No. 4

Trans-Canada Air Lines, DC-4-M2, CF-TFD, crashed below the third peak of Mount Slesse, British Columbia, on 9 December 1956. Report by the Department of Transport, Canada. Serial No. 56-16.

Circumstances

Flight 810-9 was a scheduled flight from Vancouver to Toronto. It carried a crew of 3 and 59 passagers. A cruising altitude of 19 000 feet was selected. The aircraft departed Vancouver at 1810 hours Pacific standard time on 9 December 1956 and was cleared by Air Traffic Control to Calgary Airport via Mud Bay, Abbotsford and Cultus Lake (Red 75 and Red 44). The flight made the normal position reports giving altitude and reported icing beginning at 16 000 feet, moderate turbulence 16 000 feet to 18 000 feet, heavy jolts at 19 000 feet and at 1848 requested clearance to 21 000 feet. At 1852, 810 reported a fire in No. 2 engine, that this engine had been shut down and that the aircraft was returning to Vancouver via Cultus and Abbotsford. Shortly afterwards the flight reported difficulty in maintaining height and requested clearance to descend on Green 1. The last altitude reported by Flight 810 was just above 15 000 feet which would be maintained if possible. At 1910 hours Flight 810 reported passing Hope, the altitude was not given but clearance to descend to 10 000 feet was requested. ATC cleared 810 to cross the Vancouver range at 8 000 feet or above. Flight 810 acknowledged and this was the last radio contact. All through this latter part of the flight the tone of the voice in the radio transmission, as recorded on TCA tape, did not suggest undue concern by the crew of 810. Nothing more was heard of the aircraft until a part was discovered by mountaineers on 12 May 1957, when they were climbing Mt. Slesse, at approximately the 7 600-foot level, adjacent to the third highest peak.

Investigation and Evidence

Weather

The captain and first officer arrived at the Airport at 1645 hours on 9 December and proceeded to the Weather Office for meteorological briefing. The weather map and cross section were used to show the crew that a trowal* had passed Vancouver a couple of hours earlier and would be encountered east of the Cascade range. Ahead of the trowal the air mass was very warm and moist and had given above normal rainfall in the Vancouver area that morning and afternoon. The cross section showed a solid cloud deck from 3 000 to 21 000 ft. from the Cascade to the Divide. Icing conditions were indicated in the mountain regions from 8 000 to 14 000 feet. The freezing level was pointed out to be 8 000 feet to the east of the trowal and about 6 500 feet to the west. It was indicated to the crew that, because of the very warm moist air, icing would be occasionally moderate in the icing zone. It was pointed out that westbound Flight 801 had that afternoon encountered light to moderate ice in cloud at 14 000 feet in the vicinity of Crescent Valley and that in view of these conditions 17 000 to 19 000 was suggested as a flight altitude. The winds were forecast to be 270 degrees 70 knots at 15 000 feet, and 270 degrees 85 knots at 19 000 feet. The weather encountered by 810 was as forecast and verified by other flights.

Reconstruction of the flight up to the accident

1810 hours Flight 810 departed Vancouver Airport

* trough of warm air aloft

1813 was cleared to cross Westham southbound at 3 000 feet or below and to shuttle south of Westham to 10 000 feet and to request further clearance at that time.

Flights 810 and 7 exchanged weather information at this time following which 810 requested 19 000 feet from Westham through to Calgary. ATC advised 810 to request further clearance when by Westham at 10 000 feet and informed him that 19 000 feet should be available at that time.

1815 ATC asked 810 if he was by Westham yet and 810 advised that he was by Westham 45 seconds previously.

ATC then requested 810 to make his turns east of the south leg of the Vancouver range. This was acknowledged by 810.

1821 ATC cleared 810 to the Calgary range via Vancouver and flight planned route to maintain 19 000 feet and to report over Vancouver eastbound. 810 requested departure via Mud Bay, Abbotsford and Cultus Lake. This route was approved by ATC and 810 was requested to report by Mud Bay eastbound.

1830 810 reported to Company that he was by Westham at 1828 and was estimating Princeton at 1858 at 19 000 feet via Mud Bay, Abbotsford and Cultus.

810 reported at 12 500 feet.

1835 reported leaving 13 000 feet at Abbotsford.

1840 reported leaving 15 000 feet at Cultus.

1843 leaving 17 000 feet with the statement that icing started at 16 000 feet.

1844 reported light to moderate turbulence at 16 000 feet and above.

1846 reported occasional jolts, guessing that he went through some cumulus tops between 16 000 and 18 000 feet.

1848 requested 21 000 feet.

1849 cleared to maintain 21 000 feet and to report leaving 20 000 feet. This was acknowledged.

1852 reported at 19 500 feet that they had had a fire in No. 2 engine and the engine was shut down.

1853 810 reported to Flight 4 that he was turning around southwestbound to descend back to Abbotsford, Cultus.

southwestbound turn confirmed by the radar plot-810 reported to ATC that he had lost an engine and was maintaining 19 000 feet. Requested immediate clearance to get down and reported that he was losing altitude fast. ATC cleared him to maintain 14 000 feet on Green 1.

1857 changed to ATC frequency - was cleared down to 14 000 on Green 1. Reported that he was leaving 19 000 feet on Green 1.

810 had been cleared first on Red 44 to Cultus Red 75, Mud Bay, and later via Green 1 to Vancouver.

1901 ATC asked 810 if he would be able to hold 14 000 feet and 810 replied that he thought he could.

At about this time the captain on Flight 4 advised 810 that flight conditions were poor at the lower altitudes and that they were encountering strong subsidence and moderate ice at 11 000 to 13 000 feet and advised 810 to maintain as much altitude as he could. Flight 810 replied that he was nearly down to 15 000 feet and would maintain 15 000 feet. ATC cleared 810 to maintain 14 000 or above.

1857 Flight 810 stated that he was on Green 1, yet the radar plot indicated that he was well south of Green 1 from the time he reversed course.

1901 when queried by ATC, 810 estimated that he would be at Hope in roughly 5 minutes.

1910 Flight 810 stated he was by Hope and requested descent to 10 000 feet. ATC cleared him to the Vancouver range station, to cross Vancouver at 8 000 feet or above and to remain on ATC frequency. The acknowledgment of this clearance was the last transmission from Flight 810.

The final radar plot at 1911 hours indicated that Flight 810 was approximately 12 miles south of the southern boundary on Green 1, and approximately 21 miles southeast of the Hope beacon.

Examination of the wreckage

The aircraft struck just below the peak of Mount Slesse at an approximate altitude of 7 600 feet, leaving some wreckage on a small sloping shelf, the remainder falling 2 000 feet or more down a precipice to a snow field below. The impact had reduced the aircraft and all its components to small pieces, the largest piece found was a 14-foot length hanging at the end of a control cable on the face of cliff below the wreck on the shelf. The cable was located on a finger of rock supporting at its other end tangled wreckage of small proportions. The remains of engines were noted to have been smashed into small pieces and they felt they had seen evidence of the remains of four engines. One propeller had blades remaining attached to the hub but the other three propellers had disintegrated into small pieces.

The face of the rock below the wreckage on the ledge was covered in oil here and there. There was no sign of fire except that one patch of moss or lichen appeared to be scorched. Small ledges on the rock and below the point of impact contained small particles of broken metal, and similar ledges over the 2 000-foot face of the precipice to the snow field below would probably contain similar particles.

On the lower snow slopes debris was visible in crevices approximately 15 feet under the surface of the snow.

The lower wreckage hanging on the face of the cliff was identified as a piece of main spar material but its position prevented a detailed examination to determine its exact location in the aircraft. Oil covered the face of the rocks in this area and part of a propeller piston and cylinder assembly and the oil regulator of No. 1 engine were found. Many nuts, bolts,

washers and small pieces of engine material were noted in crevices in loose rocks and on rocks in this area. The upper wreckage hanging on the cable was a small tangled mass of broken metal conduit, electric wiring and cables.

On the shelf the remains of two engines were found. One to the south of the mass of wreckage on the shelf rested in an unreachable cleft in the rock face and though badly smashed was, compared with the other engines, far more intact. The other engine, which included one of the bearers, was smashed to small pieces and lay to the north of the mass of wreckage.

Just north of the first above-noted engine, No. 2 propeller hub with two relatively undamaged propeller blades still attached was found. Nearby two other relatively undamaged propeller blades were observed but were in unreachable spots. Here and there in inaccessible spots and in the mass of wreckage further badly broken pieces of propeller blades were noted with notches in the leading edges indicating they were rotating at the moment of impact.

It was considered that the aircraft had crashed against the face of the peak at a ground speed much greater than that possible when cruising in level flight into the wind conditions known to exist on the evening of 9 December and that the point of impact must have been at or just above the upper level of the shelf.

The months of June, July and the first three-quarters of August were cold and cloudy with above average rainfall and in spite of the below average snowfall the previous winter, the snow containing the wreckage of the aircraft below the precipice was slow in disappearing. Availability of helicopters during this period was almost zero. During the last week of August a helicopter was called in and flights were made to the area of the lower wreckage in order to conclude the examination.

The remains of the aircraft lay scattered over the whole of the lower slopes with much still buried in large unstable masses of unmelted snow. The area was composed, for the most part, of quite steeply sloping ice and water-worn rock with vertical drops of varying heights of 6 feet to 70 feet. The area was approximately one third of a mile long and varied from 300 to 600 feet wide. It ended with another near vertical precipice approximately 1 000 feet high at the base of which a talus composed of large boulders lay.

Parts of engines, undercarriage, fuselage, spars, wing, ailerons and empennage were identified by serial numbers or recognized visually and the same degree of almost total disintegration noted on the peaks was found at this level.

The condition of the wreckage supported the conclusions reached after the examination of the upper wreckage that the aircraft hit the peak at a high rate of speed and not necessarily in a vertical dive, although it probably was losing altitude at a high rate. Sufficient parts of main components were found and identified to indicate that the aircraft was probably whole at the moment of impact and operating on three engines.

Discussion of the evidence

The aircraft, at the moment of crashing, was on a line that was almost a direct continuation of the radar plot. This indicates that the direction of flight remained unchanged but that the flight lost height rapidly after reporting by Hope.

Radio transcription records reveal that from 1921 on, repeated calls were made to the aircraft, to which no reply was made, which indicates that the aircraft had crashed at some time between 1910 and 1921 or very shortly thereafter. The distance between the last point recorded on the radar plot and the third peak of Mt. Slesse is just over 21 miles, and the difference between the assumed altitude as the aircraft reported by Hope and the point of impact, is 6 400 feet.

Examination of the wreckage of CF-TFD did not disclose any significant evidence that the accident occurred as a result of any further malfunctioning and/or failure of aircraft, engine or components. Subsequent to the report of a fire in No. 2 engine and shutting it down, there was no indication of fire usually associated with the crash of a large aircraft.

It is considered the estimated normal three engine level flight airspeed of the DC-4-M2 aircraft minus an estimated 85 knot head wind would give an approximate ground speed of 100 knots. If the aircraft, as is suspected, was carrying ice, this speed would normally be less. The average ground speed of the radar plots from the time the aircraft commenced its return until it disappeared, was 102 knots.

Sufficient parts of the aircraft were seen and identified to indicate the aircraft was still operating on three engines and in one piece when it crashed. The possibility of further malfunctioning or failure still exists, however, and it is unfortunate that the difficult terrain, poor weather during the summer months and wide scattering and inaccessibility of much of the debris prevented a complete examination to determine this point conclusively.

In view of the fact that only one buckled safety belt was found and all others were unbuckled with the webbing unbroken and that no message of any kind was heard from the aircraft after passing Hope, it is reasoned that whatever happened was of a sudden or catastrophic nature.

It remained, therefore, to determine why Flight 810 was not on Green 1, to which it had been cleared and what caused it to be below the altitude to which it had been cleared.

When Flight 810 reported a fire in No. 2 engine and its closing down, the report included the information that a turn south was being made to return on Red 44. This would increase the flight's distance from Green 1 and probably result in an initial track south of Red 44. A request was made by the flight to return via Red 44 and clearance was obtained and passed to the flight.

The initial difficulty in maintaining height, which resulted in a clearance being obtained to return on Green 1, obviously gave some concern to the crew of 810 as recorded in the ATC and TCA transcripts and statements of the captain and first officer of Flight 4-9. Flight 4 eastbound was not yet by Hope and 810 was still losing altitude. The crew of 810 would be aware they were still south of Green 1 and in view of the uncertainty of Flight 4's position and their estimated distance south of Green 1, almost certainly decided to remain left or south of this airway until they were sure of having passed Flight 4. Positive information that the flights had passed was not secured until just prior to Flight 810's reported passing by Hope.

The possibility that the crew of Flight 810 assumed that they were authorized to return on either Green 1 or Red 44 airways has been considered and discarded for the reason that the terrain is generally much lower in Green 1 and this no doubt made the captain decide to request Green 1 in view of initial difficulty in maintaining height.

The meteorological reports indicate the winds would be west southwest and had the aircraft been following Green 1, such winds should have given starboard rather than port drift. The direction of the wind given by the meteorologists would probably be quite true for the higher altitude but changes in wind direction at the lower altitudes are possible due to mountain masses as high and as abrupt as the Coast Range. The frontal zone was not too far west at this time and a local wind shift may have occurred but it has not been possible to establish this as a fact.

It is the invariable practice of pilots to trim for straight and level flight after the loss of an engine and this results in a sustained angle of yaw caused by the offset of the rudder to compensate for asymmetrical thrust. The worst case would be in the loss of an outboard engine, but the condition will exist to a lesser extent when an inboard engine is inoperative. In the case of Flight 810, the inboard engine (No. 2) was shut down and port drift would be induced. Under normal circumstances when flying close to the on-course of a radio range such drift would be readily appreciated and adequate correction made to the heading provided the radio signals were good. In this case, however, the aircraft was not close to the on-course signal and such drift would be more difficult to appreciate.

The back beam of the Vancouver ILS passes directly over Mt. Slesse and the remote possibility that this facility was being used in the event that LF audibility was poor was considered. The completeness of destruction of the aircraft and scattering of debris, however, prevented determination from examination of the radio panel settings. Too much reliance could not be placed on this facility in the Mt. Slesse area and its distance from the transmitter. It is considered doubtful that a pilot of this one's experience and knowledge of route and terrain would use this facility. Therefore, the possibility that the Vancouver ILS back beam was being used is pure conjecture and must be discarded.

The possibility that radio signals were poor that evening was investigated and there is no clear indication that such was the case. The TCA Radio Operator states "there was no crash static audible", but it must be remembered that he was listening on a VHF frequency where such phenomena would be at a minimum. Three captains flying on the night of the accident had not recalled any unusually heavy static on the LF frequencies. One, however, did recall some precipitation static on the lower frequencies and another stated that intermittent loss of low frequency signals would be normal occurrence on such occasions though he did not recall any abnormality. One captain's comments on the radio signal normally found between Vancouver and Princeton indicate an area from abeam of Chilliwack to a few miles east of Hope is without reliable guidance signal. Under good reception conditions both Vancouver and Princeton ranges are audible at the midway point between them. Under the conditions that existed that evening, it is probable that radio reception of the range signals was zero in the Hope area and positive fixing of position difficult, if not impossible. This could account for the crew of Flight 810 being unaware that they were so far south of Green 1.

When Flight 810 reported by Hope, altitude was not given and no message was received from the aircraft that any further difficulty in maintaining height had been encountered. The last positive height mentioned approximately nine minutes before the flight passed Hope was that Flight 810 was still above 15 000 feet and hoped to be able to maintain that altitude. The flight also advised ATC that they thought they would be able to maintain 14 000 feet. In the absence of any evidence to the contrary, it must be assumed that the aircraft was at or above 14 000 feet by Hope.

It was definitely established by a visit of the Chairman of the Board to the radar station, which supplied the information in respect to the track of the aircraft, that at the time it reported by Hope it would have had to be at some indefinite altitude above 10 000 feet. Such an altitude could well have been 14 000 feet or above.

Just prior to reporting by Hope when Flight 810 relayed ATC clearance to Flight 4 (another flight in the vicinity), which had just reported by Princeton, Flight 810 reported encountering more precipitation and doubted as to whether it "looked good or not".

Flight 810 on its journey out had reported icing and it is probable that sufficient of the icing would remain on the aircraft to make maintenance of altitude difficult. This would account for the flight's inability to maintain altitude after the loss of No. 2 engine.

The radar plot disclosed that no apparent attempt was made by the flight to return to Green 1 after passing Hope and positive that it was by Flight 4. The trackof Flight 810 was a direct continuation of the radar plotted track up to the time the aircraft disappeared from the radar screen and assuming that the aircraft was at a minimum of 14 000 feet, it would, therefore, have lost approximately 6 400 feet in a distance of just over twenty-one miles. The only explanation to account for this would be that the precipitation was severe enough to cause a loss of altitude of this magnitude over such a short distance, or some other cause such as further loss of power or encountering similar subsidence to that reported earlier by Flight 4 when on Green 1 west of Hope. The loss of altitude, from any of these causes or combination of causes would bring the aircraft down to heights at which the turbulence would be increasingly severe and at its worst in the lee of Mt. Slesse. Of all the above-noted causes, the most likely would be icing since the only evidence that it has been possible to establish definitely is that the flight was encountering more precipitation, and icing was forecast and encountered by other flights. Quite severe turbulence would also exist and could increase the control difficulties to such an extent that the pilots would not be free to transmit their difficulties by radio.

It cannot be clearly established why Flight 810 was so far south on Green 1 airway. The reason could well be any combination of the above discussed conjectures, the most likely reason being the decision to remain south of Green 1 until certainty of passing Flight 4 had been secured, in view of the high rate of ground speed they would have in the existing wind conditions and the uncertainty the crew of Flight 810 had in the earlier part of the emergency in their ability to maintain altitude. Asymmetrical thrust would definitely be a factor unless correction were made to compensate. It is reasoned that the crew of Flight 810 were aware they were south of Green 1 but not to the extent of departure. It is considered probable that more or less extensive interference to the reception of LF radio ranges contributed.

Probable Cause

The cause for the aircraft being at an altitude low enough to strike Mount Slesse is undetermined, but there is a high probability that the aircraft, while flying on 3 engines, encountered either severe icing, turbulence, subsidence, or a combination of all three, or suffered some other difficulty of such a sudden or dire nature that the crew were unable to communicate with any agency or control the aircraft.

For undetermined reasons the aircraft was not on Green Airway No. 1 to which it had been cleared by Air Traffic Control.

The following factors contributed to the accident:

a) Loss of engine power No. 2 engine shut-down, fire suspected.
b) Existence in the area of known subsidence, severe turbulence, and moderate to severe icing probably in the lower levels.

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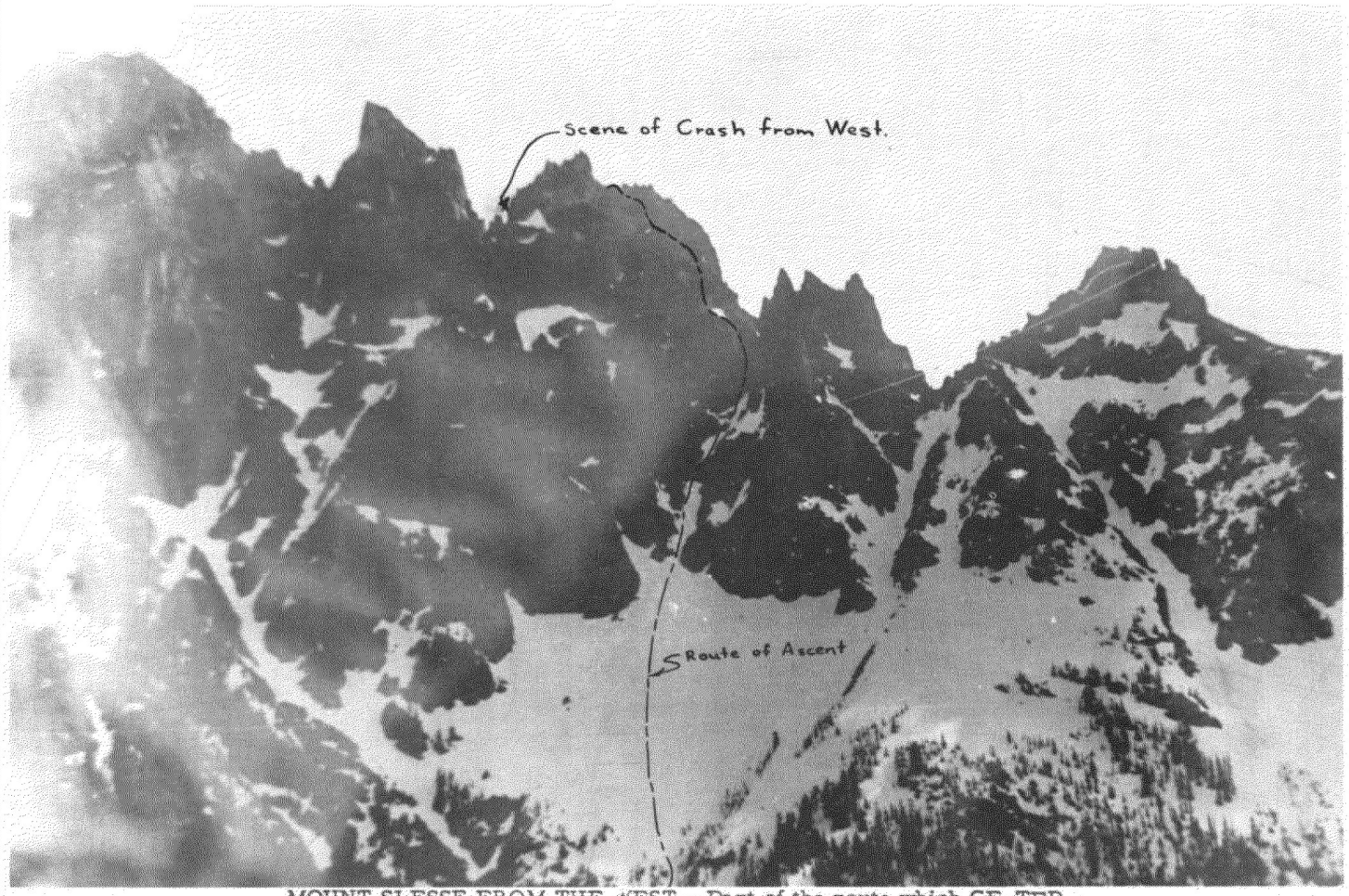
FIGURE 3



MOUNT SLESSE FROM THE WEST - Part of the route which CF-TFD took prior to the crash of 9 December 1956. This does not show the knoll from which ascents were made.

FIGURE 4

BOTTOM OF LOWER WRECKAGE OF TCA, DC-4, CF-TFD - part of centre section behind two engines. The rocks here were covered in oil and many nuts, bolts, washers and metal fragments were found stuck on rock faces and in loose rocks.

FIGURE 5

CF-TFD CRASH IN BRITISH COLUMBIA, CANADA - View of engine south of wreckage on cliff.