AIRCRAFT ACCIDENT

Air New Zealand
McDonnell-Douglas DC10-30 ZK-NZP
Ross Island, Antarctica
28 November 1979

REPORT 79-139

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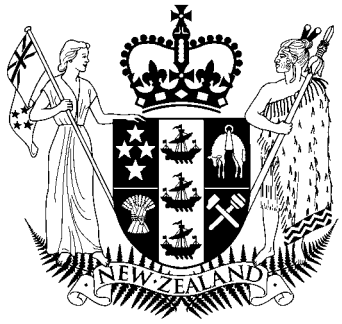

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REPORT No. 79-139

AIR NEW ZEALAND

McDONNELL-DOUGLAS DC10-30 ZK-NZP

Ross Island, Antarctica
28 November 1979

OFFICE OF AIR ACCIDENTS INVESTIGATION
MINISTRY OF TRANSPORT
WELLINGTON

The Minister of Transport

SIR

The attached report summarises an investigation made into the circumstances of an accident involving McDonnell-Douglas DC 10-30 aircraft ZK-NZP on Ross Island, Antarctica, on 28 November 1979 in which the 20 crew and 237 passengers lost their lives.

This report is submitted pursuant to regulation 16(1) of the Civil Aviation (Accident Investigation) Regulations 1978.

R. CHIPPENDALE
Chief Inspector of Air Accidents

31 May 1980

APPROVED FOR RELEASE AS A PUBLIC DOCUMENT

COLIN McLACHLAN
Minister of Transport

12 June 1980

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McDONNELL-DOUGLAS DC 10-30 ZK-NZP
Ross Island, Antarctica
28 November 1979

BASIC INFORMATION

Operator: Air New Zealand Limited

Aircraft: Type: McDonnell-Douglas DC 10
Model: Series 30
Nationality: New Zealand
Registration: ZK-NZP

Place of Accident: Ross Island, Antarctica

Date of Accident: 28 November 1979

SYNOPSIS

The occurrence of this accident was notified to the Chief Inspector of Air Accidents by Air New Zealand Limited at 2050 hours New Zealand Daylight Time[1] on 28 November 1979.

The State of Manufacture of the airframe and engines (United States) was advised of the accident on that day and invited to participate in the investigation. An accredited representative, who was a member of the National Transportation Safety Board, was appointed by the US and he was accompanied by representatives of the Federal Aviation Administration, McDonnell-Douglas Corporation and General Electric Company. The investigation was conducted by the New Zealand Office of Air Accidents Investigation.

At 0049:50 hours Greenwich Mean Time (Z) the aircraft collided with the ice-covered slopes of the northern side of Ross Island while it was inbound and 1 ½ miles east of its flight-planned track for its next turning point, Williams Field, McMurdo. The aircraft was flying toward a uniform snow covered ice slope which was beneath an 8/8 cloud cover. ZK-NZP was operating as a non-scheduled, domestic air transport flight from Auckland to Christchurch via various southern islands and the most southerly turning point, Williams Field. There were 20 crew and 237 passengers on board none of whom survived the accident.

[1] (Z + 13 hours)

1. FACTUAL INFORMATION

1.1 History of the Flight

1.1.1 In preparation for Flight TE 901 two of the pilots attended a route qualification briefing. This briefing consisted of an audio visual presentation, a review of a printed briefing sheet and a subsequent 45 minute flight in a DC 10 flight simulator for each pilot to familiarise him with the grid navigation procedures applicable to the portion of the flight south of 60° south latitude and the visual meteorological conditions (VMC) letdown procedure at McMurdo.[2] This briefing was completed 19 days prior to the scheduled departure date. The briefing gave details of the instrument flight rules (IFR) route to McMurdo which passed almost directly over Mt Erebus, a 12450 ft high active volcano, some 20 nm prior to the most southerly turning point, Williams Field. It also stated that the minimum instrument meteorological conditions (IMC) altitude was 16000 ft and the minimum altitude after passing overhead McMurdo was 6000 ft providing conditions were better than certain specified minima well in excess of the standard VMC in New Zealand. On the day of the flight the crew participated in a normal pre-flight dispatch planning.

1.1.2 At 1917 hours (Z) on 27 November 1979 Air New Zealand Flight TE 901, a DC10-30 (ZK-NZP) departed from Auckland Airport on a non-scheduled domestic scenic flight which was planned to proceed via South Island New Zealand, Auckland Islands, Baleny Island, and Cape Hallett to McMurdo, Antarctica then returning via Cape Hallett and Campbell Island to Christchurch its first intended landing point. The flight was dispatched on an IFR computer stored flight plan route. The flight deck crew consisted of the captain, two first officers and two flight engineers. Beside the fifteen cabin crew there was an official flight commentator on the flight who was experienced in Antarctic exploration.

1.1.3 The passenger load was reduced by 21 from the normal passenger seating capacity as a deliberate policy to facilitate movement about the cabin to allow passengers to view the Antarctic scenery.

1.1.4 In a discussion with the McMurdo meteorological office at 0018 hours (Z) the aircraft crew was advised that Ross Island was under a low overcast with a base of 2000 ft and with some light snow and a visibility of 40 miles and clear areas approximately 75 to 100 nm northwest of McMurdo. At approximately 0043 hours (Z) Scott Base advised the aircraft that the dry valley area was clear and that area would be a better prospect for sightseeing than Ross Island. In response to the message that the area over the Wright and Taylor Valleys was clear the captain asked the commentator if he could guide them over that way. The commentator said that would be no trouble and asked if the captain wished to head for that area at the time. The captain replied he "would prefer here first".

1.1.5 The US Navy Air Traffic Control Centre (ATCC) "Mac Centre"[3] suggested that the aircraft crew take advantage of the surveillance radar to let down to 1500 feet during the aircraft's approach to McMurdo and the crew indicated their acceptance of this offer. In the event however the aircraft was not located by the radar equipment prior to initiating its descent (or at any other time). The aircraft crew also experienced difficulty in their attempts to make contact on the very high frequency (VHF) radio telephone (R/T)and the distance measuring equipment (DME) did not lock onto the McMurdo Tactical Air Navigation System (TACAN) for any useful period. The aircraft was relying primarily on high frequency (HF) R/T during the latter part of its flight for communication with the ATCC.

[2] The simulator instructor impersonated the Williams Field GCA operator and vectored the aircraft into position for this simulated letdown.

[3] The commonly used abbreviation for the official call sign of "McMurdo Centre".

1.1.6 The area which was approved by the operator for VMC descents below 16000 feet was obscured by cloud while ZK-NZP was approaching the area, and the crew elected to descend in a clear area to the north[4] of Ross Island in two descending orbits the first to the right and the second to the left. Although they requested and were granted a clearance from "Mac Centre" to descend from 10000 to 2000 feet VMC, on a heading of 180 grid (013°T) and proceed "visually" to McMurdo, the aircraft only descended to 8600 feet before it completed a 180° left turn to 375°G (190°T) during which it descended to 5,700 feet. The aircraft's descent was then continued to 1500 feet on the flight planned track back toward Ross Island.

1.1.7 Shortly after the completion of the final descent the aircraft collided with Ross Island. The aircraft's ground proximity warning system (GWPS) operated correctly prior to impact and the crew responded to this equipment's warning by the engineer calling off two heights above ground level, 500 and 400 feet, and the captain calling for "go round power". The aircraft's 3 engines were at a high power setting and the aircraft had rotated upwards in pitch immediately prior to impact.

1.1.8 The aircraft collided with an ice slope on Ross Island and immediately started to break up. A fire was initiated on impact and a persistent fire raged in the fuselage cabin area after that section came to rest.

1.1.9 The accident occurred in daylight at 0050 hours (Z) at a position of 77°25'30" S and 167°27'30" E and at an elevation of 1467 feet AMSL.

1.1.10 The cockpit voice recorder (CVR) and digital flight data recorder (DFDR) established that the aircraft was operating satisfactorily and the crew were not incapacitated prior to the accident.

1.2 Injuries to persons

1.2.1

Injuries	**Crew**	**Passengers**	**Other**
Fatal	20	237	0
Serious	0	0	0
Minor/None	0	0	0

1.3 Damage to aircraft

1.3.1 The aircraft was destroyed by the impact forces and the post impact fire.

1.4 Other damage

1.4.1 The aircraft wreckage which was scattered over the ice slope constituted a temporary area of ecological pollution which was expected to be essentially neutralised by the progressive burial of the debris in ice and snow.

1.5 Personnel information

[4] All references to direction are related to true north unless otherwise specified.

1.5.1 Pilot in command, Thomas James Collins, held Airline Transport Pilot Licence No. 251 which was re-issued on 24 May 1979 to be valid until 30 April 1980. His type rating on the DC 10 aircraft was issued 26 August 1973. He held a current instrument rating and had held a flight navigator's licence, but this lapsed on 17 May 1971 (due to lack of opportunity for flying time as a navigator in the preceding 12 month period). He had a total flying time of 11151 hours and 2872 hours on DC 10 aircraft with a total of 140.35 hours in the last 90 days all on the DC 10 aircraft. He had last been rostered for duty on 22 November 1979 and last flew on 23 November 1979. He was well rested and had no recent illness or known significant worries prior to the flight.

1.5.2 The first officer who was in the right hand seat for the approach and descent to the accident site was Gregory Mark Cassin, who held Airline Transport Pilot Licence No. 649 re-issued on 18 October 1979 and valid until 31 January 1977. He had a total flying time of 7934 hours and 1361 hours on DC 10 aircraft with a total of 127 hours in the last 90 days all on DC 10 aircraft. He was last rostered for duty on 20 November 1979.

1.5.3 The flight engineers changed shift during the final descent.

1.5.4 The flight engineer on the panel at the time of the accident was Gordon Barrett Brooks who had a total flying time of 10886 hours and 3000 hours on DC 10 aircraft with a total of 113 hours in the last 90 days all on DC 10 aircraft. He had a valid type rating on DC 10 aircraft issued on 11 February 1973 and qualified as a flight engineer on 4 December 1957. He was last rostered for duty on 26 November 1979 and had completed a previous Antarctic flight.

1.5.5 The flight engineer who relinquished the panel during the descent (but remained on the flight deck) was Nicholas John Moloney who had a total flying time of 6468 hours and 1700 hours on DC 10 aircraft with a total of 69 hours in the last 90 days all on DC 10 aircraft. He had a valid type rating on DC 10 aircraft issued on 9 February 1976 and qualified as a flight engineer on 10 July 1967. He was last rostered for duty on 11 November 1979.

1.5.6 The other first officer Graham Neville Lucas was not on the flight deck for any of the period during the descent from the cruising flight level to the accident site.

1.5.7 The cabin crew were all duly qualified and certificated, as enumerated in Annex A.

1.6 Aircraft information

1.6.1 ZK-NZP was a McDonnell-Douglas DC 10-30 aircraft. Serial No. 46910 with a construction date of November 1974. It was imported into New Zealand on 14 December 1974 for service with Air New Zealand Limited and allocated the registration letters ZK-NZP. The Certificate of Registration (MOT 1307) was issued to Air New Zealand Limited on 12 December 1974. The Certificate of Airworthiness issued on 30 December 1974 was subsequently re-issued on 8 May 1975 and was "non-terminating unless cancelled or suspended provided that the aircraft was maintained in accordance with the Air New Zealand approved maintenance manual". The last Maintenance Release was issued on 2 November 1979 following completion of Check A and was valid for 450 flight hours. The aircraft had completed 350 hours since the issue of the last Maintenance Release.

1.6.2 Three General Electric CF6-50C engines were fitted. The No. 1 (left) engine was serial no. 455158 with 18842 hours and 4580 cycles since new and 4874 hours and 1099 cycles since the last basic shop visit; the No. 2 (tail) engine was serial no. 517267 with 6345 hours and 1404 cycles since new and 350 hours and 83 cycles since its last basic shop visit; the No. 3 (right) engine was serial no. 455412 with 16181 hours and 3951 cycles since new and 5621 hours and 1226 cycles since its last basic shop visit (6500 hours or 1500 cycles are authorised between basic shop visits).

1.6.3 The aircraft had completed 20763 flying hours since new, 3283 hours since its last Check "C" and 350 hours since the last "A" check. (The approved flying hours between "A" checks and "C" checks are 450 and 4250 respectively).

1.6.4 An examination of the aircraft's maintenance documentation confirmed that the aircraft had been maintained in accordance with an approved maintenance manual. All significant defects had been investigated and rectified prior to the accident and all applicable Civil Airworthiness Requirements (CAR) had been complied with as required.

1.6.5 The aircraft was flying with 10 maintenance concessions issued by the company under the terms and conditions of their Civil Aviation Division (CAD) approval. These concerned, a small section of vent panel trim, a "Hi Lock" fastener head missing from the centre box section of the lower forward spar cap, a temporary repair to a wing-to-fuselage fillet panel, a wire adrift from the right-hand windshield anti-ice suppressor, 3 small holes in a fire seal channel on number 3 engine, a trial period of an unmodified generator control unit, sheared rivets in saddle tank rub strip, a damaged forward drain mast, a temporary repair to an access panel and damage to a wall trim panel.

1.6.6 The aircraft's estimated all up weight was 199150 kg and the centre of gravity (CG) 22.5% of the mean aerodynamic chord (MAC) at the time of the accident. The maximum take off weight authorised was 253105 kg (actual 246507) and the CG limits at 199000 kg are 11% to 29% MAC.

1.6.7 The fuel in use was Jet A1. (Specific gravity at 15^{o} was 0.804).

1.7 Meteorological information

1.7.1 General Situation. On 28 November 1979 at 0100 hours (Z) the McMurdo area was under the influence of a surface low pressure trough extending from the Queen Maud mountains to the Ross Sea. Observations in the area reported a total cloud cover with a base of 3500 feet with layers above. The wind at McMurdo was 230^{o} Grid at 10 knots. Although local effects in the area of the accident site near Mt Erebus could have caused gusty turbulent conditions with stronger winds, the aircraft's navigation computer unit (NCU) memory recorded a wind of 138^{o}/12 knots at the time of impact. The surface visibility was good but the Antarctic procedure used to report surface and horizon definition (see Annex B) gave the surface definition at the time as poor and the horizon definition fair. Mountain tops in the area were covered in cloud.

1.7.2 Local aircraft reports :

a. A United States Navy (USN) C-130 aircraft was inbound and 80 miles from McMurdo at 0100 hours (Z). The crew described the meteorological conditions at 0100 hours (Z) as follows: "At 80 miles out and approaching from the west-north-west (the crew) observed a continuous stratoform layer covering Ross Island with cloud "domes" over Mt Erebus and Mt Terror which concealed the mountains from view. The cloud layer extended to the north of Ross Island. A lenticular "cap cloud" was over Mt Erebus above the main cloud layer." The aircraft descended into cloud at approximately 16000 feet and remained in variable cloud densities, except for one break of about 1500 feet vertically, until it descended through 2500 feet. The lowest layer was solid overcast with a ragged base. The visibility was good below the cloud base but the surface definition was poor. The aircraft encountered light turbulence during the descent but no evidence of icing and landed at McMurdo's ice runway at 0120 hours (Z).

b. At 0105 hours (Z) a helicopter flying over the slopes of Mt Erebus above Cape Royds attempted to ascend over the saddle between Mt Erebus and Mr Bird. The cloud base was above the saddle but the pilot turned back due to the poor surface definition in the area and decided to enter Lewis Bay via Cape Bird. The aircraft landed at Cape Bird hut at 0140 hours (Z) where the weather was overcast with a southerly wind and light snow. The helicopter later took off and flew around Cape Bird at 1500 feet and was below the cloud base all the way. At 0200 hours (Z) it landed on the beach 10 km from the accident site and the conditions at that time were overcast with light snow but the sun could be "made out" through the cloud occasionally. The surface definition at the time was very poor to nil.

The aircraft encountered no turbulence on the approach into a light north west wind for landing. The aircraft remained on the ice for 50 minutes during which time the sky continued overcast and the visibility was decreasing due to snow flurries. Beaufort Island could be distinguished to the north but was not clearly defined. Due to the deteriorating weather the crew decided to cut their visit short. They were not able to distinguish that the slopes to the south were elevated or separately identify cloud and snow. No bare rock was visible on the slopes but the rocky coastline below the ice cliffs was visible. The aircraft returned to Bird hut and the crew found weather conditions much the same as they were when they had departed.

c. A United States Air Force (USAF) C-141 aircraft was following some 45 minutes behind Air New Zealand Flight TE 901. The captain of this flight made the following comments about the weather:

"As we approached McMurdo we noted that Ross Island was obscured by cloud; no terrain was visible. We displaced our flight path to the west approximately 25 miles to allow a gradual, long-range descent over the water At the time we were navigating entirely by INS (inertial navigation system). We maintained 1600 feet until McMurdo picked us up on radar; as I remember, this was at about 38 miles. We began descent and entered the clouds immediately. The cloud cover appeared to be ordinary cumulus or stratocumulus. We encountered only light rime icing and light turbulence during descent. Between approximately 12500 and 11000 feel we passed between cloud layers. Visibility seemed good between clouds but no terrain was visible. We broke out of the cloud base at about 5000 feet; visibility beneath the ceiling was good. We landed at McMurdo at 0152 hours (Z) on 28 November."

1.7.3 At 0010 hours (Z) "Mac Centre" broadcast the following actual weather conditions experienced at 0001 hours (Z) on the Ice Runway "2000 overcast, visibility 40, temperature minus 4 Celsius, gridwind 200 at 20, altimeter 2930, surface fair, horizon fair".

1.7.4 At 0018 hours (Z) the forecaster at McMurdo spoke directly to the crew of TE 901 and advised the following "We have a low overcast in the area at about 2000 feet and right now we are having some light snow but our visibility is still about 40 miles. It looks like the clear areas around McMurdo are approximately between 75 and 100 miles to the northwest of us but right over McMurdo we have a pretty extensive low overcast".

1.7.5 The forecast for the McMurdo area given to crew of flight TE 901 at their pre-flight briefing was:

"McMurdo 270300-280300Z. Cloud base 3000 feet broken, variable to overcast, visibility 40 miles surface wind (Grid) 310^{o}/10 kts, occasional 3000 ft overcast, visibility 5 miles in light snow. Information from weather analysis. Much cloud with large occlusion 70^{o}S and 150°W, Byrd (Station) to South Pole. Much ridge type cloud probable, base about 3000 feet."

1.7.6 At 1943 and 2030 hours (Z) Auckland Radio passed the actual weather conditions at McMurdo to Flight TE 901 for 1900 and 2000 hours (Z) respectively. These were:

"McMurdo at 2000 estimated 8000 broken, 10000 broken. Visibility 40 miles. Temperature minus 6. Wind Grid 200°/10. Altimeter 2938. Surface definition fair; horizon definition good".

1.7.7 At 2153 hours (Z) Auckland Radio passed a new terminal forecast for McMurdo to Flight TE 901 as follows:

"Terminal forecast McMurdo valid from 272100 and it's valid until 282100. 4000 broken, 10000 broken. Visibility 40 miles. Wind Grid 220°/10 knots gusting 18 knots. The sky conditions broken variable scattered occasionally 4000 broken visibility 5 miles light snow QNH 2930".

1.8 Aids to navigation

1.8.1 The ground navigation aids available[5] to the aircraft's crew were limited to a medium frequency non-directional beacon 506 kHz (NDB) a TACAN installation suitable for interrogation by the aircraft's distance measuring equipment (DME) and a radar installation (AN/FPN 36 QUAD) which provided airport surveillance radar (ASR), precision approach radar (PAR), and an "AIMS" Mark 12 IFF system.

1.8.2 These aids were approved "for use by Antarctic Support Deep Freeze aircraft but were available to other operators for use at their own risk".

1.8.3 The Radar, NDB and TACAN were calibrated by local military aircraft to FAA standards and monitored by reports from the Operation Deep Freeze (ODF) aircraft which used them regularly.

1.8.4 Promulgation of radio navigation information at McMurdo was the responsibility of the United States navy who installed, calibrated and maintained all aids in accordance with the United States Standard Terminal Instrument Procedures Manual (TERPS). This manual was standard for the FAA, USAF, USN, US Army and the US Coast Guard. However, because of the special nature of the operations in Antarctica the aids and ATC procedures were installed specifically for the Antarctic Support, Operation Deep Freeze (ODF), aircraft. Every approach chart and letdown procedure and radio navigation chart carried specific cautions to warn of:

a. Incomplete survey data making en-route minimum altitudes unreliable.
b. Radio and radar altimeters erratic over snow.
c. Promulgated procedures are intended for use by Operation Deep Freeze aircraft only, others may use at their own risk.

1.8.5 The Air New Zealand crew was briefed that the NDB facility had been withdrawn as the result of advice from CAD to this effect but the beacon was transmitting on a 24 hour basis as the USN had decided to leave it transmitting and not to dismantle it until it failed.

1.8.6 The aircraft was fitted with an area inertial navigation system (AINS) which facilitated worldwide navigation based on radio and inertial data. The system provided data and information to navigate the aircraft on area navigation routes or great circle tracks from take-off to the final approach.

[5] In this context "available" as it refers to the M/F NDB means operating and able to be received by the aircraft equipment.

1.8.7 All the navigation aids were operating normally for the duration of the final approach of ZK-NZP, towards McMurdo, but the aircraft's DME did not lock onto the TACAN for more than one short period, the aircraft was not seen on the surveillance radar and its transponder was not detected by the radar equipment. The controls for the aircraft's transponder when retrieved from the wreckage were set to the correct code but switched to "standby".

1.8.8 The aircraft's low altitude approach placed the Mt Erebus volcano in the line of sight between these aids and the aircraft.

1.8.9 The aircraft was equipped with a Bendix RDR 1F radar which had a digital indication. This equipment has both "weather" and "mapping" modes. Although it is not approved as a navigation aid, some pilots of previous Antarctic lights reported that the radar indications of high ground correlated well with the contours which they observed visually in VMC. Expert opinion from the aircraft manufacturers was that the high ground on Ross Island would have been clearly indicated by the "shadow effect" had either pilot studied the radar presentation during the aircraft's descent to the north of the island.

1.9 Communications

1.9.1 The crew spend a considerable time endeavouring to establish a reliable communications link with "Ice Tower" and "Ice Radar" during the last 30 minutes of the aircraft's flight towards their McMurdo waypoint (the McMurdo TACAN). Three VHF frequencies were tried by the aircraft's crew 134.1 (GCA); 126.2 (Tower) and 121.5 MHz (Guard). None of these proved a reliable communications link but an occasional contact was made on 134.1 and 126.2 MHz.

1.9.2 The HF R/T link remained satisfactory between McMurdo and the aircraft. The last exchange of transmissions occurring 4 minutes 42 seconds before the accident happened.

1.9.3 As with the navigation aids the aircraft was not positioned in a line of sight with the appropriate VHF transmitters during most of the last phase of the flight.

1.10 Aerodrome information

1.10.1 Not applicable.

1.11 Flight recorders

1.11.1 Cockpit Voice Recorder. The aircraft was equipped with a Sundstrand Model B CVR Serial No. 256 Part No. 980-6005-061. A useful record was eventually obtained from the tape in the CVR but the task was made unusually difficult by the presence of the extra persons on the flight deck namely the second flight engineer, the commentator and passengers who were invited there by the captain to add interest to the flight for them.

1.11.2 The essential items of the recording from the cockpit area microphone (CAM) were almost all recovered by the joint efforts of teams in the United States and United Kingdom operating in the sound laboratories of the NTSB and the Federal Bureau of Investigation (FBI) in the USA and the Accident Investigation Branch (AIB) in the UK. The manufacturers of the CVR also aided by providing a 4 track recording of the original 8 track tape to assist these laboratories. The resultant transcript of the relevant portions of the CVR tape is attached as Annex C.

1.11.3 Digital Flight Data Recorder. The aircraft was equipped with a Sundstrand Model DFDR Part Number 981-6005-012 serial number 2484. The DFDR was not seriously damaged in the accident but the tape was broken on impact. The equipment performed satisfactorily and all the parameters had been recorded correctly. All of the record required for the investigation was recovered.

1.11.4 The DFDR record showed that the aircraft carried out 2 descending orbits, one either side of the flight plan track in the Lewis Bay area then continued toward McMurdo on this track while descending from 5800 feet to 2000 feet, initially, before finally levelling out at 1500 feet above mean sea level (AMSL). The flight from this point was straight and level with a 5° nose up attitude at 260 knots indicated air speed (IAS) until the last data sampling immediately before the impact when the aircraft rotated in pitch to approximately 10° nose up and number 1engine had "spooled up" to 94% just prior to the impact. The DFDR records each engine's N_2 rpm once every four seconds and number 1 engine's rpm was the last to be recorded prior to impact.

1.11.5 The detail of the DFDR readout and a narrative correlation of the CVR and DFDR are given as Annex D to this report.

1.12 Wreckage and impact information

1.12.1 The entire wreckage site was surveyed by a Lands and Survey Department Surveyor and an assistant from the Ministry of Works and Development. The team surveyed and marked a grid of 30m squares over the complete wreckage train and a 30m buffer zone around this area. They also plotted the position of each victim's remains and surveyed the profile of the terrain from sea level to the impact site.

1.12.2 The collision of the aircraft with the ice covered slope left a clear impression of the fuselage, wing mounted engines and flap hinges in this ice which showed that ZK-NZP was in a wings-level, nose-high attitude when the impact occurred.

1.12.3 The wreckage trail was typical of a high speed impact and resulted in extensive fragmentation of the underside of the wing and fuselage. The wing engines were stopped immediately after impact by the distortion resulting from the impact with the ice.

1.12.4 The 2 wing mounted engines, the underside of the wings and the bottom of the rear fuselage bore the main impact of the collision and some debris from each of these areas was evident in the impact crater.

1.12.5 Immediately following the initial impact the aircraft lofted over the mound of ice and snow displaced by from the impact area and flew up the 13° ice slope in a wings level attitude. Extensive destruction which continued until the wreckage came to rest would have been accentuated by an air pressure differential of approximately plus 1.1 psi between the interior of the fuselage and the outside environment.

1.12.6 The number 2 engine mounted in the tail fin, continued to deliver considerable power after the impact.

1.12.7 The integrity of the fuselage was broached early in the breakup sequence and the majority of the victims were ejected before the last of the wreckage came to rest. Most of the remainder were thrown clear by the final impact.

1.12.8 The spread of the wreckage covered a total area which was some 570m by 120m and was aligned on a bearing of 357° Grid (190° true). The wreckage area's uphill slope from the point of impact was 13° with a 5° cross slope, downhill from right to left. The accident site was located on the top of a solid layer of ice which had a light covering of dry powder snow. Two deep crevasses crossed the area of the main wreckage trail but much of the lighter debris was moved onto an adjacent, extensively crevassed area by subsequent storms and was not recovered.

1.12.9 Although the aircraft had increased its nose up pitch attitude and its engines' power was increasing immediately prior to impact, its flight path was essentially straight and level when it collided with the slope.

1.12.10 The largest portion of the aircraft remaining was the complete constant section length of the damaged cabin section which remained attached to the wing's centre and inboard sections. This portion was at the forward end of the wreckage train an was involved in a persistent, intense and deep seated fire.

1.12.11 The upper forward fuselage section which contained the front galley and flight deck came to rest short of and to the left (east) of the main fuselage section and although it was extensively damaged it was not involved in any fire.

1.12.12 The entire length of the wreckage trail, was impregnated with aviation turbine fuel and covered with soot.

1.12.13 The aircraft was in the normal configuration for cruising flight with the undercarriage and flaps and slats up. The horizontal stabiliser jack screws, indicated a nose up trim of 2° was applied at the time of impact.

1.12.14 A diagram of the wreckage distribution at the accident site is attached as Annex E.

1.13 Medical and pathological information

1.13.1 All of the aircraft's occupants who were recovered were killed by the injuries sustained as a result of the deceleration of the aircraft.

1.13.2 A review of the flight crew's medical records disclosed no evidence of pre-existing physical problems which could have affected their judgement or performance. The post-mortem and toxicological investigations did not reveal any abnormalities in any flight deck crew member.

1.13.3 An extensive effort resulted in most of the victims being recovered. Of these 213 were identified. All those recovered were subjected to a post-mortem examination in Auckland which established there was no suspicion of any cause factor related to the passengers or cabin crew.

1.13.4 A detailed review of the location of the victims who were recovered from the wreckage site was compared with the allocated seating plan as was the nature of the injuries sustained by each occupant.

1.13.5 The post-mortem examinations indicated that all the victims were killed by the injuries received at the initial impact rather than as a result of burns sustained in the subsequent fire.

1.14 Fire

1.14.1 The evidence in the wreckage trail indicated that a fire was ignited immediately after the impact and that a persistent fire raged in the centre section of the fuselage but aft of the front galley. The residual fuel in the left wing ranks which were the only fuel tanks to retain their essential integrity probably sustained this conflagration. The source of ignition was not determined.

1.14.2 The fire did not involve the fuselage interior immediately after impact and many of the victims showed no evidence of being burnt.

1.14.3 The fire burnt itself out before the wreckage was located therefore no fire fighting equipment was involved.

1.15 Survival aspects

1.15.1 The accident was unsurvivable. All of the injuries sustained indicated a deceleration at impact, that could not be survived with the type of restraint provided by a seat belt, additionally very few occupants appeared to have been wearing these seat belts.

1.15.2 The aircraft's survival equipment had not been modified or supplemented to cater for survival in the cold land or cold sea environment of the Antarctic. No training had been given to the flight or cabin crew members on Antarctic survival techniques and no adaptation of the standard emergency briefing to the passengers was planned. The CAD Airline Inspector who attended this cabin crew's pre-flight briefing was critical of this aspect and handed the Chief Purser a copy of some cold weather survival notes to study to enable him to brief his cabin crew on cold weather survival techniques during the course of the flight.

1.16 Tests and research

1.16.1 A report was received from an Air New Zealand pilot that on occasions additional waypoints fed into another Air New Zealand DC 10 aircraft's navigation computer at a later stage had "dropped out" without warning.

1.16.2 It was confirmed that several instances of waypoints "dropping out" had occurred. This resulted in an incorrect indication that a point had been passed before the aircraft actually arrived at the position. This malfunction was unlikely to occur when the system was using latitude and longitude positions and operating in the "inertial" mode as in this case because any additional waypoint would have to be inserted using latitude and longitude in the same way as the flight planned waypoints and there is no reason to believe one latitude/longitude waypoint would drop out without the others also disappearing.

1.16.3 The performance of the GPWS was evaluated and it was assessed that the warning was in accordance with the expected performance in the "terrain closure" and "flight below 500 feet without flaps and undercarriage extended" modes of the equipment (modes 2A and 4 respectively). The profile of the terrain prior to the impact was reconstructed in Air New Zealand's DC 10 simulator and the performance of the aircraft was evaluated to determine if the collision could have been avoided in response to the warning and that the warning was in fact given at the maximum time before impact that could be expected.

1.16.4 The flights in the simulator indicated that experienced pilots would not have avoided a collision and that the warning given was in accordance with the design specifications of the GPWS. With sufficient rehearsal it was possible to fly the aircraft away from the approaching slope when an extreme manoeuvre was initiated in response to the onset of the GPWS warning.

1.17 Additional Information

1.17.1 Route briefing. Two of the 3 pilots of the operating crew of flight TE 901 were subjected to the specially devised audio-visual, written and simulator route qualification briefing for the route to and from Antarctica (First Officer Lucas had not received the Antarctic route briefing). The navigation procedures to be used (particularly the use of grid navigation) the radio frequency chart indicating the probable best HF frequencies for the time of day and certain company policy matters in relation to the entertainment and welfare of passengers on the flight were all detailed.

1.17.2 An examination of this briefing revealed certain significant items were not included:

a. The authority of the US Navy's Antarctic ATC system to control the civilian Air New Zealand flight.

b. The procedure for determining the minimum flight level recognised for the Antarctic area and specifically the McMurdo control area.

c. The way in which the Air New Zealand route varied from the normal military route, which followed the reporting points depicted on the Radio Navigation Chart (RNC), (see Annex F) particularly on the leg from Cape Hallett south to McMurdo.

d. Topographical maps for use on the flight. With the exception of a Photostat copy of a small insert enlargement of a map of Ross Island (1:1,000,000), these were not issued to the crew until the day of the flight, and were of a relatively small scale i.e. 1:5,000,000 and 1:3,000,000.

e. A comprehensive discussion of the visual phenomenon peculiar to the Antarctic, i.e. the whiteout conditions, which might be anticipated with overcast sky and snow covered terrain below. (Refer paragraphs 1.17.46-58 inclusive).

f. A discussion of the procedure for attempting a landing on the local ice runway or skiways and the emergency conditions which might necessitate such a landing.

g. The most effective methods of attempting to achieve survival on the ice (with the equipment available) in the event of a successful forced landing.

h. The fact that the medium frequency NDB was still operating.

1.17.3 The original requirement for radar monitoring of any VMC letdown was deleted by the letter of amendment detailing the conditions for VMC letdowns which were to apply following the withdrawal of the NDB letdown procedure. The revised version called only for the descent to be co-ordinated with local radar control.

1.17.4 Although topographical charts for the area were available on the day of the flight the only "charts" of the area below the flight planned track from Cape Hallett to McMurdo available at the initial briefing were:

The passenger information map
(an overprint on a 1:16,000.000 chart) (Annex G)
The RNC chart (Annex F) and
A slide depicting a schematic diagram taken from the rear of a passenger brochure (Annex H)

All of which showed a track proceeding o the true west of Mt Erebus down the McMurdo Sound. While these "charts" were not intended to be used for navigation the track shown was not that to be followed by TE 901. Several members of earlier crews were of the opinion that the inbound track to McMurdo was intended to be on an alignment which was over the sea level ice to a point adjacent to McMurdo but to the west of that base. (The dialogue which accompanied the audio visual briefing referred to the RNC chart when discussing the appropriate flight levels for the flight.)

1.17.5 The strip map of the route from Christchurch to McMurdo (Annex I) issued on the day of the flight also had two tracks printed on it both depicting a passage to the west of Ross Island. A track and distance diagram (Annex J) issued at the route qualification briefing correctly depicted the intended flight plan track from Cape Hallett to the McMurdo TACAN, but this showed no relationship to geographical location or terrain.

1.17.6 The audio visual presentation of the route qualification briefing showed two slides purporting to be of the track between Cape Hallett and the McMurdo TACAN. The first which only showed Cape Adare, 73 miles northwest of the Cape Hallett waypoint, accompanies the statement "We are almost 77° south proceeding from Cape Hallett towards Ross Island at Flight Level 330. Mt Erebus, almost 13000 feet, ahead. McMurdo Station and Scott Base lie 20 miles beyond the mountain in the direction of grid north". A second slide accompanies the statement "Now approaching Erebus at 16000 feet the minimum sector altitude. In VMC a descent to this minimum altitude up to 50 miles before McMurdo will be found advantageous for viewing". This slide gave no indication of the relationship of the track to Mt Erebus, as it shows a view of Mt Erebus taken from behind the co-pilot's seat with the aircraft heading north.

1.17.7 The computer flight plan used at the briefing had been in error for 14 months in that it showed the destination point for McMurdo as two degrees ten minutes of longitude to the west of the intended turning point. This error was not corrected in the computer until the day before the flight. Although it was intended that it be drawn to the attention of the previous crew, immediately prior to their departure this was not done, nor was it mentioned during the pre-flight dispatch planning for the crew of the accident flight. The crew was shown a copy of the erroneous flight plan with the incorrect co-ordinates at the route qualification briefing but the flight plan issued on the day of the flight was correct.

1.17.8 Mention was made in both the audio-visual presentation and the written brief of "A whiteout emergency landing area for ski-equipped aircraft" located grid northwest of and adjacent to Williams Field with a landing procedure and talk down being available from the PAR (Precision Approach Radar) Controller, Williams Field.

1.17.9 The United States Navy advised "The emergency whiteout landing area does not have PAR available. Its location is primarily to the grid west of the Williams Field Skiway complex, starting one mile from the TACAN on the 240° Grid radial; arcing grid north at one mile to the 330° grid radial then out on the 330° grid radial; then out the 300° grid radial to 15 miles then arcing south on the 15 mile arc to the 240° grid radial; then inbound on the 240° grid radial to the starting point, one mile from the TACAN." "This area along with the skiway, is for ski-equipped aircraft only. Wheel equipped aircraft would use this area only if a crash landing/ wheels up landing was required."

1.17.10 On 4 February 1977 a CAD Airline Inspector witnessed the briefing at ODF Headquarters, Christchurch of the pilots in command of the first two flights. On 15 February 1977 another Airline Inspector witnessed the pre-flight dispatch planning before the first flight. This second Airline Inspector also viewed the audio visual presentation portion of the route qualification briefing in October 1977 and again on 26 November 1979. On 28 November 1979 the second Airline Inspector witnessed the pre-flight briefing given by Air New Zealand's Chief Purser.

1.17.11 The loss of communication procedure given in the briefing notes was an abbreviated and reworded version of the full procedure and the reference given for the full procedure quoted a superseded page number of the particular document quoted. (One significant omission relevant to the Antarctic was the absence of any reference to adjustments to minimum safe altitudes to be made in the Antarctic when low barometric pressures exist. This applies to "lost comms" procedures as well as normal navigation).

1.17.12 To meet the operator's responsibility to have the pilot-in-command "demonstrate that he has an adequate knowledge of the route to be flown" (see paragraph 1.17.21), Air New Zealand Limited required the pilot-in-command of each flight to practise setting up the aircraft's instruments and navigation procedures for grid navigation and simulate a night[6] VMC letdown using the arcs and distances specified for the day VMC procedure at McMurdo.

[6] The Air New Zealand DC 10 flight simulator's external presentation of terrain is limited to the night lighting of any aerodrome environment. Terrain is not simulated in any other way and the pilots undergoing training are briefed on the proximity of high ground by the simulator instructor.

1.17.13 The audio visual route qualification briefing stated that the "minimum sector altitude" or "company sector safe altitude" for approach to McMurdo was 16000 feet and that descents to the overall minimum of 6000 feet were only permitted in a sector to the true south of McMurdo in conditions of 20 km visibility or better and only then if there were no snow showers in the area and the descent was co-ordinated with the local radar controller. The written briefing notes emphasised the point thus "If VMC cannot be maintained FL 160 is the minimum safe altitude".

1.17.14 The company's briefing notes on the local McMurdo procedures had not been forwarded to the Air Traffic Control authorities at McMurdo and the Air Traffic Control staff there were not aware of the approved minimum altitudes, the VMC letdown sector approved or the conditions specified for VMC letdowns.

1.17.15 The company briefing specifically mentioned that passengers' visits to the flight deck should be firmly controlled and stressed that such visits should be limited during low-level operations.

1.17.16 The CAD had been discussing with the airline the desirability of carrying cold weather survival equipment on such flights but had not made CAD approval for these flights dependent upon the carriage of such equipment.

1.17.17 Operations specifications. The Air New Zealand Limited Operations Specifications which form part of their Air Service Certificate No. 22 specified as follows:

a. Page 61 (dated and effective 20 December 1977)

1. In accordance with subparagraph 2.12.1 of these Operations Specifications, route and aerodrome familiarisation training is required on those routes set out in the schedules forming part of (Appendix VI).

2. It shall be the responsibility of the pilot-in-command to ensure, before flight over any route, that he and the flight crew members under his command comply with the route and aerodrome qualifications required by Civil Aviation Regulation No. 79[7] and these Operations Specifications.

b. Page 62 (dated and effective 16 October 1978)

1. The area and aerodrome qualifications specified in the schedules to this appendix shall be deemed to comply with the regulation. A pilot who holds a valid area qualification in accordance with Schedule I will be qualified for flights on all routes within that area or between that area and any adjacent area for which he holds a valid area qualification, provided that he also holds valid aerodrome qualifications for the appropriate aerodromes and their alternates.

2. The Company shall maintain an approved record of the area and aerodrome qualifications of all its pilots.

3. Where the requirements specified in these schedules cannot be met the Director may approve an alternative means of compliance with the regulations.

4. Where the Company undertakes non-scheduled flights which are not of a continuing nature the Flight Operations Director shall ensure that sufficient route familiarisation training is provided to comply with Regulations 79[7].

5. The following schedules form part of this appendix:

[7] Regulation 79 became Regulation 77 with amendment 22 to Civil Aviation Regulations with effect from 12 February 1979 but the Operations Specifications had not been amended as at 28 November 1979.

Schedule IArea Qualification
Schedule IIAerodrome Qualification
Schedule IIISummary of Approved Aerodrome Qualification

c. Page 63 (dated and effective 20 September 1977) and Page 64 (dated 12 May 1978 and effective 17 May 1978)

1. **Designated Areas**
For the purpose of route familiarisation training the following geographic areas have been designated.

d. **Antarctic**
The Antarctic area shall cover flights within the area of compass unreliability south of the Antarctic Circle.

2. **Area Qualification Requirements**
Area qualification shall consist of the following:

a. A comprehensive pre-flight briefing which covers at least the following items:

(i) En-route and terminal routing
(ii) Terrain and minimum safe altitudes
(iii) The seasonal meteorological condition and statistics
(iv) Meteorological communication and ATC facilities, services and procedures
(v) Navigation facilities
(vi) Prohibited and restricted areas
(vii) Search and Rescue facilities and procedures
AND within 30 days

b. A flight in the area under the supervision of a person authorised by the Flight Operations Director.

3. **Period of Validity and Requalification**
An area qualification shall remain valid for a period of 12 months from the date of the flight qualification specified in 2(b) and shall be extended to 12 months from the date of each subsequent flight in that area, either as a crew member or as an observer on the flight deck of an approved air carrier.

Where more than 12 months have elapsed from the last flight in that area the comprehensive briefing and flight under supervision specified in 2(a) and (b) initial issue shall be required for requalification.

d. Page 65 (dated and effective 16 October 1978)

2. **Standard Aerodrome Qualification**
2.1 Standard aerodrome qualification shall consist of the following requirements for pilots in command.

(a) A comprehensive briefing which shall include:

(i) Seasonal meteorological conditions
(ii) Terrain and minimum safe altitudes
(iii) Approach aids and procedures
(iv) Prohibited and restricted areas

(v) Any special procedures including SIDs and STARs
(vi) Ground facilities
AND within 30 days
A flight into the aerodrome which may be completed as an observer on the flight deck of an air New Zealand or approved airline operators aircraft, **OR**

(b) An approved pictorial presentation for that aerodrome.

e. Page 70 (dated 12 May 1978 and effective 17 May 1978) which is the second page of Appendix VI Schedule III "Summary of Airport Qualification Requirements – Pilots-in-Command".

AIRPORTS	**Initial Qualification**	**Requalification after 12 months**	**Requalification after 24 months**
Antarctic			
McMurdo Sound	RCU and SIM	RCU	Initial Qualification

Note: Qualification applies only to cloud break procedure and approach – no landing requirement.

1.17.18 In a letter 98/4/4 of 6 December 1977 headed ROUTE QUALIFICATION REQUIREMENTS – OPERATIONAL SPECIFICATIONS to Air New Zealand Limited, the Director of Civil Aviation stated in part:

"Additionally, the slide presentation of the Antarctic has also been approved for familiarisation purposes."

1.17.19 None of the pilots on this flight had previous Antarctic experience but on 24 October 1979 a signal message from Air New Zealand Limited to CAD asked:

"OPS 880 Flight Operations. Reference our telecon regarding the operation of company flights to Antarctica and return non-stop it is our understanding that because of the briefing programme carried out in our route training unit and the simulator detail covering exercises in grid navigation and the NDB could break at McMurdo that there is no requirement for flight under supervision. The briefing and simulator detail are completed within the week prior to operating the flight[8]. Would you please confirm that our understanding is correct".

In a reply dated 24 October 1979 CAD stated:

"OPS 523 98/4/14. Your OPS 880 is confirmed correct and Ops Specs will be amended to reflect such detail".

1.17.20 While the CAD had not specified any specific minima for the flight their approval for the operation of the flights was subject to them being conducted in accordance with the criteria suggested by the company.

1.17.21 Civil Aviation Regulations paragraph 77(1)(a) and (b) states:

77. Route and aerodrome qualifications of pilot in command –

(1) A pilot shall not act as pilot in command of an aircraft engaged in an air transport operation on a particular route unless:

[8] The briefing for the pilots of this flight on 28 November was completed on 9 November 1979.

(a) he has demonstrated to the operator that he has an adequate knowledge of the route to be flown and the aerodromes which are to be used, including an adequate knowledge of:

(i) The terrain and minimum safe altitudes;
(ii) The seasonal meteorological conditions;
(iii) The meteorological, communication, air traffic facilities, services and procedures;
(iv) The search and rescue procedures; and
(v) The navigational facilities associated with the route along which the flight is to take place; and

(b) He has demonstrated to the operator that he has adequate knowledge of procedures applicable to flight paths over heavily populated areas of high traffic density, obstructions, physical layout, lighting, approach aids, and arrival, departure, holding and instrument approach procedures and applicable meteorological minima. Provided that any portion of the demonstration relating to arrival, departure, holding or instrument approach procedures may be accomplished in an aircraft flight simulator if specifically approved by the Director.

1.17.22 Approval for Antarctic flights. In June 1971 the Minister of Transport summarised the situation regarding proposals for Air New Zealand Limited to fly to Antarctica as follows:

"Officers of the Civil Aviation Division of the Ministry of Transport and of Air New Zealand have made a complete study of the possibility of operating to Antarctica. A joint team visited the area in November 1969 and on their recommendation it was decided to defer any further action in the meantime. This decision was brought about by a lack of passenger terminal accommodation facilities at McMurdo, ground transportation problems and operational requirements including fuel reserves. While the operation is technically possible it would impose such restrictions as to make it a very doubtful viable economic operation. The project has not been abandoned but, in view now of Air New Zealand's re-equipment programme, it has for the present been deferred".

1.17.23 Following the visit to Antarctica, of the joint team mentioned in the Minister's statement, the Director of Civil Aviation (DCA) had stipulated that if certain conditions could be met by Air New Zealand Limited flights to the Antarctic would be approved. These conditions stipulated in letter 98/4/76 of 19 December 1969 included:

"2 (d) Prior to commencing revenue earning operations a proving flight will be required unless the pilot-in-command has previous experience of operations at McMurdo Sound.

4. It will be (Air New Zealand's) responsibility to submit for approval a scale of protective clothing to be supplied for passengers and crew and a revision of the contents of the aircraft emergency pack for Antarctic weather conditions".

The remaining conditions applied specifically to operations involving the DC 8 aircraft and the approval was generally for DC 8 aircraft with a planned landing at McMurdo. However, no further familiarisation visits were made to Antarctica by either CAD or Air New Zealand Limited representatives.

1.17.24 Following Air New Zealand's re-equipment with DC 10-30 aircraft a proposal was made in December 1976 by Air New Zealand Limited that they be permitted to conduct flights from Auckland to Christchurch by way of Antarctica. (The operation differed from the previous DC 8 proposal in that no landing or descent below 16000 feet was planned in Antarctica and accordingly no flaps, slats or undercarriage extension was intended).

These were proposed as charter flights but in the event became non-scheduled domestic air transport flights. To support their request for the initial 2 flights Air New Zealand Limited submitted the details under the following headings (their letter HO:AC:13 of 24 December 1976);

Flight schedule
All up weight
Proposed route
Reserve fuel
Provision for a depressurisation emergency
Briefing of captains by Operation Deep Freeze Headquarters

In a letter of the same reference dated 18 January 1977, Air New Zealand Limited submitted amended details of Maximum Zero Fuel Weight; flight time; route and flight planning details.

1.17.25 The Director of Civil Aviation granted approval (98/4/76) dated 19 January 1977) for the two flights subject to Air New Zealand's compliance with detailed instructions on the following:

Route to be submitted in writing.
Communications procedures. Both normal and in the event of a communications blackout. To be submitted for inspection. Specification of navigation procedures below 70°S by the operator.

A briefing by Christchurch Air Traffic Control/Deep Freeze for the captain and co-pilot to be completed not less than three days prior to departure. (To be attended by an Airline Inspector from CAD to ensure Regulation 79(1)(a) (now Regulation 77) was complied with). An Airline Inspector to be carried as an observer on the first flight.

1.17.26 It was subsequently proposed by the operator and agreed by CAD that the briefing by Christchurch Air Traffic Control/Deep Freeze Headquarters would be attended by the captains of the 2 flights only and they would, in turn, brief their own crews.

1.17.27 On 2 February 1977 Air New Zealand Limited submitted a letter to meet the requirements of DCA letter of 19 January 1977. There is no record of any comment on this letter by DCA, but the first flight was utilised by an Airline Inspector to make a formal Air Transport Flight Inspection Report on form CA 1333. This report dated 15 February 1977 showed all items on the en route inspection check list to be satisfactory and the summary of the flight was: "Nil adverse comments. A well conducted flight in all respects". (See Annex K). This was the last recorded flight inspection. A further inspection was planned in 1979 but it did not eventuate.

1.17.28 On 10 August 1977 Air New Zealand letter HO:B:22 requested authority to conduct five flights overflying Antarctica in the McMurdo area undertaking to operate these flights to the specification earlier submitted with the following exceptions:

"a. A proposal to permit descent to 6000 feet QNH in VMC or by the approved NDB procedure in IMC provided that:

1. Cloud base to be 7000 feet or better.
2. Visibility reported to be 20 kms or better.
3. ASR is available and used to monitor flight below flight level 160.
4. No snow showers in the area.

Flight in the McMurdo area below flight level 160 will be restricted to an arc corresponding to a bearing of 120° Grid through 360° G to 270G from the NDB within 20 nm in order to keep well clear of the Mr Erebus region.

b. Two captains and a co-pilot will be crewed on each flight, they will receive a comprehensive briefing and complete a simulator detail involving a letdown and climb-out procedure, particular emphasis being placed on the use of grid navigation procedures."

1.17.29 Air New Zealand's letter of 10 August 1977 was acknowledged by CAD granting formal approval for the flights requested and further flights of a similar nature should they be required. They also approved the proposed descent to 6000 feet QNH in VMC or by the approved NDB procedure.

1.17.30 Air New Zealand Limited made a further application on 19 September 1978 for 4 flights in November 1978 with the statement "We propose to operate over the same routes as the previous charters, utilising the same crew training and operational procedures". DCA approved this request specifically noting that as for the previous year a descent to 6000 feet was approved under the same conditions.

1.17.31 In early 1979 some concern was felt within CAD regarding the need to carry survival equipment appropriate to the Antarctic area to honour the undertaking to observe all the standards in Annex 6 to the International Civil Aviation Organisation's Convention. The standard in this case being specified in Annex 6 paragraph 6.6 which reads as follows:

"Aeroplanes when operated across land areas which have been designated by the State concerned as areas in which search and rescue would be especially difficult, shall be equipped with at least one survival radio equipment, stowed so as to facilitate its ready use in an emergency, which operates on VHF and in accordance with the relevant provisions of Annex 10. The equipment shall be portable, not dependent for operation upon the aeroplane power supply, and capable of being operated away from the aeroplane by unskilled persons. Aeroplanes shall also be equipped with such signalling devices and life-saving equipment (including means of sustaining life), as may be appropriate to the area being overflown".

1.17.32 Investigations were being undertaken to establish the practice of other airlines flying over Arctic and Antarctic areas and as a result Air New Zealand Limited was written to on the subject in a letter from CAD on 9 August 1979 asking that the Company examine the equipment carried by Qantas and the protection made available together with the advantages and disadvantages which would be associated with a requirement for Air New Zealand Limited to carry similar equipment on all Antarctic flights.

1.17.33 On 27 September 1979 Air New Zealand Limited wrote to the Director of Civil Aviation advising him they were planning a further series of "charters" overflying Antarctica on November 7, 14, 21 and 28 and proposed to operate over the same routes as the previous year utilising the same crew briefing, training and en-route procedures.

1.17.34 On 3 October 1979 CAD granted approval for the proposed flights in 1979 and in a supplementary paragraph reminded Air New Zealand Limited that no reply had been received regarding their letter on the carriage of Antarctic survival equipment in the DC 10 aircraft for these operations.

1.17.35 On 10 October 1979 Air New Zealand Limited advised CAD that:

"It is our opinion that the carriage of survival suits is unwarranted as it would only be used in the event of a landing at McMurdo Airfield. This would only be as a result of a double engine failure or unfightable fire as other contingencies are covered, allowing for a return to Christchurch. These risks are also taken on all long haul operations over Arctic areas and although some operators do carry such gear, . . ., others do not. On the basis of infrequent exposure to an extremely unlikely emergency situation, Air New Zealand does not propose to carry survival equipment on the four scenic flights scheduled in November of this year."

1.17.36 The matter was under discussion informally between various officers of Air New Zealand Limited and the CAD Airline Inspectors as recently as 27 November 1979.

1.17.37 Civil Aviation Regulation 108 (2) states:

The Director may require the following equipment to be installed in any or all aircraft engaged in operations over areas in which search and rescue would be especially difficult.

(a) At least one approved emergency locator transmitter (ELT) stowed so as to facilitate its ready use in an emergency. The equipment shall be portable, have its own independent power supply and be capable of being operated away from the aircraft by unskilled persons.
(b) Such signalling devices and life-saving equipment (including means of sustaining life) as the Director considers appropriate to the area being flown over.

1.17.38 On 13 October 1977 the Commander of the USN Support Force in Antarctica advised in a message (No. 3100) to CAD Christchurch:

"UNLCAS // NO 3100 //
SUPPORT OF NON-SCAR ANTARCTICA FLIGHTS
A. YOU 130335Z PASEP
1. IRT REF A, AIR TRAFFIC CONTROL/FLGIHT FOLLOWING AND WEATHER FORECASTING SUPPORT FROM MCMURDO STATION WILL BE AVAILABLE ON A LIMITED BASIS AND FOR ADVISORY INFORMATION ONLY.
2. CURRENT REGULATIONS DO NOT PROVIDE FOR USN WEATHER FORECASTING ACCESSIBILITY TO COMMERCIAL CARRIERS. ADDITIONALLY, THE LIMITED ASSETS AT MCMURDO AND THE LACK OF REPORTING STATIONS FURTHER RESTRICT THE RELIABILITY OF REPORTED WEATEHR. THEREFORE, ANY ACTION TAKEN IN RESPONSE TO MCMURDO WEATHER REPORT MUST BE THE RESPONSIBILITY OF THE PILOT IN COMMAND.
PAGE 2 RBYWQH6497 UNCLAS
3. AIR TRAFFIC CONTROL/FLIGHT FOLLOWING SHALL TAKE THE FORM OF LOCATION ADVISORY OF DEEP FREEZE AIRCRAFT AND POSITION REPORT RELAY ONLY.
4. LIMITED SAR CAPABILITY EXISTS OVER LAND. VERY LITTLE OVER WATER.
5. REQUEST YOU ADVISE ALL PARTICIPANTS EXCEPT PAN AM WHICH HAS PREVISOULY BEEN DONE BY SEPCOR."

1.17.39 On 6 November 1979 a file note records that Air New Zealand Limited telephoned a CAD Airline Inspector and advised that as the McMurdo NDB had been withdrawn Air New Zealand DC 10s would descend below their safety height (in the McMurdo area) of 16000 ft only in VMC conditions, with no snow showers and with at least 20 km visibility. No descents would be made below 6000 feet. This information was reflected in an amendment DAA:14/13/28 of 8 November 1979, issued for the crew briefing sheets for flight TE 901 which stated:

McMurdo NDB not available
Delete all reference in briefing dated 23/10/79.
Note that the only letdown procedure available is **VMC** below FL160 to 6000' as follows:

1. Vis 20 km plus.
2. No snow shower in area.
3. Avoid MT EREBUS area by operating in an arc from 120° Grid through 360G to 270G from McMurdo Field, within 20 nm of TACAN CH29.
4. Descent to be co-ordinated with local radar control as they may have other traffic in the area."

A copy of this amendment was recovered from the cockpit wreckage.

1.17.40 On 22 November 1979 CAD advised Air New Zealand Limited that reports had been received from US Authorities in Antarctica that civil aircraft had been observed at lower than normal altitudes over some glaciers and at 1000 above ground level.

1.17.41 Security. The passengers for flight TE 901 were each subjected to the normal airport security check as for an international flight. No freight was carried and only the overnight baggage of passengers deplaning at Christchurch was carried in the cargo hold.

1.17.42 Radio propagation conditions. The magnetometer and ionosonde records made at Scott Base over the period 1200 (Z) 27 November to 1200 (Z) 28 November 1979 showed:

a. The 3-hourly index of magnetic disturbance (k-index) did not exceed a value of 3 (on a scale of 0-10) over the period.
b. The ionograms taken at 15 minute intervals showed no unusual ionisation changes over the period.

The Scott Base Senior Technical Officer of the Antarctic Division of the Department of Scientific and Industrial Research (DSIR) therefore concluded that there was no significant magnetic disturbance or evidence that radio propagation conditions would have been in any way abnormal for the period under consideration.

1.17.43 The Superintendent of the Antarctic Division of the DSIR studied all of the processed film that was recovered from that exposed by passengers on the flight and was able to determine and demonstrate that the aircraft had followed a track over Northern Victoria Land consistent with that intended on the aircraft's flight plan and had approached Ross Island on track. Before crossing the coast of Ross Island east of Beaufort Island however, the aircraft had obviously completed some descending turns. The photographs studied indicated that in many cases the last or second to last photographs were taken when the aircraft was in a position about 6 miles east of Beaufort Island, while the aircraft was heading in a southerly direction. In a number of other cases the last photographs (some taken only seconds before the collision) show the eastern shoreline of Cape Bird and the north eastern and north western coastline of Lewis Bay and a cloud layer with a base of some 2000 feet, above an unbroken snow covered slope.

1.17.44 The aircraft flew for some time within sight of Beaufort Island, which was clearly visible. The sun was shining on the north eastern slopes of Mt Bird with rock outcrops and the ice cliff face around this section of Lewis Bay clearly visible.

1.17.45 From the photographs the Superintendent deduced the following information on the weather. Over Northern Victoria Land the weather was clear with an almost complete absence of cloud at any altitude. The aircraft flew over continuous cloud layers from about Franklin Island to just north of Beaufort Island where the aircraft was able to descend through an obvious break in the cloud cover. Several photographs show a clearly defined cloud base beyond and above the Lewis Bay coastline of something less than 2000 feet.

1.17.46 Whiteout phenomenon. The following detailed information (paragraphs 1.17.46-1.17.58) was included in authenticated information supplied to the investigating team by the USN Antarctic Support force. Whiteout is an atmospheric effect which results in loss of depth perception and is especially common in Polar regions when there is snow cover. Only two conditions are necessary to produce a whiteout, a diffuse shadowless illumination and a mono-coloured white surface. Whiteout, it must be emphasised, is not necessarily associated with precipitation or fog or haze. The condition may occur in a crystal clear atmosphere or under a cloud ceiling with ample comfortable light and in a visual field filled with trees, huts, oil drums and other small objects.

1.17.47 In Polar regions these conditions occur frequently. Large unbroken expanses of snow are illuminated by a sky overcast with dense, low stratus clouds that blot out all trace of surface texture or shadow and merge hollows and snow covered objects into a flattened white background. In addition, cloud and sky may have the same apparent colour, so horizon discrimination is lost and the ground plane disappears. Whiteouts also occur in water or ice fog, blowing snow or precipitation conditions.

1.17.48 Those who have not been exposed to whiteout are often sceptical about the inability of those who have experienced it, to estimate distance under these conditions, (and to be aware of terrain changes and the separation of sky and earth).

1.17.49 The probable reason for the diffuse lighting which is responsible for a whiteout is a complex process where a large percentage of the light which penetrates the cloud cover is reflected back by the snow, and similarly is reflected by the white cloud undersurface, and so on. The transmission and reflection paths which this system develops are most complex as they pass from one water droplet or ice crystal to another through the cloud and are then reflected by the myriads of ice mirrors tilted in all directions on the snow surface. The consequence is that the light is diffused and results in a white shadowless lighting effect.

1.17.50 For the person operating on the ground, whiteout may only be a nuisance in that he may stumble and fall on terrain which appears to be flat but which actually has undulations. In crossing ice, crevasses may be missed.

1.17.51 For the pilot of the fixed wing aircraft there are several hazardous losses of perception. First there is the effect of loss of horizon, where it becomes impossible or very difficult to separate sky from earth since both are the same colour and to establish a ground plane. The result on an attempted landing may be misjudgement of the approach or a stall well above the surface, or else the pilot may fly the aircraft “into the ground”.

1.17.52 A second major problem for pilots who must operate in winter with snow or ice landings where to strip exists is that they will have considerable difficulty assessing the condition of the terrain and determining whether it is flat or hummocky. They may, in landing encounter hummocks which cannot be avoided since they are literally not visible, and damage the aircraft and/or suffer injuries.

1.17.53 A third hazard reported by many pilots is disorientation, especially occurring on take off, where features such as trees which are providing a ground plane referenced are lost as the aircraft turns away from them and the pilot suddenly encounters a complete loss of references and height and altitude perception leading to disorientation.

1.17.54 Some flyers have also reported a phenomenon known as the “floating air strip”, where a dark or black runway appears to be floating well above the apparent ground level once again resulting in disorientation.

1.17.55 One other hazard is the effect caused by dark coloured rocks or ridges visible above the snow, which may give the impression that good contrast conditions exist, resulting in a landing attempt on terrain which is not suitable for the purpose, but which due to the whiteout effect appears to be safe since the pilot has not realised that the dark colour of the rocks is giving the illusion of contrast.

1.17.56 The helicopter pilot is faced often with difficulty in estimating his distance above ground and establishing his attitude. A combination of loose snow with the characteristic snow cloud plus whiteout can make helicopter operations difficult.

1.17.57 In addition, a commonly reported problem is a loss of distance judgement or perception and it becomes difficult to estimate whether a perceived hill or hummock is a distant hill or a small protrusion a few feet away.

1.17.58 One of the most critical effects of a whiteout is a loss of height perception and this appears to be a problem for pilots during aircraft turns especially if there are marginally visible references.

1.18 New Investigation techniques

1.18.1 Three of the aircraft’s navigation computers’ memory modules were recovered from the accident site and returned to the manufacturer in an attempt to retrieve the flight plan waypoints that had been entered for flight TE 901 from Cape Hallett onwards. The manufacturer was able to retrieve all the information from one navigation computer unit (NCU) for the latter and remaining section of the flight which would normally be available in an undamaged installation. This included data not normally displayed or accessible to the pilots which the units provide for the calculation of the items displayed.

1.18.2 The detail of the flight plan recovered determined that the flight plan had been entered as specified on the computer printout for the route from Cape Hallett onwards, that no additional waypoints had been inserted in the vicinity of McMurdo and no offset from the flight plan track had been flown. It was also established that all three ISUs were indicating positions within the allowable accuracy limits for the time they had been operating.

1.18.3 It is important that, in such cases, no attempt is made to gain access to this equipment by installing the memory modules in an aircraft NCU. The recovery is a delicate task requiring special techniques. The modules should be carefully packaged and returned to the manufacturer for investigation and no attempt made to apply any current to the modules prior to the manufacturer’s investigation.