No. 5

Maritime Central Airways, DC-4, CF-MCF, accident near Issoudun, P.Q. on 11 August 1957. Report of Board of Inquiry released by the Minister of Transport, Canada

Circumstances

CF-MCF departed London, England at 2148 GMT on 10 August on a charter flight to Toronto, Canada, with planned refuelling stops at Keflavik, Iceland and Goose Bay, Labrador. It carried a crew of 6 and 73 passengers (including 2 infants). The aircraft departed from Keflavik at 0512 GMT on 11 August, after a stop of 1 hour 6 minutes during which it was refuelled to capacity. At 1320 GMT it advised that it would overfly Goose Bay and proceed to Montreal. It arrived over Goose Bay at 1403, nineteen minutes ahead of its ETA, over Seven Islands at 1558 GMT and over Quebec Radio Range at 1807 hours. Quebec Radio Range Station relayed a message to the aircraft at 1810 requesting it to contact Montreal Range approaching Rougemont for clearance - this was the last contact with the aircraft. It crashed at approximately 1815 GMT, 4-1/2 miles west of Issoudun, killing all persons aboard.

Investigation and Evidence

The Aircraft

All servicing and maintenance procedures had been satisfactorily carried out in accordance with the Operations Manual of Maritime Central Airways Limited as approved by the Department of Transport. The Certificate of Airworthiness had been renewed on 13 March 1957 and was valid at the date of the crash.

The Crew

All crew members were properly licensed, medically and mentally fit and adequately experienced to make the flight.

The captain had flown a total of 13 500 hours, of which 2 000 were with Maritime Central Airways and of these 1 000 were on DC-4 type aircraft. He had been involved in a previous accident and had been the subject of a number of medical boards, which had assessed him fit for aircrew duties.

Loading

The licensed take-off gross weight for CF-MCF was 73 800 lbs. The load sheet at London showed a take-off weight of 72 869 lbs including a fuel load of 15 540 lbs. The fuel tanks were, however, filled at London and Keflavik to capacity - i.e. 2 868 U.S. gallons weighing 17 208 lb which would make the gross take-off weight in excess of the maximum permissible.

The overload on take-off from both London and Keflavik was calculated to be approximately 1 840 lb.

The landing weight at Keflavik was calculated to have exceeded the maximum permissible landing weight by approximately 2 830 lbs.

At the time of the accident, the weight of the aircraft was well below the maximum permissible figure. The actual distribution of the load was unknown. However, it was calculated that at the time of the accident the centre of gravity was at or beyond the aft limit - the aircraft was trimmed for a tail heavy condition.

The Flight

The flight from London to Keflavik was completed at 0406 hours GMT, seven minutes ahead of flight plan. Following

refuelling, the aircraft departed Keflavik at 0512 for Goose Bay, cruising at 8000 ft until it was cleared at 0946 to 6 000 ft. At 1320 hours the aircraft, following receipt of the Montreal weather forecast, advised Goose Bay that it would overfly Goose Bay and proceed to Montreal. Approaching Goose Bay a request for a clearance to cruise at 4 000 ft to Lake Eon and at 6 000 ft to Montreal was denied, following which the pilot chose to proceed VFR on Airway Red 1 until a clearance was issued at 1607 GMT for an IFR flight at 6 000 ft. At 1654 CF-MCF reported having passed Mont-Joli at 6 000 ft, estimating Quebec at 1758 and Montreal at 1850. The aircraft reached Quebec at 1807 and then estimated arrival at Montreal as at 1902 - this would make the aircraft 27 minutes behind the original estimate of 1835 hours GMT. The last contact with the aircraft was at 1810 hours GMT and at that time everything seemed normal. The accident occurred approximately 5 minutes later.

The Wreckage

The aircraft had embedded itself deeply into the ground and the crater contained the front section of the fuselage frame with the engines and the badly disintegrated port and starboard wings. The fuselage crater was approximately 15 ft deep, and the engine craters were between 10-1/2 and 11 ft in depth, the engines and fuselage being covered by water. The left wing had made a groove to the left side of the main crater and in alignment with the fuselage. The crater conformed to the aircraft striking the ground vertically. Large sections of the left wing skin were found to be corrugated indicating that the left wing had struck parallel to the ground and in so doing had caused the skin to corrugate very uniformly. The right wing was almost completely demolished, but it showed a different type of failure which would indicate that the aircraft must have hit the ground with the left wing leading slightly.

All major components of the aircraft were found in the wreckage, the pieces of which covered an area of about 125 000 square feet. The wing spar caps and ailerons were found in their correct position in relation to the centre line of the aircraft which would indicate that the aircraft came in straight, not spinning.

Conclusions following Examination of Wreckage

The following facts were established:

1. The aircraft struck the ground in an almost vertical attitude of approximately 70° from the horizontal and a few degrees left wing down;

2. The aircraft hit the ground at a speed calculated to have been in excess of 200 kts;

3. The two pilots at the controls had their seat belts on and fastened at the time of the accident;

4. Control of the aircraft had probably been lost prior to the crash;

5. Structural failure of the aircraft, engines or propellers prior to ground impact, premature in-flight failure or lack of adequate engine lubrication, explosion, foul play or sabotage, fire in the air or lightning strikes could be eliminated as being the probable effective cause of the accident.

The Fuel Situation

The flight plan showed the fuel on board the aircraft to be 16 122 lb and the figures for fuel remaining transmitted in the Aireps are consistent with this figure. The investigation, however, showed that the actual fuel on board was 17 208 lb (16 992 lb after taxying and run-up) and it was considered that the flight plan and

Airep figures were adjusted to be consistent with the incorrect figures shown on the load sheet. According to previous records the captain normally reckoned full tank capacity to be 16 650 lb and it is probable that his computations of fuel remaining were based on this figure. Using such a figure, the captain would have reckoned on 553 lb remaining on arrival over Montreal and on this basis 1 238 lb would have remained at 1815 hours (the time of the accident). The Board computed, however, taking the initial fuel load as 16 992 lb instead of 16 650 lb, that the fuel on board the aircraft at the time of the accident would have been approximately 1 580 lb. The Board, despite conflicting evidence of expert witnesses about the fuel situation, rejected the possibility of fuel shortage as the immediate cause of the accident. The Board was satisfied that there was sufficient fuel on board for the revised VFR flight plan from Goose Bay to Montreal but the amount of fuel was insufficient to satisfy the IFR reserve fuel requirements prescribed in the Air Regulations.

Weather

All ground witnesses stated that around the time of the accident there was a thunderstorm accompanied by heavy torrential rain and high gusting winds. Some also mentioned hail.

Several storms were radar plotted by the McGill University Stormy Weather Group at Montreal Airport, one of which was plotted to be on Airway Red 1 southwest of Quebec. The strength of this storm could not be ascertained owing to the extreme range. Also, owing to active thunderstorms between the radar plotting station and the storm plotted on Airway Red 1 southwest of Quebec, the strength of this plot was reduced.

Fifteen minutes after the estimated time of the accident (i.e. at 1830 GMT), the Quebec Radio Range Station issued a special weather report as follows:

> "Estimated 3 000 broken, 12 000 overcast, visibility 6, with thundershowers, wind west 10, clouds cumulus 6, altocumulus 4, visibility northeast through southeast 15."

A Research Meteorologist, specializing in aviation hazards, stated -

> "Turbulence is a significant thunderstorm hazard to aviation perhaps having the most serious of the thunderstorm hazards. The air motions which constitute this hazard are of two kinds. There is a relatively large scale vertical motion referred to as a draft. The drafts measure perhaps a couple of miles across with velocities in updrafts being measured at 90 ft per second or more and somewhat smaller in downdrafts. An aircraft caught in such a draft would experience a steady vertical motion which could cause up to 5 000 ft gain or 2 000 ft loss of altitude during a traverse of the draft in a flight starting at 6 000 ft. Such motions would not cause a severe structural strain but if the pilot attempted to maintain his altitude he could be placed in a anusual nose-up or nose-down attitude."

> ..."Loss of control is another hazard that can be associated with severe thunderstorm turbulence. This is particularly true if the pilot had placed the aircraft in a nose-up or nose-down attitude to correct for drafts. Once control of the aircraft had been lost it would be difficult to recover in very turbulent air."

Pilots will, under ordinary circumstances, alter course to avoid, if possible, going through the storm area but two factors might have made it unlikely that the pilot of CF-MCF attempted to circumnavigate the storm:

1. Having refiled IFR, it is possible that the flight was in cloud and that the aircraft flew unknowingly into a hidden active cumulonimbus. It is to be noted, however, that one pilot, who landed at Quebec at 1806 GMT, having come from Mont-Joli VFR at a height of 1 500 ft, stated that the weather was clear all the way through from Mont-Joli to Quebec.

2. Being low on fuel and having no weather reports showing the possibility of cumulonimbus build-ups in the area, the pilot elected to penetrate what could have appeared to a tired crew to be a minor build-up.

Once the aircraft entered the turbulent area, one can only speculate as to what actually happened.

The possibility of fuel cross-feed being in use at this stage of the flight is considered remote. It is reasonable to assume that each engine was being fed from its main tank. As previously stated, the calculated amount of fuel on board the aircraft at the time of the accident was 1 580 lbs or approximately 263 U.S. gallons total, or 66 U.S. gallons approximately in each main tank. When the aircraft is not in a level flight condition the total amount of fuel carried cannot be drawn from the tanks. Therefore, the possibility remains that extreme aircraft attitudes caused by severe turbulence could result in movement of the small amount of fuel remaining in the tanks, allowing air to be drawn into the fuel lines. This would cause the engines to cut, not necessarily simultaneously but within a period of a few seconds of each other. This could all happen in a very short period of time with the crew being extremely occupied maintaining control. If these cuts occurred at a large throttle opening, as fuel was again supplied to the engines, the resultant power surge could cause the propellers to overspeed. The possibility of this happening to all four engines simultaneously cannot be overlooked.

It is possible that with all four propellers overspeeding, the buffeting vibration and drag caused complete loss of control, leading to a dive from which recovery from a relatively low altitude was impossible.

It is also possible that the aircraft encountered heavy turbulence unexpectedly, followed by a momentary loss of control during which time the aircraft assumed an extreme attitude, recovery from which was followed by a stall. In an effort to keep the airspeed within reasonable limits and maintain altitude, the crew would have had to alter engine power settings. With the engine windmilling at a high rate of speed and with the propellers in full fine pitch at impact, the pilot must have had occasion to close the throttles in an attempt to limit airspeed to the rough air penetration speed. If the aircraft was stalled in this condition, with the centre of gravity aft, or beyond the aft limit, this would likely give a more rapid and extreme angle to the nose-up pitch. It is to be noted in this respect that the wreckage revealed that the aircraft was trimmed nose-down at the time of impact (measured as 6° elevator tabs up.)

The natural method of recovery would be to apply power and push the nose down and because of the aft centre of gravity, complete and rapid recovery would probably require more power than normal. With power off at the stall, all propellers would move to the low pitch setting. A violent nose-down pitch at stall recovery with a resultant rapid build-up of airspeed and a sudden application of power could result in a tendency for the propellers to overspeed. Unless this was checked immediately, as the airspeed built up, the centrifugal turning moment of the propeller blades would not allow the propeller governor to regain control and the engine revolutions would then be controlled by the propeller. Recovery from this condition, even in favourable weather with normal elevator trim settings, would be extremely difficult and would be unlikely in heavy turbulence.

Loss of the control of the aircraft due to heavy turbulence and subsequent dive down to the ground are consistent with the established facts that CF-MCF struck the ground in an almost vertical attitude at a speed of over 200 kts and with the damage found in the strip examination of the four engines.

Fatigue

The crew had ample off duty time prior to their departure from London.

At the time the flight passed over Quebec, they had been on duty approximately 22 hours and 42 minutes, of which 19 hours and 20 minutes had been in the air.

When questioned as to whether he felt that there was a fatigue consideration in this case, a Specialist in Aviation Medicine replied:

> "I believe if a pilot is on duty for 24 hours continuously, he would be tired but I do not know whether he would be fatigued to the point where it would interfere with his judgment and the safe performance of his duties, especially a pilot with more than 12 000 hours of flying. If during the 24 hours on duty, he was able to be relieved of the duties and responsibilities and adequate rest facilities were available so that he could relax for one or two intervals of at least 1 to 2 hours, I do not believe he would be fatigued to the point where it would interfere with the safe performance of his duties."

The rest facilities provided for the crew in CF-MCF were a bunk in the main forward cabin over passenger seats on the starboard side of the aircraft. There were no seats available in the passengers' cabin.

Regarding the rest facilities, the Specialist said - "the location, accessibility and lack of privacy of them were inadequate and left much to be desired."

Another captain stated that when he flew the Atlantic with the captain of CF-MCF on a previous flight, depending on the weather en route, the three pilots shared their rest periods and these usually ran anywhere from 2 to 3 hours non-stop without coming back into the cockpit. This would allow the crew a certain amount of rest but it is felt that during a period of 22 hours and 42 minutes, of which over 19 hours were in the air, with only 2 to 3 hours' rest the crew would have been very tired, although their condition would, in all probability, not interfere with their normal duties. It is, however, felt that their capacity to deal with an emergency would have been very low.

The flight, as originally planned, with three approximately equal sectors, each within the operating range of the aircraft, appears to have been normal and reasonable.

There appears to have been no logical reason why the captain should have elected to press on to the extreme range of his aircraft, to land at an airfield still short of destination.

Probable Cause

The accident was attributed to severe turbulence encountered whilst flying in a cumulonimbus cloud, resulting in a chain of events quickly leading up to a complete loss of control and causing the aircraft to dive to the ground in a near vertical nose-down attitude.

Recommendations

1. Neither the Aeronautics Act, the Air Regulations nor the Air Navigation Orders directly prescribe any hours of duty for flight crews. The matter is dealt with indirectly by means of the Operating Certificate, Part VII of the Air Regulations and Information Circulars 0-43-51, 0-2-52 dealing with operations of aeroplanes, scheduled and non-scheduled air services respectively.

Section 6.3.6.4 of Information Circular 0.2.52 provides that:

"An operator shall establish limitations of the flight time of flight crew members. These limitations shall be such as to ensure that fatigue, either occurring in the flight or successive flights or accumulating over a period of time, does not endanger the safety of a flight. The limitations shall be approved by the Minister."

The result is that the limitation of flight time of flight crew members to ensure that fatigue does not endanger the safety of the flight may differ in various airline companies; some may fix a certain number of hours of duty per day while others will be on a basis of a certain number of hours per week, per month, or three month period. The Regulations may apply to all crew members indiscriminately or various categories may be treated separately. The Regulations may differ depending on the type of operations covered or whether the flights are scheduled or non-scheduled.

In the countries which carry on the largest air transportation services, such as the United Kingdom, United States, France and Italy, the Regulations are developed and issued by the State.

The Board, with a view to preventing undue fatigue of the operating crew, strongly recommended that appropriate Regulations applying to all types of commercial operations, scheduled or non-scheduled, be issued, establishing limitations of flight and airborne time of flight crew members. Such Regulations should also set out the minimum space to be allotted to crew quarters and rest facilities, such rest facilities to be separate from the space occupied by the passengers.

2. The Board considered that on international flights, for the safety of air navigation, there should be some type of flight watch system and that the Air Regulations should provide for such a system. The Board, however, did not consider that it had sufficient data in this respect to make any specific recommendations but suggested that the question be given serious consideration by the Department of Transport.

3. In the Weight and Balance Manifest of CF-MCF there was no allowance or provision for the weight of the various articles in the commissary's department. With a view to preventing overloading of the aircraft, the Board recommended that a proper allowance be made in the Weight and Balance Manifest of the aircraft for every item on board regardless of its weight.

4. The Board further recommended that in all cases of secondhand aircraft imported for commercial operation a close check be made of the standard of their previous maintenance and service, modification status and recording, major changes to role, weight and balance and that the said aircraft be weighed before being put into operation.

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Non-scheduled
En route
Loss of control

ICAO Ref: AR/575