THE STATEMENT OF THE BOARD OF INQUIRY

CONDUCT OF THE INVESTIGATION

1. The President of the Board was notified and briefed by the Commander, ATG at 2230(L) 29 Mar 85 and 0700(L) 30 Mar 85. Other Board members were notified and arrangements made to meet at CFB Edmonton/Namao. All Board members plus three designated members of DFS were briefed by the Base Commander, CFB Edmonton and the Board was convened at Namao at 1200(L), 30 Mar 85. Since the accident occurred the previous evening, all immediate response actions had been completed. The crash site was secure and the fire was under control. Pertinent documentation and records along with the FDR from aircraft 130330 were turned over to the Board.

2. The Board members examined the crash site at 1230(L) 30 Mar 85 and established immediate priorities as follows:

a. photograph the entire crash site;

b. arrange removal of the bodies from the wreckage for further examination;

c. mark and identify wreckage/debris around the north ramp, runway and taxiways to restore the flight line to full operational capability;

d. clean up a fuel spill in fuel compound and commence repairs to the fuel pump house;

e. restore power to the facilities damaged in the crash;

f. establish a witness list and call for witness photographs; and

g. send the FDR for 130330 (Trucker Lead) and 130333 (Trucker Three) to DFS for analysis.

With these activities in progress the Board began its detailed investigation.

3. The Board divided the investigation into four major areas. These were:

a. the organizing, planning and conduct of the fly-past for the RCAF 61st Anniversary celebration;

b. the mechanical status of the three CC130s in the fly-past 130330, 130331 and 130333.

c. the currency and medical status of the flight crew and extra crew on the CC130 aircraft formation; and

d. the recovery procedure used by the CC130 formation after the fly-past.

61st ANNIVERSARY AIR DISPLAY

4. To celebrate the 61st Anniversary of the RCAF, CFB Edmonton arranged a fly-past of base aircraft in conjunction with an Officers' Mess Dinner on 29 Mar 85. An examination of all documents and records indicates that the administrative process for request, approval and tasking followed existing procedures. Some minor discrepancies were noted in this process. A NOTAM was not issued advising of the time and location of the minor air display. The on duty controllers at Namao were not aware of the planned fly-past, and although the base had appointed an Air Display Director he was not on location during the fly-past. None of these discrepancies adversely affected the fly-past nor did they have any bearing on the accident that followed.

5. The development, briefings and conduct of the fly-past conformed to established procedures. The fly-past plan had been used on other occasions and was familiar to some participants. A full scale briefing was given by the ADD on Wednesday, 27 March 1985. The pre-mission briefing did not include specific emergency procedures, specific aircraft spacing within individual formations, nor specific recovery procedures. The only reference to recoveries was that the helicopter and Twin Otter formation elements would turn left after the fly-past for independent recoveries and the CC130 formation would turn right after the fly-past for a recovery on Runway 29. The air display participants who were interviewed indicated satisfaction with the content of the briefing and were not disturbed that the omitted items listed above were not covered. Each formation element briefed independently on precise recovery procedures. The CC130 formation leader did not brief emergency or lost wingman procedures for their fly-past or recovery.

6. The mission, with the exception of some necessary changes to routings to holding points and holding altitudes, was flown exactly as planned and briefed. The weather was good and the early evening visibility was good. All elements with the exception of the CC130 formation recovered uneventfully. The participants interviewed were "quite pleased" with the way the fly-past went.

7. Based on an analysis of all activities and events up to the recovery of the CC130 formation nothing surfaced as a significant finding or potential accident cause factor. All formations were flown IAW all existing directives and guidelines and all altitude limitations were met. The Board terminated further investigation in this area.

CC130 AIRCRAFT MAINTENANCE STATUS

8. An examination of the maintenance records and documents of aircraft 130330, 130331 and 130333 showed that all required inspections and checks had been completed. Historical maintenance data showed no trends in recurring unserviceabilities and there were no outstanding operational restrictions or MRS entries that would affect airworthiness or limit the capability of these aircraft to perform the tasked mission. All fluid samples checked normal. Information from the FDR of 130330 (Trucker Lead) showed all engine and airframe parameters normal up to the mid air collision. Voice recordings from 130330 did not reveal any difficulties that the crew experienced with the aircraft. Unfortunateldy the FDR in 130331 (Trucker Two) had been removed and this fact significantly hindered the Board's investigation. However, a review of Namao Tower tapes on tower and interplane frequency gave no indication that Trucker Two was experiencing any mechanical difficulties. More detail on aircraft status and FDR limitations is contained in the Technical Member Report.

9. Based on the available information the Board finds no reason to suspect a mechanical malfunction on aircraft 130330 or 130331. With no pertinent mechanical findings or cause factors, excepting the FDR problem noted above, the Board terminated the technical investigation.

CURRENCY AND MEDICAL STATUS OF CREW MEMBERS

10. There were ten fatalities resulting from the mid air collision of aircraft 130330 (Trucker Lead) and 130331 (Trucker Two). All the bodies were recovered from the wreckage and positive identification was made. All records and documents pertaining to flying history, qualification, currency, mission scheduling, flight authorization, and medical status were examined by the Board.

11. From the wreckage the following crew status and flight deck locations were determined:

a. Aircraft 130330 Trucker Lead -

NAME AND MOC	AUTHORIZED CREW DUTY	FLIGHT DECK LOCATION
Capt Register L. (USAF), Plt	Aircraft Commander Formation Leader	Left Pilot Seat (secured)
Capt Kennedy K.E., Plt	Co-Pilot (AC qualified)	Right Pilot Seat (secured)
Capt Tulloch B.J., Nav	Navigator (Lead Nav qualified)	Navigator Station (undetermined)
Sgt Brown R.H., FE	Flight Engineer (Operational)	FE Station (secured)

b. Aircraft 130331 Trucker Two -

NAME AND MOC	AUTHORIZED CREW DUTY	FLIGHT DECK LOCATION
Capt Drake R., Plt	Aircraft Commander	Left Pilot Seat (secured)
Capt Whalen R., Plt	Co-Pilot (AC qualified)	Right Pilot Seat (secured)
WO Oness W.I., FE	Flight Engineer (Operational)	FE Station (secured)
Capt Thornton J.D., Plt	Extra crew (AC qualified)	Aft of pilot's stations (unsecured)
Capt Mahaffey I.D., Plt	Extra crew (AC qualified)	Aft of pilot's stations (unsecured)
Cpl Doucet J.M., ATC	Extra crew	Aft flight deck (unsecured)

12. A record review of all primary flight crew members, Capt Register, Capt Kennedy, Capt Tulloch, Sgt Brown, Capt Drake, Capt Whelan, and WO Oness indicated they were all qualified on the CC130 and had met all prescribed aircrew trade requirements and currency requirements. They were not on crew rest and they had no other primary duties other than the tasked mission on 29 Mar 85.

13. The extra crew had no formal crew duties on the mission but it was confirmed that Capt Thornton and Capt Mahaffey were also qualified on the CC130 and had met all aircrew trade requirements and currency requirements. There were no specific flight requirements for Cpl Doucet.

14. Medical Status. The Board Medical member reviewed all medical, dental and, where applicxable, aeromedical records of all the accident victims. Autopsies were performed on all the bodies as were toxicology tests. All the primary crew members met all aircrew medical requirements and were deemed fit to fly. Nothing was found in the autopsies to indicate pre-existing disease and the toxicology analysis was negative. The same medical review and tests were completed on the extra crew with the same results. Further details on the medical investigation are contained in the Statement of the Medical Member.

15. The Board determined that all primary crew members and the two aircrew extra crew members met all aircrew requirements, were current and authorized to fly the mission and were medically fit. The Corporal extra crew member was authorized to fly the mission and was fit to fly. Since the Board's investigation into the currency and medical status of the crew members revealed nothing that would bear on or relate to the cause of the accident this area of investigation was terminated.

CC130 FORMATION RECOVERY PROCEDURE (BATTLE BREAK)

17. The final area investigated by the Board was the circumstances and events surrounding the CC130 formation recovery procedure hereafter referred to as the "Battle Break". The Board sub-divided this area into specific investigative units so that when the sub-units were placed together the Board would have a historical profile on the broad subject of Battle Breaks. As well, the actual flight profile flown on this Battle Break was reconstructed through information gained from photographs, eyewitnesses, Flight Data Recorders, control tower tapes, and flight simulation data provided by the 34th Tactical Transport Squadron, Little Rock AFB, Arkansas.

18. The "Battle Break" is an overhead pitching manoeuvre usually initiated from a low altitude, over a point of intended touchdown which positions an aircraft for landing after a high speed straight in approach. It employs a 360° turn during which the aircraft climbs, loses speed, configures for landing, and descends to cross the runway threshold at normal height and approach speed. It is a tactical procedure developed many years ago to enable fighter aircraft to minimize vulnerability to ground fire and air attack as much as possible during post mission recovery. It is also an aesthetically pleasing manoeuvre to watch from the ground and has been employed for many years at air displays by many types of CF aircraft. Though it has no current tactical transport application the use of this type of recovery by Air Transport Group CC130s for air display purposes is known to have occurred as early as 1976 and has been used on many occasions since, principally at air displays conducted by 435(T) Sqn.

19. Although no formal ATG policy exists with regard to air display qualification or training, the CO 435 Squadron recognized a requirement to identify and select individuals best suited for air display missions, particularly those seen to call for formation flypasts. A small number of pilots were therefore selected to an "air display" list based on past performance of normal duties and assessed potential. These pilots have historically been Tactical Airlift School instructors with a low turnover rate. Consequently, as individuals were periodically added to the list they would be informally shown air display formation station keeping techniques by the incumbents as laid out in squadron orders as well as how to perform the battle break recovery.

20. Because there is no established syllabus or curriculum for this training, techniques differ amongst TALS pilots in the execution of the battle break, particularly from a formation posture. It was, however, taught as a procedural manoeuvre when recovering from the air display formation. That is, wingmen would fly a specific profile without reference to lead, initiated either by lead's call or movement of the preceding aircraft. This approach to execution had been adopted to avoid follower aircraft having to use increasingly steep bank angles to keep lead in sight. In theory, if each aircraft flies the same break profile at three second intervals, separation between aircraft should increase steadily during the pull up and climbing turn, resulting in 1200' to 1500' spacing in the downwind position. Testing done by the 34th Tactical Training Sqn (USAF) on the C130E weapons system trainer at Little Rock AFB proved this theory to be correct. Using a 3 second interval from the 435 Sqn air display formation spacing and battle break profile, follower aircraft could not catch or contact, within the "G" or manoeuvring capability of the C130, a preceding aircraft if it was flying the briefed profile.

21. The profile adopted by 435 Squadron for this manoeuvre was, at a predetermined point, to initiate a 10^{o} nose up pitch attitude followed immediately be a 60^{o} bank, 2G climbing turn to the downwind position. Power was to be reduced to flight idle promptly after the bank angle was established. The break interval between succeeding aircraft in formation was three seconds. The procedural execution of this manoeuvre by a formation in "air display" spacing involved losing sight of the preceding aircraft, then reacquiring it at some point during the climbing turn and adjusting spacing visually prior to commencing final turn for a normal TAL formation landing. There was no specific, briefed point by which a follower aircraft had to reacquire the preceding aircraft and there was no procedure developed or practiced should a follower aircraft not reacquire the preceding aircraft by a given point in the manoeuvre. The importance of the requirement to maintain 2"G" during the turn was not emphasized during training or briefing for a formation battle break, in fact, "pushing off" pitch angle and "G" loading was an accepted level off technique by most air display pilots. Increasing bank and "G" loading to arrest a climb rate, though routinely practiced by one instructor, was not taught as a level off technique.

22. A practice was held for some of the pilots scheduled to participate in the 61st Anniversary air display a little over two weeks prior to the event. Squadron policy dictated that only pilots occupying the left seat were required to be familiar with air display formation procedures. The training was therefore restricted to those scheduled for left seat duties the day of the flypast, although they were not in the formation positions they were scheduled to be in for the display when a formation battle break was executed to terminate the mission.

23. Capt Register had been selected to the air display list and had performed in several air displays in 1984. When it became apparent that the pilot who had participated in the practice on the 13th and was

scheduled to lead the flypast on the 29th would not return from another tasking in time to participate in the display, Capt Register was scheduled as his replacement.

24. He was briefed on his duties by the Air Display Director, though not specifically on the type of recovery the CC130 formation was to use. He, in fact, conducted the flypast formation briefing for all participants prior to briefing the CC130 crews on specific CC130 formation details, including the formation battle break recovery.

25. He briefed a left battle break recovery from an echelon right formation on Runway 29 using "air display" spacing. He stipulated a 10^{o} pull up followed by a 60^{o} bank, 2 "G" turn. Power was to be reduced to flight idle after the bank was established. The pull up point for lead was to be abeam the tower with wingmen pulling up at 3 second intervals, taken from lead's "pull up now" call. Although he had performed the manoeuvre several times in 1984 either as a single ship or as a wingman, it could not be determined whether Capt Register had ever led a formation battle break.

26. Capt Register did not fly the battle break profile as briefed, while leading the CC130 formation. The flight data recorder tracings show clearly that power was reduced to flight idle while establishing a 12^{o} nose up pitch angle and prior to rolling on bank. Neither the desired bank nor positive "G" were established until 8 seconds after the "pull up now' command, delaying any heading change until 5 seconds after number two should have begun his pull up. This dramatically reduced the vertical separation between the two aircraft which would have been achieved as a result of the three second break interval, as well as significantly widening lead's turn radius. The commencement of lead's level off attempt resulted in low "G" values and premature pitch angle reduction, further widening lead's turn and effectively eliminating the remaining separation from number two.

27. Using the flight data recorder information from the lead aircraft to program the C130E weapons system trainer, the 34 TTS staff instructors, employing less that 2 "G" and 60^{o} of bank, were able to achieve simulated contact with the programmed aircraft using $2\frac{1}{2}$ to $3\frac{1}{2}$ second break intervals from lead's pull up.

28. As the two aircraft came together, the number two aircraft was on the approximate track of the ideal profile. Lead was clearly occupying number two's airspace at the time of impact.

Cause

STATEMENT OF TECHNICAL MEMBER

INTRODUCTION

1. The technical member was notified at home in Belleville, Ontario at 2330L 29 Mar 85, and accompanied other Trenton Board members to CFB Edmonton, leaving Trenton at 0800L 30 Mar 85 and arriving in Namao at 1200L.

2. Following an introductory briefing for all Board and DFS personnel, the BAMEO was contacted to ensure that the required initial response procedures had been initiated. It was ascertained that aerial photos and some ground photos had been taken, all maintenance log books and forms had been impounded, site security was in place, Safety Systems and EOD personnel had commenced identifying and safetying explosive and high pressure components, and the Flight Data Recorder (FDR) from A/C 330 had been located and secured. Additionally, manpower support was arranged and a plan developed for wreckage identification and recovery.

GENERAL

3. From eyewitness accounts it was determined that the mid-air collision between A/C 330 and 331 had occurred at 5340.8N and 11328.8W, or approximately 100 ft east of the centerline of Alpha taxiway and 450 ft north of the ramp area. Debris was strewn over an area approximately 2700 ft by 1400 ft, which created a formidable undertaking for personnel involved in wreckage analysis and recovery.

4. Priority was given to three tasks required for the Base to resume normal operations. These included restoring operational use of the runway and taxiways, clean up of the fuel spill and repair of the pump house, and restoring essential power. This latter task required the erection of several new hydro poles to replace ones which had been damaged during impact or in the post-impact fires.

COLLISION ANALYSIS

5. A small amount of debris was found scattered beneath the point where the mid-air collision occurred. The bulk of the wreckage of both aircraft impacted the ground in four distinct crash sites (including the empennage of A/C 330) approximately 1500 ft west of the initial collision point. Analysis of the impact of the two aircraft was facilitated by eyewitness accounts of the sequence of events, but complicated by the fact that two large aircraft were involved, both camouflaged, with considerable post-impact breakup, and post-impact fires which destroyed much of the

wreckage. Some wreckage away from the main crash sites could be identified as to which aircraft it came from either by serial number or by colour, since A/C 330 was painted in the original grey camouflage pattern while A/C 331 had the green/grey pattern.

A/C 330 BREAKUP SEQUENCE

6. Study of the path of the wreckage confirms eyewitness accounts that the lead aircraft (330) was struck very hard underneath by the #2 aircraft (331) during the Battle Break manoeuvre, creating a large 5-foot diameter hole in the area forward of the left hand wheel well. Also the impact fractured the tail section of A/C 330 around the ramp/door joining location, canting the tail down and eventually causing the tail to separate. Approximately two-thirds of the right hand horizontal stabilizer and elevator was missing from the tail section of A/C 330. It is probable that either the #3 or #4 propeller of A/C 331 contacted this area after the tail fractured. These propellers were torn from A/C 331 at this time and landed a considerable distance from the main crash site. Propeller damage to the right horizontal stabilizer was clearly evident. Also, red paint smears, matching the red paint found on the propeller blades, were found on this area. Slight damage also occurred to the left hand elevator trim tab and horizontal stabilizer, which would indicate some propeller contact.

7. The entire tail section of A/C 330, including the cargo door, separated from the fuselage prior to ground impact due to the force of the collision, and landed in an upright position on the north side of the CMTT warehouse (Bldg 130). Impact forces allowed the rudder to come free of the vertical stabilizer and it was found lying 15 feet north of the tail section.

8. Indications are that following the collision, A/C 330 was out of control. With extensive damage to the port underside, compounded by loss of the tail section, flight recovery was not possible. It came to rest in an inverted attitude in the MSE parking lot on the south side of the CMTT warehouse, impacting with very little forward motion. The angle of impact was determined to be 60-70°. The high angle of impact kept the major portion of the wreckage confined to a small area. Since the cockpit area hit the ground first, it was immediately covered by the main fuselage, which slid forward after initial contact. The post-impact fire destroyed much of the wreckage, as well as a large section of the CMTT warehouse.

9. Investigation of the wing flap screwjacks indicated approximately 10% flap on impact vice the fully up indication at the moment of collision determined from the FDR. It is possible that during the post-collision period the pilot of A/C 330 attempted to regain some control by lowering the flaps.

A/C 331 BREAKUP SEQUENCE

10. An analysis of the wreckage indicates that the cockpit area of A/C 331 struck A/C 330 with considerable force, severing the cockpit at the 245 bulkhead. Scrape marks were found on the upper portion of the cockpit and fuselage of A/C 331, conforming in pattern to rivet heads found on the belly of the lead aircraft. The cockpit, still containing the crew, then proceeded on a ballistic trajectory to the ground, where it impacted at approximately 30° and came to rest at a point, 300 ft west of the MSE building (187).

11. In the meantime the remainder of A/C 331 continued to break up in the air with large sections of fuselage wall peeling away aft of the 245 bulkhead to approximately the FS400 position. The aircraft inverted along a relatively flat trajectory, landing in the POL compound with only a slight amount of forward velocity. The small impact angle is evidenced by ground scars of the horizontal stabilizer and wings. It skidded along the ground inverted, coming to rest in the area of the pumphouse (Bldg 194), approximately 700 ft from the cockpit. A post-impact fire consumed much of the aircraft.

WRECKAGE ANALYSIS

12. The damage to both aircraft was so extensive that it was impossible to glean much information from flight instruments and other significant components. The post-impact fires resulted in further destruction of the aircraft, and in most cases control cables, instruments, warning lights and structural members were non-existent. The cockpit of A/C 331, although not involved in a fire, was so badly damaged it took a crane and fire-fighting equipment to get it even partially separated. However, what little remained of both aircraft was thoroughly examined for any signs of pre or post collision failure and impact failure. Specialist assistance was provided by Capt C.C. Johnson, a QETE accident investigation engineer.

AIRCRAFT SERVICEABILITY

13. There was no sign of birdstrikes or FOD damage to either aircraft. All engines were examined and determined to be operating normally at the time of collision, and turning at low RPM on impact with the ground. It is believed that the initial collision forces damaged control cables in both aircraft. After careful examination of the damage to the right hand elevator of A/C 330 and the fractured tail section it was concluded that the flight controls were essentially inoperable after the initial collision.

14. The FDR recovered from the lead aircraft (330) indicated that all systems were functioning normally at the time of collision. There is no reason to suspect that the #2 aircraft (331) was not operating normally at the time the collision occurred.

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15. Although there was no evidence of any unserviceability, the following components were removed and forwarded to QETE Hull (Attention QETE 6-4) for further in-depth analysis:

a. Engine S/N 109246 (#2 from A/C 330);

b. Engine S/N 109248 (#4 from A/C 331); and

c. Throttle quadrant A/C 331.

AIRCRAFT CONFIGURATION AT TIME OF COLLISION

16. From analysis of the FDR from A/C 330 and examination of the wreckage, the configuration of both aircraft at the moment of collision was:

a. Bare floor;

b. external fuel tanks installed;

c. flaps full up;

d. nose and main landing gear up; and

e. cargo door and ramp closed.

17. Fuel load distribution at take-off was as follows:

	A/C 330	A/C 331
#1 Main	7200	6800
#2 Main	6000	6100
Left Aux	0	100
Left Ext	200	200
Right Ext	200	200
Right Aux	0	200
#3 Main	6000	6000
#4 Main	7100	7000
Total	26,700 pounds	26,600 pounds

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AIRFRAME AND ENGINE HISTORY

18. The following history was extracted from the aircraft records:

a. Airframe A/C 330

Airframe CC130330 had a total of 11771.9 hours since new and had flown 387.3 hours since its last inspection. This inspection, a #1 Progressive Structural Inspection and #3 Periodic Inspection was completed 19 Nov 84 at CFB Edmonton. Servicing level inspections were completed as required. The PI was valid until 1 Apr 85 and a B check was signed off on form CF 335 by an authorized Sr NCO at 2155Z 29 Mar 85. A review of maintenance history over the past few months with particular emphasis on the period 1 Mar-29 Mar 85 revealed no unserviceability trends germane to this accident. Examination of form CF 354 showed there were no SIs outstanding. Examination of form CF 355 showed the following mods still outstanding: C-12-130-000/CF-536, 539, 542 and 545. These Mods were due variably on or before the next Supp Check, Periodic Inspection or PSI. The fact that these Mods were not embodied did not affect the aircraft's airworthiness or the accomplishment of the assigned mission.

b. T56 Engines A/C 330

The following is basic information on the engines installed on CC130330. These engines had no significant unserviceability trends which could have affected their performance:

(1) #1 engine, S/N AE109228, installed 22 Aug 84 at 11061.1 airframe hours. TSN is 9749.9 hrs and TSO is 2632.8 hrs, with 387.3 hrs since a #4 Periodic;

(2) #2 engine, S/N AE109246, installed 5 Feb 85 at 11548.4 airframe hours. TSN is 8841.3 hrs and TSO is 223.5 hrs, with an Acceptance Check at that time;

(3) #3 engine, S/N AE109815, installed 24 Dec 82 at 8977.9 airframe hours. TSN is 7307.3 hrs and TSO is 2855.0 hrs with 387.3 hrs since a #3 Periodic;

(4) #4 engine, S/N AE109234, installed 21 Aug 84 at 11061.1 airframe hours. TSN is 9302.0 hrs and TSO is 2855.0 hrs, with 387.3 hrs since a #2 Periodic.

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c. Airframe A/C 331

Airframe CC130331 had a total of 11888.8 hours since new and had flown 194.6 hours since a Supp Check, completed 13 Feb 85. The major inspections prior to that were a #2 Periodic, completed 15 Oct 84 and a #4 PSI, completed 27 May 83. Servicing level inspections were completed as required. The PI was valid until 5 Apr 85 and a B check was signed off on form CF 335 by an authorized Sr NCO at 2200Z 29 Mar 85. An operational restriction was recorded on the Aircraft Information Record, indicating the FDR/CPI system was inoperative. A review of maintenance history over the past few months with particular emphasis on the period 1 Mar-29 Mar 85 revealed no unserviceability trends germane to this accident. Examination of form CF3521 showed there were no SIs outstanding. Examination of form CF355 showed the following Mods still outstanding: C-12-130-000/CF-526, 536, 539, 542, 545, 511 and 519. These Mods were due variably on or before the next Supp Check, Periodic Inspection, or PSI. The fact that these Mods were not embodied did not affect the aircraft's airworthiness or the accomplishment of the assigned mission.

d. T56 Engines A/C 331

The following is basic information on the engines installed on CC130331. These engines had no unserviceability trends which could have affected their performance:

(1) #1 engine, S/N AE109225, installed 26 Oct 83 at 10032.7 airframe hours. TSN is 9733.4 hrs and TSO is 1856.1 hrs, with 615.4 hrs since a #2 Periodic;

(2) #2 engine, S/N AE109249, installed 6 Nov 84 at 11306.1 airframe hours. TSN is 8887.8 hrs and TSO is 582.7 hrs, with an Acceptance Check at that time;

(3) #3 engine, S/N AE109445, installed 3 Oct 81 at 7739.9 airframe hours. TSN is 8428.3 hrs and TSO is 4148.9 hrs, with 615.4 hrs since a #1 Periodic;

(4) #4 engine, S/N AE109248, installed 15 Feb 85 at 11694.2 airframe hours. TSN is 8799.8 hrs and TSO is 1041.1 hrs, with 617.9 hrs since a #1 Periodic.

ANALYSIS OF FLUID SAMPLES

19. Required fluid samples from the aircraft wreckage or from source were collected. Because of the severity of the impact and fire damage, there was a limit to the number of fluid samples that could be taken. These samples were as follows:

a. JP-4 from bowser used to refuel A/C 330 and 331;

b. LOX from 50 gal trailer S/N 1607-2;

c. Fuel from FCU line S/N 331621 (A/C 331);

d. Gearbox oil from QEC 3304310-41 (A/C 331);

e. Hydraulic fluid, rudder boost unit filter (A/C 330);

f. Hydraulic fluid, prop dome assy S/N N223380 (A/C 331, #3 prop);

g. Hydraulic fluid, prop dome assy S/N N223638 (A/C 331, #4 prop);

h. Hydraulic fluid, prop dome assy S/N N227097 (A/C 330, #3 prop);

j. Hydraulic fluid, prop dome assy S/N N223164 (A/C 330, #4 prop);

k. Hydraulic fluid, prop dome assy S/N N227099 (A/C 331, #2 prop);

m. Oil from accessory drive gearbox, engine S/N 109228 (A/C 330, #1 engine); and

n. Oil from accessory drive gearbox, engine S/N 109225 (A/C 331, #1 engine).

An analysis of these samples showed that they met required military specifications.

FLIGHT DATA RECORDER/CRASH POSITION INDICATOR SYSTEM

20. FDR data from A/C 330 was invaluable in confirming that the aircraft engines and flight controls were responding normally to crew inputs up to the time of the accident. The FDR information from A/C 333, the #3 aircraft, was also valuable in comparing flight parameters attained in accomplishing the Battle Break procedure. However, the lack of a serviceable FDR in the #2 aircraft, A/C 331, significantly hindered the Board in its investigation.

21. The current policy regarding operating without a serviceable FDR is summarized in Air Command message SO AMT 2125 281830Z Jun 84 (Annex H), with similar information appearing in CFB Edmonton BAMI 12-130-0G0/MF-Z02/ED25 dated 21 Feb 83. In essence they provide authority to treat unserviceable FDRs as minor unserviceabilities. If all avenues of rectification have been exhausted, the aircraft is to proceed with a minor entry in the Maintenance Record Set.

22. In the case of A/C 331, the FDR was deployed inadvertently on the ground on 28 Mar 85. Maintenance personnel suspected this was caused by residual chaff from a previous incident where the FDR deployed in flight when chaff was dispensed. FDR components were removed for bench check and preparations made to vacuum the inside of A/C 331 to remove any residual chaff. A/C 331 was originally not scheduled to participate in the flypast but was required when one of the original aircraft was unavailable. The only minor procedural discrepancy was in recording the lack of a serviceable FDR/CPI as an Ops Restriction, rather than a minor unserviceability. In fact, this ensured that it was accorded the required visibility and was not buried in the minors.

23. The other factor that emerges is that there does not seem to be any ATG policy covering aircraft operating without an FDR/CPI. Squadron personnel use a 25 NM operating radius as a rule of thumb but there is no written policy that limits operations outside this radius, or defines the requirement for an FDR when performing non-routine flying operations such as air displays, LAPES, etc. It is clear that some policy must be developed, especially since the two newly acquired CC130s, A/C 334 and 335 will not have an FDR/CPI for several months. The installation of an FDR/CPI system in these aircraft should proceed on a priority basis, and every effort made to install some form of CPI or ELT on an interim basis.

SUMMARY

24. The following conclusions are based on the analysis of available information and observations made:

a. the engines, airframes and associated systems of both aircraft were serviceable before and at the time of the collision;

b. all maintenance performed on both aircraft conformed to established procedures and the investigation revealed no significant discrepancies in this regard. (The recording of an unserviceable FDR/CPI system as an Ops Restriction vice minor defect, although technically incorrect, provided the required visibility);

c. A/C 331, the number two aircraft, did not have a serviceable FDR/CPI system, a factor which hindered the investigation; and

d. no clear policy guidelines exist providing for operating ATG aircraft without an FDR/CPI system.

24. It is recommended that:

a. a policy be developed establishing guidelines for operating ATG aircraft without an FDR/CPI system;

b. the installation of an FDR/CPI system for the two new CC130s, A/C 334 and 335, proceed on a priority basis; and

c. efforts be accelerated to install some form of CPI or ELT in A/C 334 and 335 as an interim measure.

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STATEMENT OF THE MEDICAL MEMBER OF THE BOARD

1. The investigation by the medical member of the Board of Inquiry commenced at 0930 hrs 29 March 1985 on arrival at CFB Edmonton.

REMOVAL OF REMAINS

2. The major task initially was removal of the bodies of the victims from the cockpit wreckage areas of CC130330 and CC130331. There were visible human remains in the area surrounding the 331 cockpit wreckage so this area was addressed first. All human remains were numbered, photographed in situ, and a corresponding numbered stake driven into the ground at the location of the remains. Three badly mutilated bodies were found in the area of the wreckage and removed to a temporary morgue adjacent to the accident. A crane was required to lift the cockpit wreckage of 331 to remove the remaining three bodies. It was evident that at least two bodies had been thrown from the cockpit on impact with the ground. The site was surveyed and by correlating the location of remains, type of tissue, and injuries to the victims it was possible to allocate all but 1800g of tissue to individual victims. There is some circumstantial evidence, principally the large amount of blood on the cockpit wreckage, that suggests some of the crew of 331 may have been severely injured in the collision with 330.

3. The cockpit area of 330 was next sifted for human remains. This wreckage had been severely burned necessitating a very thorough, bucketful by bucketful, searching of the wreckage. Four severely charred human torsos were located, along with some human bone. The location of the torsos corresponded to the crew cockpit locations. The sifting of the wreckage of 330 was greatly aided by the Deputy Chief Medical Examiner and by two identification experts from the RCMP.

IDENTIFICATION

4. The next priority task was the identification of the victims. All victims of 331 were positively identified on the basis of fingerprints. It was also possible to get a positive fingerprint identification on Capt Register (AC of 330). The remaining three victims of 330 were positively identified on the basis of dental XRays. The identification process was hampered by the fact that fingerprints on the Canadian airmen are only held in Ottawa. Another area that could have hampered identification was that there were no identification markings on the dentures worn by one crewman; luckily fingerprints could be obtained from this individual. Dog tags were found from four individuals but since they were not found in direct contact with human remains their usefulness for identification purposes was minimal.

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AUTOPSIES

5. Autopsies were performed on all victims. This process was greatly aided by the Deputy Chief Medical Examiner for Alberta, Dr. D. Pounder, who flew a team of pathologists to Edmonton to expedite the autopsies. No evidence of any pre-existing disease was found at autopsy.

TOXICOLOGY

6. Toxicological samples were obtained and sent to both DCIEM and the Medical Examiner's laboratory for analysis. Ethanol was found in samples from five of the victims on analysis at DCIEM. No ethanol was found in any of the samples analysed by the Medical Examiner's laboratory. These positive ethanol levels are almost certainly due to putrefaction rather than ingestion. Chloroquine, an anti-malarial drug was found by both laboratories on samples from four individuals. This would not have had an effect on flying ability and is not an unusual finding in ATG aircrew.

HUMAN FACTORS

7. An extensive human factors investigation was carried out on the two pilots in control at the time of the accident, Capt Register and Capt Drake. It was decided, in consultation with Command Surgeon, Air Command, that this would be the most productive approach in view of the relatively large number of victims. A less extensive investigation was also carried out on the two co-pilots, Capt Kennedy and Capt Whalen. Information was obtained through review of the medical records, personal files, records of proficiency checks, course reports and through interviews with squadron associates and in the case of Capt Drake with his wife as well. Capt Register's wife declined to be interviewed and left the Edmonton area early in the investigation.

8. The complete details of the human factors investigation is contained in the "Separate Medical Report" iaw CFMO 42-03. A summary of the relevent items are included here:

a. Capt Register

(1) Capt Register was a 36 year old USAF exchange officer. He was married with three children, all boys, ages ten, seven, and two. He had no personal, financial, family or occupational problems. He was to be posted back to the United States in July of this year and was contemplating leaving the USAF for a career in civil aviation.

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(2) Capt Register had been an avionics technician in the US Marine Corps prior to joining the USAF and had served a tour in VietNam. After receiving a degree in wildlife management he joined the USAF and following basic pilot training had converted to the CC130 aircraft, and had greater than 3400 hours on type at the time of the accident. His flying ability was rated as average.

(3) Capt Register was medically fit at the time of the accident. His annual aircrew medical and aeromedical training were current. His rest and nutrition prior to the accident was normal. He had eight hours sleep on the evening preceding the accident.

b. Capt Drake

(1) Capt Drake was a 34 year old pilot who came to 435 Sqn and the CC130 Hercules aircraft after a tour on the Snowbird aerobatic team. He was married with two children. He had no financial, personal, family or occupational problems.

(2) Prior to joining the CAF Capt Drake had received a BA from the University of Alberta in Recreation and had worked for a short while at Vegreville Alberta. On completion of basic pilot training, Capt Drake served as an instructor at 2 CFFTS Moose Jaw and then did a tour on the Snowbirds. He had 3900 hours total flying time with 1500 hours on the CC130. His flying ability was rated as average to above average.

(3) Capt Drake was medically fit with a current annual aircrew medical and aeromedical training. His rest and nutrition prior to the accident was adequate with eight hours sleep on the evening prior to the accident.

LIFE SUPPORT EQUIPMENT

9. This crash was non-survivable and was not influenced by the lack of, condition, or type of life support equipment carried. Note was made of the dark grey colour of the 20 man life rafts carried by the CC130.

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MEDICAL CRASH RESPONSE

10. The base surgeon, a nurse and three medical assistants responded with two ambulances to the crash scene within five minutes of the crash. Additional support in the form of two ambulances and a multiple casualty unit were obtained from the City of Edmonton.

11. Four firefighters were treated for minor injuries.

CONCLUSIONS

12. Conclusions from the medical investigation of this accident are:

a. All aircrew were medically fit to fly at the time of the accident.

b. There was no evidence of pre-existing disease.

c. There were no psychosocial or personal problems which contributed to the accident.

d. Rest, nutrition or fatigue was not a factor in this accident.

e. Both pilots in command were experienced CC130 pilots, although not experienced in the battle break.

f. All victims died from multiple injuries sustained at the time of the accident or at impact with the ground.

g. All victims were positively identified.

h. Identification of victims would have been facilitated by the holding of fingerprints at the base.

j. Toxicological results were negative except for Chloroquine, an anti-malarial medication.

k. Cooperation with the Medical Examiner and RCMP is attainable and highly desirable.

m. Lack, type of, or condition of life support equipment did not contribute to the deaths of the crewmen.

n. The CC130 carries life rafts which are an inappropriate colour.

not pertinent

p. The medical crash response was timely and appropriate.

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RECOMMENDATIONS

13. That Air Command develop an identification envelope to be attached to the CF2034 (Medical Records) of each aircrew member. This envelope should contain fingerprints, current dental XRays, and ideally footprints.

14. That aircrew using dentures be required to have an identifying number incorporated into the dentures.

SUPPLEMENTARY RECOMMENDATIONS

15. That Air Command investigate the substitution of a more visible life raft for use in the CC130 aircraft.

T.V. Davis, Capt
Flight Surgeon

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CAUSES, FINDINGS AND RECOMMENDATIONS

CAUSE FACTORS

1. The Board assigns cause factors as follows:

   a. Personnel - Pilot - Technique. The pilot (Trucker Lead) deviated from the briefed Battle Break profile to the extent that the designed time, vertical and horizontal separation between Lead and Trucker Two was lost.

   b. Personnel - Pilot - Inattention. The pilot (Trucker Two) lost visual contact with Lead and continued the manoeuvre through to impact without reacquiring Lead.

   c. Personnel - Supervision/435 Sqn/Inattention. 435 Squadron supervisory personnel assigned pilots to perform a manoeuvre in the CC130 for which they were inadequately trained and in the case of two pilots had no training at all.

   d. Personnel - Management/435 Sqn, CFB Edmonton, ATGHQ/Information. The absence of policy with respect to Air Display manoeuvres permitted the planning and conduct of an unpublished procedure. There are no written instructions or Standard Operating Procedures describing the CC130 Battle Break. This manoeuvre was widely used and condoned at all levels.

FINDINGS

2. Staffing and authorization for flypast was in accordance with current regulations and procedures.

3. The air display briefing and flypast was conducted in accordance with current regulations, however recovery was an individual formation responsibility.

4. The CC130 formation leader did not brief emergency or lost wingman procedures for their flypast or recovery.

5. Weather was not a factor. Visibility at the time of the accident was good.

6. Air traffic control was not a factor.

7. The CC130 formation lead briefed a battle break recovery procedure prior to the mission.

8. No formal Air Transport Group policy exists with regard to air display qualifications or training.

9. The battle break manoeuvre is not a published procedure. There is no established syllabus or curriculum for training in this manoeuvre.

10. Techniques for performing the battle break manoeuvre differ amongst designated air display pilots.

11. The procedural execution of the battle break profile adopted by 435 Sqn dictated that, from a formation posture, using air display spacing, follower aircraft would lose sight of the preceding aircraft.

12. There was no procedure developed or practiced by 435 Squadron should a follower aircraft not reacquire the preceding aircraft by a given point in the manoeuvre.

13. The extreme risks of not flying the adopted profile precisely when in formation were not stressed during training or air displays.

14. 435 Squadron policy dictated that only pilots occupying the left seat were required to be familiar with air display formation procedures.

15. Not all pilots who participated in the air display on 29 Mar 85 had been trained in the battle break manoeuvre.

16. It could not be determined whether the CC130 formation lead pilot, Capt Register had ever led a formation battle break. The lead co-pilot had no training on the battle break.

17. Capt Register, while leading the CC130 formation battle break, did not fly the briefed profile.

18. It is probable that Capt Drake, flying the number two aircraft, flew approximately the briefed profile and flew into lead without reacquiring visual contact.

19. Severe structural damage to both aircraft made recovery impossible.

TECHNICAL FINDINGS

20. All maintenance orders and instructions had been complied with and both aircraft were serviceable at the time of the collision.

21. CC130331 did not have a flight data recorder installed which hindered the accident investigation.

MEDICAL FINDINGS

22. All aircrew were qualified, current and fit to fly at the time of the accident.

23. All victims were positively identified.

24. Identification of victims would have been facilitated by the retention of personnel fingerprint information at the base.

25. Toxicological results were negative.

26. The lack, type or condition of life support equipment did not contribute to the deaths.

ADDITIONAL FINDINGS

27. All personnel in CC130330 and CC130331 were on duty at the time of the accident and were authorized to fly the mission. The list of those personnel follows:

213 524 630 Capt Register L.B. (USAF)	Plt	-	Killed
242 034 570 Capt Kennedy K.E.G.	Plt	-	Killed
623 812 799 Capt Tulloch B.J.	Nav	-	Killed
436 102 313 Sgt Brown R.H.	FE	-	Killed
617 404 322 Capt Drake R.W.	Plt	-	Killed
445 222 136 Capt Whalen D.A.J.	Plt	-	Killed
447 597 360 Capt Thornton J.D.	Plt	-	Killed
247 487 462 Capt Mahaffey I.D.	Plt	-	Killed
431 277 425 WO ONess W.I.	FE	-	Killed
257 487 462 Cpl Doucet J.M.T.	ATC	-	Killed

28. The cause of the deaths was severe multiple trauma resulting from the crash.

29. All deaths were attributable to military service.

30. No specific blame is assigned in this accident.

31. The Base response to this disaster and subsequent support activities was outstanding.

SUPPLEMENTARY FINDINGS

32. Clear guidelines do not exist within Air Transport Group for the operation of aircraft without an FDR/CPI system.

33. Life-rafts in use in the CC130 fleet are an inappropriate colour. (?)

RECOMMENDATIONS

34. It is recommended that:

a. ATGHQ delineate air display policy with respect to applicability, method and resources;

b. for approved air displays, ATGHQ develop and publish a suitable VFR formation recovery procedure that ensures continuous visual contact with the preceding aircraft and includes lost wingman procedures; and

c. all pilots selected for air display missions be adequately trained.

Property Damage/Claims Against the Crown

35. Seven privately owned motor vehicles were destroyed in the accident. JAG Ottawa//DLAW/C has been advised. The Board is not aware of any potential claims against the Crown.

President

Member

Member

Member

Member

SUPPLEMENTARY RECOMMENDATIONS

36. It is recommended that:

a. a policy be developed establishing guidelines for operating ATG aircraft without a FDR/CPI system;

b. the installation of a FDR/CPI system for the two new CC130s, A/C 334 and 335, proceed on a priority basis;

c. efforts be accelerated to install a CPI or ELT in A/C 334 and 335 as an interim measure;

d. that Air Command (Command Surgeon) develop an identification envelope to be attached to the CF 2034 (medical records) of each aircrew member. This envelope should contain fingerprints, current dental x-rays, and footprints;

e. that Air Command investigate the substitution of a more visible life raft for use in the CC130 aircraft; and

f. that an Administrative Coordinator position be added to the composition of future Boards. (This position is vital to the efficient conduct of the Board and would be a valuable learning experience for a UFSO or other junior Air Operations officer).