE DEGRADATION DUE TO DISTRIBUTED UPPER-SURFACE ROUGHNESS AND LEADING EDGE SHAPE MODIFICATION

R.H. Wickens and V.D. Nguyen
Applied Aerodynamics Laboratory
Institute for Aerospace Research
National Research Council Canada
Ottawa, Canada K1A 0R6

April 1991

SUMMARY

A wind tunnel investigation has assessed the effects of distributed upper surface roughness, and leading edge ice formation on a powered wing propeller model.

In the unpowered state, it was found that roughness reduces the lift slope, and maximum lift by 30 to 50 percent, depending upon particle size and Reynolds number. The leading edge region is especially sensitive to these disturbances, however removal of the roughness over a small portion of the nose restored the wing to close to its original performance.

The application of power to the wing, with an increase of slipstream dynamic pressure increases the lift slope and maximum lift; however this benefit is lost if the wing is roughened. Subtraction of the propeller reactions indicated that the slipstream interaction accounted for half the lift increase, and also resulted in reduced drag for the clean surface. This drag reduction was removed when the wing was roughened, indicating that the degradation of wing performance due to roughening is relatively greater when a slipstream is present, compared to the unpowered wing.

Leading edge ice accretion causes similar large losses in lift and increases of form drag although a comparison of the two types of contamination showed that leading edge ice produces a smaller reduction of lift slope prior to flow separation. In both types of contamination, Reynolds number is important, and emphasizes the necessity of testing under near full-scale conditions.

List of Symbols

C_L lift coefficient $\dfrac{L}{\frac{1}{2}\rho V^2 S_w}$

C_D Drag coefficient $\dfrac{D}{\frac{1}{2}\rho V^2 S_w}$

C_m moment coefficient $\dfrac{M}{\frac{1}{2}\rho V^2 S_w c}$

c wing chord

S_w wing area

C_{T_p} propeller thrust coefficient $\dfrac{T_p}{\rho N^2 D^4}$

C_{N_p} propeller normal force coefficient $\dfrac{N_p}{\rho N^2 D^4}$

C_{m_p} propeller pitching moment coefficient $\dfrac{M_p}{\rho N^2 D^5}$

C_c wing chord force coefficient $\dfrac{C_c}{\frac{1}{2}\rho V^2 S_w}$

C_{D_o} parasite drag coefficient (unpowered)

C_{L_s}, C_{D_s}, C_{m_s} wing coefficients with the propeller reactions removed

C_s leading edge suction coefficient

D propeller diameter

N propeller rotation speed (RPS)

J propeller advance ratio $\frac{V}{ND}$

k roughness particle size

INTRODUCTION

Recent flying accidents resulting from adverse weather conditions in the form of freezing rain or snow, have focussed attention on the degradation of aerodynamic surfaces. One of the most recent accidents, involving a Fokker F-28, mk 1000 jet aircraft, and the subject of a Commission of Inquiry in Canada, dealt specifically with the degradation of such surfaces due to ice and snow contaminants on the wings. The information contained in this paper stems in part from the investigation conducted for the Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario, March 10, 1989. (Ref. 10) Investigations of the effects of uniform roughness on airfoils shows clearly that stalling is premature, loss of maximum lift can be as high as 50%, (depending on Reynolds Number) and form drag reaches very high levels at angles of attack below normal clean wing stall.

The effect of upper surface roughness on complete aircraft configurations is less well known; however there is a long history of aircraft accidents related to flight in icing conditions, and several recent accidents, including the Air Ontario F-28 accident, involving swept-wing jet aircraft have highlighted the problem. In these situations it was observed that early flow separation and stalling was a characteristic result of ice and snow contaminants on the wing. Flow breakdown was accompanied not only by a loss of lift and an increase of drag, but also wing-dropping as a result of outer panel flow separation and wing tip stall prior to inboard wing stall. Experimental data on simulated upper surface contamination on a swept-wing model of a typical jet-commuter aircraft have confirmed what was suspected from flight experience, and have also demonstrated that large changes of trim will occur on the full-scale aircraft.

Figure (1a) from ref. (1) shows, for various two-dimensional airfoil configurations, losses in maximum lift and reductions the angle of attack for maximum lift that result from simulated hoar frost contamination. Large increases of drag also occur, and are attributed to form-drag after separation and stall. Early wind tunnel tests on the effects of upper surface roughness on maximum lift of airfoils is also reported in reference (2), for conventional airfoils. This data shows that the loss of maximum lift is critically dependent on Reynolds Number, and also roughness particle size. For example at Reynolds Number greater than 10 million (typical for takeoff) the loss in maximum lift approaches 50% of the clean airfoil value. In comparison, at the

Reynolds number values typical of low speed wind tunnel testing the loss of maximum lift is much lower, thus highlighting the dangers of assessing wing contamination effects at other than full-scale conditions. There is little or no corresponding data for modern, supercritical airfoil shapes.

Wing drag also increases as a result of surface roughness. This is due to an increase in skin friction in unseparated flow, but mainly from increases in form drag after premature separation has occurred. If the roughness elements protrude above the laminar sublayer of the turbulent boundary layer in attached flow, the result is an increase of skin friction and the production of more turbulence. Increasing the Reynolds Number aggravates this effect and increases the probability of separation particularly around the nose, since the sub-layer will be thinner. This would presumably explain the higher losses in maximum lift incurred at high Reynolds number.

If the roughness height is large in comparison to the laminar sub-layer (as would be the case for freezing rain or ice accretion) then the frontal drag of these elements determines the average tangential force, and their shape, orientation and distribution become important, and increased turbulence and dissipation in the thickened boundary layer will lead to premature flow separation and stall.

Propeller-driven aircraft, where the slipstream passes over the wing surface, are thought to be less sensitive to the effects of upper surface contamination compared to the typical swept-wing configuration. This is due in part to the effects of sweep, that reduce the wing lift-slope, compared to a straight wing; and the effects of slipstream interaction, that augment span loading locally, increase wing lift slope, and also delay flow separation at high angles of attack. Thus the rotation angle on takeoff of a straight wing propeller-driven aircraft is likely to be less than that for an equivalent swept wing aircraft, with no slipstream interaction, and the likelihood of a premature stall may not arise.

Notwithstanding this apparent beneficial comparison, the propeller-driven aircraft may still experience significant losses of lift and large increases of drag if premature flow separation occurs when the wing upper surface is contaminated. Figure 1b from Ref. (1) for the Fokker F-27 turboprop transport wind tunnel model indicates however, that smaller losses in maximum lift may be expected from a contaminated wing, compared with the airfoil test results of Figure (1a). The corresponding reduction in critical angle of attack is also small and in some cases positive, and was attributed to a significant change in the wing-slipstream stall pattern. The extent to which the slipstream may remain attached to the wing surface is unknown but its influence may affect the overall stall pattern even when roughened by ice.

In view of the unknown nature of the complex interactions of wing boundary layer, propeller slipstream and distributed roughness, and the lack of experimental data, it was decided to use the half-wing propeller model of reference (3) to obtain some preliminary data on the effects of upper surface roughness in a slipstream and also the effects of typical in-flight ice accretion shapes on the leading edge. The utility of the data to aircraft design or performance estimation will be limited; the model configuration is not typical of current propeller transport configurations, and the test Reynolds Number was low (Re = 1.3 million).

MODEL

The general arrangement of the rectangular, unswept half-wing model is shown in figure 2. The wing, having a NACA 4415 airfoil section, was untwisted and was equipped with a 30 percent chord plain flap extending along the semi-span. The aspect ratio was 4.85. A nacelle containing a 20 hp water-cooled induction motor was underslung on the wing approximately one chord length above the floor. The four-bladed propeller was located 70% chord in front on the leading edge and was equipped with an adjustable pitch-setting mechanism. The two foot diameter propeller was the same model used in the investigations reported in references (3) and (4). In these reports full aerodynamic characteristics of the isolated propeller and also the interference effects of this wing model are reported. The relevant geometry of the propeller is listed as follows:

Propeller

Diameter	2.0 ft.
No. of blades	4
Solidity	0.127
Blade section at 0.75R	65 Series (design Cl = 0.7)

The complete model installation Figure, (2a), (2b), was mounted on the wind tunnel balance at the 30% chord location. The propeller motor was supported in a slender nacelle but did not have a separate thrust or normal force balance in this experiment. The wind tunnel balance thus measured the combined effects of wing and propeller reactions.

EXPERIMENTAL PROCEDURE

The wing was pitched through an angle of attack range from 6 to 26 degrees. A complete stall and flow breakdown was not achieved with this model due probably to the effects of the low aspect ratio, Reynolds number and the half-model configuration. Maximum lift was achieved however, and this was used as a basis of comparison for the effects of roughness. Model lift, drag and pitching moment were measured on the wind tunnel balance. Pitching moment was taken about the 30% chord location. The measured forces include the propeller reaction comprised of thrust, normal force and pitching moment. The test Reynolds Number was 1.3 million (2.3 million for the unpowered wing only).

Propeller static thrust was measured on the wind tunnel balance under wind-off conditions. At the desired test conditions thrust was varied by adjusting the blade pitch settings to a value that corresponded approximately to the take off thrust coefficient of a typical turbo-prop aircraft. Under wind-on conditions at a dynamic pressure of 25 psf, and a propeller rotational speed of 3000 rpm, this thrust coefficient C_{T_p} was estimated from the data of ref. (5) to have a value of 0.115. Propeller thrust and normal force change with incidence, and the variation of these quantities, used in other section of this report, were also determined from the data of Ref. (5).

SIMULATED ROUGHNESS

Roughness, in the form of a uniform distribution of carborundum grit was applied over various portions of the chord. Three grades of standard grit were used: 150(.0041"), 80(.0083"), 46(.0165"). These correspond approximately to average roughness heights of .03", .06", and .11" respectively on a full-scale wing of 10 ft. chord. The roughness height/chord ratios for this test were 0.000227, .000461 and .000916 respectively. In addition a heavy grade (50 grit) of commercial sandpaper was applied to the wing surface. The roughness height and concentration of this application was considered to be significantly greater than the standard grit particles applied manually to the wing surface.

The roughness was applied initially to the upper surface from the leading edge stagnation region to the flap hinge line. Since only the forward portion of the chord was found to be sensitive however, most of the investigation was performed with only the first 25-30% of the chord roughened and the results presented in this report are for 30% coverage. The density of application was not varied or determined precisely.

In addition to distributed roughness application, shapes representing rime and glaze ice accretions were applied to the wing leading edge. The shapes were similar to those of ref. (6) and are shown in Figure (2c).

PRESENTATION OF RESULTS

Unpowered Wing

The unpowered wing data presents the effects of various grit sizes (46, 80, 150) deposited on the upper surface, and also a heavy grade of sandpaper attached to the upper surface. The amount of coverage along the chord corresponded to about 30%. Tests were also done at a higher Reynolds number (2.3 million), for the unpowered wing only.

Figure 3 shows the behaviour of Cl, Cd, and Cm for the unpowered wing in the clean and contaminated states for standard grit sizes at the test Reynolds number of 1.3 million, and for heavy sandpaper at Re = 2.3 million. The main effect of wing contamination is a reduction of lift slope and maximum lift by amounts that range between 20 - 25% for a Reynolds number of 1.3 x 10^6, and larger losses for the higher Reynolds number. The angle of attack for maximum lift (clean) was 20 degrees; this was reduced to about 15 degrees with contamination on the upper surface.

Drag is also increased at angles of attack below stall, and large increases of form drag occur when the flow separates. In general these losses, particularly at maximum lift, increase with particle size, with the highest loss occurring where sandpaper was applied to the wing (Fig. 3a). All reductions of lift increase with increasing Reynolds number as Reference (2) points out, and this is also the case in this test. The effect of roughness on pitching moment was small at angles of attack below stall; there appears to be a slight nose-up shift of the Cm versus α curve, and its magnitude increases slightly with grit size. The application of rough sandpaper at the high reynolds number increases this nose-up shift slightly.

The most significant parameters appear to be roughness size and Reynolds number, however it was observed that when a small portion (15%) of the leading edge was cleaned off, wing lift and drag was restored to close to its clean performance, however moment was not fully restored.

Powered Wing

With the blades installed and set to the angle for take-off thrust, the propeller was operated wind-on at an advance ratio of 1.4. This was much higher than a typical takeoff advance ratio, however it was the only way a high thrust coefficient could be achieved due to current and temperature limitations of the motor. As mentioned before propeller forces were not measured separately, however both thrust and normal force were inferred from the isolated propeller data of references (3) and (5) for further analysis of these results.

Figure (4) shows the effects of propeller thrust on lift, drag and pitching moment on the unpowered clean wing at a Reynolds number of 1.3 million. A higher Reynolds number test condition was not possible in the powered tests due to limitations of the motor. The application of power with the resulting slipstream interaction results in an increase of both the lift slope and the maximum lift by about 25%, and stalling angle is increased by about 4 degrees. The drag polar is shifted by an amount that corresponds to the thrust force plus a leading edge thrust on the wing due to increased suction. The drag equivalent of the estimated propeller thrust has a value of about 0.085, which, when subtracted from the total wing force at zero lift, apparently produces a negative drag or thrust on the wing. This effect, known as the "Squire Effect", has been alluded to before (Ref. 7), and is attributed to the effects of flow rotation in the slipstream.

The pitching moment shown in figure (4c) exhibits an increased nose-up tendency due to the effects of the propeller and slipstream flow. The slope of the pitching moment curve vs α is increased with the application of power and beyond maximum lift there is a large nose-down shift of the pitching moment. The large change in moment is attributed mainly to the propeller normal force acting about the wing centre of rotation (Figure 2).

Effects of Roughness - Powered Wing

With roughness applied to the wing upper surface there appears to be a loss of lift slope and maximum lift of about 25 to 35% depending upon roughness element size. (Figure (5)). In effect, the benefits of powered lift, resulting from slipstream interaction, is lost. Drag also increases as the flow separates prematurely, and there also is an increase in the parasite drag at zero lift due to roughness, and increased dynamic pressure in the slipstream. The effect of roughness on wing pitching moment is small at angles of attack below stall, ($\alpha < 10°$) but the moment becomes more nose down as roughness size increases.

The application of the heavy sandpaper roughness further deteriorated the wing performance under power at the Reynolds number of 1.3 million. Maximum lift decreased slightly, as did the lift slope; although the stall was not sharply defined. Drag also increased near zero lift but the pitching moment did not change significantly, although the tendency continued to be nose-down.

A comparison was made between the powered and unpowered wing drag polars to show the relative effects of roughness with and without power (Figure 6). It is clear from these graphs that roughness, especially when it reaches the heavy proportions of sandpaper coverage, has a much more adverse effect on drag of the powered wing than for the unpowered wing in uniform flow. The lift curves exhibit about the same degree of degradation of performance between powered and unpowered configurations. The pitching moment change appears to be smaller when the wing is powered and is accompanied by an increase in slope (Cm vs alpha) and a small displacement in the nose up direction.

In order to simulate the scrubbing action of the slipstream, a portion of the roughness was removed at the propeller location. This resulted in a modest improvement of performance.

Wing-slipstream characteristics

In order to separate the propeller from the total wing forces, and to compare unpowered wing characteristics with those with the wing immersed in a slipstream, the isolated propeller data were estimated from Reference (5) and (Figure 7) and were removed from the wind tunnel balance data as follows:

$$C_{L_s} = C_L - \left(2/J^2\right)\left(D^2/S_w\right)\left[C_{T_p} \text{Sin}\,\alpha + C_{N_p} \text{Cos}\,\alpha\right] \qquad (1)$$

$$C_{D_s} = C_D - \left(2/J^2\right)\left(D^2/S_w\right)\left[C_{T_p} \text{Cos}\,\alpha - C_{N_p} \text{Sin}\,\alpha\right] \qquad (2)$$

$$C_{M_s} = C_M - \left(2/J^2\right)\left(D^2/S_w\right)\left[C_{N_p}\left(\frac{\bar{x}}{c}\right) + C_{T_p}\left(\frac{\bar{y}}{c}\right) + C_{M_p}\left(\frac{D}{c}\right)\right] \qquad (3)$$

No attempt was made to correct the propeller data for the blockage and upwash effects of the wing; however the comments of Ref (8) and the experimental data of Ref (4) suggest that these interactions may be small.

The powered clean wing characteristics with the propeller reactions removed are shown in Figure (8). The lift curve lies between the powered and unpowered curves, suggesting that the slipstream interaction contributes about half of the powered lift increment to maximum lift, and lift-slope.

The drag polar (Figure 8) indicates significantly less drag due to the effects of the slipstream flow, particularly at low values of C_L (< 0.4), and near zero lift the wing actually produces a thrust. This has been attributed to the effects of slipstream rotation (Ref. 7), with the wing acting as a flow straightener. This result should probably be taken with caution, however, since no direct measurement of propeller thrust or normal force was available.

There appears to be a nose-down change in pitching moment when propeller forces are removed, since neither thrust or normal force are contributing (Figure 8c). The slipstream interaction evidently produces a lesser slope of the Cm vs α curve, and more nose-down moment, compared with the unpowered wing. A partial explanation of this change is given in Reference 4, and is attributed to changes in chordwise pressure distribution over the region of the wing covered by the slipstream.

Slipstream Interaction - Roughness

The loss of performance due to distributed roughness, for the wing-slipstream interaction, appears to be somewhat larger than that for the unpowered wing in steady uniform flow. This may be due to the high thrust coefficient of this test, and the resulting augmentation of local pressures on the wing. Figure (9) shows lift ,drag and moment for the unpowered wing and for the wing immersed in a slipstream. Also shown is a shaded boundary that indicates the changes in drag due to increasing roughness in each case. The shaded areas in both graphs represent the maximum loss incurred by distributed roughness of varying grit size, including the heavy sand paper application. The negative drag generated on the wing near zero lift (Figure 9b) is all but removed by the action of the contamination on the nose and upper surface of the wing. In contrast the unpowered wing incurs a slightly lower drag loss due to roughness. At a lift coefficient Cls of about .36, the net drag is zero on the clean powered wing. For values of lift greater than this, drag rises rapidly, and eventually exceeds that of the unpowered wing since thrust is now no longer contributing a force in the streamwise direction and lift is reduced by the amount of the propeller normal force contribution. The effect of increasing roughness in both cases increases drag, particularly before stall.

The propeller contribution to pitching moment is mostly unstable (i.e. nose up). Therefore, removal of the propeller forces makes Cm more negative, and decreases the slope of the Cm vs α curve. The changes to pitching moment are relatively smaller when roughness is applied to the wing (Figure 9) compared to the clean condition. The slipstream interaction on the clean wing results in a slightly more stable pitching moment curve (Cms vs α) compared with the unpowered wing. The application of roughness causes, in both cases, a loss of stability in the pitching moment curves.

Leading edge ice accretion

In addition to uniform roughness on the wing upper surface, tests were also made with modifications to the leading edge that represented rime and glaze ice accretion (Figure 2). The data shown in Figure (10) for the unpowered wing show that such gross changes to the leading edge profile cause losses of maximum lift in the 30 to 50 percent range. Reynolds number is important and a further reduction of maximum lift of 15 to 20% will occur when reynolds number is increased to 2.3 million. Similar significant changes to pitching moment also arise from these leading edge shapes, particularly at high Reynolds numbers.

With the application of power, lift slope and maximum lift are increased but the wing performance is well below normal and the drag polars indicate high drag levels at all lift coefficients. Figure (11) shows a comparison between uniform contamination and leading edge accretion of heavy rime ice, for the drag polars and pitching moments of the ice-contaminated wing for the powered configuration. Leading edge ice results in less reduction of lift slope before stall, but a larger lift loss after stall.

Figure (11d) shows the effect of a slipstream interaction on the wing lift and drag for a medium and heavy leading edge rime accretion. As with distributed roughness, leading edge ice contamination effectively removes the benefits of slipstream flow rotation.

Chord force and leading edge suction

The effective performance of an airfoil or wing depends on the production of negative pressures along the leading edge, and a leading edge suction force that ensures that the aerodynamic force becomes normal to the relative wind. The determination of the chord force coefficient C_c and the leading edge suction coefficient C_s indicate the degree to which lifting efficiency can be achieved.

C_c and C_s can be determined from experimental data as follows:

$$C_c = C_D \cos \alpha - C_L \sin \alpha \quad (4)$$

and for small angles

$$C_s = C_{D_o} - C_c \quad (5)$$

C_c and C_D can also be determined from the parabolic drag polar relationship (Ref. 9). Figure 12a shows the relationship between unpowered wing drag C_D and chord force C_c, and the effects of distributed roughness on both parameters, for the unpowered wing. It appears that roughness has a relatively larger effect on drag than on chord force.

Corresponding values of leading edge suction coefficient for the unpowered wing also show the effects of contamination. Below stall C_s is not greatly diminished by contamination around the nose, but drops suddenly beyond maximum lift.

Figure (12c) shows chord force vs. lift coefficient for the powered wing with leading edge ice and roughness, and with the propeller forces removed. The accretion of ice tends to lower the leading edge force at low values of C_{L_s} , but distributed roughness appears to have a more serious effect at higher lift coefficients.

CONCLUSIONS

1) The main effect of distributed upper surface roughness on an unpowered wing is to reduce lift slope and maximum lift by as much as 30 to 50 percent, depending upon roughness size, Reynolds number, and to a lesser extent, coverage.

2) The magnitude of the loss of maximum lift increases with roughness size, and also with Reynolds number and testing of roughened wings should be done at as high a Reynolds number as possible.

3) Roughness increases the parasite drag at zero lift and also results in a premature stall with resulting large increases of form drag.

4) The leading edge region is especially sensitive to distributed roughness regardless of particle size; there is a significant increase in drag and corresponding decrease of leading edge suction at angles of attack below stall. Conversely, removal of the roughness over a small portion of the nose restores the wing to almost clean performance.

5) If the wing is powered and clean, the slipstream interaction increases lift slope and maximum lift by 25 percent, for thrust coefficients appropriate to the take-off condition. If roughness is applied, maximum lift decreases by more than 25%, thus producing a lifting performance somewhat below the unpowered wing in the clean state. This may have significance in the event of an engine failure; the contaminated wing will suffer a further loss in maximum lift in the unpowered state.

6) An attempt was made to isolate the slipstream interaction on the wing by subtracting estimated propeller forces. When comparing the performance of the powered and unpowered wings, it was noted that roughness produced slightly higher losses on the wing immersed in the slipstream.

7) Loss of lift due to an accretion of rime or glaze ice on the leading edge of the wing may reach as high as 50 percent even when the wing is powered, and is sensitive to Reynolds number. Loss of maximum lift is greater for heavy rime ice than for heavy distributed roughness.

LIST OF REFERENCES

1. Wing Tips - Fokker product support division, #14, December 1989.

2. Jones, R., Williams, D.H. - The effect of Surface Roughness on the Characteristics of Airfoils. RAE R&M 1708, Feb. 1936.

3. Nishimura, Y. - An Experimental Investigation by Force and Surface Pressure Measurements on a Wing Immersed in a Propeller Slipstream. Part I: Force and Moment Measurements. NRC-CR-501, March 1968.

4. Nishimura, Y. - Surface Pressure Measurements Part II, NRC LR-525, June 1969.

5. Wickens, R.H. - Aerodynamic Force and Moment Characteristics of a Four-Bladed Propeller Yawed through 120 Degrees. NRC-LR-454. May 1966.

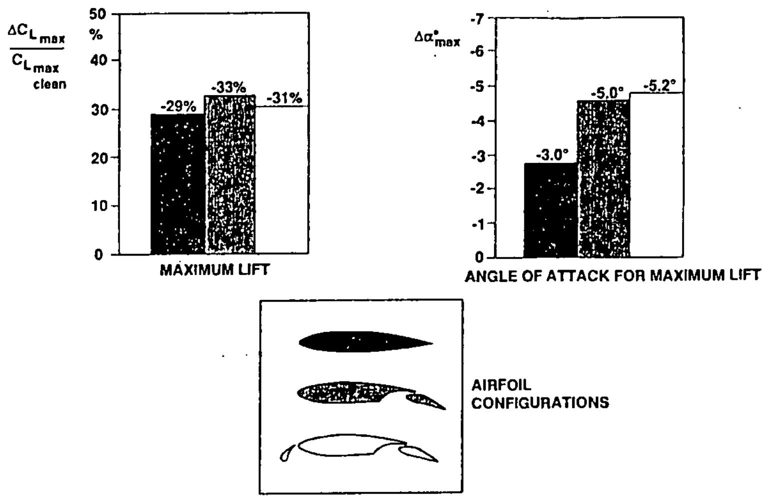
6. Olson, W., Shaw, R., Newton, J. - The Shapes and the Resulting Drag Increase for a NACA 0012 Airfoil, NASA TM 83556, 1984.

7. Squire, H.B., Chester, W. - Calculation of the Effect of Slipstream on Lift and Drag. ARC R&M 2368, 1950.

8. Durand, Vol II. Aerodynamic Theory.

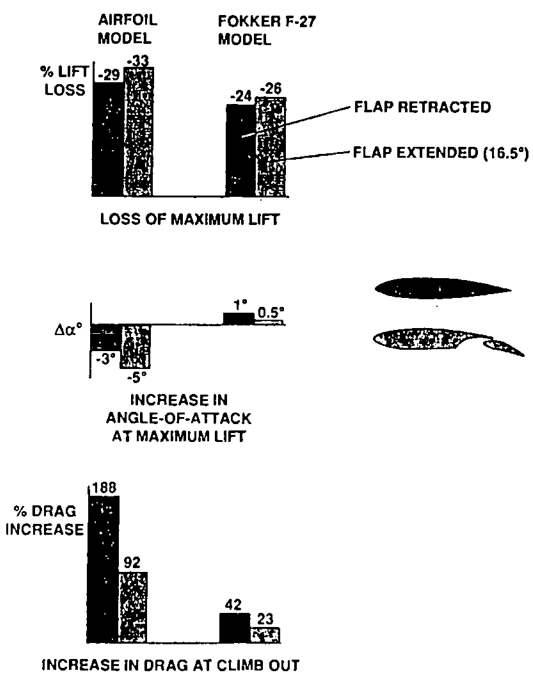
9. Schlichting, H., Truckenbrodt, E. - Aerodynamics of the Airplane - McGraw-Hill 1979.

10. Morgan, J.M., Wagner, G.A., Wickens, R.H. - A Report of the Flight Dynamics of the Fokker F-28 mk 1000 as they pertain to the accident at Dryden, Ontario, March 1989. NRC/NAE misc. 64



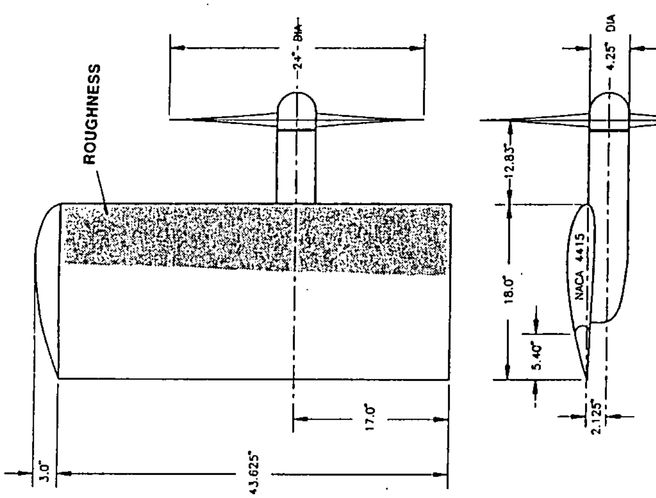
WING-ROUGHNESS-INDUCED LOSS OF MAXIMUM LIFT AND REDUCTION IN ANGLE OF ATTACK FOR MAXIMUM LIFT (REF. 1)

FIGURE 1

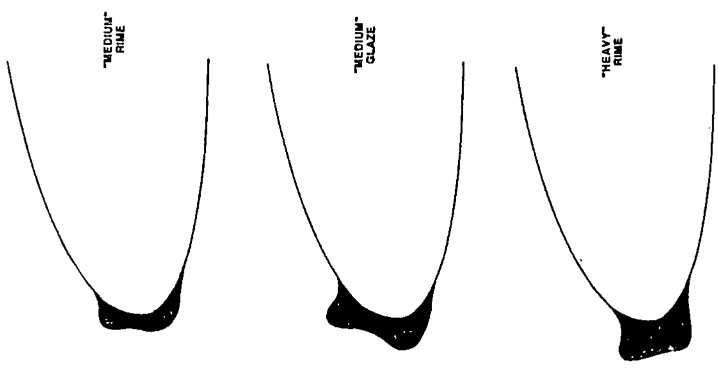


COMPARISON OF LIFT LOSS AND DRAG RISE FOR AIRFOIL AND PROPELLER-SLIPSTREAM MODELS

WING-PROPELLER MODEL WITH DISTRIBUTED ROUGHNESS



PLAN AND CROSS-SECTIONAL VIEW OF MODEL



VARIOUS SHAPES OF THE LEADING EDGE GEOMETRY MODIFICATION

FIGURE 2

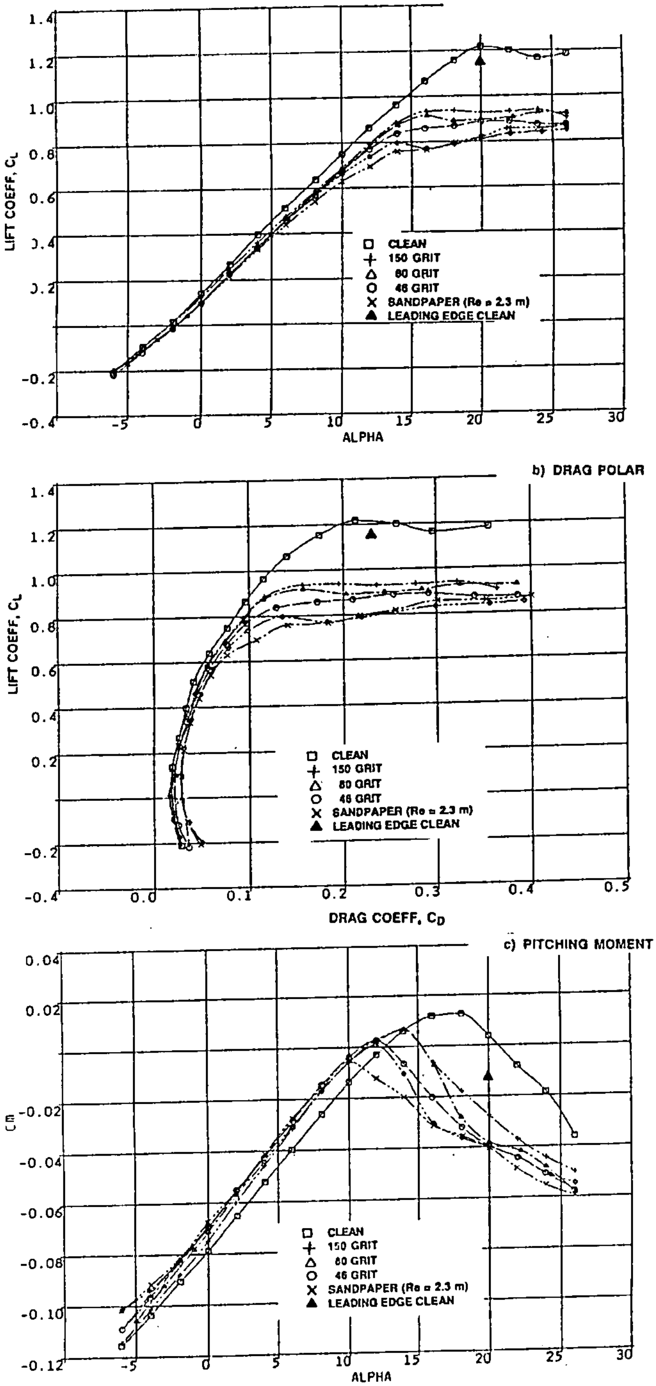


FIGURE 3

EFFECTS OF UNIFORM ROUGHNESS ON UNPOWERED WING PERFORMANCE, Re = 1.3 m, 30% COVERAGE

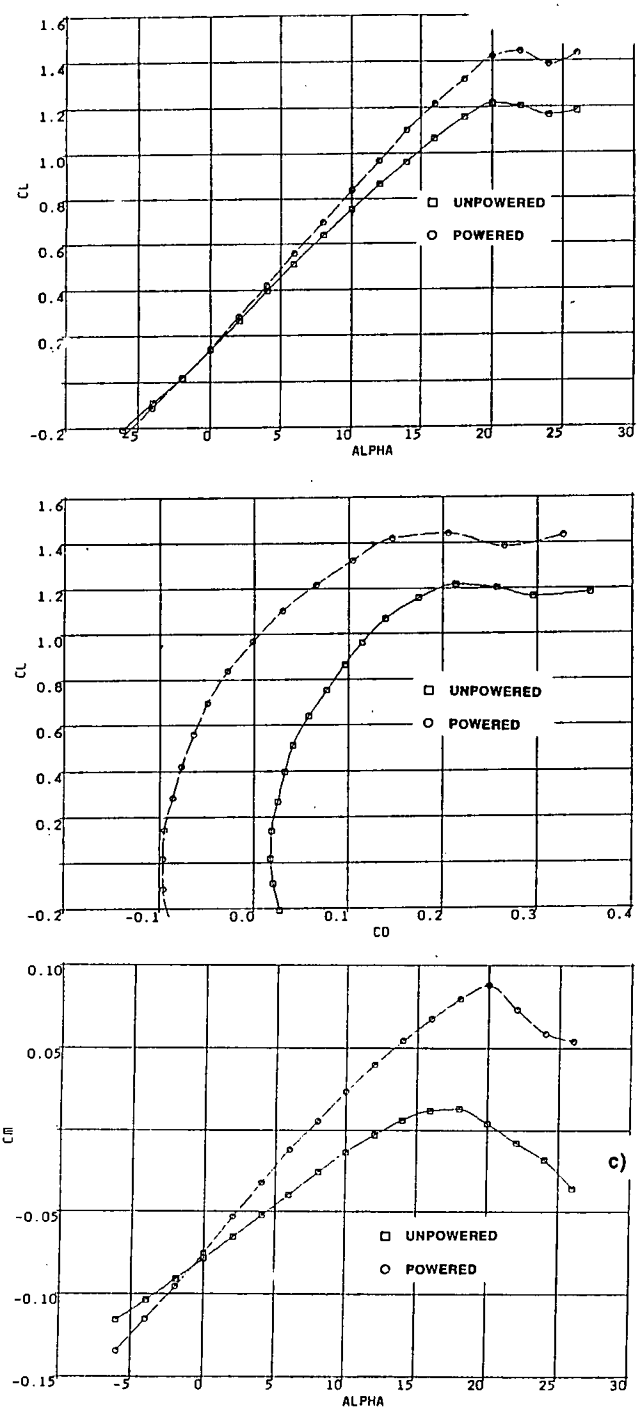


FIGURE 4

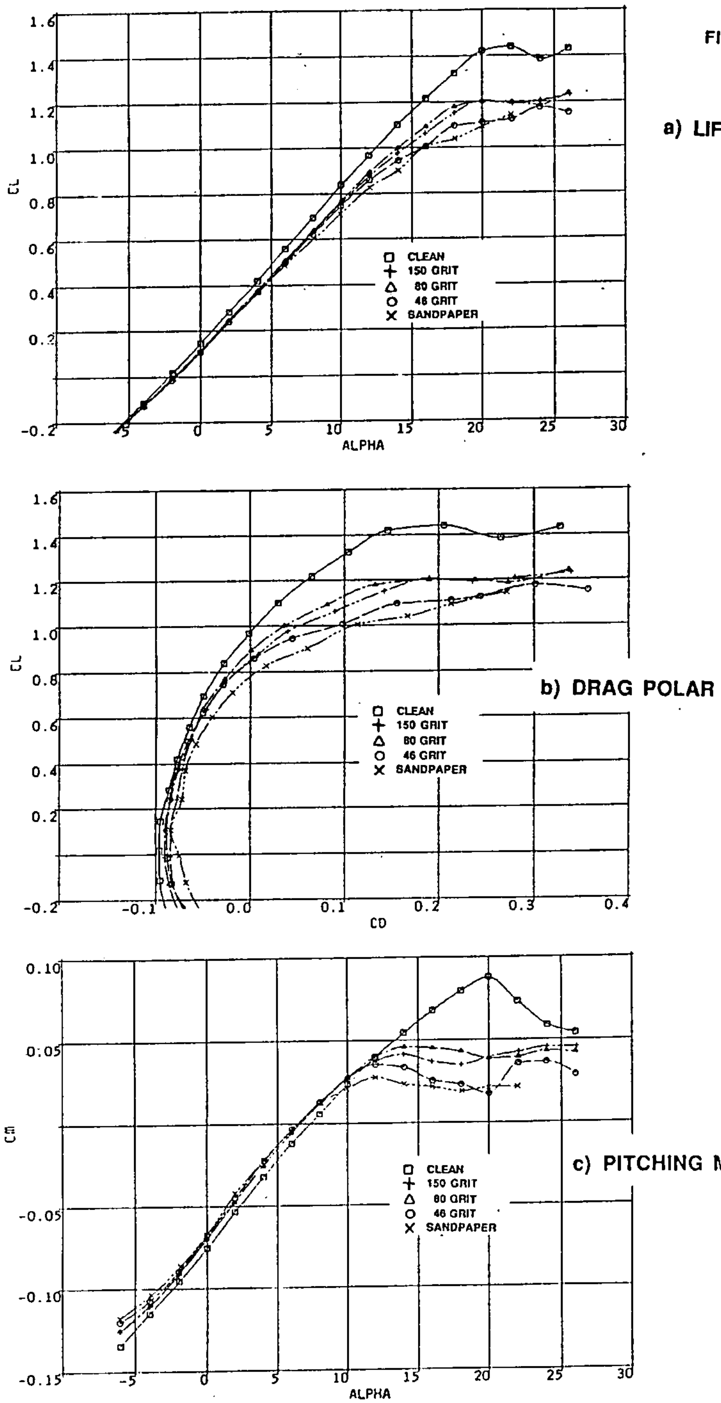
a) LIFT

b) DRAG

c) PITCHING MOMENT

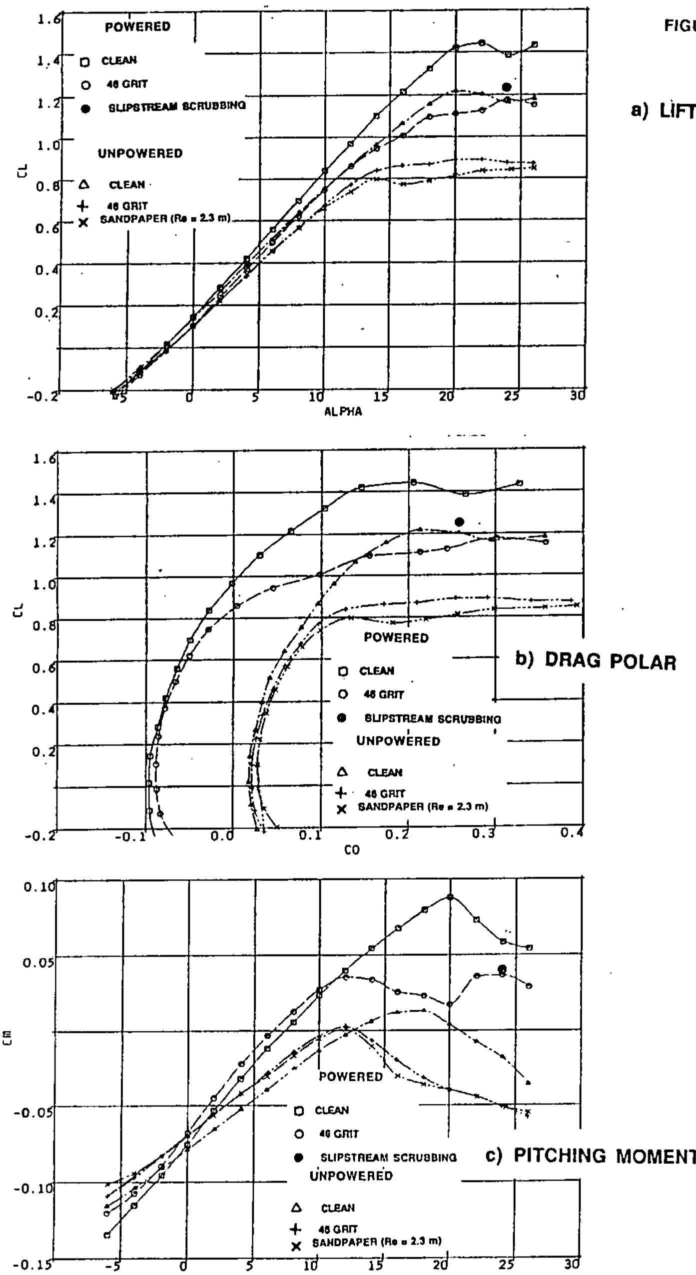
COMPARISON OF POWERED AND UNPOWERED CLEAN WING PERFORMANCE $C_{T_p} = 0.115$, Re = 1.3 m

FIGURE 5



EFFECT OF UNIFORM ROUGHNESS ON POWERED WING PERFORMANCE, C_{T_p} = 0.115, Re = 1.3 m

FIGURE 6



COMPARISON OF EFFECTS OF UNIFORM ROUGHNESS ON POWERED AND UNPOWERED WING, 46 GRIT, 30% COVERAGE, $C_{T_p} = 0.115$, Re = 1.3×10^6

19

PROPELLER THRUST, NORMAL FORCE AND PITCHING MOMENT

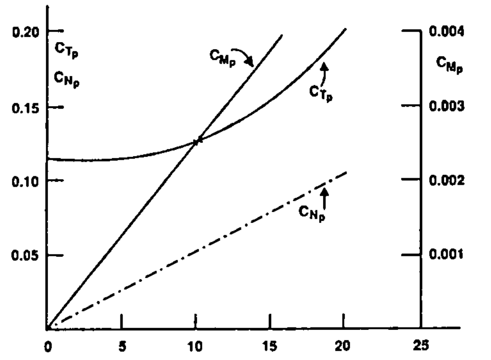
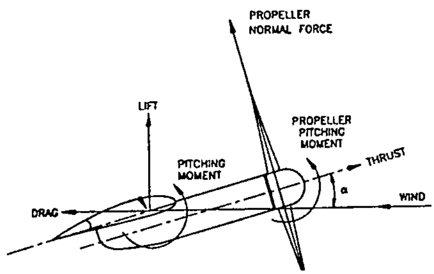


FIGURE 7



CONVENTION OF FORCES, MOMENTS AND ANGLE

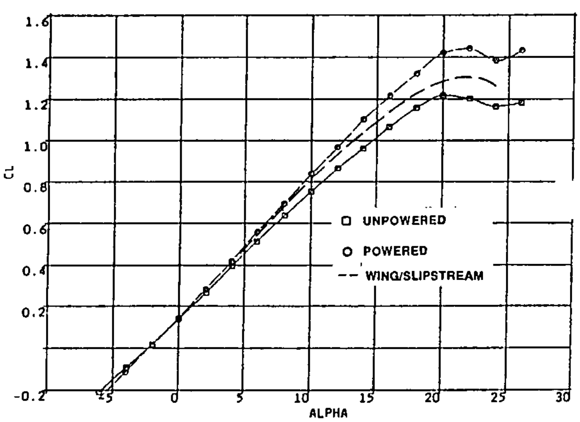
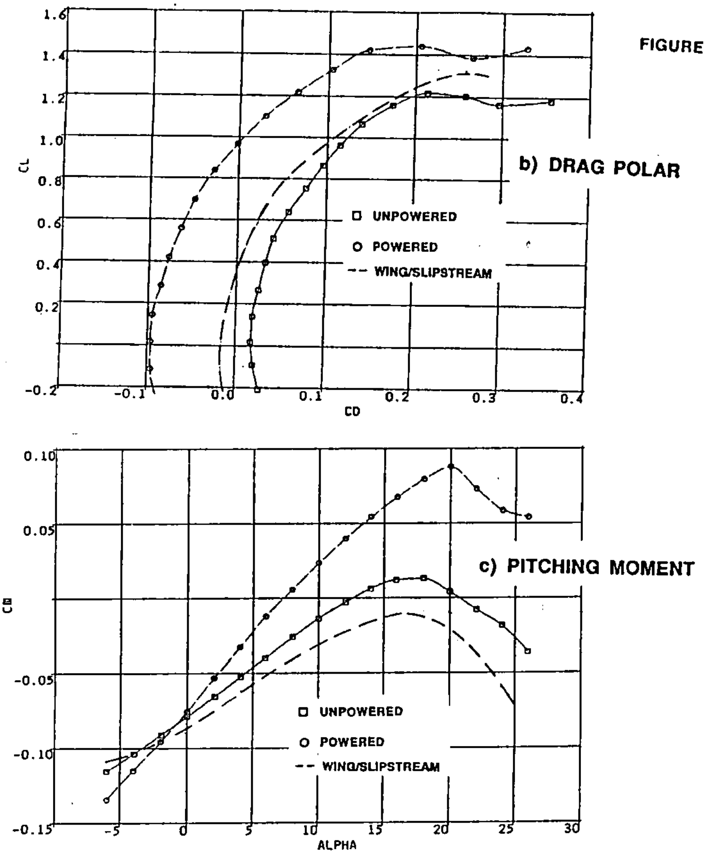


FIGURE 8

a) LIFT

REMOVAL OF PROPELLER REACTIONS FROM THE CLEAN, POWERED WING, C_{T_p} = 0.115, Re = 1.3 m

FIGURE 8



REMOVAL OF PROPELLER REACTIONS FROM THE CLEAN, POWERED WING, $C_{T_p} = 0.115$, Re = 1.3 m

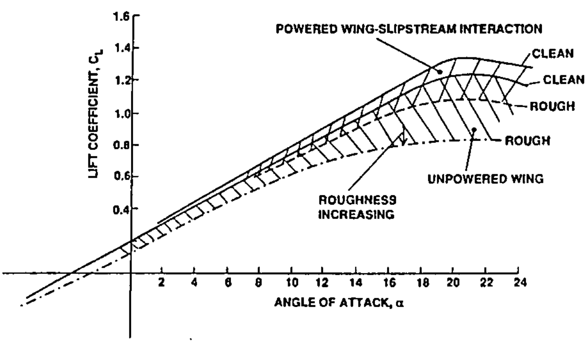


FIGURE 9

COMPARISON OF LIFT LOSS DUE TO DISTRIBUTED ROUGHNESS, OF AN UNPOWERED WING, AND A POWERED WING WITH PROPELLER REACTIONS REMOVED. $C_{T_p} = 0.115$, Re = 1.3×10^6

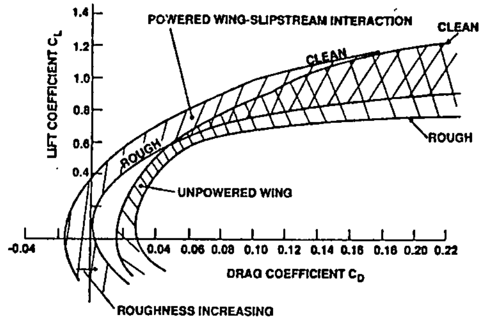
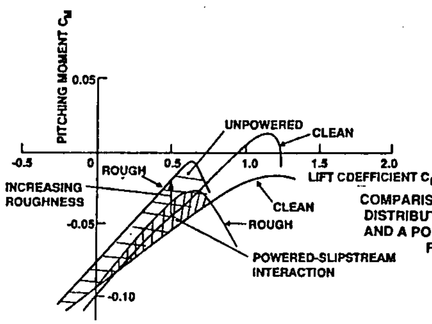


FIGURE 9

COMPARISON OF DRAG LOSSES DUE TO DISTRIBUTED ROUGHNESS, OF AN UNPOWERED WING AND A POWERED WING WITH PROPELLER REACTIONS REMOVED.
$C_{T_p} = 0.115$, $Re = 1.3 \times 10^6$



COMPARISON OF PITCHING MOMENT CHANGES DUE TO DISTRIBUTED ROUGHNESS, OF AN UNPOWERED WING AND A POWERED WING WITH PROPELLER REACTIONS REMOVED. $C_{T_p} = 0.115$, $Re = 1.3 \times 10^6$

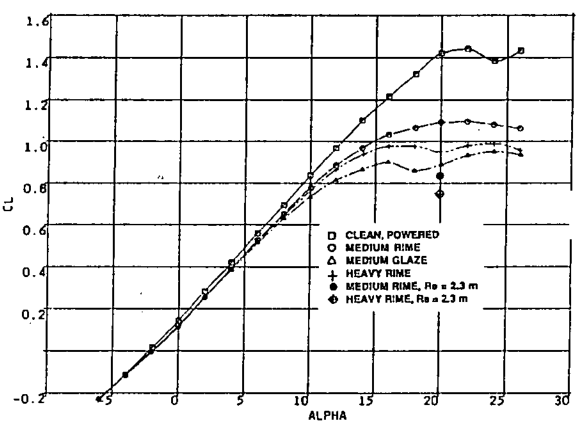
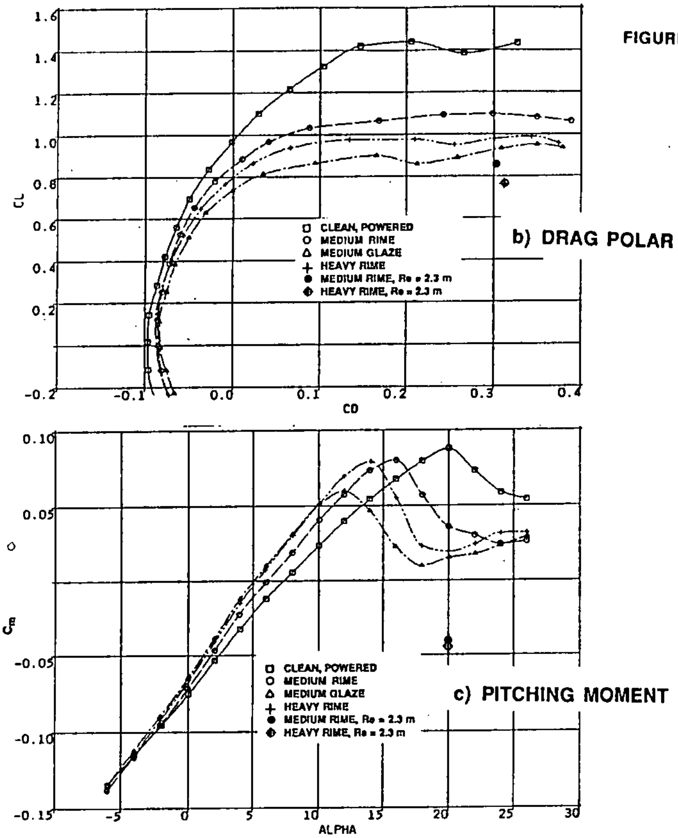


FIGURE 10

a) LIFT

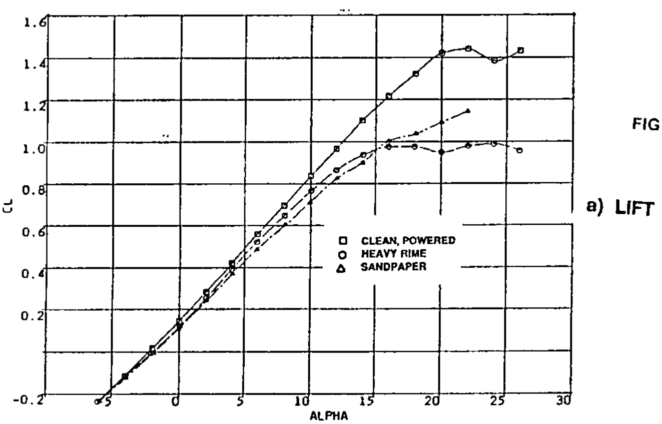
EFFECT OF LEADING EDGE ICE ON POWERED WING PERFORMANCE,
$C_{T_p} = 0.115$, $Re = 1.3$ m

FIGURE 10



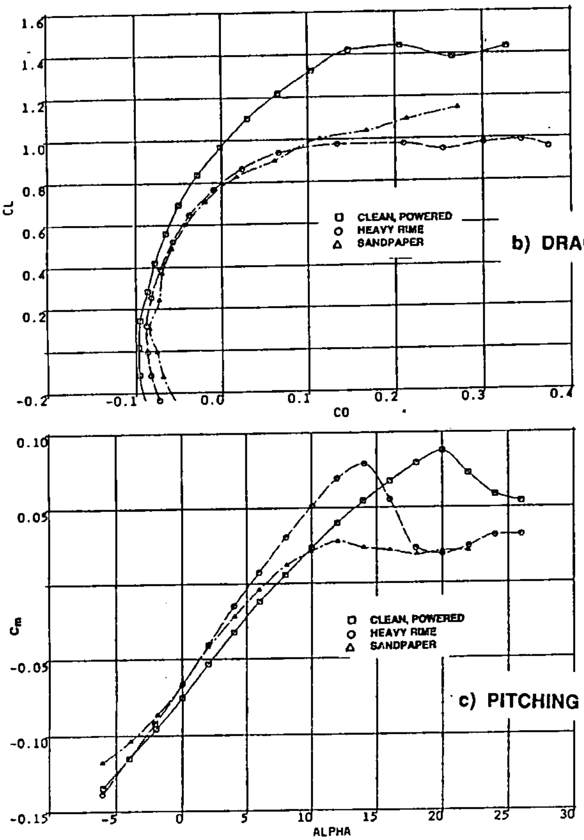
EFFECT OF LEADING EDGE ICE ON POWERED WING PERFORMANCE, C_{T_p} = 0.115, Re = 1.3 m

FIGURE 11



COMPARISON OF LEADING EDGE ICE AND UNIFORM ROUGHNESS, C_{T_p} = 0.115, Re = 1.3 m

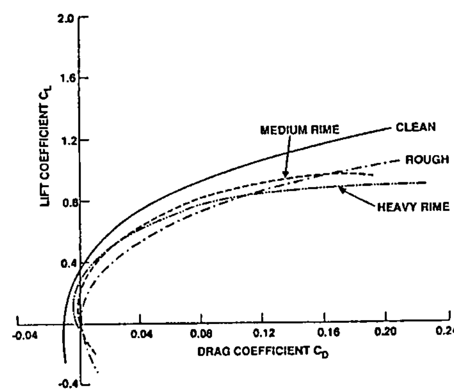
FIGURE 11



b) DRAG POLAR

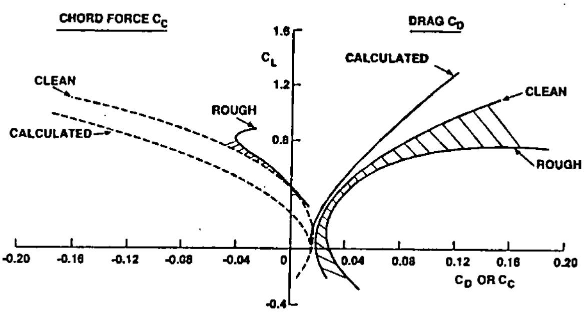
c) PITCHING MOMENT

COMPARISON OF LEADING EDGE ICE AND UNIFORM ROUGHNESS, $C_{T_p} = 0.115$, Re = 1.3 m

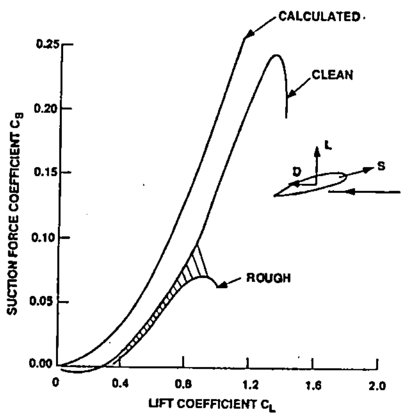


<u>DRAG POLAR</u>
COMPARISON OF DISTRIBUTED ROUGHNESS (50 GRIT SANDPAPER) AND LEADING EDGE ICE FOR POWERED WING-SLIPSTREAM INTERACTION (PROPELLER REACTIONS REMOVED) $C_{T_p} = 0.115$, Re = 1.3×10^6

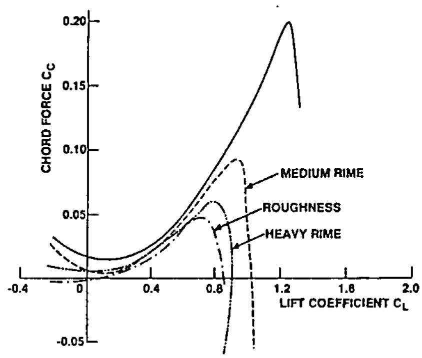
FIGURE 12



COMPARISON OF DRAG AND CHORD FORCE FOR CLEAN AND ROUGHENED UNPOWERED WING (50 GRIT SANDPAPER)



LEADING EDGE SUCTION FORCE COEFFICIENT FOR CLEAN AND ROUGHENED UNPOWERED WING



CHORD FORCE vs LIFT COEFFICIENT
COMPARISON AND LEADING EDGE ICE FOR POWERED WING-SLIPSTREAM INTERACTION (PROPELLER REACTIONS REMOVED) $C_{T_p} = 0.115$, $Re = 1.3 \times 10^6$

Appendix 6

Freezing Precipitation on Lifting Surfaces

Myron M. Oleskiw, Ph.D.

April 23, 1990
Updated September 1991

National Research Council Canada
Institute for Mechanical Engineering
Cold Regions Engineering

Conseil national de recherches Canada
Institut de génie mécanique
Ingénerie des régions froides

NRC CNRC

Freezing Precipitation on Lifting Surfaces

M. M. Oleskiw

Technical Report

Rapport technique

1991/09

IME-CRE-TR-003
NRC No. 32124

UNLIMITED
UNCLASSIFIED

ILLIMITÉE
NON CLASSIFIÉE

Canada

UNLIMITED
UNCLASSIFIED

ILLIMITÉE
NON CLASSIFIÉE

FREEZING PRECIPITATION ON LIFTING SURFACES

PRÉCIPITATION GLAÇANTE SUR LES SURFACES PORTANTES

M. M. Oleskiw, Ph.D.

Institute for Mechanical Engineering
Technical Report

Institut de génie mécanique
Rapport technique

1991/09

IME-CRE-TR-003
NRC no. 32124

R. Frederking, Head/Chef
Cold Regions Engineering Program/
Programme d'ingénierie des régions froides

J. Ploeg
Director General/
Directeur général

ABSTRACT

As a part of its investigation, the Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario asked the National Research Council to estimate the quantity and form of the precipitation adhering to the Fokker F-28's wings during its ill-fated take-off attempt.

Since precipitation measurements at Dryden were not taken sufficiently frequently to determine the quantity of precipitation which fell during the aircraft's stopover at Dryden, an empirical formula, utilizing the visibility recorded by the weather observer and by a transmissometer, was used to provide an estimate of 1.38 mm of snowfall.

A thermodynamic analysis of the influence of the take-off roll upon the precipitation layer on the wings indicated that no significant change occurred during this interval. However, the wing tank fuel temperature during the final stopover was calculated to be below 0°C. Therefore, heat removed from the lower part of the precipitation layer could have caused it to freeze. As a result, when the upper snow layer was blown away during the take-off roll, it likely left behind, on the wing, a very rough ice layer with potentially serious effects on the aircraft's aerodynamic performance.

RÉSUMÉ

La Commission d'enquête sur l'écrasement d'un avion d'Air Ontario à Dryden (Ontario) a demandé au Conseil national de recherches Canada d'estimer la quantité et la forme de précipitation qui a adhérée aux ailes du Fokker F-28 au moment de sa malheureuse tentative de décollage.

Puisque les mesures de précipitation à Dryden n'ont pas été prises assez fréquemment pour déterminer la quantité de neige qui a tombée durant l'escale de l'avion à Dryden, une formule empirique, utilisant la visibilité notée par l'observateur météorologique et par un transmissomètre, a été employée pour donner une estimation de 1.38 mm de la chute de neige.

Une analyse thermodynamique de l'influence du roulement au décollage sur la couche de précipitation sur les ailes a indiqué qu'il n'y avait pas eu de changement considérable pendant cet intervalle. Toutefois, la température du carburant dans les réservoirs des ailes de l'avion durant l'escale finale était moins de 0°C. Par conséquent, la chaleur transmise de la plus base partie de la couche de précipitation aurait pu geler celle-ci. À cause de ça, quand la plus haute couche de neige s'est envolée durant le roulement au décollage, elle a probablement laissé une couche de givre très rugueuse sur les ailes, avec des effets possiblement sérieux sur le fonctionnement aérodynamique de l'avion.

CONTENTS

CONTENTS (Cont'd)

LIST OF TABLES

CONTENTS (Cont'd)

LIST OF SYMBOLS

Symbol		Units
a	Constant	K^3
a_∞	Speed of sound in the freestream flow	$m \cdot s^{-1}$
C	Mean aerodynamic chord of the wing	m
C_p	Pressure coefficient	
c_p	Specific heat at constant pressure	$J \cdot K^{-1} \cdot kg^{-1}$
C_s	Mass concentration of the snowflakes in the air	$kg \cdot m^{-3}$
D	Cylinder diameter	m
$e_{0°C}$	Saturation vapour pressure over the precipitation layer's surface	kPa
e_a	Saturation vapour pressure just outside the boundary layer	kPa
h	Convective heat transfer coefficient	$W \cdot m^{-2} \cdot K^{-1}$
h_C	Local convective heat transfer coefficient over a wing	$W \cdot m^{-2} \cdot K^{-1}$
h_D	Local convective heat transfer coefficient over a cylinder	$W \cdot m^{-2} \cdot K^{-1}$
I	Mass flux of accreting snowflakes	$kg \cdot m^{-2} \cdot s^{-1}$
k	Constant	
k_a	Thermal conductivity of air	$W \cdot m^{-1} \cdot K^{-1}$
k_f	Thermal conductivity of wing tank fuel	$W \cdot m^{-1} \cdot K^{-1}$
k_m	Fraction of precipitation layer in liquid form	$W \cdot m^{-1} \cdot K^{-1}$
k_p	Thermal conductivity of the precipitation layer	$W \cdot m^{-1} \cdot K^{-1}$
k_s	Thermal conductivity of aluminum	$W \cdot m^{-1} \cdot K^{-1}$
L_e	Latent heat of evaporation at 0°C	$J \cdot kg^{-1}$
L_f	Latent heat of fusion	$J \cdot kg^{-1}$
m_1	Mass of liquid 1	kg
m_2	Mass of liquid 2	kg
Nu_C	Wing Nusselt number	
Nu_D	Cylinder Nusselt number	
p_a	Local air pressure just outside the boundary layer	kPa
p_∞	Static pressure	kPa
q_a	Heat flux to cool the precipitation layer to the freezing point	$W \cdot m^{-2}$
q_c	Heat flux due to convection	$W \cdot m^{-2}$
q_e	Heat flux due to evaporation or sublimation	$W \cdot m^{-2}$
q_f	Heat flux to freeze the unfrozen portion of the precipitation layer	$W \cdot m^{-2}$
q_i	Heat flux due to conduction into the wing of the aircraft	$W \cdot m^{-2}$
q_k	Heat flux from kinetic energy of the impinging snowflakes	$W \cdot m^{-2}$
q_m	Heat flux from freezing the partially-melted impinging snowflakes	$W \cdot m^{-2}$
q_s	Heat flux from short and long-wave radiation	$W \cdot m^{-2}$
q_v	Heat flux from frictional heating of the air in the boundary layer	$W \cdot m^{-2}$
R	Precipitation rate	mm/h

CONTENTS (Cont'd)

Symbol		Units
r	Recovery factor for viscous heating	
Re_C	Wing Reynold's number	
Re_D	Cylinder Reynold's number	
T	Thickness of accumulated snow layer	m
T_f	Thickness of a given volume of wing fuel	m
T_p	Thickness of precipitation layer	mm
T_s	Thickness of the aluminum skin of the aircraft wing	m
t_a	Local air temperature just outside the boundary layer	°C
t_f	Temperature of wing tank fuel	°C
t_{fi}	Fuel temperature before flight	°C
t_{ft}	Fuel temperature after flight at altitude of duration τ	°C
t_m	Temperature of mixture of liquids 1 and 2	K
t_p	Temperature of the precipitation layer	°C
t_T	Total air temperature at altitude	°C
t_w	Wet-bulb temperature	°C
t_1	Temperature of liquid 1	K
t_2	Temperature of liquid 2	K
V	Visibility	km
V_a	Local air velocity	$m \cdot s^{-1}$
V_∞	Aircraft airspeed	$m \cdot s^{-1}$
β	Local collision efficiency	
ν_∞	Kinematic air viscosity	$m^2 \cdot s^{-1}$
ρ_s	Snow density	$kg \cdot m^{-3}$
ρ_∞	Freestream air density	$kg \cdot m^{-3}$
σ	Stefan-Boltzmann constant	$W \cdot m^{-2} \cdot K^{-4}$
τ	Time to freeze snow layer	s
τ_a	Duration of flight at altitude	s

FREEZING PRECIPITATION ON LIFTING SURFACES

1.0 INTRODUCTION

In a letter dated 1989 June 20, Mr. D. J. Langdon of the Canadian Aviation Safety Board (now the Transportation Safety Board of Canada, CTSB) wrote to the Low Temperature Laboratory (now Cold Regions Engineering) of the National Research Council (NRC) requesting assistance in the investigation of the 1989 March 10 accident to Fokker F-28 Mk1000, registration C-FONF, at Dryden, Ontario. Witness testimony to that point had indicated that snow had been seen to fall on the wings of the aircraft during its station-stop at Dryden, and some witnesses had reported that the snow had appeared to turn to ice during the take-off roll.

Mr. Langdon (acting on behalf of Mr. J. Jackson, an advisor to the Inquiry) requested that the following analyses be performed:

- an estimation of the weight of snow per unit area which could have collected on the aircraft prior to take-off;
- a determination of whether or not wet snow crystals could have stuck to the leading edge of the wing during take-off; and
- a determination of whether or not snow on the surface of the wing could have turned to ice (as reported by witnesses) through the mechanisms of adiabatic and evaporative cooling of the airflow over the wing.

This report addresses these requests in the three sections which follow. Section 2 attempts to estimate the amount of snow which would have accumulated on the aircraft during its station-stop at Dryden. Section 3 presents an analysis of adiabatic and evaporative cooling of the wing and its effects on the precipitation extant and impinging on the wing during the take-off roll. Finally, Section 4 discusses the possibility of the wing surface being cooled by the fuel in the wing tanks, and what effect that might have had on the precipitation.

2.0 QUANTITY OF PRECIPITATION ACCUMULATED

2.1 Precipitation Recorded on the Surface Weather Record

With respect to estimating total precipitation accumulation on the upper surfaces of the Fokker F-28 aircraft during its station-stop at Dryden, the aircraft movements of interest are: the time of arrival from Thunder Bay (17:40 UTC); and the time of take-off from Dryden (18:10 UTC). During this time period, the weather details of interest at the Dryden Airport, as observed and reported on the Atmospheric Environment Service (AES) Surface Weather Record, are noted in Table 1. Column 1 shows the recorded

Table 1. Weather at Dryden, Ontario on 1989 March 10

TIME (UTC)	DRY BULB TEMP. (°C)	DEW POINT TEMP. (°C)	WEATHER	VISIBILITY (mi)	SNOWFALL RATE WATER EQUIVALENT (mm/h)
17:00	1.0	-4.0	very light snow grains	14	0
17:07			light snow grains	14	0 to 2.5
17:23			-	14	0
17:42			light snow	14	0 to 2.5
17:48			light snow	2.5	0 to 2.5
18:00	0.7	-3.0	light snow	2.5	0 to 2.5
18:06			moderate snow	0.375	2.6 to 7.5
18:11			light snow	0.75	0 to 2.5
18:12	0.3	-2.1	light snow	0.75	0 to 2.5

time of the observation. Columns 2 and 3 respectively give the dry bulb and dew point temperatures as measured by the observer. Column 4 records the type of weather, including the type of precipitation and its rate of accumulation. The visibility indicated in Column 5 was obtained by determining the most distant object visible to the observer. The water equivalent of the snowfall rate (quantity of water which would be measured if the snow was melted) is presented in Column 6. This rate is derived from the precipitation rate in Column 4 by the definitions presented in the AES Manual of Observations (MANOBS).

The ranges of snowfall rate indicated in Table 1 are not sufficiently precise to allow a reasonable estimate of the amount of snowfall during the F-28's station-stop. Fortunately, precipitation accumulation may also be estimated from visibility data. Two sources of visibility data from the Dryden Airport are available for analysis: the meteorological observer's data as given in Table 1; and recordings from a Transport Canada transmissometer.

2.2 Relating Precipitation Rate to Visibility

Stallabrass (1987) performed a series of experiments relating snowfall concentration with visibility, and snowfall concentration with precipitation rate. The correlation coefficient for the best-fit line relating the former two quantities for all types of snow crystals was 94.3%. Stallabrass stated that the correlation between the latter two quantities was expected to be poorer based on earlier predictions by other researchers. This was believed to be a function of the considerable variability in terminal fall velocity of the ice crystals and snowflakes, depending upon, for example, whether or not the crystals and flakes were heavily rimed or partially melted. This variability would tend to affect the rate of precipitation more than the mass concentration in the air. Despite these difficulties, Stallabrass suggested that based upon his measurements, precipitation rate R (mm/h water equivalent) could be estimated from visibility V (km) by the relationship

$$V = 0.919R^{-0.64} \tag{1}$$

with a correlation coefficient of 0.91. Inverting this relationship with V in miles gives

$$R = 0.417\,V^{-1.56}\ ; \tag{2}$$

and with V in feet gives

$$R = 2.68\times 10^{5}\,V^{-1.56}. \tag{3}$$

Based upon Stallabrass's observations, the extreme values of the precipitation rate measured for a given visibility were approximately between 1/3 to 3 times those predicted by the best-fit line.

Given this degree of variability in the precipitation rate versus visibility relationship, an attempt has been made to compare two predictions of total precipitation accumulation at Dryden versus the recorded precipitation accumulation. Two sources of visibility data have been used: the Surface Weather Record; and transmissometer data. The actual precipitation accumulation has been assumed to be that noted by the meteorological observer during the 6 hour interval between 18:00 UTC on March 10 and 00:00 UTC on March 11. Unfortunately, no optional measurement of precipitation accumulation was noted between the measurements at these two mandatory times.

2.3 Precipitation Inferred from Surface Weather Record Visibility

Table 2 displays the estimation of total water-equivalent snowfall accumulation at Dryden between March 10 18:00 UTC and March 11 00:00 UTC as derived from the visibility data recorded on the AES Surface Weather Record. Column 1 indicates the time at which an interval begins with approximately constant visibility. Column 2 gives the length of the time interval, while Column 3 shows the visibility. The precipitation rate derived from Column 3 using Eq. 2 is given in Column 4. The accumulation of snowfall in each time interval (Column 2 multiplied by Column 4) is displayed in Column 5. The total interval length (3.8 h) is not equal to 6 h because no snow was observed to fall

Table 2. Integration of precipitation rate based upon the meteorological observer's visibility estimates for the period between March 10 18:00 UTC and March 11 00:00 UTC.

BEGINNING OF TIME INTERVAL (UTC)	INTERVAL LENGTH (h)	VISIBILITY (mi)	WATER EQUIVALENT SNOWFALL RATE (mm/h)	WATER EQUIVALENT SNOWFALL OVER TIME INTERVAL (mm)
18:00	0.10	2.5	0.10	0.01
18:06	0.08	0.375	1.93	0.15
18:11	0.52	0.75	0.65	0.34
18:42	0.30	2.5	0.10	0.03
19:00	0.35	3.0	0.08	0.03
19:21	0.65	5.0	0.03	0.02
20:52	0.13	4.0	0.05	0.01
21:00	0.12	2.5	0.10	0.01
21:07	0.30	1.5	0.22	0.07
21:25	0.37	1.0	0.42	0.16
21:47	0.30	0.5	1.23	0.37
22:05	0.33	0.75	0.65	0.21
22:25	0.25	1.0	0.42	0.11
TOTALS:	3.80			1.52

during some of the 6 h interval. The total accumulated water-equivalent snowfall is predicted as 1.52 mm. This is significantly less than the total accumulated water-equivalent snowfall recorded on the Surface Weather Record of 6.0 mm. This discrepancy will be discussed in more detail below.

2.4 Precipitation Inferred from Transmissometer Data

Table 3 presents data recorded by and interpreted from the Transport Canada transmissometer which was located near the runway on which C-FONF landed and departed on March 10. The strip-chart recorded by this device has been analysed by Mr.

Table 3. Integration of precipitation rate based upon the Transport Canada Transmissometer's visibility estimates for the 6 h period between March 10 18:00 UTC and March 11 00:00 UTC.

BEGINNING OF TIME INTERVAL (UTC)	INTERVAL LENGTH (h)	TRANSMISSIVITY (%)		VISIBILITY (ft)		WATER EQUIVALENT SNOWFALL RATE (mm/h)		WATER EQUIVALENT SNOWFALL OVER TIME INTERVAL (mm)	
		RAW	CORR.	RAW	CORR.	RAW	CORR.	RAW	CORR.
18:00	0.08	76	70	2600	2050	1.26	1.83	0.10	0.15
18:05	0.08	74	68	2400	1900	1.43	2.06	0.11	0.16
18:10	0.08	82	76	3700	2600	0.73	1.26	0.06	0.10
18:15	0.08	87	81	5000	3500	0.45	0.79	0.04	0.06
18:20	0.08	83	77	4000	2800	0.64	1.12	0.05	0.09
18:25	0.08	85	79	4500	3000	0.54	1.01	0.04	0.08
18:30	0.92	90	84	6000	4200	0.34	0.60	0.31	0.55
19:25	0.58	91	85	6000	4200	0.34	0.60	0.20	0.35
20:55	0.08	85	79	4500	3000	0.54	1.01	0.04	0.08
21:00	0.08	78	72	2900	2200	1.06	1.64	0.08	0.13
21:05	0.08	82	76	3700	2600	0.73	1.26	0.06	0.10
21:10	0.17	83	77	4000	2800	0.64	1.12	0.11	0.19
21:20	0.08	78	72	2900	2200	1.06	1.64	0.08	0.13
21:25	0.33	54	48	2600	2050	1.26	1.83	0.42	0.60
21:45	0.08	58	52	1400	1100	3.31	4.83	0.26	0.39
21:50	0.08	54	48	1250	1050	3.95	5.19	0.32	0.42
21:55	0.08	61	55	1450	1300	3.14	3.72	0.25	0.30
22:00	0.08	67	61	1850	1500	2.14	2.97	0.17	0.24
22:05	0.08	68	62	1900	1550	2.06	2.83	0.16	0.23
22:10	0.17	83	77	4000	2800	0.64	1.12	0.11	0.19
22:20	0.33	88	82	5500	3700	0.39	0.73	0.13	0.24
TOTALS:	3.70							3.10	4.78

B. Sheppard, Senior Instrument Meteorologist, Data Acquisition Systems Branch, Atmospheric Environment Service, Environment Canada. His interpretation of these data has been provided to the Inquiry in the form of a report. Mr. Sheppard has noted that at certain intervals, the transmissometer turns off its transmitting light for a short time to determine the amount of background skylight received. Two such intervals were recorded during the period of interest, and both show values of about 6%. One possible interpretation of this result, as indicated by Mr. Sheppard, is that all values taken from the transmissometer strip-chart should be reduced by 6%.

Column 1 of Table 3 indicates the time at which an interval, with approximately constant visibility (as interpreted from the sensor's strip-chart), begins. Column 2 gives the length of this time interval. Column 3 shows a representative value of transmissivity for the interval as interpreted from the strip-chart. Column 4's transmissivity has been obtained from Column 3's "raw" value by applying the 6% "correction" discussed above. Columns 5 and 6 display the visibility values obtained from Columns 3 and 4. Columns 7 and 8 give the water-equivalent snowfall rate derived from Column 5 and 6 using Eq. 3. Finally, Columns 9 and 10 exhibit the accumulated water-equivalent snowfall obtained by multiplying Column 2 by Columns 7 and 8, respectively.

The total interval length at the bottom of Column 2 of Table 3 is, to within the resolution of the interpretation of the strip-chart, the same as for the comparable quantity in Table 2. The total accumulated water-equivalent snowfall values displayed at the bottoms of Columns 9 and 10 are significantly higher than the 1.52 mm of Table 2. The "corrected" value is 80% of the 6.0 mm measured over the interval by the meteorological observer. However, in comparing the "corrected" visibility values in Table 3 with those made by the meteorological observer, it is evident that the subtraction of 6% from all "raw" transmissivity values to obtain the "corrected" ones has resulted in "corrected" visibility values which are significantly lower than those noted by the observer. A case in point is the time period surrounding 19:15, where the observer recorded a visibility value of 3 mi (15,840 ft) as compared to the "corrected" value of 4200 ft. Evidently, while this correction may be appropriate for lower values of tranmissivity, it should not be equally applied to "raw" values near the upper limit of transmissivity (in the range of 87 to 100%). Even the "raw" value of transmissivity at this time indicates a lower value of visibility (6000 ft) than noted by the observer. This may be attributed to the values of transmissivity between 18:30 and 20:00 UTC (90 or 91%) which should actually be interpreted as greater than 6000 ft. The maximum water-equivalent snowfall rate derived from the observer's visibility estimates during this period is 0.10 mm/h. If the transmissometer's values are reduced from 0.34 mm/h, then the accumulated water-equivalent snowfall over this 1.5 h period would be reduced from 0.51 mm to 0.15 mm. That would reduce the accumulated water-equivalent snowfall for the 6 h period from 3.10 mm to 2.74 mm.

The net result of this analysis is to indicate that if the observer's accumulated water-equivalent snowfall is to be "calibrated" to achieve 6.0 mm over the 6 h period, then the value of 1.52 mm from Table 2 must be multiplied by a factor of 3.95. If the transmissometer's "raw" accumulated water-equivalent snowfall (corrected for those periods when the transmissivity is 87 to 100%) is compared to the observed amount, the multiplicative "calibration" factor is 2.19.

2.5 Estimating Precipitation During C-FONF's Station Stop at Dryden

Returning to the period of C-FONF's station-stop at Dryden, Table 4 contains data from both of these methods for this time period. Columns 1 and 2 once again indicate the

Table 4. Integration of precipitation rate during the station-stop of C-FONF at Dryden on 1990 March 10.

BEGINNING OF TIME INTERVAL (UTC)	INTERVAL LENGTH (h)	TRANSMISSOMETER READING (%)	VISIBILITY (ft)		WATER EQUIVALENT SNOWFALL RATE (mm/h)		WATER EQUIVALENT SNOWFALL OVER TIME INTERVAL (mm)	
			TRANS.	OBS.	TRANS.	OBS.	TRANS.	OBS.
17:40	0.083	93	73920	73920	0.01	0.01	0.00	0.00
17:45	0.083	91	73920	73920	0.01	0.01	0.00	0.00
17:50	0.083	91	13200	13200	0.10	0.10	0.01	0.01
17:55	0.083	92	13200	13200	0.10	0.10	0.01	0.01
18:00	0.033	86	4700	13200	0.50	0.10	0.02	0.00
18:02	0.033	76	2600	13200	1.26	0.10	0.04	0.00
18:04	0.033	68	1900	13200	2.05	0.10	0.07	0.00
18:06	0.033	74	2400	1980	1.43	1.93	0.05	0.06
18:08	0.033	79	3000	1980	1.01	1.93	0.03	0.06
TOTALS:	0.50						0.23	0.14

beginning of the time interval and the length of the time interval respectively. The transmissometer reading is displayed in Column 3. Columns 4 and 5 exhibit a representative visibility for the interval. Column 4's data are derived from Column 3 with a correction to the observer's values when the transmissometer reading is between 87 and 100%. The data in Column 5 are converted from the values taken from the

Surface Weather Record. Columns 6 and 7 give the water-equivalent snowfall rate as derived from Columns 4 and 5. Finally, Columns 8 and 9 tabulate the accumulated water-equivalent snowfall obtained from Columns 2, 6 and 7.

Totals over the 0.5 h time interval of the accumulated water-equivalent snowfall derived from the transmissometer and the observer's notes are 0.23 mm and 0.14 mm respectively. Multiplying these two values by their corresponding "calibration" factors (as determined above), produces best estimates of water-equivalent snowfall accumulation, while the aircraft was on the ground, of 0.50 mm and 0.55 mm. These accumulations are equivalent to a mass per unit area of 0.5 and 0.55 kg m^{-2}.

In order to determine the likely thickness of this layer of precipitation, we need to know its density. Estimating an appropriate value for the precipitation layer density when it has been formed through the accumulation of wet snow is rather difficult since it can vary depending upon the conditions of snowflake formation and also upon the heat balance within the layer itself. A simplification adopted by Makkonen (1989), which will be accepted here as well, is to utilize a statistical mean value for the snow density (ρ_s) of 400 kg·m^{-3}. The higher of the two estimates of water-equivalent snowfall accumulation then gives a best value for the thickness of the precipitation layer of T_p = 1.38 mm of snow. Because of the inherent uncertainty involved in estimating snow density and precipitation rate from visibility (especially when the crystals and snowflakes are wet), the level of confidence to attribute to this value is difficult to assess.

3.0 FREEZING OF THE ACCUMULATED PRECIPITATION

3.1 Thermodynamic Influences upon the Accumulated Precipitation Layer

The state (frozen/liquid) of the precipitation which had accumulated on the wings of Fokker F-28 C-FONF by the end of its station-stop and during the aircraft's take-off roll at Dryden on 1989 March 10 can be estimated through an analysis of the thermodynamic influences upon this precipitation layer.

While the aircraft was parked near the terminal building, the precipitation layer would have been influenced by: the temperature and humidity of the surrounding air; the ambient wind speed; the quantity and temperature of continuing precipitation; the solar and long-wave radiation; and the conduction of heat in to or out of the aircraft wing. These influences could have allowed the layer to begin freezing, depending upon their relative values. Acting differentially upon the layer itself, would have been variations in the conductivity to the wing, depending upon the underlying structure of the wing and variations of its temperature. As the aircraft taxied to the runway and then began its take-off roll, the importance of the ventillation by the airflow over the wing would have increased.

In order to completely evaluate the relative contributions of these factors, an extensive numerical modelling effort of the differential equations involved would be necessary. However, because of the inherent uncertainty in estimating several of the factors, and as a result of the comparatively slow variation of the most important ones, the problem can be simplified somewhat. This section will deal with the heat balance during the aircraft take-off roll, while Section 4 will estimate net heating or cooling of the precipitation layer while the aircraft was stopped or taxiing.

3.2 Terms in the Heat Balance Equation

Following (in part) the lead of Makkonen (1984), a steady-state heat balance equation may be formulated for the processes influencing the precipitation layer:

$$q_a + q_f + q_v + q_k + q_m + q_s = q_c + q_e + q_i \,, \tag{4}$$

with the heat fluxes (heat per unit area and time: $J \cdot m^{-2} \cdot s^{-1}$) defined as:

- q_a the heat which must be released to cool the precipitation layer from the air temperature to the freezing point;
- q_f the heat which must be released to freeze the unfrozen portion of the precipitation layer;
- q_v the frictional heating of the air in the boundary layer;
- q_k the kinetic energy converted to heat during the impact of the impinging snowflakes;
- q_m the heat released in freezing the partially-melted impinging snowflakes;
- q_s the heat added by short and long-wave radiation;
- q_c the heat removed by convection;
- q_e the heat removed by evaporation (from a wet surface) or sublimation (from frozen surface); and
- q_i the heat conducted into the wing of the aircraft.

The terms on the left hand side of Eq. 4 are sources of heat which must be dissipated if the precipitation layer is to freeze completely. The terms on the right hand side are potential heat sinks.

If all of the terms in Eq. 4 except for q_f are evaluated for a given set of conditions and a location on the wing's surface, and Eq. 4 is rearranged to solve for q_f, then the value for q_f may be substituted into Eq. 5 to determine the time τ (s) required for the accumulated snow layer of thickness T (m) to freeze:

$$\tau = \frac{L_f \rho_s k_m T}{q_f} \tag{5}$$

where L_f is the latent heat of fusion (freezing of water = 3.34×10^5 J·kg^{-1}), ρ_s is the density of the precipitation layer, and k_m is the fraction of the precipitation layer which is in liquid form.

Incorporating a suitable value for the fraction of the precipitation layer which is liquid upon its formation can be a difficult task. Makkonen (1989) was able to derive a criterion to determine whether or not snowflakes would be partially melted as they fall. For the flakes to begin to melt during their fall, the wet-bulb temperature (t_w) must be greater than 0°C. The Surface Weather Record provided by AES indicates that t_w was near -0.7°C during the station-stop of C-FONF at Dryden. This suggests that the snowflakes should not have been melting during their fall through the layer of the atmosphere nearest the ground. To better estimate the state of the snowflakes upon impact, it would be necessary to have a temperature and dew-point sounding at Dryden from which to estimate the wet-bulb temperature aloft. However, an atmospheric sounding is not taken at Dryden on a regular basis. Since the estimated sounding provided by AES was derived from actual soundings at rather distant locations (the nearest available), it contains a uncertain amount of error. Witness testimony has indicated that the snow which fell during the station-stop was in the form of large wet flakes. Since the formation of such large flakes is greatly enhanced by partial melting of the ice crystals which accumulate to form the flakes, we must assume that the snowflakes were indeed partially melted upon impact. For the purposes of this section, a value for the water fraction of the falling snow of $k_m = 0.1$ has been utilized in the calculations which follow. Section 4 will present further discussion upon the fraction of the precipitation which was melted at impact with the wings and upon the effect of this estimate on the final results.

The above discussion of the thermodynamic influences upon falling snowflakes reveals an interesting and possibly surprising fact. The snowflakes may remain completely frozen because of the convective and evaporative cooling they experience even if the air temperature is above 0°C, provided that the dew-point temperature is sufficiently low (ie. the air is sufficiently dry) that the wet-bulb temperature remains below 0°C. Using the conditions at Dryden on 1989 March 10 1800 Z as an example, the flakes could remain completely frozen at an air temperature as high as about +1.3°C. In any case, unless the snowflakes were completely melted during their fall through a very warm layer of air, they would remain at 0°C. As a result, we shall assume that the precipitation layer formed by the snow on the aircraft wings was initially at the freezing temperature, and thus that no heat would be required to cool this layer to the freezing point (ie. $q_a = 0$).

The frictional heating of the air in the boundary layer will be given by:

$$q_v = \frac{h r V_a^2}{2 c_p} \tag{6}$$

where h is the convective heat transfer coefficient (see below), r is the recovery factor for viscous heating (either 0.85 for a laminar boundary layer, or 0.90 for a turbulent boundary layer), V_a is the local air velocity ($m \cdot s^{-1}$) just outside the boundary layer at a given location on the wing, and c_p is the specific heat of air at constant pressure ($1004\ J \cdot K^{-1} \cdot kg^{-1}$).

The local air velocity V_a at some point on the wing can be estimated in the following way. First, the local air pressure just outside the boundary layer (p_a) is obtained from a rearrangement of the following definition of the pressure coefficient (see, for example, Houghton and Brock, 1970):

$$C_p = \frac{p_a - p_\infty}{\frac{1}{2}\rho_\infty V_\infty^2} \tag{7}$$

where V_∞ is the airspeed ($m \cdot s^{-1}$) of the aircraft and p_∞ is the static pressure and ρ_∞ is the air density at a distance away from the wing. A value of $1.24\ kg \cdot m^{-3}$ has been used for ρ_∞. Appropriate values of C_p for the F-28 wing were obtained from Fokker. Next, the speed of sound (a_∞) in the freestream flow is calculated from:

$$a_\infty = \sqrt{\frac{1.4 p_\infty}{\rho_\infty}} \ . \tag{8}$$

Finally, the local air velocity V_a can be determined from:

$$V_a = \sqrt{5 a_\infty^2 \left[1 - \left(\frac{p_a}{p_\infty} \right)^{1/3.5} \right] + V_\infty^2} \ . \tag{9}$$

The kinetic energy of the snowflakes transferred to heat as the snowflakes collide with the wing's surface is:

$$q_k = \frac{IV_\infty^2}{2} \tag{10}$$

where I is the mass flux (kg·m^{-2}·s^{-1}) of the accreting snowflakes. The mass flux of the accreting snowflakes, in turn, is given by:

$$I = \beta C_s V_\infty \tag{11}$$

where β is the local collection efficiency of the wing for snowflakes and C_s is the mass concentration of the snowflakes in the air (kg·m^{-3}).

The heat released in freezing the melted fraction k_m (estimated to be 0.1) of the impinging snowflakes may be calculated from:

$$q_m = I k_m L_f \, . \tag{12}$$

The heat added by long-wave radiation can be approximated by:

$$q_s = \sigma a (t_\infty - t_{0°C}) \tag{13}$$

where σ is the Stefan-Boltzmann constant (3.24×10^{-9} J·m^{-2}·K^{-4}·s^{-1}), a = 8.1×10^{7} K^{3} and t_∞ is the air temperature in the freestream flow. Eq. 10 has been obtained by linearizing the equation for the difference in the long-wave radiation emitted by the precipitation surface and the snowflake-laden air. The effect of short-wave (solar) radiation on the wing's surface during the take-off roll is difficult to estimate because of the uncertainty of the quantity of radiation which would have been able to penetrate the precipitation falling at that time. As a result, it will be assumed that the precipitation was sufficiently heavy that little solar heating occurred at this time.

The heat removed by convection to the airflow passing over the wing is:

$$q_c = h(0°C - t_a) \tag{14}$$

where t_a, the local air temperature just outside the boundary layer at a given location on the wing, is obtained from:

$$t_a = t_\infty \left(\frac{p_a}{p_\infty} \right)^{2/7} \tag{15}$$

The heat removed by evaporation to the drier air flowing over the wing is:

$$q_e = \frac{hkL_e}{c_p p_a}(e_{0^\circ C} - e_a) \tag{16}$$

where $k = 0.62$, L_e is the latent heat of evaporation at 0°C (2.50×10^6 J·kg^{-1}) and $e_{0^\circ C}$ and e_a are the saturation vapour pressures over the precipitation layer's surface and the air just outside the boundary layer respectively.

If it is assumed for the moment that there is no conduction of heat into the wing of the aircraft (ie. $q_i = 0$), then Eq. 4 can now be evaluated locally at various points along the surface of the wing where the various terms may have differing relative values. In order to determine the variation of these terms during the take-off roll of the aircraft, three representative airspeeds (10, 30 and 50 m·s^{-1}) have been chosen to cover the interval of 0 to 130 kt (the airspeed interval during the take-off roll). The points which have been chosen along the wing's upper surface are at about 3% chord and at about 25% chord. The first point is intended to be representative of the portion of the wing where the pressure coefficient has its greatest negative value (at an angle of attack of -2°, during the take-off roll), whereas the second is typical of the upper wing surface in contact with the fuel cell inside the wing.

Returning for a moment to define the convective heat transfer coefficient (mentioned earlier):

$$h_C = \frac{k_a \mathrm{Nu}_C}{C} \tag{17}$$

where k_a is the thermal conductivity of air (2.41×10^{-2} J·m^{-1}·s^{-1}·K^{-1}), C is the mean aerodynamic chord of the wing (3.5 m), and Nu_C is the wing Nusselt number which in turn is related to Re_C, the wing Reynold's number. This latter quantity is defined by:

$$\mathrm{Re}_C = \frac{V_\infty C}{\nu_\infty} \tag{18}$$

where ν_∞ is the kinematic air viscosity. A representative value of 1.34×10^{-5} m^2·s^{-1} has been used.

Following Pais et al. (1988), the local Nusselt number on a smooth NACA 0012 airfoil (which shall be used to approximate the characteristics of the Fokker F-28 wing) over a Reynold's number range of $7.6\times10^5 \le \mathrm{Re}_C \le 2.0\times10^6$ can be approximated by

$$2.4 \leq \frac{\mathrm{Nu_C}}{\sqrt{\mathrm{Re_C}}} \leq 4.2 \tag{19}$$

over the first 5% of the airfoil surface at an angle of attack of 0°, and by

$$2.2 \leq \frac{\mathrm{Nu_C}}{\sqrt{\mathrm{Re_C}}} \leq 3.4 \tag{20}$$

near the 17% point (which will be assumed to be representative near the 25% point as well).

The wing Reynold's numbers for the three representative airspeeds chosen earlier (10, 30 and 50 $m \cdot s^{-1}$) are 2.61×10^6, 7.84×10^6 and 1.31×10^7 respectively. Since the latter two Reynold's numbers do not fall within the range of application of Eqns. 19 or 20, another attempt has been made to estimate the appropriate values over the first 5% of the airfoil. For the purposes of estimating the local convective heat transfer coefficient, the forward several percent of the wing's surface may be represented approximately by the front half of a cylinder with diameter D = 0.25 m. The local convective heat transfer coefficient over the cylinder is then:

$$h_D = \frac{k_a \mathrm{Nu_D}}{D} \tag{21}$$

with the cylinder Nusselt number $\mathrm{Nu_D}$ related to the cylinder Reynold's number, in turn given by:

$$\mathrm{Re_D} = \frac{V_\infty D}{\nu_\infty} . \tag{22}$$

The values of the cylinder Reynold's numbers for the three airspeeds are $\mathrm{Re_D} = 1.86\times10^5$, 5.60×10^5, and 9.36×10^5 respectively. Žukauskas and Žiugžda (1985) give the following relationships between cylinder Reynold's numbers and cylinder Nusselt number for flow over the appropriate portions of a smooth cylinder:

$$0.6 \leq \frac{\mathrm{Nu_D}}{\sqrt{\mathrm{Re_D}}} \leq 1.0 \tag{23}$$

for $\mathrm{Re_D} = 1.86\times10^5$, and

$$1.05 \leq \frac{Nu_D}{\sqrt{Re_D}} \leq 1.4 \tag{24}$$

for $Re_D = 7.7\times10^5$. The values for flow over a rough cylinder tend to be at least 2 to 3 times higher.

Two other quantities require calculation before Eq. 4 can be evaluated. The mass concentration of the snowflakes in the air C_s may be estimated from the visibility data of Section 2. During the time of take-off, the visibility was estimated to be 3000 ft by the transmissometer and 1980 ft by the AES observer. Using a mean value of about 2500 ft, and the relationship between visibility and mass concentration given by Stallabrass (1987):

$$C_s = 0.286\, V^{-1.286} \tag{25}$$

for C_s in g·m^{-3} and V in km, we obtain a value for the mass concentration of $C_s = 4.06\times10^{-4}$ kg·m^{-3}.

The other quantity requiring estimation is the local collision efficiency of the wing for snowflakes, β. Very little information is available regarding the collision efficiency of snowflakes with objects such as wings. However, King (1985) has been able to demonstrate that snowflake trajectories in the vicinity of the disturbed airflow around an aircraft wing or fuselage may be approximated by the trajectories of appropriately-sized droplets. It appears that the relationship between the droplet and snowflake sizes is related to their terminal velocity in air. Noting that the largest snowflakes in a study by Mellor and Mellor (1988) tended to have terminal velocities in the vicinity of 1.3 m·s^{-1}, and that water droplets of diameter 300 µm fall at about that same speed, the numerical model described in Oleskiw (1982) was used to calculate the trajectories of such droplets in the vicinity of a NACA 0012 airfoil under conditions equivalent to those during the take-off roll of C-FONF. These simulations indicated that for an airfoil of 3.5 m chord, in an airflow at a temperature of 0°C and a pressure of 97.1 kPa, the collision efficiencies at 10, 30 and 50 m·s^{-1} would be 25%, 31% and 32% respectively at a position about 0.03 C (ie. at a distance of about 3% of the chord length rearward from the nose. Further, it was determined that the droplets (and thus, by inference, the snowflakes) would not impact any further back along the wing than 0.19 C. Thus, the collision efficiency at 0.25 C would be 0%.

3.3 Evaluating the Heat Balance Equation

The derived values of the various terms in Eqns. 4 and 5 for each of the three airspeeds and each of the two positions along the wing surface are displayed in Table 5. Column 1 indexes the rows by Case Number. Columns 2 and 3 indicate the airspeed (V_∞) and the

Table 5. Derivation of the time required to freeze the layer of precipitation on the wings of C-FONF at various speeds during the takeoff roll and at two positions along the wing's surface.

CASE	CASE PARAMS.		CONVECT. HEAT TRANSFER COEFF.	SNOW MASS FLUX	PROPERTIES OF AIRFLOW JUST OUTSIDE BOUNDARY LAYER			CONTRIBUTING HEAT FLUX TERMS						NET HEAT FLUX	TIME TO TOTALLY FREEZE PRECIP. LAYER
	V_∞ ($m \cdot s^{-1}$)	X/C	h ($W \cdot m^{-2} \cdot K^{-1}$)	I ($kg \cdot m^{-2} \cdot s^{-1}$)	p_a (kPa)	V_a ($m \cdot s^{-1}$)	t_a (°C)	q_c ($W \cdot m^{-2}$)	q_e ($W \cdot m^{-2}$)	$-q_v$ ($W \cdot m^{-2}$)	$-q_k$ ($W \cdot m^{-2}$)	$-q_m$ ($W \cdot m^{-2}$)	$-q_s$ ($W \cdot m^{-2}$)	q_f ($W \cdot m^{-2}$)	τ (s)
1	10	0.03	35	1.02×10^{-3}	96.97	18.9	0.27	-9.45	52.7	-5.3	-0.1	-33.9	-0.1	3.85	4800
2	30	0.03	88	3.78×10^{-3}	96.46	44.5	-0.14	12.3	133.2	-73.9	-1.7	-126.3	-0.1	-56.50	-
3	50	0.03	114	6.50×10^{-3}	95.27	74.3	-1.11	126.2	174.8	-282.1	-8.1	-217.1	-0.1	-206.40	-
4	10	0.25	30	0	97.09	13.1	0.37	-11.1	45.2	-2.2	0	0	-0.1	31.80	574
5	30	0.25	52	0	96.74	39.1	0.09	-4.4	78.9	-35.7	0	0	-0.1	38.70	471
6	50	0.25	67	0	96.05	65.3	-0.48	32.1	101.9	-128.4	0	0	-0.1	5.50	316
7	67	0.03	132	6.80×10^{-3}	83.21	167.9	-11.4	1499.1	230.8	-1661.7	-15.3	-227.1	-0.1	-174.30	-

fractional distance along the chord from the nose, respectively. Column 4 shows the convective heat transfer coefficient from Eq. 17 (h_C) or Eq. 21 (h_D). Column 5 indicates the mass flux of accreting snowflakes (I), while Columns 6, 7 and 8 indicate the air pressure, air velocity and air temperature just outside the boundary layer (p_a, V_a and t_a respectively). The terms q_c, q_e, $-q_v$, $-q_k$, $-q_m$ and $-q_s$ (which contribute to the net heat flux) are given in Columns 9 through 14. Column 15 shows the net heat flux (q_f) obtained from the sum of Columns 9 through 14 while Column 16 indicates the time (τ) required to freeze the water fraction of the precipitation layer.

Beginning with Case 1 (10 $m \cdot s^{-1}$ and $X/C = 0.03$), the convective heat transfer coefficients predicted from Eqns. 17 and 21 are $h_C = 36.7$ $W \cdot m^{-2} \cdot K^{-1}$ and $h_D = 33.3$ $W \cdot m^{-2} \cdot K^{-1}$ respectively. The good agreement between these values appears to validate the approach of using a cylinder to approximate the leading edge of the wing for the purposes of obtaining appropriate convective heat transfer coefficients. Since the air temperature outside the boundary layer remains above freezing (0.27°C), the convective heat transfer (q_c) is negative. While there is significant cooling by evaporation (q_e), it is offset to a large extent by the sum of the frictional heating of the boundary layer (q_v) and the heat released by the freezing of the incoming partially-melted snowflakes (q_m). Both the kinetic energy released by the impacting snowflakes (q_k) and the heat added by long-wave radiation (q_s) make very small contributions to the overall heat balance. The net result (q_f) is an extremely slow rate of cooling at this point on the airfoil.

Case 2 (30 $m \cdot s^{-1}$ and $X/C = 0.03$) shows that the local air temperature would be reduced below freezing, thus creating some convective cooling (q_c). The evaporative cooling (q_e) is also increased, but almost exactly offset by the heat released by the freezing of the incoming snowflakes (q_m). The other significant heat source is the frictional heating of the boundary layer. The net result in this case is thus a consistent rate of heating at the precipitation layer.

In Case 3 (50 $m \cdot s^{-1}$ and $X/C = 0.03$), the air temperature outside the boundary layer has cooled adiabatically to -1.11°C, significantly increasing the convective cooling (q_c). The greater airspeed has also increased the evaporative cooling (q_e) from Case 2. The much greater heat load imposed by the frictional heating (q_v) of the boundary layer and by the influx of partially-melted snowflakes (q_m), however, results in a large overall heat gain. The temperature of the precipitation layer at this speed is predicted to increase with time.

Moving to a point on the wing further back from the leading edge (Case 4, 10 $m \cdot s^{-1}$ and $X/C = 0.25$), there is no mass flux of accreting snowflakes because the flakes do not impinge upon the airfoil this far back from the leading edge. As a result, there is no kinetic energy converted to heat (q_k) or heat released from freezing (q_m) of the snowflakes. Because of the relatively low airspeed at this point (13.1 $m \cdot s^{-1}$ versus the freestream value of 10.0 $m \cdot s^{-1}$), the temperature just outside the boundary layer remains above freezing (0.37°C), and thus the convective heat transfer (q_c) is negative. Other contributions to the heat transfer equation are small, and thus the net cooling (q_f) is small but positive. The time required to freeze the layer, however, remains very long.

Case 5 (30 m·s^{-1} and X/C = 0.25) is very similar in net effect to Case 4. The evaporative cooling (q_e) and frictional heating (q_v) of the boundary layer are greater than in the previous case, but the convective heat transfer (q_c) remains negative because of the air temperature outside the boundary layer which remains just above freezing. Again, the time required to freeze the layer at this airspeed is very long.

With the higher speeds of Case 6 (50 m·s^{-1} and X/C = 0.25), the air temperature just outside the boundary layer once again goes negative (-0.48°C), and thus some convective cooling (q_c) takes place. This cooling plus the evaporative cooling (q_e) are almost exactly offset by the frictional energy (q_v) added to the boundary layer. The net effect (q_f) is almost no heating or cooling of the precipitation layer.

Finally, in order to determine if conditions on the wing would change significantly when the aircraft rotated at an airspeed of about 130 kt, another set of calculations (Case 7) was made using the pressure coefficient distribution provided by Fokker for an angle of attack of α = 5° (67 m·s^{-1} and X/C = 0.03). The high airspeed near the point of minimum aerodynamic pressure (167.9 m·s^{-1} as compared to the freestream value of 67 m·s^{-1}) led to significant cooling of the airflow just outside the boundary layer (to -11.4°C) and thus to a high convective heat transfer (q_c). However this high value was more than offset by an even higher heat input from the frictional heating (q_v) of the boundary layer. The high evaporative cooling (q_e) was almost exactly matched by the heat released by the freezing of the melted fraction of the incoming snowflakes (q_m). As a result, the net effect (q_f) was a continued heating of the precipitation layer under these conditions.

The calculations of this section have demonstrated that under the assumptions that have been adopted, it does not appear that sufficient cooling would have been available during the take-off run of the Fokker F-28 at Dryden to have had any significant impact upon the state of the precipitation layer accumulated on the upper surface of the wing. In general, the adiabatic cooling of the air just outside of the boundary layer plus the evaporative cooling caused by less than saturated air are more or less offset by the frictional heating of the boundary layer in combination with the heat required to freeze the partially-melted snowflakes impacting on the wing.

Only two potentially significant heat transfers have been omitted from this analysis. Any solar radiation which might have penetrated the cloud layer and precipitation would have contributed still more heating to the accumulated precipitation. Conduction of heat into the wing, on the other hand, could have contributed to the cooling of the layer, and thus will be investigated in the next section.

4.0 CONDUCTION OF HEAT INTO THE WING FUEL TANKS

In order to estimate the effect of heat conduction into the wing of the aircraft from the layer of precipitation which accumulated during the station-stop of C-FONF at Dryden, it is necessary to realize that the wing of the Fokker F-28 contains integral fuel tanks which wet the wing skin for most of the length of the wings. These tanks are situated between wing spars located at about 12% and 56% of the wing chord back from the wing's leading edge. For the purposes of calculating heat transfers in to and out of the precipitation layer, it is thus essential to be able to determine the temperature of the fuel in the wing tanks both before and after the refuelling at Dryden. The temperature of fuel before refuelling would have been influenced primarily by: the temperature of the fuel stored in the tanks during the previous night; the temperature of the fuel which was loaded into the aircraft at various refuelling stops that morning; and by the cooling of the fuel during flight at altitudes where the outside air temperature was significantly cooler than near the ground. The temperature of the fuel after refuelling would have also been influenced by the temperature of the fuel added during refuelling at Dryden. We shall begin this section by estimating the wing tank fuel temperatures during the station-stop at Dryden.

4.1 Estimating Wing Tank Fuel Temperatures During C-FONF's Stop at Dryden

During 1989 April 5 and 6, Mr. Garry Cooke of the TSBC Winnipeg office undertook a set of measurements in Dryden at the direction of Mr. Dave Rohrer of the Inquiry staff. These measurements are reproduced in Table 6.

Column 1 of Table 6 shows the date and time of the measured outside air temperatures. The fuel tender temperatures are displayed in Columns 2 and 3 respectively. The variation of outside air temperature over the approximately 24 h period of the measurements shows the typical diurnal variation which would be expected. The data of Column 3 indicate that the fuel tender temperature also exhibits a diurnal variation, but of lesser magnitude than that of the outside air temperature. Additionally, the diurnal cycle of the fuel temperature appears to be delayed by perhaps two hours. Both these effects are expected because of the relatively poor conductivity of the fuel, and the fact that the temperature of this volume of fuel is being changed primarily by conduction through the skin of the fuel tank as well as by convection in the fuel and in the outside air. From these data, it may be generalized that under outside air temperature variations similar to those measured during this experiment, the tank temperature in the early morning (when the outside air temperature is near its minimum) would likely be about 2°C warmer than ambient, whereas several hours later in the morning, it would likely be 2 to 3°C colder than ambient. An important assumption in these estimates is that there would be no significant solar radiation at this time of day to cause additional heating of the tank. Since, according to information provided by Mr. Dave Rohrer, the fuel at Winnipeg and Thunder Bay is also stored in above-ground tanks, we shall assume that the above relationship between outside air temperature and fuel temperature can be

Table 6. Outside air and fuel tender temperatures at Dryden, Ontario on 1989 April 5 and April 6.

DATE AND TIME (CST)	OUTSIDE AIR TEMPERATURE (°C)	FUEL TENDER TEMPERATURE (°C)
April 5 16:00	7.5	3.2
April 5 19:00	2.0	2.2
April 5 22:00	-2.0	0.0
April 6 06:15	-8.0	-5.0
April 6 09:15	-3.0	-3.5
April 6 12:15	1.5	-1.5
April 6 15:15	3.0	0.5

applied for the fuel loaded from those facilities as well.

The next step is to estimate the rate of cooling of the fuel in the Fokker F-28's wing fuel tanks during flight at altitude. Three sources of information on this subject have been consulted to aid in this determination.

Walker (1952) displays the fuel temperature in the wings of a de Havilland Comet measured during a flight at near 450 mph at an ambient air temperature of about -60°C. The fuel temperature begins at near 15°C, and decreases initially, upon ascent to altitude, at a rate of about $20°C{\cdot}h^{-1}$.

Mr. G.L. Borst of Propulsion Engineering, Renton Division, Boeing Commercial Airplanes has provided similar curves of the variation with time of the main wing tank fuel temperature during the flight of a Boeing 757-200 aircraft. Utilizing a temperature difference between initial tank temperature and outside air temperature during flight of about 50°C, leads to an estimate of the initial rate of change of fuel temperature of near $15°C{\cdot}h^{-1}$.

Mr. R. Jellema, Manager Fleet Airworthiness, Engineering Department, Fokker Aircraft has stated that the limited F-28 fuel cooling records available indicate a maximum cooling rate of the fuel in the wing tanks of about $15°C{\cdot}h^{-1}$. He has also provided the following relationship using the total air temperature at altitude (t_T) and the initial fuel temperature before flight (t_{f_i}) to predict the fuel temperature (t_{f_τ}) during flight at altitude of duration τ_a:

$$t_{f\tau} = t_T + (t_{fi} - t_T)e^{-\tau/12} \ . \tag{26}$$

For an initial temperature difference (t_{fi} - t_T) of 50°C, the fuel temperature predicted by this equation drops by about 25°C during the first hour. Since this equation appears to give results similar to the others reported above, it will be utilized to predict the cooling of the fuel within the wing tanks of the Fokker F-28.

During an experiment performed by Mr. Dave Rohrer and Mr. Ron Coleman of the TSBC on 1989 April 14, the temperatures of various parameters relating to the fuel tank temperatures of the Fokker F-28 were measured at several station-stops (Dryden, YHD; Thunder Bay, YQT; and Sault Ste. Marie, YAM) during a flight from Winnipeg (YWG) to Toronto (YYZ). In order to verify the utility of Eq. 26 for the prediction of fuel temperatures as a result of flight at altitude, the data from this experiment are presented in Table 7.

Column 1 of Table 7 indicates the location and relative time of the measurements which follow. Columns 2 and 3 show the duration and temperature of flight segments at cruise altitude. Columns 4 and 5 display the quantity and temperature of the fuel uploaded into the aircraft at a given station-stop (if applicable). Column 6 gives the quantity of fuel in the F-28's wing fuel tanks just prior to take-off or upon landing. Column 7 exhibits the fuel temperature measured by draining a small amount of fuel from the wing drain valve nearest the fuselage of the aircraft. Column 8 indicates the fuel temperature predicted through the use of Eq. 26 for flight segments, and the "law of mixtures" (Eq. 27) after refuelling. If two liquids of mass m_1 and m_2 and initial absolute temperatures t_1 and t_2 (K) respectively, are well mixed together, then the absolute temperature (K) of the resulting mixture is given by:

$$t_m = \frac{(t_1 m_1 + t_2 m_2)}{m_1 + m_2} \ . \tag{27}$$

Column 9 of Table 7 shows the temperature of the fuel in the tanks deduced from the temperature measured on the wing's lower surface nearest the fuselage. These data have been displayed because it seems significant that the temperatures measured at this location are consistently colder than the measured fuel temperature in Column 7. This may indicate that the fuel temperature displayed in Column 7 is not really representative of the fuel in the tanks. This particular location was chosen because the interior of the wing's skin is always in contact with the fuel in the wing tank at this location. It should also respond rapidly to changes in fuel temperature as a result of refuelling. A "correction" of up to 2°C was applied to the measured skin temperature when the significant difference between the skin temperature and the air temperature was believed to be influencing how well the skin temperature at this point was indicating the fuel

Table 7. Prediction of fuel tank temperatures at various station-stops of a Fokker F-28 flight from Winnipeg to Toronto on 1989 April 16.

	FLIGHT		REFUELLING FUEL		WING TANK FUEL			WING TANK FUEL DEDUCED FROM LOWER SURFACE	
LOCATION & COMMENTS	TIME (min)	AIR TEMP. (°C)	WEIGHT (lb)	TEMP. (°C)	WEIGHT (lb)	MEAS. TEMP. (°C)	CALC. TEMP. (°C)	MEAS. TEMP. (°C)	CALC. TEMP. (°C)
WPG - prior to departure					14000	10	-	4	-
Flight leg	10	-10							
YHD - upon arrival					11600	8	8.4	3	2.9
Flight leg	10	-15							
YQT - upon arrival					8700	6	6.1	1.5	1.6
Refuelling			5300	8					
YQT - prior to departure					14000	6	6.8	1.5	2.3
Flight leg	16	-24							
YAM - upon arrival					9900	2	3.0	-3	-1.0
Refuelling			1100	3					
YAM - prior to departure					11000	2	3.0	-4	-0.6
Flight leg	21	-23							
YYZ - upon arrival					6200	0	-1.2	-2	-3.2

temperature. Finally, Column 10 displays the fuel temperature predicted through the use of Eq. 26 for flight segments, and Eq. 27 after refuelling. The difference between Columns 8 and 10 is that the former is initiated upon the measured wing tank temperature, whereas the latter is initiated upon the wing tank temperature deduced from the lower wing surface temperature measurement.

Inspection of the data presented in Table 7 reveals that the calculated fuel temperatures in Columns 8 and 10 are reasonably representative of the fuel temperatures measured or estimated in Columns 7 and 9 respectively. This suggests that Eqns. 26 and 27 are appropriate means of estimating fuel temperatures in the wing tanks of the Fokker F-28.

Turning now to the flight of C-FONF on 1989 March 10, Table 8 displays the data used to predict the temperature of the fuel in the wing tanks during the station-stop at Dryden. Column 1 gives the location and approximate time for the entries which follow. Columns 2 and 3 indicate the duration and temperature of flight segments at cruise altitude. Column 4 shows the air temperature observed during the station-stop. Columns 5 and 6 exhibit the quantity and estimated temperature of the fuel uploaded to or downloaded from the aircraft's fuel tanks at a given station-stop (if applicable). These temperatures have been estimated by adjusting the measured air temperature by the relationships deduced from the data of Table 6. Finally, Columns 7 and 8 display the quantity and temperature in the F-28's wing tanks. Column 8's estimates are initialized with the predicted fuel temperature at Winnipeg, and are based upon subsequent calculations of cooling at cruise altitude by Eq. 26 and mixing during refuelling by Eq. 27.

The refuelling fuel temperature (Column 4 of Table 8) at Winnipeg (YWG) has been estimated at 0°C because the measured air temperature was steady near 0°C overnight. The fuel uploaded at Thunder Bay (YQT) was predicted to be at near -5°C based upon a minimum temperature of -7.8°C several hours earlier and an air temperature of near -3°C during the refuelling. Finally, the temperature of the fuel in the refuelling truck at Dryden was approximated by 0°C as a result of the small difference between the overnight minimum temperature (-2.3°C) and the air temperature at the time of refuelling (1.0°C). The last column in Table 8 reveals that the predicted fuel temperature in the wing tanks cooled consistently during the flight segments after departure from Winnipeg until refuelling at Dryden. In general, the fuel tank temperatures were predicted to be within about 1.5°C of the outside air temperatures at all station stops prior to the final stop at Dryden. The 3500 lb of 0°C fuel uploaded at Dryden likely warmed the wing tank temperature to about -4.7°C from the estimated -6.4°C prior to refuelling. Both of these temperatures were significantly below the ambient air temperature of between 1.0 and 0.4°C.

Table 8. Prediction of fuel tank temperatures during the flight segments of Fokker F-28 C-FONF on 1989 March 10.

LOCATION & TIME	FLIGHT		STATION STOP	REFUELLING FUEL		WING TANK FUEL	
	TIME	AIR TEMP.	AIR TEMP.	WEIGHT	TEMP.	WEIGHT	TEMP.
(UTC)	(min)	(°C)	(°C)	(lb)	(°C)	(lb)	(°C)
YWG: Refuelling			0.1	7100	0		
YWG: 13:30 - Prior to departure			0.1			16000	0.0
Flight leg	7	-27					
YHD: 14:19 - Upon arrival			-1.8			12800	-1.5
Flight leg	9	-27					
YQT: 15:32 - Upon arrival			-4.2			9600	-3.3
YQT: Refuelling			-3	6000	-5		
YQT: After Refuelling						15600	-4.0
YQT: Download fuel			-3	-2800	-4.0		
YQT: 16:55 - Prior to departure			-2.6			12800	-4.0
Flight leg	13	-27					
YHD: 17:40 - Upon arrival			1.0			9500	-6.4
YHD: 17:45 - Refuelling			1.0	3500	0		
YHD: 18:10 - Prior to departure			0.4			13000	-4.7

4.2 Evaluating the Rate of Freezing of the Precipitation Layer

With a knowledge of the likely fuel tank temperature while C-FONF was on the ground at Dryden, we are now ready to evaluate the heat flux terms in Eq. 4 to determine the net heat flux, and from this, the time required to freeze the water in the precipitation layer.

It was explained in Section 3 that since the precipitation layer was formed by falling wet snowflakes, it must have been at the freezing temperature as it was being formed. Thus for the first term in Eq. 4, $q_a = 0$. The wind speeds recorded by the AES observer between 17:40 and 18:10 UTC varied between 0 and 4 kt. Using this latter value (equivalent to about 2 $m \cdot s^{-1}$), it becomes apparent from comparison to values in Table 5 that at such low wind speeds, the third, fourth and sixth terms (q_v, q_k and q_s, respectively) are all near zero.

Between 17:40 and 18:00 UTC, the water-equivalent precipitation rates estimated from the transmissometer's measurements and "corrected" through the use of the procedure of Section 2, were between 0.02 and 0.22 $mm \cdot h^{-1}$. Between 18:00 and 18:10 UTC, these precipitation rates are believed to have varied between 1.1 and 4.5 $mm \cdot h^{-1}$. These four values are equivalent to mass fluxes of 5.6×10^{-6}, 6.1×10^{-5}, 3.1×10^{-4} and 1.3×10^{-3} $kg \cdot m^{-2} \cdot s^{-1}$. Utilizing Eq. 12, the heat released in freezing these partially-melted snowflakes (q_m) is thus 0.2, 2.0, 10.4 and 41.8 $J \cdot m^{-2} \cdot s^{-1}$ respectively.

With a wind speed of 2 $m \cdot s^{-1}$ and thus a wing Reynold's number of $Re_C = 5.2\times10^5$, Eq. 20 may be used to determine the wing Nusselt Number ($Nu_C = 1950$). From Eq. 17 we can then calculate the value of the convective heat transfer coefficient ($h_C = 13.4$ $W \cdot m^{-2} \cdot K^{-1}$). Since the Dryden air temperature was observed to be near 0.7°C during the period of heaviest snowfall, Eq. 14 leads us to an estimate of the value of the convective heat flux for this wind speed and temperature ($q_c = -9.4$ $J \cdot m^{-2} \cdot s^{-1}$).

The Dryden dew point temperature at 18:00 UTC was noted to be -3.0°C. Using Eq. 16 gives an estimate of the evaporative heat flux ($q_e = 25.8$ $J \cdot m^{-2} \cdot s^{-1}$).

Finally, the flux of heat conducted into the wing of the aircraft may be estimated with the following relationship:

$$q_i = \frac{t_p - t_f}{\dfrac{T_p}{2k_p} + \dfrac{T_s}{k_s} + \dfrac{T_f}{2k_f}} \qquad (28)$$

where t_p and t_f are the temperatures of the precipitation layer (0°C) and the wing tank fuel (-4.7°C) respectively. The thicknesses of the precipitation layer, the aluminum skin of the wing and a suitable volume of tank fuel are given by T_p, T_s and T_f respectively. The thermal conductivity of the three layers are represented by k_p, k_s and k_f respectively.

In Eq. 28, the conduction is assumed to occur between the midpoints of the two outer layers.

Since it was assumed above that the density of the precipitation layer was 400 $kg{\cdot}m^{-3}$, then the thickness of the near 0.55 $kg{\cdot}m^{-2}$ layer of precipitation as estimated in Section 2 would have been T_p = 1.38 mm of wet snow. The thermal conductivity of snow has been taken to be k_p = 0.47 $W{\cdot}m^{-1}{\cdot}K^{-1}$. The thickness of the aluminum skin used in these calculations is T_s = 4 mm. Since the thermal conductivity of the aluminum, estimated at k_s = 138 $W{\cdot}m^{-1}{\cdot}K^{-1}$ (see, for example, the SAE Aerospace Applied Thermodynamics Manual), is so much greater than that of the snow or the fuel, this thickness estimate will play little part in the accuracy of the overall calculation of conductive heat flux.

It is necessary to ensure that the fuel layer is sufficiently thick that it is able to absorb the heat which might be transferred to it from the precipitation layer without significantly changing its mean temperature. Assuming again that 10% of the precipitation layer is water and the remainder snow, then the heat per unit area which must be removed to freeze the water is equal to the product of: the melted fraction of snow (0.1); the latent heat of fusion (L_f = 3.34x10^5 $J{\cdot}kg^{-1}$); and the mass per unit area of the precipitation layer (0.55 $kg{\cdot}m^{-2}$). This product is equal to 1.84x10^4 $J{\cdot}m^{-2}$. Now, since the specific heat capacity of JP4 fuel is c_p = 1.93x10^3 $J{\cdot}kg^{-1}{\cdot}K^{-1}$, and the density of JP4 is approximately 789 $kg{\cdot}m^{-3}$, then the thickness of a layer of fuel which will be warmed by 1°C in absorbing the heat from the freezing of the precipitation layer will be T_f = 12 mm. The thermal conductivity of JP4 has been taken to be k_f = 0.14 $W{\cdot}m^{-1}{\cdot}K^{-1}$ (see, for example, Kays and Crawford, 1980). In addition to the layers mentioned above, there is also a layer of plastic-like material which lines the inside of the F-28's wing fuel tanks. Since this layer is likely on the order of 5 mm or less, and since the thermal conductivity of this layer is likely near that of Nylon or Teflon (both having the same conductivity as the JP4 fuel), this layer will have only a small effect upon the thermal heat flux between the precipitation layer and the fuel. Inserting all of the appropriate values from above into Eq. 28 gives a conductive heat flux of q_i = 106 $J{\cdot}m^{-2}{\cdot}s^{-1}$.

All of the above heat flux terms may now be utilized to solve for the net heat flux into or out of the precipitation layer. These data are displayed in Table 9. Column 2 of this table displays the water-equivalent snowfall rates representative of the ranges between 17:40 to 18:00 UTC and between 18:00 and 18:10 UTC. Column 3 gives the assumed water fraction of the precipitation layer formed by the accumulation of falling wet snowflakes. Columns 4 through 7 exhibit the values of the heat flux terms which contribute to the net heat flux. Column 8 shows the net heat flux while the time estimated to completely freeze the water fraction of the wet snow in the precipitation layer is given in Column 9.

As the mass flux of the falling wet snowflakes increases from 5.6x10^{-5} $kg{\cdot}m^{-2}{\cdot}s^{-1}$ to 1.3x10^{-3} $kg{\cdot}m^{-2}{\cdot}s^{-1}$ (Case 8 through Case 11), the heat which must be extracted to freeze the water fraction of the incoming wet snowflakes increases (Column 4 of Table 9).

Table 9. Derivation of the time required to freeze the layer of precipitation on the wings of C-FONF as a result of various snowfall rates and estimates of the initial water fraction of the layer.

CASE	PRECIP. RATE	INITIAL WATER FRACTION OF LAYER	CONTRIBUTING HEAT FLUX TERMS				NET HEAT FLUX	TIME TO TOTALLY FREEZE PRECIP. LAYER
	R	k_m	q_m	q_c	q_e	q_i	q_f	τ
	(mm h^{-1} water equiv.)		(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(W·m^{-2})	(s)
8	0.02	0.1	-0.2	-9.4	25.8	106	122.20	151
9	0.22	0.1	-2.0	-9.4	25.8	106	120.40	153
10	1.1	0.1	-10.4	-9.4	25.8	106	112.00	165
11	4.5	0.1	-41.8	-9.4	25.8	106	80.60	229
12	2.7	0.1	-25.4	-9.4	25.8	106	97.00	190
13	2.7	0.2	-50.9	-9.4	25.8	53.9	19.40	1900
14	2.7	0.3	-76.3	-9.4	25.8	36.1	-23.80	-
15	2.7	0.1	-25.4	-9.4	25.8	53.9	44.90	411
16	2.7	0.1	-25.4	-9.4	25.8	36.1	27.10	681

With all of the other heat flux terms remaining constant for these cases, the predicted net heat flux gradually decreases. This results in increasing estimates of the time required to totally freeze the water fraction of the precipitation layer. However, the longest time required (Case 11, 229 s), is still significantly shorter than the 600 s period between the commencement of heavier snowfall (18:00 UTC) and the approximate time of take-off (18:10 UTC).

In order to provide a baseline for the other cases which follow, another set of calculations was performed (Case 12). Here the water-equivalent snowfall rate was chosen to be the mean value (2.7 mm·h^{-1}) over the time interval 18:00 to 18:10 UTC. The time required to freeze the layer is estimated at 190 s.

In an effort to evaluate the sensitivity of the predicted time to freeze the water fraction of the precipitation layer to changes in the estimated water fraction of the falling snowflakes, another two sets of calculations (Cases 13 and 14) were performed. In

Case 13, it was assumed that the falling snowflakes were 20% water by mass. As a result of the doubled heat required to freeze the greater water fraction of the falling wet snowflakes, the net heat flux decreased to 19.4 $J{\cdot}m^{-2}{\cdot}s^{-1}$ and the time required to freeze the precipitation layer rose significantly to 1900 s. A water fraction of 0.3 (Case 14) led to a net heat flux of -23.8 $J{\cdot}m^{-2}{\cdot}s^{-1}$. These two cases demonstrate that as the water fraction of the falling snowflakes increases, this not only increases the heat which must be removed to freeze the falling flakes, it also increases the heat needed to be removed to freeze the precipitation layer. The combination of effects leads to a very rapidly increasing time to freeze the precipitation layer, eventually resulting in a predicted inability of the wing tank fuel to remove enough of the heat from the precipitation layer to allow it to freeze at all.

Finally, in order to determine the effect upon these calculations of an increase in the total thickness of the precipitation layer, Case 12 was repeated with layers of doubled and tripled thickness (Cases 15 and 16). In the first of these two cases, as a result of the increased amount of heat which must be transferred to the wing tank fuel, the thickness of the fuel layer must be increased to maintain a small increase of temperature as a result of this heat transfer. This results in an approximately 50% decrease in the conductive heat flux (Column 8). The net heat flux is thus 44.9 $J{\cdot}m^{-2}{\cdot}s^{-1}$ and the time to freeze the precipitation layer increases to 411 s from 190 s. In the final set of calculations (Case 16), the thickness of the fuel layer which absorbs the heat from the precipitation layer is increased yet again. This further reduces the net heat flux, and results in an estimate of the time to freeze the water fraction of the precipitation layer of 681 s.

From these cases, it is evident that increasing the assumed water fraction of the falling wet snowflakes dramatically increases the time required to freeze the precipitation layer. In fact, with a snowflake water fraction of 0.3, there would no longer be conduction of heat from the precipitation layer to the wing fuel tanks, and the water in the wet snow would not freeze at all. On the other hand, increasing the depth of the precipitation layer from about 1.4 to 4.1 mm of wet snow increases the time to freeze the precipitation layer significantly, but would still allow most of the layer to freeze in the 600 s interval during the heavier snowfall (18:00 to 18:10 UTC). Further increases in the precipitation layer thickness would permit only some lower fraction of the layer to freeze, with the upper portion remaining wet snow.

5.0 DISCUSSION AND SUMMARY

The estimated thickness of wet snow which would have accumulated on the wings of C-FONF during its station-stop at Dryden on 1989 March 10 is 1.38 mm. This value has been determined from analyses of the visibility data recorded by the AES observer at the Dryden Airport, and by a transmissometer located near the runway. The relationship used to estimate precipitation rate from visibility is an empirical one, and the data from which it was derived show considerable scatter. The main uncertainty in the relationship is due to the variation in terminal velocity of the snowflakes because of variations in their size and wetness (and thus density). Since the relationship has been derived for "normal" snow, it may be expected that if the snowflakes are wet, then they will fall faster than "normal". This would permit the snowflakes to accumulate more quickly at the ground than would "normal" snowflakes, while obstructing the visibility to the same extent. Therefore, it is expected that despite the efforts in Section 2 to "calibrate" the visibility to precipitation rate relationship, unusually wet snowflakes may have contributed to a greater depth of precipitation than that estimated above.

The extensive calculations described in Section 3 lead to the conclusion that an insufficient amount of cooling to freeze the precipitation layer would have been provided by the mechanisms of: adiabatic cooling of the air as it accelerated over the wing; and evaporative cooling as a result of the comparatively dry air near the ground at the time of take-off. In general, the adiabatic cooling of the air just outside of the boundary layer plus the evaporative cooling caused by less than saturated air were more or less offset by the frictional heating of the boundary layer in combination with the heat required to freeze the partially-melted snowflakes impacting on the wing. Any impinging snowflakes during the take-off roll would thus have likely met a partially wetted precipitation layer surface, and this fact, in combination with the fact that the snowflakes themselves would likely have been somewhat wet, leads to the conclusion that many of these snowflakes would have stuck to the forward portions of the precipitation layer during the take-off roll.

The investigation of the contribution of the conductive heat flux from the precipitation layer on the wing to the wing fuel tanks shows that, under certain circumstances and in combination with the other heat flux terms, sufficient cooling might have resulted in a complete freezing of the water fraction of the precipitation layer during the 10 min interval of the heavier snowfall rate while the aircraft was on the ground (18:00 to 18:10 UTC).. The assumed value of the falling snowflake's water fraction has been shown to significantly alter the time required to freeze the precipitation layer. The thickness of the precipitation layer has also exhibited a strong influence upon the freezing time. Given that the depth of the wet snow on the wings was likely greater than the best estimate of 1.38 mm calculated from the available data, it seems probable that the heat conduction into the wing fuel tanks would have permitted a lower portion of the water in the wet snow layer to have frozen, while leaving some upper portion in a partially liquid state. Because the density of the wet snow was between that of dry snow (100 $kg \cdot m^{-3}$) and ice (near 920 $kg \cdot m^{-3}$), this layer was composed of a lattice of deformed and coagulated ice crystals interspersed with air pockets and water. As the water froze in the lower portion of this layer, it would likely have left a very rough interface between the lower and upper portions of the precipitation layer. As the aircraft rolled down the runway, the remaining water in the upper portion of the precipitation layer might have been forced to drain away, possibly carrying with it some of the ice in the upper portion of the layer. The resulting very rough surface on the wings could have had a significant impact on the aerodynamic performance of the aircraft. It is interesting to note that the thermal conductivity of the aluminum skin of the aircraft is much greater than that of the wet snow, the air or the fuel in the wing tanks. As a result, the aluminum skin might have conducted heat away from the precipitation layer even further forward on the wing than the location of the wing spar forming the forward wall of the wing tanks. Thus the hypothesized rough precipitation layer surface may have extended forward to the more aerodynamically critical portions of the wing.

6.0 REFERENCES

Houghton, E. L. and Brock, A. E. 1970. Aerodynamics for Engineering Students. Second Edition. Edward Arnold (Publishers) Ltd., London.

Kays, W. M. and Crawford, M. E. 1980. Convective Heat and Mass Transfer. 2nd Edition. McGraw-Hill Book Company, New York, NY.

King, W. D. 1985. Air Flow and Particle Trajectories around Aircraft Fuselages. Part III: Extensions to Particles of Arbitrary Shape. Journal of Atmospheric and Oceanic Technology **2** (4): 539-547.

Makkonen, L. 1984. Modeling of Ice Accretion on Wires. Journal of Climate and Applied Meteorology **23** (6).

Makkonen, L. 1989. Estimation of Wet Snow Accretion on Structures. Cold Regions Science and Technology **17**: 83-88.

Mellor, M. and Mellor, A. 1988. Some Characteristics of Falling Snow. Cold Regions Science and Technology **15**: 201-206.

Oleskiw, M. M. 1982. A Computer Simulation of Time-Dependent Rime Icing on Airfoils. Ph.D. Thesis, University of Alberta, Edmonton.

Pais, M. R., Singh, S. N. and Zou, L. 1988. Determination of the Local Heat-Transfer Characterisitics on Simulated Smooth Glaze Ice Accretions on a NACA 0012 Airfoil. AIAA 26th Aerospace Sciences Meeting, Reno, Nevada, January 1988. American Institute of Aeronautics and Astronautics, Washington, D. C.

SAE Committee AC-9, Aircraft Environmental Systems, 1969. SAE Aerospace Applied Thermodynamics Manual. 2nd Edition. Society of Automotive Engineers, Inc., New York, NY.

Stallabrass, J. R. 1987. Measurements of the Concentration of Falling Snow. *In* Snow Property Measurement Workshop. Chateau Lake Louise, April, 1985. *Edited by* P. R. Kry. National Research Council Canada, Ottawa. pp. 389-410.

Walker, J. E. 1952. Fuel Systems for Turbine-Engined Aircraft. Journal of the Royal Aeronautical Society: 657-679.

Žukauskas, A. and Žiugžda, J. 1985. Heat Transfer of a Cylinder in Crossflow. *Translated by* E. Bagdonaite. *Edited by* G. F. Hewitt. Hemisphere Publishing Corporation, Washington, D. C.

REPORT DOCUMENTATION FORM/FORMULAIRE DE DOCUMENTATION DE RAPPORT

<table>
<tr><td colspan="2">REPORT No./
NO DU RAPPORT

1 IME-CRE-TR-003</td><td colspan="2">REPORT No./
NO DU RAPPORT

2 32124</td><td colspan="2" rowspan="2">SECURITY CLASSIFICATION/
CLASSIFICATION DE SECURITÉ
3
___ Top Secret/Très secret
___ Secret
___ Confidential/Confidentiel
___ Protected/Protégée
XX Unclassified/Non classifiée</td></tr>
<tr><td colspan="4">DISTRIBUTION/DIFFUSION
___ Controlled/Controlée
4 XX Unlimited/Illimitée</td></tr>
<tr><td colspan="6">DECLASSIFICATION: DATE OR REASON/DÉCLASSEMENT: DATE OU RAISON

5</td></tr>
<tr><td colspan="6">TITLE, SUBTITLE/TITRE, SOUS-TITRE

6 Freezing Precipitation on Lifting Surfaces</td></tr>
<tr><td colspan="6">AUTHOR(S)/AUTEUR(S)

7 M. M. Oleskiw</td></tr>
<tr><td colspan="6">SERIES/SÉRIE

8 Technical Report</td></tr>
<tr><td colspan="6">CORPORATE AUTHOR/PERFORMING ORGANIZATION/
AUTEUR D'ENTREPRISE/AGENCE D'EXÉCUTION

National Research Council of Canada
9 Institute for Mechanical Engineering</td></tr>
<tr><td colspan="6">SPONSORING OR PARTICIPATING AGENCY/AGENCE DE SUBVENTION OU PARTICIPATION

Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario
10 P.O. Box 687, Adelaide Station, Toronto, ON M5C 2J8</td></tr>
<tr><td>DATE

11 1991/09</td><td>FILE/DOSSIER

12 3741-4</td><td>SPECIAL CODE/
CODE SPÉCIALE
13 REA00</td><td>PAGES

14 31(vi)</td><td>FIGURES

15 0</td><td>REFERENCES

16 12</td></tr>
<tr><td colspan="6">NOTES

17 This report was requested by Mr. D. J. Langdon, Chief, Systems Engineering, Canadian Aviation Safety Board in a letter dated 1989 June 20. The request was made on behalf of Mr. J. Jackson, Investigator in Charge, Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario</td></tr>
<tr><td colspan="6">DESCRIPTORS (KEY WORDS)/MOTS-CLÉS

18 ICE, ICING, DEICE, DEICING, ANTIICING, SNOW, ATMOSPHERIC PRECIPITATION</td></tr>
<tr><td colspan="6">SUMMARY/SOMMAIRE

19 Please see Abstract.</td></tr>
<tr><td colspan="6">ADDRESS/ADDRESSE
Dr. R.M.W. Frederking, Head
Cold Regions Engineering
Institute for Mechanical Engineering
Montreal Road, Ottawa, K1A 0R6, Canada
20 (613) 993-2439</td></tr>
</table>

Appendix 7

Human Factors Aspects of the Air Ontario Crash at Dryden, Ontario: *Analysis and Recommendations to the Commission of Inquiry*

Robert L. Helmreich, Ph.D.

December 12, 1990

Human Factors Aspects of the Air Ontario Crash at Dryden, Ontario: Analysis and Recommendations to the Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario

Robert L. Helmreich, Ph.D
NASA/University of Texas Aerospace Crew Research Project[1]

Austin, Texas
December 12, 1990

1. The author's research reported here was sponsored by NASA-Ames Research Center Cooperative Agreement NCC2-286, Robert L. Helmreich, Principal Investigator. The opinions reported herein are those of the author and do not represent the position of NASA. All data collected in air carriers is maintained in secure databases and is conducted under a strict confidentiality agreement specifying that no organizations or individuals will be identified.

Introduction and Overview

At the request of the *Commission of Inquiry into the Air Ontario Crash at Dryden, Ontario*, evidence assembled in the course of investigation into the causes of the crash was examined in terms of human factors and organizational issues. Material reviewed included reports of the Operations Group and the Human Performance Group, interviews with relevant personnel, and sworn testimony presented before the Commission. When viewed from a research perspective, the body of facts suggests an operational environment that allowed an experienced crew to reach a flawed decision regarding the safety of take-off during snowfall with accumulating contamination of the aircraft's wings.

The absence of direct evidence from voice or flight recorders initially seems to be a serious hindrance to the investigative effort. In fact, the lack of this type of evidence has resulted in a more extensive exploration of broader issues, including regulatory and organizational factors than might otherwise have been conducted. Because of the depth of the investigation, the lessons to be gained from this in-depth investigation may prove to be of value for the governance of flight operations and the training of crews.

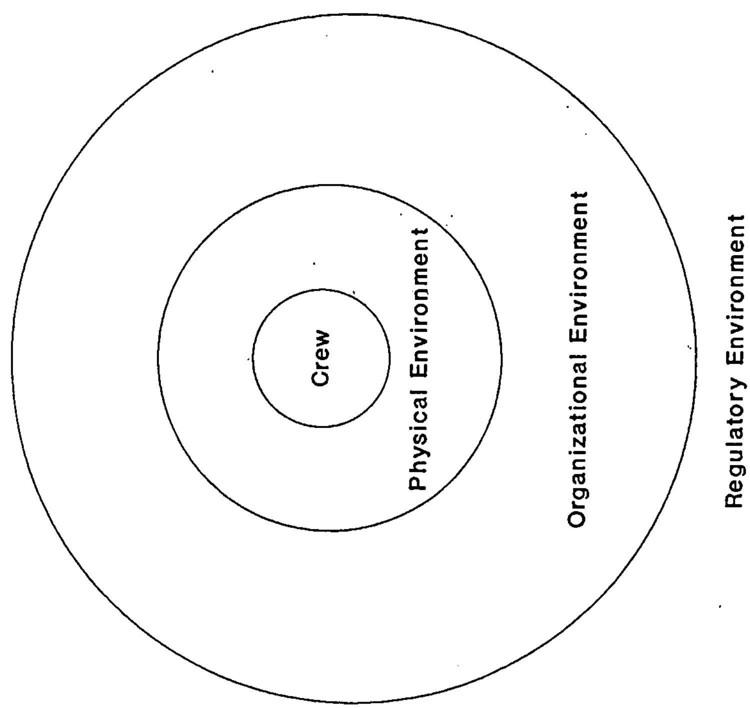
It may be useful to outline the background for the author's opinions. They grow out of more than twenty years experience conducting research into the multiple determinants of human behavior and performance under the sponsorship of agencies such as the National Science Foundation, the Office of Naval Research, the National Aeronautics and Space Administration, and the Federal Aviation Administration. Current investigations are under the auspices of the NASA/University of Texas Aerospace Crew Research Project, directed by the author. Included in the project are investigations of personality factors relative to pilot and Astronaut selection, group dynamics, aircraft characteristics such as automation, and organizational issues such as the development and influence of subcultures (Helmreich & Wilhelm, 1990; Helmreich, in press).

Another central element of the research is evaluation of the effectiveness of training in *Crew Resource Management* (*CRM*: Helmreich, 1991). *CRM* training is aimed at improving crew coordination, decision making, situational awareness, and interpersonal communications. It stresses the importance of utilizing all available resources inside and outside the cockpit and the development of an effective team including cabin crewmembers in the process. The concept of *CRM* is becoming widely accepted and is an integral part of training in many organizations. Only recently, however, has empirical research demonstrated that such training can affect flightcrew behaviour (Helmreich, Chidester, Foushee, Gregorich, & Wilhelm, 1990; Helmreich, Wilhelm, Gregorich, & Chidester, 1990).

Underlying the research is the fact that the behaviour of flightcrews in any given situation is determined by a number of simultaneously operating factors. These include: 1) the regulatory environment - operational standards and supervision; 2) the organizational environment - the culture and behavioural norms of the organization including morale, policies and standards, organizational stability and change, and available resources; 3) the physical environment - meteorological and operating conditions and the aircraft, including its condition and capabilities; 4) the crew environment - interpersonal coordination and communications including cockpit, cabin, and ground personnel, and individual characteristics of crewmembers - training, experience, motivation, personality, attitudes, fatigue, and stress both from the immediate operational situation and significant personal life events (Foushee & Helmreich, 1988; Helmreich, 1990). Figure 1 shows graphically the environments surrounding flight operations. Events and circumstances exemplifying these categories will be discussed as they relate to the Dryden crash and possible reasons for the actions of the crew of Air Ontario Flight 363.

The results of this analysis suggest that the concatenation of multiple factors from each category allowed the crew to decide to take off with contaminated wings. According to this view, no single factor taken in isolation would have triggered the crew's behaviour prior to and during take-off, but in combination they provided an environment in which a serious procedural error could occur. This array of contributory influences without a single, proximal cause warrants classification of the accident as a system failure. The analysis will attempt to define these influences and their inter-relationships. Observations and suggested counter-measures will also be provided.

Figure 1. Flightcrew Environments:
Factors Influencing Behaviour



Human Factors of the Air Ontario Crash 4

History of the Trip. The crew reported in at Winnipeg at approximately 0630CST Monday, March 6, for a five day trip in Fokker F-28, registration CFONF, involving six legs per day ending at 1530CST. The trip schedule and crew pairings are shown in Figure 2. Captain George Morwood had flown with the two flight attendants before, but none had flown with First Officer Keith Mills. After flying the Monday, March 6 sequence, Captain Morwood was displaced Tuesday by Captain Robert Nyman and Wednesday by Captain Alfred Reichenbacher. He resumed the trip for Thursday, March 9 and Friday, March 10.

On March 10, the crew checked in at Winnipeg at approximately 0640 and discovered that the Auxiliary Power Unit (APU) was inoperative. The aircraft departed for Dryden at 0749, approximately 10 minutes late after waiting for de-icing. It was further delayed at Dryden by poor weather at Thunder Bay. At Thunder Bay the flight was refueled on the basis of a passenger load of 55. However, an additional 10 passengers were added, placing the aircraft over the computed maximum allowable gross weight for take off. After some debate over course of action, the aircraft was defueled and the additional passengers retained. The flight departed Thunder Bay 64 minutes late and arrived at Dryden 1130CST. The aircraft was refueled at Dryden with an engine running because there were no ground start facilities there. Contrary to Air Ontario policy stated in the cabin manual, passengers remained on board during refueling.

During the stop at Dryden snow was falling and accumulating on the wings. First Officer Mills commented on the radio to Kenora at 1200, "...quite puffy snow, looks like its going to be a heavy one". Shortly after beginning to taxi, a passenger asked Flight Attendant Katherine Say when the plane was going to be de-iced. The flight attendants did not inform the flightcrew of these expressed concerns about the need to de-ice.

The flight was delayed for approximately four minutes while a light aircraft landed. At 1207CST the flight was cleared to Winnipeg and at 1209 First Officer Mills transmitted that the flight was about to take off. The aircraft lifted off but never left ground effect and crashed into trees beginning 126 meters from the end of the runway. The aircraft was destroyed by impact and fire. Both pilots, one flight attendant, and twenty-one passengers were killed. Forty-four passengers and one crew member survived with injuries. The chronology for March 10 is shown in Figure 3.

Figure 2. Trip Routing March 6 - 10, 1989
Air Ontario Line for Morwood/Mills

Segments	Crew	
Winnipeg-Dryden	MAR 6 -	Morwood/Mills
Dryden-Thunder Bay		Say/Hartwick
Thunder Bay-Dryden	MAR 7 -	Nyman/Mills
Dryden-Winnipeg		Say/Hartwick
Winnipeg-Thunder Bay	MAR 8 -	Reichenbacher/Mills
Thunder Bay-Winnipeg		Say/Hartwick
	MAR 9 -	Morwood/Mills
		Say/Hartwick
	MAR 10 -	Morwood/Mills
		Say/Hartwick

Figure 3. Air Ontario Flights 362/363
March 10, 1989

Segment	Times	Delay
Winnipeg-Dryden	0749-0819CST	13 min
Dryden-Thunder Bay	0850-0932CST	20 min
Thunder Bay-Dryden	1104-1130EST	64 min
Dryden - crash	1203-(1211)CST	

RLH 10/24/90

I. The Regulatory Environment.

The crew of Air Ontario 363 was governed by the regulations and practices of Transport Canada. Several aspects of the current regulations provided an indirect, deleterious influence on the crew's operational environment. These allowed the development of a situation which failed to provide safeguards in this case against flawed decisions concerning landing and take-off in Dryden under adverse weather conditions. The following issues are cited as relevant to the accident.

I(a). The failure to provide clear guidance for organizations and crews regarding the need for de-icing. The regulatory requirement in effect at the time of the accident prohibited aircraft from commencing a flight "...when the amount of frost, snow, or ice adhering to the wings, control surfaces, or propellor of the aeroplane may adversely affect the safety of the flight". As noted in the *Commission of Inquiry into the Air Ontario Crash at Dryden Ontario Interim Report* (1989), "...there are no existing Transport Canada-approved guidelines which dispatchers or flight and ground crews may use to assist them in making a reasoned judgment as to what amount of contamination to an aircraft's lifting surfaces would adversely affect the safety of flight". In the absence of guidelines, idiosyncratic views of the degradation caused by differing amounts of contamination could prevail. There were also no formal requirements for training in the effects of icing contamination and associated phenomena such as "cold soaking", and the differential susceptibility of different aircraft types to icing effects.

I(b). A lack of rigour in regulating and monitoring the operations of Air Ontario, Inc., following its merger and during the initiation of jet service in the F-28. Transport Canada allowed the F-28 operation to continue passenger service for a number of months without an approved Minimum Equipment List and an accepted Aircraft Operating Manual specifying standard operating procedures. Closer monitoring of the initiation of this service would have revealed other significant operational problems including inconsistent content in manuals (i.e., different manuals in the cockpit and conflicts between cabin and cockpit manuals) and problems in weight and balance computations. It would have been especially important at this time to conduct extensive line observations of crew performance in the F-28. Testimony of Transport Canada witnesses identifies a lack of resources for the enforcement of safety regulations and monitoring of flight operations.

I(c). An audit of Air Ontario operations that was delayed and incomplete in scope. Evidence from several airline mergers that have been observed in the U.S. suggests that they create conditions which warrant increased regulatory surveillance. There are always disruptions in operational effectiveness surrounding the joining of disparate operations that call for increased efforts directed toward monitoring operations and ensuring compliance with appropriate safety standards. Strikes have also been observed to create major operational problems, even after their settlement, and to interfere with effective crew-management communications. A national audit of Air Ontario was scheduled for February, 1988. While the airworthiness, passenger safety, and dangerous goods portion of the audit were completed as scheduled, the flight operations portion was postponed until July, 1988 and again until November, 1988, when it was completed. The combination of a merger, a strike, and the introduction of a new aircraft type, would seem to have mandated an extensive audit of the operation. It is noteworthy that the audit that was conducted failed to examine the most significant operational change in the organization, the initiation of jet service in the F-28. Testimony by the leader of the audit indicates that he was inexeperienced in audit procedures, was directing his first audit, and had a limited staff. The statement that examination of crew training records forms the heart of an audit certainly reflects an honest opinion. However, from the author's research experience, an alternative view can be proposed that the observable behaviour of crews in line operations is the key to understanding the level of safety and effectiveness in flight operations.

I(d). The failure to require effective training and licensing requirements for flight dispatchers and to establish regulations governing dispatch and flight following. Transport Canada had no formal requirements for the training and licensing of dispatchers and allowed a carrier such as Air Ontario to operate with a pilot self-dispatch system. While the arrangement at Air Ontario was in compliance with regulations, it practiced much less rigorous control of operations than its parent organization, Air Canada.

I(e). The lack of clear criteria for the qualifications and training of airline management, Check Airmen, and Air Carrier Inspectors. In times of rapid organizational change frequent shifts in operational conditions and practices are common as is substantial turnover in managerial positions. While organizations normally strive to maintain the highest possible level of experience and competence, in the absence of formal rules, compromises are frequent. It is suggested that more clearly defined guidelines could help organizations recognize situations where they need outside expertise to increase the safety and effectiveness of operations. In evaluating personnel, both the extent and quality of experience can serve as indicators of whether there are sufficient qualifications to direct and evaluate operations effectively. In the case of a new operation such as the initiation of F-28 service, such determinations may be difficult for those directly involved to make.

One persistent problem in the standardization of air carrier operations is the fact that regulatory inspectors and Check Airmen monitoring line operations are normally limited to working within a single aircraft type. The implication of this is that procedural variances that develop between the aircraft fleets of an organization fail to be detected by individuals who are restricted to dealing with a single component of the organization. Several airlines are adopting the policy of having evaluators monitor crew coordination and effectiveness across aircraft types to gain insight into type differences and developing subcultures.

II. The Organizational Environment.

A number of factors surrounding the nature and operation of Air Ontario created an environment conducive to operational error. At the highest level, Air Canada, despite owning controlling interest, *failed* to require Air Ontario to operate to Air Canada standards and failed to provide resources to achieve these standards. Similarly, a number of decisions and practices at Air Ontario served to allow an operation with significant safety-related deficiencies to develop and continue. The focus of this discussion is not on faulting organizations for failing to go beyond regulatory requirements. Rather, it is to discuss the *operational impact* of the organizational setting and practices that were present at this time. The factors to be discussed have been observed to impact operations in other air carriers facing similar constraints. It should be noted, however, that organizations undergoing such transformations might not be in a position to recognize their safety implications from within.

II(a). Lack of operational support from Air Canada. During the period of initiation of F-28 service, Air Canada owned a seventy-five percent, controlling interest in Air Ontario which operated under shared ("AC") flight designators. Air Canada has long experience in jet transport operations and stringent requirements for dispatch and flight following. The resources of this organization would have been highly valuable in smoothing the transition to the merged carrier and initiating jet service in the F-28. According to testimony, there were financial reasons (maintaining independent operations and pay scales) for maintaining a separation between the two carriers and there was no regulatory requirement for sharing resources and standards.

II(b). The disruptive impact of mergers and strikes. Mergers among air carriers have become increasingly frequent in recent years. In the course of our investigations, research into crew attitudes and behaviour has been conducted in several airlines which were the results of one or more mergers. As part of the research, crewmember attitudes toward management of the flightdeck are assessed using a survey instrument, the *Cockpit Management Attitudes Questionnaire (CMAQ)* (Helmreich, 1984; Gregorich, Helmreich, & Wilhelm, 1990). Attitudes regarding flightdeck management have been validated as predictors of crew performance and were derived from research implicating them as relevant in many accidents and incidents (Helmreich, Foushee, Benson, & Russini, 1986). The data show significant differences in attitudes as a function of previous organizational membership in each organization we have studied - in one case nearly a decade after a merger.[2] The results clearly indicate the existence of enduring subcultures within organizations. The issues measured by the CMAQ are shown in Appendix I. It is our premise that when cultural factors support the maintenance of differing attitudes about the appropriate conduct of flight operations, the effectiveness of flightcrew performance is likely to be compromised. Degani and Wiener (1990), in their study of normal checklist usage in air carrier operations, suggest that the stresses of merger can result in crews retaliating against management by disregarding mandated checklist procedures. The process of combining seniority lists from merging organizations also frequently results in poor relations among crewmembers from the different airlines. We have found that pejorative nicknames are often employed to label crewmembers from the opposite side of mergers.

Similarly, our data indicate that labour-management strife can have a deleterious effect on crewmembers' morale and attitudes toward their organizations. While there is no evidence to suggest that a crash has resulted directly from the impact of a strike, there is no doubt that the negative climate fostered by poor pilot-management relations is not conducive to effective team performance. In several airlines, even some years after a strike, relations among pilots and between pilots and managements remain poor.

2. A report on the impact of mergers with the organizations involved de-identified is under preparation for release in 1991.

Human Factors of the Air Ontario Crash **10**

Evidence from Air Ontario personnel supports the existence of differing sub-cultures in Austin Airways and Air Ontario with occasional categorization of former Austin Airways personnel as "Bush Pilots" who could be assumed to have informal, operational practices at variance with those of former Air Ontario flightcrews. The F-28 program was disproportionately managed by former Austin Airways personnel who could have influenced the operation in the direction of Austin Airways norms. The dominance of Air Ontario flight operations management by Austin Airways personnel also created ill-will among some former Air Ontario pilots. Morale problems and poor relations among crewmembers can interfere with effective teamwork and crew coordination.

One finding from our research into Crew Resource Management training is that it can serve to reduce differences in attitudes about flightdeck management between subcultures and between crew positions. Air Ontario management had looked into such training. Captain Robert Nyman, Director of Flight Operations, testified that the *CRM* courses available did not appear to fit the Air Ontario operation. Both the Chief Pilot and Chief Training Pilot attended a *CRM* course presented in Toronto by a major airline and reported it to be both of limited value and expensive.

II(c). High personnel turnover following the merger. In the period between the merger of the two carriers and the accident, there were substantial changes in personnel. Part of the operation was sold and the size of the combined organization was reduced from eight hundred to approximately six hundred. There was also turnover in two critical areas of management, Vice President of Flight Operations and Director of Flight Operations. Similarly, the position of Safety Officer was filled, became vacant due to a resignation, and subsequently re-filled. The lack of continuity in management could have impeded needed supervision of operational issues such as the introduction of a new aircraft type and standardization of operations following the merger. Programs such as *CRM* cannot alleviate operational problems associated with a lack of management stability and consistent direction.

II(d). Lack of organizational experience in jet operations. Air Ontario as an organization did not have experience in jet transport operations. At the time of the introduction of the F-28, efforts were made to acquire outside expertise in management and representations to this effect were made to Transport Canada. Ultimately, Captain Claude Castonguay, who had substantial jet transport operational experience (including in the F-28) was hired, but resigned after one month. Six months later he was called back to perform two line indoctrinations. In his letter of resignation, Captain Castonguay stated, "So much as I would like to keep working to establish your FK28 program, I have concluded that I cannot function in my duties as Check Pilot when I do not get the support I need." No one was subsequently hired from outside the organization to fill this role, leaving Air Ontario to manage the process with internal resources.

II(e). Deficiencies in Systems Operation Control (SOC) practices. Air Ontario operated with a dispatching system that consisted partly of full flight following and partly of pilot self dispatch. Although this system was permitted by current Transport Canada regulations, it failed to provide crews with the same level of support and resources given crews in the parent organization, Air Canada.

In the absence of regulations mandating formal training and licensing for dispatchers, Air Ontario primarily employed on the job training for dispatch personnel. For the introduction of the F-28, brief training in the operation of this type of aircraft was provided only for duty managers. In contrast, Air Canada provides its dispatchers with more formal training and operational guidelines - including rules that would forbid dispatching an aircraft with an inoperative APU into a station such as Dryden with no ground start capabilities. That the Air Ontario system was deficient is indicated by observed errors in flight releases such as fuel load calculations using wrong parameters. Indeed, the flight release for CFONF contained errors on the day of the accident.

II(f). Lack of standard operating procedures and manuals for the F-28. Service was initiated without a specific Air Ontario operating manual for the F-28. There was also no approved Minimum Equipment List for some months after passenger service began. There were inconsistencies between cockpit and cabin manuals provided crews. For example, the cabin manual required passenger disembarkation for refueling with an engine running while there was no parallel rule in the cockpit manual. Crews thus lacked formal organizational guidelines either from resources available on the flightdeck or from SOC.

II(g). Inconsistencies/deficiencies in training F-28 crewmembers. Initial training of F-28 crewmembers, including both ground school and simulator training, was contracted with Piedmont Airlines. Piedmont itself was involved in a merger with USAir which decided to achieve standardization of the merged operation by shifting all former Piedmont personnel to

USAir procedures and manuals. There were several implications of this organizational environment for Air Ontario crews. The first was that some received training from the Piedmont F-28 manual while those training later worked with the USAir manual. Since Air Ontario had not developed its own manuals, some individuals returned with the Piedmont Manual and others with that of USAir. While Air Ontario stated that the Piedmont Manual was its standard, this was not clearly communicated to crews and no efforts were made to provide all crews with the same manual. Air Ontario also failed to receive updates to the manuals it was using. Although the Fokker Aircraft Flight Manual was carried in the aircraft, there was a lack of training involving this manual and there were discrepancies between the Fokker and Piedmont manuals, for example in computing corrections for runway contamination. A second result of the Piedmont merger was a scarcity of simulator time for completing the training of Air Ontario crews. Because of this, a number of pilots were trained in the aircraft by newly qualified Air Ontario pilots rather than in the Piedmont simulator. Even with highly experienced instructors, there is an industry consensus that simulator training provides broader and more effective training.

Crewmembers surveyed by the Safety Officer following the accident generally reported their Line Indoctrination at Air Ontario to be "fair" in quality. One deficiency noted was a failure to define clearly the duties of the pilot flying and the pilot not flying.

II(h). Leadership of the F-28 program. Captain Joseph Deluce was selected as Project Manager and Chief Pilot for the F-28 and Convair 580. Captain Deluce had numerous responsibilities including line flying during the strike which preceded aircraft delivery and conducting training and line indoctrination in the F-28 for new crewmembers. He also carried Chief Pilot responsibilities for both fleets. Captain Deluce had limited operational experience in both the F-28 and the Convair 580. Airlines typically choose individuals with substantial experience in an aircraft type to be Chief Pilot.

One incident that may have had a significant impact on crewmember attitudes was the removal of an F-28 crew from a line trip to meet with the Chief Pilot for allegedly writing up too many maintenance discrepancies on the aircraft. The perception of other crewmembers of such an event would likely be of a lack of leader support for optimal operating conditions and a strong pressure to operate at all costs.

II(i). The informal culture at Air Ontario. One of the more striking findings to emerge from our research into flightcrew behaviour has been the discovery of significant differences between aircraft fleets within organizations in attitudes regarding flightdeck management and in ratings of behaviour in both line operations and Line Oriented Flight Training conducted in the simulator (Helmreich, Chidester, Foushee, Gregorich, and Wilhelm, 1990; Helmreich, 1990). These have been observed even in organizations with a strong commitment to standardization and form one of the justifications for implementing CRM training to develop common standards and values. Informal subcultures frequently tolerate or encourage practices which are at variance with organizational policies or regulatory standards.

Conditions at Air Ontario during the period of initiation of F-28 service would appear to have been conducive to the development of a non-standard subculture. These include previously noted lax regulatory supervision, high management turnover, the self-dispatch system with SOC personnel who lacked knowledge of the F-28 and were generally inexperienced, and the lack of clearly specified and enforced standard operating procedures. The reputation of being "Bush pilots" was attached to former Austin Airways pilots who formed a large percentage of the leadership of the F-28 program. Evidence of procedural variance is found in several reported practices. An example is writing mechanical problems or *snags* on paper to be passed to relieving crews instead of entering them in the aircraft logbook, thus permitting deferral of maintenance and avoiding the grounding of aircraft - a practice in violation of Transport Canada regulations. Others include the so-called "eighty knot check", a visual examination of the wing surfaces during take-off to ensure that contamination had blown off prior to rotation, and the practice of making overweight landings. A related fact is that Captain Deluce, the Chief Pilot, had been involved in at least two earlier, reported incidents involving take-offs with snow or ice contaminated surfaces. These suggest that the culture, at least among former Austin Airways crewmembers, may have allowed crews considerable leeway in making decisions about whether to take-off with surface contamination - a practice that was not proscribed by current Transport Canada regulations. It seems likely that the message communicated during training, and in the Fokker manual for the F-28, that *no* snow, ice, or frost should be present on wings may have been discounted to some extent by crews who had successfully operated (albeit in different types of aircraft) with some degree of contamination. Additionally, the Check Airmen appointed for the F-28 fleet were inexperienced in the aircraft and with jet operations and may not have been in a strong position to impose standards.

II(j). Maintenance problems with the F-28. A number of maintenance problems were encountered with the F-28. These were exacerbated by a lack of familiarity with the aircraft on the part of maintenance personnel and a shortage of spare parts. The Journey Log for the accident aircraft, CFONF, listed a number of problems between June and December, 1988, many deferred for extended periods. These included earlier problems with the Auxiliary Power Unit (APU) in August and October of 1988. On several occasions in 1989 the cabin filled with smoke with passengers aboard.

On the day of the accident, CFONF was dispatched with an inoperative APU and had three other deferred maintenance items including roll and yaw in the autopilot and a fuel gauge reading intermittently. Other discrepancies that were brought to the attention of the cockpit crew by the cabin crew prior to the first flight on March 10 included inoperative exit lights, dim cabin emergency floor lighting, missing oxygen masks, and problems closing the main door because of a missing clip.

II(k). Flight Attendant training. The practice of Flight Attendant training at Air Ontario discouraged flight attendants bringing operational issues to the attention of the flightdeck and questioning operations. Training stressed the competence of pilots and fostered a position of total reliance on the cockpit crew. Two examples of the results of this separation of cabin and cockpit can be seen on the day of the accident. These included the hot refueling of the aircraft in Dryden at variance with the cabin manual and the failure of the flight attendants to relay passenger concerns about de-icing to the flightdeck. In contrast to this lack of communication, the concepts taught in Crew Resource Management stress the importance of complete information exchange between the flightdeck and the cabin.

III. The Physical Environment

A number of negative factors were present in the operating environment facing the crew on March 10. These included an aircraft with mechanical problems including the inoperative APU and poor weather that had created an early delay for de-icing in Winnipeg and a subsequent hold in Dryden because of weather at Thunder Bay. Indeed the weather was unsettled in the entire region that day necessitating non-standard alternates at a greater than normal distance, thus increasing dispatch fuel requirements. There was also a change in the passenger manifest in Thunder Bay increasing the passenger load and necessitating defueling to meet weight restrictions for take off and landing at Dryden. At Dryden, there was no ground start equipment making it necessary to leave an engine running and forcing the Captain to hot refuel. Finally, snow was falling during the station stop in Dryden.

IV. The Crew Environment

A number of factors that were present in the crew environment of the accident flight have been identified through research in other organizations as significant stressors that can serve to reduce flightcrew effectiveness. These include both situational factors surrounding the operation and characteristics of individual crewmembers.

Situational Factors

IV(a). Crewmembers' unfamiliarity with the aircraft and their training experience. Both Captain Morwood and First Officer Mills were new to the F-28 and had fewer that 100 hours of operational experience in this aircraft type. After completion of ground and simulator training at Piedmont, Captain Morwood returned to flying the Convair 580 and his line transition to the F-28 was further delayed by the Air Ontario strike. First Officer Mills received his training in the aircraft rather than the simulator. For Captain Morwood, the delay in reinforcing his training on the line could have rendered him less effective initially. For First Officer Mills, the lack of opportunity to acquire skills and confidence in the simulator could have had a similar effect.

There is growing concern in the industry, based on several recent accidents in the U.S., about the safety implications of pairing crewmembers new to an aircraft soon after completion of line indoctrination, particularly under adverse weather conditions. There is obviously a significant learning curve in becoming comfortable with a new aircraft, particularly one substantially different from prior equipment. One of the basic premises of the crew concept of flight operations is that crewmembers support each other in service of the goal of safe and effective flight management. When *both* crewmembers are still acquiring familiarity with the aircraft, the margin of safety is reduced. Efforts are underway in the U.S. to set requirements for operational experience after initial training and to mandate scheduling of newly qualified crewmembers with those having substantial experience in the aircraft type.

IV(b). Organizational background and lack of experience working together. Several additional issues made the pairing of Captain Morwood and First Officer Mills potentially stressful. One was the fact that Morwood came from the Air Ontario organization while Mills' background was with Austin Airways. Additionally, both Morwood and Mills had been operating as Captains in their prior aircraft. Individuals accustomed to acting as pilot in command have been noted to function less effectively when paired. These factors, combined with the lack of enforced standard operating procedures (including the noted failure to specify pilot flying - pilot not flying duties in the F-28 line indoctrination), could well have reduced the effectiveness of this crew as a *team.*

This trip was also the first time that the crew had operated together and Captain Morwood was displaced for two days. Experimental simulation research conducted by NASA-Ames Research Center (Foushee, Lauber, Baetge, & Acomb, 1986) found that crew coordination and effectiveness is increased by the simple fact of working together as a team. In this study, crews who were fatigued (from a three day, multi-segment line trip) or not fatigued (coming from days off) flew an experimental simulation involving bad weather and mechanical malfunctions. The purpose of the study was to explore the effects of operationally induced fatigue on performance. The most surprising and serendipitous finding from the study was that *crews who had flown together previously performed better than crews paired for the first time whether or not they were fatigued!*

IV(c). Delays and stresses imposed by the operating environment. The initial segment of March 10 was delayed because of a need to de-ice the aircraft in Winnipeg. As noted, there were also major (APU) and minor mechanical problems with CFONF. In a radio communication, Captain Morwood commented "...everything else has gone wrong today." After the first leg, an additional delay was experienced because of poor weather in Thunder Bay. On arrival at Thunder Bay, additional passengers were taken aboard from a cancelled flight after refueling, making it necessary to remove fuel to meet weight requirements and causing it to depart more than an hour behind schedule. On arrival at Dryden, it was necessary to refuel with an engine running because of the lack of ground start capability. At the same time, snow was falling. As the Captain had fewer than 100 hours in the aircraft type, he required a higher RVR than a more experienced pilot would have. He may (or should have been) concerned that visibility would become below his minimum requirement prior to departure. The flight was already running late and a number of passengers had tight connections in Winnipeg. A final delay of approximately four minutes was incurred to await the arrival of a Cessna 150 which was experiencing difficulties because of the poor weather.

Personal Factors

IV(d). Captain George Morwood. Captain George Morwood was 52 years old and had more than 24,000 hours flying time. His operational experience was entirely in Canadian operations. He had worked for the predecessor of Air Ontario and had served as a Check Pilot and Chief Pilot for the Convair 580 at Air Ontario. He trained on the F-28 at Piedmont Airlines in January and February of 1988, but did not begin line flying in the F-28 until December, 1988. At the time of the crash he had 81 hours in the aircraft. His jet experience included approximately 600 hours in the Gulfstream G-2.

According to his record and peer reports, Morwood was above average in ability. He had shown concern with safety issues in his prior management positions and was aware of icing effects, including those caused by differential temperatures of fuel and ambient air. According to his record, he had delayed or cancelled flights because of icing. Probably based on his long experience as a Check Pilot, and Chief Pilot, Captain Morwood was reported to be in the habit of operating as an "instructor" while flying. In theory, this characteristic could be an annoyance to highly experienced junior crewmembers such as First Officer Mills who had considerable experience flying as a Captain.

Captain Morwood was reported to have a strong commitment to on time operations and a high level of concern for his passengers. There were a number of delayed passengers with connecting flights in Winnipeg on March 10. In addition, Morwood had a scheduled personal trip immediately following his last flight segment. These factors could have heightened motivation to complete the scheduled flying.

IV(e). First Officer Keith Mills. Keith Mills was 35 years old and had more than 10,000 hours flight experience. He began flying for Austin Airways as DHC6 Co-pilot in 1979 and became a Captain on the Hawker-Siddely HS748 in February 1988. He completed F-28 ground training in January, 1989 and aircraft training at Air Ontario. At the time of the crash he had 65 hours in the F-28 and approximately 3,500 jet hours in the Cessna Citation.

Mills had some record of difficulties with "stick and rudder" aspects of flying, but he met all regulatory requirements for competence. His failure to receive simulator training in the F-28 and Morwood's long experience and reputation as a perpetual "instructor" may have made Mills somewhat reluctant to practice optimal crew resource management concepts and to provide operational suggestions to Captain Morwood. Mills also had a scheduled personal trip at the end of his last flight segment.

V. The Situation of March 10

The picture that emerges from examination of the regulatory and organizational environments in which this crew was operating is one of an array of factors which served to undermine their effectiveness and to increase the stress of flight operations. None of these factors taken alone is likely to *cause* an accident - as evidenced by the fact that the F-28 was operated without incident or accident for months prior to March 10. However, when these factors were combined with the particular conditions of the physical environment (the inoperative APU, lack of facilities at Dryden, weather conditions, pressures to take off, etc.) the margin of safety was clearly reduced. Factors in the crew environment such as the operational unfamiliarity of the crew with each other and the aircraft doubtless exacerbated the situation.

V(a). Environmental Stressors. In considering the crew's actions on March 10, the environmental factors that may have been perceived as stressors should be reviewed. Psychological stress can serve to reduce individual and team effectiveness especially in the areas of interpersonal communications and coordination and decision making. Relevant classes of stressors include time pressure, and frustrations associated with inadequate resources and sub-optimal operating conditions. Captain Morwood and First Officer Mills faced a number of these conditions throughout their day. It may provide a useful context for the situation at Dryden to summarize them chronologically.

1. On accepting the aircraft in Winnipeg, the APU was found to be unserviceable. As noted previously, there were three additional, deferred maintenance items and other items in the cabin reported by the flight attendants.

2. The marginal weather throughout the region forced an initial delay for de-icing and the adoption of a distant alternate with a consequent requirement to carry additional fuel.

3. It was necessary to plan for "hot refueling" in Dryden because an engine would have to be left running. This may have triggered additional concerns because of company policy (and a stated requirement in the Fokker Publication on Cold Weather Operation) that the aircraft could not be de-iced with the engines running. However, it is not clear whether Captain Morwood had received a company memorandum about de-icing policy for the F-28.

4. SOC dispatched the flight with a clearly erroneous Flight Release. Testimony from pilot witnesses indicated little confidence in the SOC operation. It may have been a source of frustration or concern for the crew on this date to have been dispatched with no explicit accommodation for the unserviceable APU under adverse weather conditions.

5. Both crewmembers had fewer than 100 hours in the F-28. In addition to the stress imposed by lack of familiarity with the aircraft, Captain Morwood had more restrictive limits for visibility because of his low experience level in type. This could have added to his concerns about getting in and out of stations with poor weather.

6. The flight was delayed on its initial stop in Dryden because Thunder Bay weather was below landing limits.

7. There was considerable confusion surrounding the loading of additional passengers in Thunder Bay and the need to defuel the aircraft to meet weight restrictions. The crew had to communicate with SOC through a radio relay by Air Canada since there was no direct communications link from the flightdeck. This situation increased the delay of the flight to more than an hour on departure from Thunder Bay.

8. The fire trucks required for hot refueling were not in position on the aircraft's arrival at Dryden. This factor added to the accumulating delay and probable frustration of the crew over the disruptions surrounding the day's operations.

9. The date of the accident was the beginning of the March school break. There were many passengers with connections to make. The crew expressed concern over this in radio communications.

10. As the flight landed in Dryden, it began to snow, with the fall increasing during the stop. While the reported visibility was above minima, the actual visibility may have been at or below the Captain's minima at the time of take off.

While none of these issues alone can be considered an overwhelming stressor, taken in concert they indicate a taxing operational environment.

From the perspective of hindsight, it seems likely that a change in any one of a number of conditions might have provided the extra margin of safety needed. For example, a more stringently regulated and managed dispatch system would probably have precluded operations into Dryden on the return from Thunder Bay. An effective training program in Crew Resource Management could have resulted in a review of the operational situation involving both pilots and led to a critical evaluation of the decision to take off without de-icing. Similarly, training that encouraged cabin crewmembers to share operational concerns with flightcrews and pilots to listen to such concerns might also have triggered further consideration of the implications of accumulating contamination on the aircraft.

The issues discussed in preceding sections have an empirical basis as significant influences on flightcrew behaviour, but a weighting of each as a determinant of the outcome of Flight 363 cannot be made from the available record. Nor can the decision processes surrounding the take off from Dryden be specified in the absence of Cockpit Voice Recorder evidence. However, it is possible to envision a likely scenario for the crew's actions based on consideration of the four sets of determinants of crew behaviour described previously. It must be stressed that this represents a *post hoc* reconstruction that may be erroneous in part or whole.

VI. A Scenario for Crew Decision Making in Dryden

In retrospect, the decision to operate into Dryden on the return from Thunder Bay without a functioning APU was questionable, but understandable. The initial stop in Dryden was uneventful, despite a delay because of weather conditions in Thunder Bay. Although the forecast for the region showed a risk of freezing precipitation, on approach to Dryden conditions were VFR. Making the stop would minimize passenger disruption. However, once on the ground in Dryden, the weather and operational situation deteriorated. At the same time, the crew had conducted a day of flying that must be considered stressful because of the mechanical problems with CFONF, increasing delays, the changed passenger load resulting in additional delay, and the crew's relative inexperience in F-28 operations. While on the ground in Dryden, the following issues faced the Crew:

1. Considerations surrounding refueling with an engine running
2. Pressures to get passengers to Winnipeg for connections
3. The inconvenience of stranding passengers in Dryden with limited facilities
4. Logistic problems surrounding de-icing with an unserviceable APU and no ground start capability
5. The need to import ground start equipment if both engines were to be shut down and consequent long delay
6. Snowfall during the stop causing both aircraft and runway contamination and deteriorating visibility that might be below minimums for the Captain
7. The implications of contamination on the aircraft
8. The implications of contamination on the runway (including conflict between Fokker and Piedmont manuals in this area)
9. The additional delay posed by the arrival of the Cessna 150
10. Planned personal trips which would be impacted by long delay in Dryden

One of the effects of psychological stress (including that imposed by time pressure) is an inability to process multiple sources of information as effectively as under more relaxed conditions. As listed in the previous section, a case can be made for the fact that the crew, and especially Captain Morwood as pilot in command, was under considerable stress by the time the flight stopped for the second time in Dryden. It may also be inferred that the operating standards of Air Ontario and the absence of formal training and organizational endorsement of crew coordination concepts, would have tended to preclude rigorous *crew* evaluation of the operational situation.

Surrounding the decision to take off are several critical questions. One is whether the crew was aware of the safety implications of the accumulating snow. As noted, Captain Morwood had a history of concern and awareness of icing risks. He had delayed the initial flight of the day for de-icing. Testimony by a representative of Transport Canada included an incident when Captain Morwood insisted on going back to the gate in the Convair 580 for de-icing even though the Inspector had remarked that the snow seemed dry and the propellers were blowing it off the wings. Also, a 1983 letter from Air Ontario management endorsing the Captain's authority to de-ice when circumstances require was found in Captain Morwood's flight bag at the accident scene.

A second question is whether the crew was aware of the accumulation of snow on the wings at Dryden. The Captain visited the terminal during the stop in his shirt-sleeves and would have been aware of snow falling. During a conversation with SOC during this period, he commented to Ms. Mary Ward that the weather at Dryden was "going down." The cockpit crew also had the ability to observe the wings from the cockpit and the testimony of informed passengers indicated that snow was accumulating visibly there. It seems inconceivable that the crew would have been unaware of snow on the wings. The fact that Morwood inquired of the station manager at Dryden about de-icing facilities there also suggests awareness.

Despite his knowledge of icing and probable awareness of the snow gathering on the wings, it seems most likely that Captain Morwood weighed costs and benefits surrounding the issues listed above and concluded that the best course of action would be to take off expeditiously. Several things may have influenced this decision. One is that because of the multiple stressors involved in the situation and his focus on completing the trip, he failed to weigh the risks as heavily as the benefits from getting out before the weather deteriorated further. The ambiguity of regulations regarding icing could also have influenced his decision. Although it was noted that emphasis was placed in training at Piedmont on taking off with no wing contamination, he may not have felt that the issue was as serious in the F-28 as other aircraft given higher rotation speeds and additional opportunity to blow the accumulation off during take-off roll.

The role of First Officer Mills in this decision is, of course, indeterminate. However, based on considerations regarding experience and status it is not likely that he was heavily involved by Captain Morwood.

There was probably a misperception about the nature of the contamination as it relates to "cold soaking", the situation when portions of an aircraft are at a temperature below the ambient temperature because of having descended from altitudes where ambient air is colder or from heat transfer to areas containing fuel colder than the ambient temperature. Pilots interviewed by the author were primarily concerned with heat transfer at high altitudes and less aware of the phenomenon occurring on the ground due to cold fuel in wing tanks. The Piedmont manual which was used at Air Ontario addresses this phenomenon in a section on Cold-Weather Operations. It states:

> "When the tanks contain sufficient fuel of sub zero temperatures as may be the case after long flights at very low ambient temperature, water condensation or rain will freeze on the wing upper surfaces during the ground stop forming a smooth, hardly visible ice coating.
>
> During take off this ice may break away and at the moment of rotation enter the engine causing compressor stall and/or engine damage." (Piedmont F-28 Manual, Exhibit 307 3A-24-1)

A decision could well have been reached that the snow would blow off, given the large fluffy flakes coming down and the lack of accumulation on the tarmac surrounding the aircraft. The possibility that a layer of rough ice caused by cold soaking extended to the leading edge was probably not entertained by either Morwood or Mills.

Psychological pressure to complete the trip as scheduled, commonly referred to as "get home-itis", cannot be ruled out. Captain Morwood was clearly concerned about holiday passengers with connecting flights in Winnipeg and both he and Mills had personal trips planned after completion of the trip. Had the flight been cancelled in Dryden, it would have been necessary to fly in ground start equipment causing a lengthy delay and disruption of crew and passenger plans. Once on the ground in Dryden, the implications of a long delay doubtless had a subtle influence on the decision process.

A final chance to re-evaluate the situation was probably missed when the flight took its final delay for the landing of the Cessna 150. However, the accumulation of stress and frustration surrounding the day's operations had probably reduced the crew's effectiveness and decision making capabilities by this time.

While the Captain as Pilot in Command must bear responsibility for the decisions to land and take off in Dryden on the day in question, it seems equally clear that the aviation system failed him at the critical moment by not providing effective management, guidelines, and procedures that would assist him in such decisions.

In the following section, observations and suggested corrective measures are offered in the hope that they may provide greater resources for future crews who find themselves in stressful situations trying to evaluate multiple pieces of information and having to make choices among unpleasant, alternative courses of action.

VII. Observations

The following are corrective measures that could be taken to increase system safety and effectiveness. It is noted that the first recommendation of the Commission to Transport Canada was to remove the ambiguity from regulations surrounding wing contamination and that this was favorably received.

VII(a). Monitoring of air carrier operations. It would be valuable to establish guidelines for air carrier management in terms of qualifications needed for effective job performance. A similar set of standards could be established for Air Carrier Inspectors and others involved in surveillance of airline operations. Requirements for inspectors and check airmen could include training in the evaluation of human factors aspects of flight operations.

Training in the conduct of air carrier audits and requirements for qualification of audits could be strengthened. In particular, emphasis in audits should be on observation of line operations evaluating both human factors and technical proficiency.

Strengthened requirements for flight dispatch and the training of dispatchers should be developed for all airline operations.

VII(b). **Winter operations.** Yearly training and review of Winter operations procedures should be conducted. This should include not only general issues regarding icing, cold soaking, and de-icing procedures, but also information specific to particular aircraft types as needed.

VII(c). **Common standards for major airlines and their feeder operations.** Airlines operating under a common designator should maintain the same standards of training, dispatching, and performance. The need is probably greater for effective training and organizational support in smaller carriers that operate into secondary stations with fewer facilities. In many cases, pilots in regional carriers may have had less experience and less formal training. The resources of the major carriers could be highly beneficial for the safety and effectiveness of these regional carriers and could allow them to establish levels of training that they could not effect independently.

VII(d). **Formal training in Crew Resource Management for all crewmembers.** Accumulating experience in the U.S. and many other countries has demonstrated the importance of *CRM* training. The U.S. has encouraged this training through an Advisory Circular and it is a requirement for operating under a new Special Federal Aviation Regulation called the *Advanced Qualification Program*. Efforts are underway in the U.S. to initiate a regulatory requirement mandating *CRM* training for all air carriers operating under Parts 121 and 135 of the Federal Aviation Regulations. A copy of the *CRM Advisory Circular* and a proposed revision drafted by the author as part of a committee of the Air Transport Association are included as Appendix II and II-A. A premise of the Advisory Circular, supported by empirical research, is that a single training experience in *CRM* concepts is insufficient to provide long term changes in crew coordination and performance. Such training must be accompanied by opportunities to practice the concepts and to receive reinforcement for their use. Check Airmen and Instructors have been identified as critical to this endeavour and should be given training in the evaluation and reinforcement of human factors issues as an extension of their traditional role (Helmreich, Chidester, Foushee, Gregorich, & Wilhelm, 1989). This type of evaluation and reinforcement can and should occur both in ground training and during line checks and should center on clearly understandable exemplars of effective and ineffective performance that have come to be called ***behavioural markers*** of crew performance. Examples of these and a form for evaluation of crew performance (the *CRM/LOS Checklist*) are included as Appendix

III. There is a growing belief that this training can be effectively extended to cabin crews and other operational personnel. One can speculate that had both the flight attendants and cockpit crew completed *CRM* training and accepted its concepts, there might have been an exchange of information that would have precluded the take off.

VII(e). Crew oriented training and evaluation. The historical emphasis in aviation has been on individual, technical proficiency and both training and evaluation have centered on the performance of the individual pilot. However, data from accidents and incidents suggest that the *CRM*-related issues isolated in accidents and incidents involve failures of *crews* to operate effectively as *teams*. Many airlines and military units have reacted to this by increasing the emphasis in training and checking on crew-level performance. In checking line operations this is accomplished by including the performance of the crew as a unit as part of the evaluation and debriefing (for example, using the *CRM/LOS Checklist* as a template for evaluation).

Another approach being used increasingly (and required in the U.S. for carriers that will operate under the *Advanced Qualification Program*) is the use of *Line Oriented Flight Training (LOFT)* which involves complete crews training in simulators under realistic operating conditions including flight releases, air traffic communications, and facing a variety of operational problems including inflight emergencies. A key to the success of this training is that it is *non-jeopardy* meaning that crews are allowed to experiment with a variety of behaviours and approaches without placing their licenses at risk. Events are allowed to proceed without intervention by the Instructor and are usually recorded on videotape for subsequent review and debriefing. In its early development, *LOFT* required access to high fidelity simulators placing this form of training out of the reach of many organizations, especially regional and commuter airlines. However, recent research and theorizing (Franz, Prince, Salas, & Law, 1990; Helmreich, Kello, Chidester, Wilhelm, & Gregorich, 1990; Helmreich, Wilhelm, & Gregorich, 1988) suggests that low fidelity simulators and training devices may provide excellent settings for training in crew coordination and should make the technique available to almost all organizations.

VII(f). Establishment of a Safety Office in all air carriers. In addition to regulatory monitoring of air carriers, an independent Safety Office can serve an important function in isolating potential threats to safety. A Safety Officer with direct access to top management is in a position to initiate corrective action when threats to safety are uncovered. In addition to training in investigative techniques, training in human factors, database management, and analysis would also be highly desirable for Safety Officers and their staffs.

References

Degani, A., & Wiener, E.L. (1990). *Human factors of flight-deck checklists: The normal checklist* (NASA contract report 177549). Moffett Field, CA: NASA Ames Research Center.

Foushee, H.C., & Helmreich, R.L. (1988). Group interactions and flightcrew performance. In E. Wiener & J. Nagel (Eds.), *Human factors in modern aviation*, (pp. 189-227). New York: Academic Press.

Foushee, H.C., Lauber, J.K., Baetge, N.M., & Acomb, D.B. (1986) *Crew factors in flight operations III: The operational significance of exposure to short-haul air transport operations*. Moffett Field, CA, U.S.: NASA-Ames Research Center, TM 88322.

Franz, T.M., Prince, C., Salas, E., & Law, J.R. (1990). Low fidelity flight simulation: Applications for aircrew coordination training. in press.

Gregorich, S.E., Helmreich, R.L., & Wilhelm, J.A. (1990). The structure of Cockpit Management Attitudes. *Journal of Applied Psychology, 75*, 682-690.

Helmreich, R.L. (1984). Cockpit management attitudes. *Human Factors, 26*, 583-589.

Helmreich, R.L. (1990). *Studying flightcrew interaction: The intersection of basic and applied research.* Talk presented at the dedication of the NASA-Ames Research Center Human Performance Research Laboratory. Moffett Field, CA.

Helmreich, R.L. (1991). The long and short term impact of Crew Resource Management training (pp. 81-83) In *Proceedings of the AIAA/NASA/FAA/HFS Conference: Challenges in Aviation Human Factors: The National Plan.* Vienna, VA.

Helmreich, R.L., Chidester, T.R., Foushee, H.C., Gregorich, S.E., & Wilhelm, J.A. (1989). *Critical issues in implementing and reinforcing Cockpit Resource Management Training.* Austin, NASA/UT Technical Report 89-5.

Helmreich, R.L, Chidester, T.R., Foushee, H.C, Gregorich, S.E. & Wilhelm, J.A. (1990, May). How effective is Cockpit Resource Management Training? Issues in evaluating the impact of programs to enhance crew coordination. *Flight Safety Digest,* 1-17. Arlington, VA: Flight Safety Foundation.

Helmreich, R.L., Foushee, H.C., Benson, R., & Russini, W. (1986) Cockpit resource management: Exploring the attitude-performance linkage. *Aviation, Space and Environmental Medicine, 57,* 1198-1200.

Helmreich, R.L., Kello, J.E., Chidester, T.R., Wilhelm, J.A. & Gregorich, S.E. (1990) Maximizing the operational impact of Line Oriented Flight Training (LOFT): Lessons from initial observations. NASA/UT Technical Report 90-1.

Helmreich, R.L. & Wilhelm, J.A. (1990). Determinants of flightcrew behavior. In *Proceedings of the International Civil Aviation Organization Human Factors Seminar (A-276 - A-286).* Leningrad, USSR.

Helmreich, R.L., Wilhelm, J.A., & Gregorich, S.E. (1988) Notes on the concept of LOFT: An agenda for research. NASA/The University of Texas at Austin Technical Report 88-1.

Helmreich, R.L., Wilhelm, J.A., Gregorich, S.E., & Chidester, T.R. (1990) Preliminary results from the evaluation of Cockpit Resource Management Training: Performance ratings of flightcrews. *Aviation, Space, and Environmental Medicine, 61,* 576-579.

FINAL REPORT
CONTENTS

VOLUME I

VOLUME II

VOLUME III

DSS cat. no. CP32-55/1992E (Vol. 1–3)
ISBN 0-660-14382-8 (Vol. 1–3)