29/83

Report of the Royal Commission

to inquire into

The Crash

on

MOUNT EREBUS, ANTARCTICA

of a

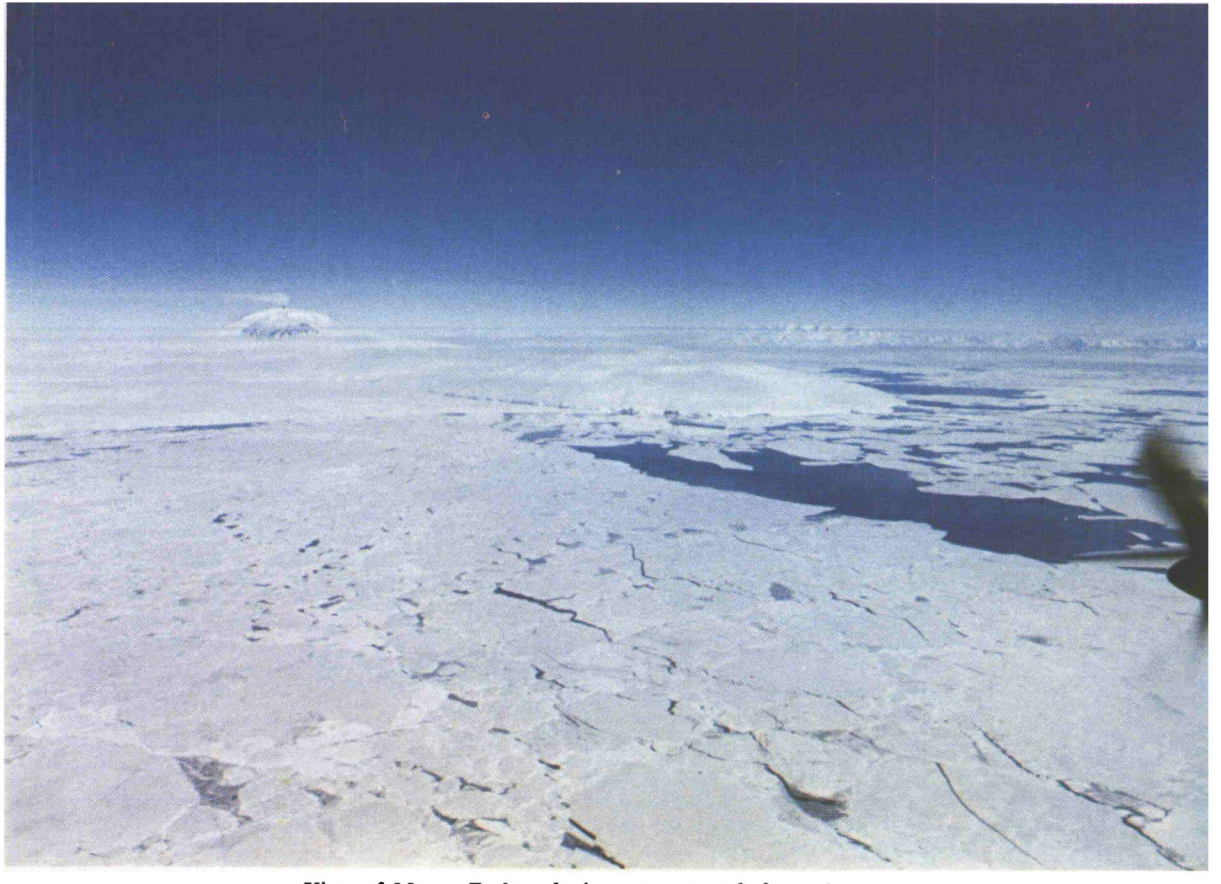
DC10 AIRCRAFT

operated by

AIR NEW ZEALAND LIMITED

1981

Royal Commission to inquire into and report upon the crash on Mount Erebus, Antarctica, of a DC10 aircraft operated by Air New Zealand Limited



View of Mount Erebus during an approach from the north

Report of the Royal Commission

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1981

Presented to the House of Representatives by Command of His Excellency the Governor-General

BY AUTHORITY:
P. D. HASSELBERG, GOVERNMENT PRINTER, WELLINGTON, NEW ZEALAND—1981

Price $8.60

ROYAL COMMISSION TO INQUIRE INTO AND REPORT UPON THE CRASH ON MOUNT EREBUS, ANTARCTICA, OF A DC10 AIRCRAFT OPERATED BY AIR NEW ZEALAND LIMITED

Royal Commissioner

The Honourable P. T. Mahon, Judge of the High Court at Auckland.

Secretary

Mr L. N. McElhinney	...	23 June 1980 to 31 December 1980
Mr M. G. Werner	...	1 January 1981 to 27 March 1981

Administrator

Mr J. H. Blackaby

ELIZABETH THE SECOND, by the Grace of God Queen of New Zealand and Her Other Realms and Territories, Head of the Commonwealth, Defender of the Faith:

To our Trusty and Well-beloved The Honourable PETER THOMAS MAHON, of Auckland, a Judge of the High Court of New Zealand:

GREETING:

WHEREAS, on the morning of the 28th day of November 1979, a DC10 Series 30 aircraft, operated by Air New Zealand Limited and bearing the nationality and registration marks ZK-NZP, took off from Auckland, at the beginning of a flight designated as Flight TE 901, a scenic passenger flight over Antarctica:

And whereas the next point of intended landing of the aircraft, after taking off from Auckland, and flying over Antarctica, was Christchurch:

And whereas, on the 28th day of November 1979, the aircraft crashed on the slopes of Mount Erebus, Antarctica, in the course of Flight TE 901:

And whereas the crash of the aircraft resulted in the total loss of the aircraft and in the death of all persons, believed to have numbered 257, on board:

And whereas, on the 28th day of November 1979, the aircraft was a New Zealand aircraft and Air New Zealand Limited was both the registered owner and the operator of the aircraft:

And whereas, it is expedient that inquiry should be made into the causes and circumstances of the crash:

KNOW YE that We, reposing trust and confidence in your integrity, knowledge, and ability, do hereby nominate, constitute, and appoint you, the said The Honourable PETER THOMAS MAHON to be a Commission to inquire into and report upon:

(a) The time at which the aircraft crashed:

(b) The cause or causes of the crash and the circumstances in which it happened:

(c) Whether the aircraft and its equipment were suitable for Flight TE 901?

(d) Whether the aircraft and its equipment were properly maintained and serviced?

(e) Whether the crew of the aircraft held the appropriate licences and ratings and had adequate experience to make Flight TE 901?

(f) Whether, in the course of Flight TE 901, the aircraft was operated, flown, navigated, or manoeuvred in a manner that was unsafe or in circumstances that were unsafe?

(g) Whether the crash of the aircraft or the death of the passengers and crew was caused or contributed to by any person (whether or not that person was on board the aircraft) by an act or omission

in respect of any function in relation to the operation, maintenance, servicing, flying, navigation, manoeuvring, or air traffic control of the aircraft, being a function which that person had a duty to perform or which good aviation practice required that person to perform?

(h) Whether the practice and actions of the Civil Aviation Division of the Ministry of Transport in respect of Flight TE 901 were such as might reasonably be regarded as necessary to ensure the safe operation of aircraft on flights such as TE 901?

(i) The working and adequacy of the existing law and procedures relating to—

(i) The investigation of air accidents; and

(ii) In particular, the making available to interested persons of information obtained during the investigation of air accidents:

(j) And other facts or matters arising out of the crash that, in the interests of public safety, should be known to the authorities charged with the administration of civil aviation in order that appropriate measures may be taken for the safety of persons engaged in aviation or carried as passengers in aircraft:

And for the better enabling you to carry these presents into effect you are hereby authorised and empowered to make and conduct any inquiry or investigation under these presents in such manner and at such time and place as you think expedient, with power to adjourn from time to time and place to place as you think fit, and so that these presents shall continue in force and any such inquiry may at any time and place be resumed although not regularly adjourned from time to time or from place to place:

And you are hereby strictly charged and directed that you shall not at any time publish, save to His Excellency the Governor-General, in pursuance of these presents or by His Excellency's direction, the contents of any report so made or to be made by you, or any evidence or information obtained by you in the exercise of the powers hereby conferred on you, except such evidence or information as is received in the course of a sitting open to the public:

And We do further ordain that you have liberty to report your proceedings and findings under this Our Commission from time to time if you shall judge it expedient to do so:

And, using all due diligence, you are required to report to His Excellency the Governor-General in writing under your hands, not later than the 31st day of October 1980 your findings and opinions on the matters aforesaid, together with such recommendations as you think fit to make in respect thereof:

And, lastly, it is hereby declared that these presents are issued under the authority of the Letters Patent of His Late Majesty King George the Fifth, dated the 11th day of May 1917, and under the authority of and subject to the provisions of the Commissions of Inquiry Act 1908, and with the advice and consent of the Executive Council of New Zealand.

In Witness whereof We have caused this Our Commission to be issued and the Seal of New Zealand to be hereunto affixed at Wellington this 11th day of June 1980.

Witness The Right Honourable Sir Keith Jacka Holyoake, Knight Companion of the Most Noble Order of the Garter, Knight Grand Cross

of the Most Distinguished Order of Saint Michael and Saint George, Member of the Order of the Companions of Honour, Principal Companion of the Queen's Service Order, Governor-General and Commander-in-Chief in and over New Zealand.

[L.S.] KEITH HOLYOAKE, Governor-General.
By His Deputy RONALD DAVISON.

By His Excellency's Command—

L. R. ADAMS-SCHNEIDER, Acting for the Prime Minister.

Approved in Council—

P. G. MILLEN, Clerk of the Executive Council.

Extending the Time Within Which the Royal Commission to Inquire Into and Report Upon the Crash on Mount Erebus, Antarctica, of a DC10 Aircraft operated by Air New Zealand Limited May Report

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ELIZABETH THE SECOND, by the Grace of God Queen of New Zealand and Her Other Realms and Territories, Head of the Commonwealth, Defender of the Faith:

To our Trusty and Well-beloved The Honourable PETER THOMAS MAHON, of Auckland, a Judge of the High Court of New Zealand: GREETING:

WHEREAS by Our Warrant dated the 11th day of June 1980 We nominated, constituted, and appointed you, the said The Honourable PETER THOMAS MAHON to be a Commission to inquire into and report upon the causes and circumstances of the crash, on the 28th day of November 1979, on the slopes of Mount Erebus, Antarctica, of a DC10 aircraft operated by Air New Zealand Limited:

And whereas by Our said Warrant you were required to report to His Excellency the Governor-General, not later than the 31st day of October 1980, your findings and opinions on the matters aforesaid:

And whereas it is expedient that the time for so reporting should be extended as hereinafter provided:

Now, therefore, We do hereby extend until the 31st day of December 1980, the time within which you are so required to report, without prejudice to the continuation of the liberty conferred on you by Our said Warrant to report your proceedings and findings from time to time if you should judge it expedient to do so:

And we do hereby confirm Our said Warrant and the Commission thereby constituted save as modified by these presents:

And, lastly, it is hereby declared that these presents are issued under the authority of the Letters Patent of His Late Majesty King George the Fifth, dated the 11th day of May 1917, and under the authority of and subject to the provisions of the Commissions of Inquiry Act 1908, and with the advice and consent of the Executive Council of New Zealand.

In Witness whereof We have caused this Our Commission to be issued and the Seal of New Zealand to be hereunto affixed at Wellington this 6th day of October 1980.

Witness The Right Honourable Sir Keith Jacka Holyoake; Knight Companion of the Most Noble Order of the Garter, Knight Grand Cross of the Most Distinguished Order of Saint Michael and Saint George, Member of the Order of the Companions of Honour, Principal Companion of the Queen's Service Order, Governor-General and Commander-in-Chief in and over New Zealand.

[L.S.] KEITH HOLYOAKE, Governor-General.

By His Excellency's Command—

DUNCAN MACINTYRE, Acting for Prime Minister.

Approved in Council—

A. C. McLEOD, Acting for Clerk of the Executive Council.

Further Extending the Time Within Which the Royal Commission to Inquire Into and Report Upon the Crash on Mount Erebus, Antarctica, of a DC10 Aircraft operated by Air New Zealand Limited May Report

---

ELIZABETH THE SECOND, by the Grace of God Queen of New Zealand and Her Other Realms and Territories, Head of the Commonwealth, Defender of the Faith:

To our Trusty and Well-beloved The Honourable PETER THOMAS MAHON, of Auckland, a Judge of the High Court of New Zealand: GREETING:

WHEREAS by Our Warrant dated the 11th day of June 1980 We nominated, constituted, and appointed you, the said The Honourable PETER THOMAS MAHON to be a Commission to inquire into and report upon the causes and circumstances of the crash, on the 28th day of November 1979, on the slopes of Mount Erebus, Antarctica, of a DC10 aircraft operated by Air New Zealand Limited:

And whereas by Our said Warrant you were required to report to His Excellency the Governor-General, not later than the 31st day of October 1980, your findings and opinions on the matters aforesaid:

And whereas by Our further Warrant dated the 6th day of October 1980 the time within which you were so required to report was extended until the 31st day of December 1980:

And whereas it is expedient that the time for so reporting should be further extended as hereinafter provided:

Now, therefore, We do hereby extend until the 28th day of February 1981, the time within which you are so required to report, without prejudice to the continuation of the liberty conferred on you by Our said Warrant to report your proceedings and findings from time to time if you should judge it expedient to do so:

And we do hereby confirm Our said Warrant dated the 11th day of June 1980 and the Commission thereby constituted save as modified by these presents:

And, lastly, it is hereby declared that these presents are issued under the authority of the Letters Patent of His Late Majesty King George the Fifth, dated the 11th day of May 1917, and under the authority of and subject to the provisions of the Commissions of Inquiry Act 1908, and with the advice and consent of the Executive Council of New Zealand.

In Witness whereof We have caused this Our Commission to be issued and the Seal of New Zealand to be hereunto affixed at Wellington this 15th day of December 1980.

Witness The Honourable Sir David Stuart Beattie, Knight Grand Cross of the Most Distinguished Order of Saint Michael and Saint George, Principal Companion of the Queen's Service Order, one of Her Majesty's Counsel learned in the law, Governor-General and Commander-in-Chief in and over New Zealand.

[L.S.] DAVID BEATTIE, Governor-General.

By His Excellency's Command—

R. D. MULDOON, Prime Minister.

Approved in Council—

P. G. MILLEN, Clerk of the Executive Council.

Further Extending the Time Within Which the Royal Commission to Inquire Into and Report Upon the Crash on Mount Erebus, Antarctica, of a DC10 Aircraft operated by Air New Zealand Limited May Report

---

ELIZABETH THE SECOND, by the Grace of God Queen of New Zealand and Her Other Realms and Territories, Head of the Commonwealth, Defender of the Faith:

To our Trusty and Well-beloved The Honourable PETER THOMAS MAHON, of Auckland, a Judge of the High Court of New Zealand: GREETING:

WHEREAS by Our Warrant, dated the 11th day of June 1980, We nominated, constituted, and appointed you, the said The Honourable PETER THOMAS MAHON to be a Commission to inquire into and report upon the causes and circumstances of the crash, on the 28th day of November 1979, on the slopes of Mount Erebus, Antarctica, of a DC10 aircraft operated by Air New Zealand Limited:

And whereas by Our said Warrant you were required to report to His Excellency the Governor-General, not later than the 31st day of October 1980, your findings and opinions on the matters aforesaid:

And whereas by Our Warrant, dated the 6th day of October 1980, the time within which you were so required to report was extended until the 31st day of December 1980:

And whereas by Our Warrant, dated the 15th day of December 1980, the time within which you were so required to report was further extended until the 28th day of February 1981:

And whereas it is expedient that the time for so reporting should be further extended as hereinafter provided:

Now, therefore, We do hereby extend until the 27th day of March 1981, the time within which you are so required to report, without prejudice to the continuation of the liberty conferred on you by Our said Warrant, dated the 11th day of June 1980, to report your proceedings and findings from time to time if you should judge it expedient to do so:

And We do hereby confirm Our said Warrant, dated the 11th day of June 1980, and the Commission thereby constituted save as modified by these presents:

And, lastly, it is hereby declared that these presents are issued under the authority of the Letters Patent of His Late Majesty King George the Fifth, dated the 11th day of May 1917, and under the authority of and subject to the provisions of the Commissions of Inquiry Act 1908, and with the advice and consent of the Executive Council of New Zealand.

In Witness whereof We have caused this Our Commission to be issued and the Seal of New Zealand to be hereunto affixed at Wellington this 23rd day of February 1981.

Witness The Honourable Sir David Stuart Beattie, Knight Grand Cross of the Most Distinguished Order of Saint Michael and Saint George, Principal Companion of the Queen's Service Order, one of Her Majesty's Counsel learned in the law, Governor-General and Commander-in-Chief in and over New Zealand.

[L.S.] DAVID BEATTIE, Governor-General.

By His Excellency's Command—

R. D. MULDOON, Prime Minister.

Approved in Council—

P. G. MILLEN, Clerk of the Executive Council.

Further Extending the Time Within Which the Royal Commission to Inquire Into and Report Upon the Crash on Mount Erebus, Antarctica, of a DC10 Aircraft operated by Air New Zealand Limited May Report

---

ELIZABETH THE SECOND, by the Grace of God Queen of New Zealand and Her Other Realms and Territories, Head of the Commonwealth, Defender of the Faith:

To our Trusty and Well-beloved The Honourable PETER THOMAS MAHON of Auckland a Judge of the High Court of New Zealand: GREETING:

WHEREAS by Our Warrant, dated the 11th day of June 1980, We nominated, constituted, and appointed you, the said The Honourable PETER THOMAS MAHON to be a Commission to inquire into and report upon the causes and circumstances of the crash, on the 28th day of November 1979, on the slopes of Mount Erebus, Antarctica, of a DC10 aircraft operated by Air New Zealand Limited:

And whereas by Our said Warrant you were required to report to His Excellency the Governor-General, not later than the 31st day of October 1980, your findings and opinions on the matters aforesaid:

And whereas by Our Warrant, dated the 23rd day of February 1981, the time within which you were so required to report was further extended until the 27th day of March 1981:

And whereas it is expedient that the time for so reporting should be further extended as hereinafter provided:

Now, therefore, We do hereby extend until the 30th day of April 1981, the time within which you are so required to report, without prejudice to the continuation of the liberty conferred on you by Our said Warrant, dated the 11th day of June 1980, to report your proceedings and findings from time to time if you should judge it expedient to do so:

And We do hereby confirm Our said Warrant, dated the 11th day of June 1980, and the Commission thereby constituted save as modified by these presents:

And, lastly, it is hereby declared that these presents are issued under the authority of the Letters Patent of His Late Majesty King George the Fifth, dated the 11th day of May 1917, and under the authority of and subject to the provisions of the Commissions of Inquiry Act 1908, and with the advice and consent of the Executive Council of New Zealand.

In Witness whereof We have caused this Our Commission to be issued and the Seal of New Zealand to be hereunto affixed at Wellington this 23rd day of March 1981.

Witness The Honourable Sir David Stuart Beattie, Knight Grand Cross of the Most Distinguished Order of Saint Michael and Saint George, Principal Companion of the Queen's Service Order, and of Her Majesty's Counsel learned in the law, Governor-General and Commander-in-Chief in and over New Zealand.

[L.S.] DAVID BEATTIE, Governor-General.

By His Excellency's Command—

R. D. MULDOON, Prime Minister.

Approved in Council—

P. G. MILLEN, Clerk of the Executive Council.

COUNSEL APPEARING

Assisting Commission

Mr W. D. Baragwanath
Mr G. M. Harrison

For Air New Zealand Limited

Mr L. W. Brown, Q.C.
Mr D. A. R. Williams
Mr R. J. McGrane
Miss D. Henare

For the consortium representing the estates of deceased passengers

Mr J. S. Henry, Q.C.
Mr C. M. Nicholson, Q.C.
Mr K. L. Peterson

For the estate of First Officer G. M. Cassin

Mr R. L. MacLaren
Mr J. W. Stewart

For the estate of Captain T. J. Collins and the Airline Pilots Association

Mr A. F. MacAlister
Mr P. J. Davison

For the New Zealand Institute of Marine and Power Engineers (Representing Flight Engineers)

Mr P. T. Cavanagh

For the manufacturers of the DC10 aircraft the McDonnell-Douglas Corporation of Long Beach, California

Mr D. G. Lee
Mr R. J. Katz
Mr M. J. Foley (of the Bar of California)

For the Civil Aviation Division, Ministry of Transport

Mr D. S. Morris
Mr S. B. W. Grieve
Mr J. E. Connell
Mr K. I. Murray

For the estate of P. Mulgrew

Mr B. P. Keene

For the Office of Air Accident Investigations, Ministry of Transport

Mr N. C. Anderson

ACKNOWLEDGMENTS

Mr R. Chippindale, Chief Inspector of Air Accidents, New Zealand.

Mr R. B. Thomson, Superintendent, Antarctic Division of the New Zealand Department of Scientific and Industrial Research.

Air-Marshal Sir Rochford Hughes.

The Ministry of Foreign Affairs for New Zealand, and its Consular Officers in Los Angeles and Washington, D.C.

Mr Martin J. Foley of the Californian Bar.

Lieutenant-Commander E. A. Fessler of the Judge-Advocate General's Branch of the United States Navy, Washington, D.C.

Commander J. E. Goodson and Captain P. T. Briska of the United States Navy Base, Pensacola, Florida.

Captain A. P. Ginsburg (United States Air Force) of the Wright Patterson Base, Dayton, Ohio.

Mr Wayne G. Shear (Director of Engineering) and Mr Daryal Kuntman (Manager, Radar Systems Design) both of the Avionics Division of the Bendix Corporation, Fort Lauderdale, Florida.

Mr G. W. Shannon (Vice-President, Operations) of Bradley Air Services Limited, Carp, Ontario, Canada.

Mr Paul Turner of the National Transportation Safety Board, Washington, D.C.

Mr W. H. Tench, Chief Inspector of Air Accidents for the United Kingdom.

Mr L. S. H. Shaddick, Inspector of Air Accidents attached to Mr Tench's Office.

Mr Roger Green, specialist in the psychological aspect of flight skills, including visual illusion, attached to the Royal Air Force at Farnborough.

Air Commodore David Crooks, Deputy Chief of Staff of the Royal New Zealand Air Force.

FOREWORD

1. The Commission heard evidence over a period of 75 days. The notes of evidence comprised 3083 pages and the text of the submissions of counsel at the conclusion of the hearing comprised 368 pages. Two hundred and eighty-four exhibits were produced.

2. The evidence was recorded on a DEC Tabletop Data System PDT 151 machine and copies of evidence were made available to counsel twice daily.

3. In addition to hearing evidence in Auckland, I travelled overseas with Mr W. D. Baragwanath and spent over 3 weeks in the United States, Canada and in the United Kingdom interviewing experts and obtaining depositions from witnesses who were not available to come to New Zealand for the hearing. A total of 15 people were interviewed.

4. I paid a visit to Antarctica over a period of 3 days from 26–29 November 1980. I was accompanied by:

Mr W. D. Baragwanath and Mr G. M. Harrison (Counsel assisting the Commission)

Sir Rochford Hughes (Technical Consultant to Counsel assisting the Commission)

Air Commodore David Crooks (Royal New Zealand Air Force)

Mr R. B. Thomson (Superintendent, Antarctic Division of the New Zealand Department of Scientific and Industrial Research)

Mr J. E. Davies (Director of Administration and General Services for Air New Zealand)

There, I was given the opportunity of inspecting all relevant areas of the terrain, including the crash site on the slopes of Mt. Erebus, and we inspected the radio and radar and air traffic control facilities at McMurdo Sound.

5. Counsel were provided with a written summary of the result of the enquiries made by Mr Baragwanath and myself in our overseas visit, and also in relation to what we observed and were told in Antarctica.

6. I have drafted this report in such a manner as to avoid wherever possible technical terms and technical abbreviations, in the hope that the narrative will be clear to people without technical knowledge of the niceties of aerial navigation and the like. McMurdo time is 12 hours ahead of Greenwich Mean Time and New Zealand daylight time is 13 hours ahead of Greenwich Mean Time. In this report I have used local time, meaning, in that respect, McMurdo time.

7. Where reference is made to the transcript of evidence, as opposed to the written briefs of evidence submitted, then I use the initial "T" with the appropriate page number. Exhibits are indicated by their recorded number.

8. I express my indebtedness to all counsel engaged for the industry and skill with which they dealt with such a variety of evidential and technical disputes, and for the comprehensive clarity of their final submissions.

Letter of Transmittal

To His Excellency, The Honourable Sir David Beattie, G.C.M.G., Q.C., Governor-General and Commander-in-Chief in and over New Zealand:

MAY IT PLEASE YOUR EXCELLENCY,

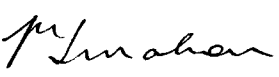
His Excellency the then Governor-General by Warrant dated the 11th day of June 1980 appointed me the undersigned PETER THOMAS MAHON to report upon the terms of reference stated in that Warrant.

I was originally required to present my report to Your Excellency by 31 October 1980 but this date was extended and further extensions to 30 April 1981 were granted.

I now humbly submit my report for Your Excellency's consideration.

Dated at Auckland this 16th day of April 1981.

I have the Honour to be Your Excellency's
Most Obedient Servant.



Royal Commissioner.

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PROLOGUE

1. The Ross Dependency is located in the northern area of the antarctic continent. It comprises that sector which is between 160° east and 150° west longitude, together with the islands lying between those degrees of longitude and south of latitude 60°.

2. Ross Island is located at the point where the Ross Sea meets the permanent Ross ice shelf which extends far away to the south towards the polar region.

3. The south-west corner of Ross Island consists of a long narrow peninsula and at the point where the tip of this peninsula joins the permanent ice shelf there are located two permanent scientific bases. They occupy opposing sides of the tip of the peninsula and are about 2 miles apart.

4. One of these bases is McMurdo Station which is an American scientific base. The other is Scott Base which is the New Zealand Antarctic base of the Department of Scientific and Industrial Research. Each of the bases therefore is used for scientific research. McMurdo Station is serviced by aircraft of the United States Navy, whereas Scott Base is serviced by aircraft of the Royal New Zealand Air Force and the Royal Australian Air Force. There is a landing field located on the ice shelf to the south of the two bases.

5. That stretch of the Ross Sea which lies between Ross Island and the mainland of Antarctica to the west is known as McMurdo Sound. The sea extends as far south as the Ross ice shelf, which is approximately level with the location of McMurdo Station and Scott Base. For most of the year the sea of McMurdo Sound is covered with thick ice. In summer the ice breaks up and this process gradually proceeds far enough south so as to enable ice-breaker ships to penetrate down to the head of the Sound. For a geographical display of this area see fig. 2, pages 6–7.

6. McMurdo Sound is about 40 miles long and is approximately 40 miles wide. At a point about midway down the Sound, with Ross Island to the east and the mainland to the west, the Sound narrows to approximately 32 miles and then almost immediately widens again to its 40-mile width and continues at that approximate width until terminating at the ice shelf. In the month of November the winter ice cover of McMurdo Sound is in the course of being broken up into pack ice and at that time of year the breaking-up process has proceeded as far south as about the entrance to the Sound. Therefore the approach by air to the McMurdo area, flying south from New Zealand in November of any year, will be over the water of the Ross Sea, then over areas of pack ice interlaced with sea water, and then as the approach to the Sound is reached, the aircraft will thereafter be flying down the Sound over solid ice.

7. The ordinary military route used by aircraft of the United States Navy, the Royal Australian Air Force and the Royal New Zealand Air Force proceeds down the centre of McMurdo Sound and then, as the head of the Sound is drawing near, the descending aircraft will turn left so as to line up with its approach across the ice shelf to the landing field. The crew of an aircraft approaching McMurdo Sound from the north will therefore be looking at the scene depicted in photograph fig. 1, at page 2. As the aircraft flies over the Ross Sea, with McMurdo Sound in the distance, the air crew will see on their right the long vista of Victoria Land with its ranges of mountains extending far away to the south beyond the limit of

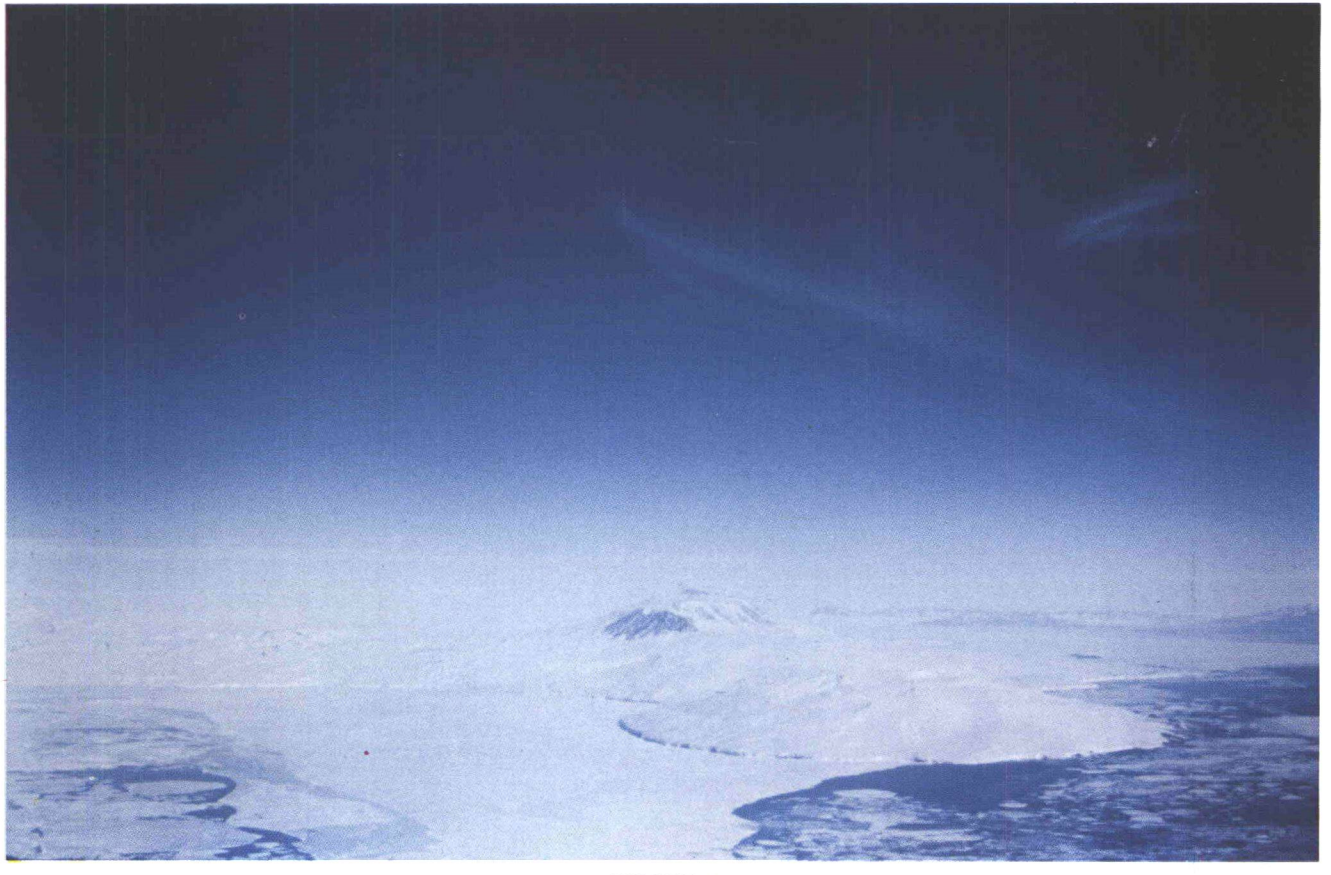


FIGURE 1

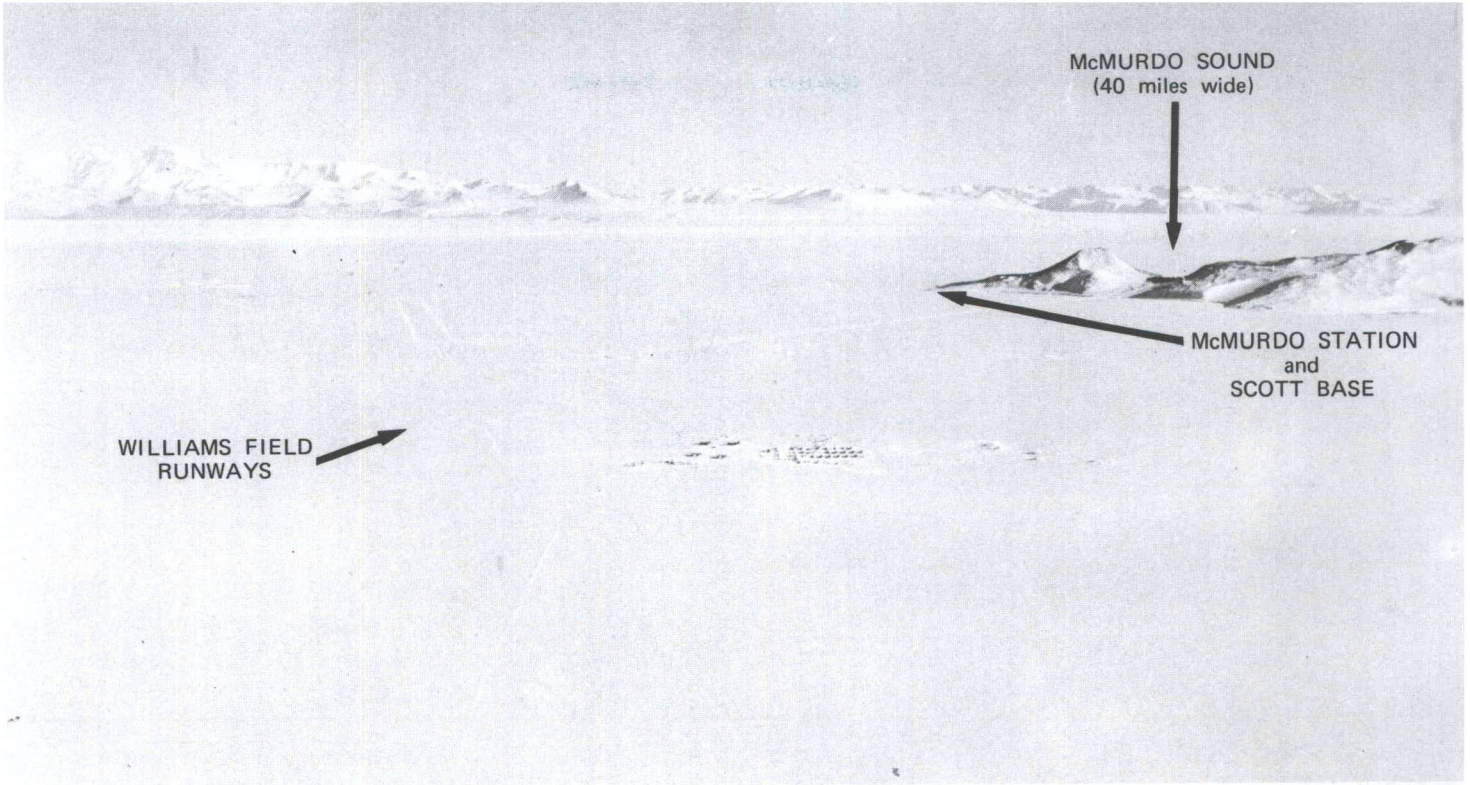

McMURDO SOUND
(40 miles wide)
McMURDO STATION
and
SCOTT BASE
WILLIAMS FIELD
RUNWAYS

FIGURE 1A

human vision. Forward of the aircraft and to the left will be observed the distinctive outlines of Ross Island dominated by Mt. Erebus. This mountain is an active volcano. Rising from the crater, at its peak, there is a permanent long plume of steam. There are three other mountains on the island, but the others do not approach in altitude the 12 450-foot height of Mt. Erebus.

8. As the aircraft enters the Sound, and if one assumes it is flying down the centre of the Sound, the air crew will see on their left the 5380-foot peak of Mt. Bird and that peak will be 22 miles to the left. Then, as the aircraft flies on and reaches a point approximately half way down the Sound, it will find itself abeam of Mt. Erebus, and the peak of that mountain will be 27 miles of the left of the aircraft. During this flight path down McMurdo Sound the mountains of Victoria Land on the right will be between 25 and 30 miles away.

9. There is located at the landing field, operated and maintained by the United States Navy, a radio and radar installation under the command of the United States Navy air traffic controller and his staff. The landing field radar is able to pick up an aircraft on its screen at a range of 40 miles, which means that the radar operator is able to monitor an aircraft as it flies down the Sound and starts its descent towards the landing field. In addition of course, there are radio transmitters at the airfield by which the "Ice Tower" (as this installation is called) can keep in continuous radio contact with the approaching aircraft. The main radio communications centre at McMurdo, however, is contained at McMurdo Station itself. This is known as "Mac Centre" and the operators there can listen to radio communications back and forth from an aircraft and the Ice Tower. They have their own communication with the Ice Tower, and Mac Centre has the ability to communicate by radio with an approaching aircraft. Military air traffic descending to land at Williams Field adopt an instrument approach which will generally commence at the Byrd reporting point, a geographical position (not a landmark) located in the centre of the Sound. This position is situated in the centre of the Sound between Cape Bernacchi and Cape Royds and is 35 miles from the ice runway at Williams Field, which is the approximate location of the Ice Tower. Fig. 1a, page 3, is a photograph of the McMurdo area.

10. As will be apparent from the situation thus generally described, the air traffic in McMurdo Sound is almost entirely limited to American, New Zealand, or Australian military aircraft, and all such aircraft, during the seasons of the year appropriate to such flying, will land at the American landing field. However, as from 1977 the McMurdo area had been visited from time to time in the early and late summer by sightseeing aircraft, operated either by Qantas or by Air New Zealand.

11. The Air New Zealand aircraft, which were DC10 airliners, would fly down to the head of the Sound and normally turn left so as to over-fly the flat ice shelf to the south of McMurdo Station and Scott Base. Such flights were normally at low altitudes so as to afford passengers a clear look at McMurdo Station, Scott Base, the Scott Memorial Hut, and other local features of interest. These aircraft would then come back and fly past Scott Base again, would fly away to the north up McMurdo Sound, parallel with Victoria Land, and then would climb up to cruising altitude and fly back to New Zealand.

12. On the morning of 28 November 1979 the personnel at McMurdo Station and Scott Base were expecting the arrival of an Air New Zealand DC10 aircraft carrying sightseeing passengers. The flight plan radioed to

McMurdo from Auckland had named the pilot in command as Captain Collins. As in the case of previous flights, this aircraft was expected to arrive at about 1 p.m. local time. Mac Centre had been advised of the departure of the DC10 from Christchurch and had obtained radio contact with the aircraft when it was some hundreds of miles away. It was expected that the DC10 would fly down McMurdo Sound approximately along the military air route which I have mentioned. Assuming the pattern of previous Air New Zealand flights to be repeated, the aircraft would come in from the north and in the vicinity of Ross Island would descend to a low level so as to afford the passengers the type of sightseeing to which I have referred. The aircraft would probably fly down the Sound at an altitude of somewhere between 1500 feet and 3000 feet. One thousand five hundred feet is a perfectly safe altitude at which to fly over flat ground in clear weather, and was the cause of no concern to the United States Air Traffic Control. The military responsibility of the radar and radio operators was merely to ensure that the aircraft maintained a course which kept it clear of any helicopters which might be operating in the near neighbourhood. McMurdo Air Traffic Control was also expecting the early arrival of two United States Navy aircraft. One was a C–130 Hercules transport approaching from the south-east which was expected to land on the ice runway at about 1.20 p.m. The other was a United States Air Force C–141 Starlifter jet which was approaching from New Zealand some 50 minutes behind Flight TE 901.

13. On this particular day, therefore, Mac Centre expected the DC10 to arrive in the vicinity of McMurdo Sound some time between 12 noon and 1 p.m. When the DC10 was about 140 miles out from McMurdo, Mac Centre transmitted a weather forecast. This was to the effect that there was a low overcast over Ross Island and the McMurdo area, and that there were a few snow showers but that visibility extended for 40 miles. A little later, the aircraft was informed that there were areas free from cloud over Victoria Land to the west. Mac Centre suggested that once the aircraft was within 40 miles of McMurdo Station, meaning thereby the entrance to McMurdo Sound, it could be picked up by radar and its descent through cloud guided down to an altitude of 1500 feet. This suggestion was accepted by the air crew. At 1500 feet, under the cloud layer in the McMurdo area, visibility would be unlimited in all directions.

14. By 12.32 p.m. the aircraft reported itself to be 43 miles to the north but with a cloud layer below and asked for approval to descend in visual meteorological conditions (VMC) which meant that the pilot expected to find a gap in the cloud through which he proposed to descend, flying visually and not under radar control. At that stage the DC10 was at an altitude of 18 000 feet and Mac Centre approved its descent in VMC conditions.

15. By 12.35 p.m., however, it was confirmed between Mac Centre and the DC10 that the aircraft was now descending to 10 000 feet and was requesting a radar let-down through cloud. This request was accepted by Mac Centre. The position at that point therefore was that the Captain of the DC10 was complying with Mac Centre's original suggestion that he descend with radar assistance through cloud and emerge under the cloud layer where, at 1500 feet, he would have unlimited visibility.

16. At 12.42 p.m. the aircraft informed Mac Centre that it was flying VMC and that it would proceed visually to McMurdo. This message indicated to Mac Centre that the aircraft had found an area free of cloud through which it would descend before levelling out at an altitude less

Mount Woolnough
Mt Gran
2235
Gateway Nunatak
1810±
Mackay Glacier
The Flatiron
Discovery Bluff
Mt England
Cape Roberts
Peatop Mtn
1191 Mt Suess
1090±
Gonville and Caius Range
1540
271
Detour Nunatak
1728
Clare Range
1180±
2229 Robison Pk
Mt Mahony 1870
1343
Dunlap
Mt Dearborn 2300±
Skew Pk 2537
Willett Range
1531
260
Sponsors Pk
1454
St Johns Range
656
Spike
Victoria Valley
Stocettler Ridge
2477
Barwick Val
Apocalypse Peaks
Balham Val
Insel Range
Mt Insel
Mt Doorly
Land aerodrome (no facilities)
Shapeless Mtn 2739
1416
McKelvey Val
1766
Mt Cerberus
277
HUT (NZ)
King Pin 122
816
OLYMPUS RANGE
Mt Aeolus
Wright Valley
MESERVE GLACIER CAMP (US)
759
862
Mt Coleman
Mt Fleming
Dais 905
Hut
ASGARD RANGE
Mt Odin
2255
Mt Thor
1516
Mt Barnes
1882
Taylor Valley
Northwest Mtn
2174
Round Mtn
2308
Hills
LAKE BONNEY HUT
1097
Finger Mtn
Friis Hills
1586
Depot Nunatak
1969
Kukri
Pyramid Mtn
2140±
1490±
Bettle Pk
Taylor Glacier
Ferrar Glacier
Cavendish Rocks
1243
2420
Cathedral Rocks
2700±
Tabular Mtn
New Mtn
Beacon Hts
Mt Crean
Lashly Mts
Knobhead
2600±
1690
2985
Mt Feather
Table Mtn
2170±
2450±
Pivot Pk
Ugolini Pk
ROYAL SOCIETY RANGE
2316
964
The Portal
Mt Lister
59-60
2015
Portal Mtn
2446
3010±
2556
1770
1007
The Spire
Rampart Ridge
1890±
Mt Rücker 3816
1448
555
Angino Buttress
Mt Metschel 1843
Mt Huggins 3733
Stepaside Spur
Mt Kempe
Mount Dromedary
SKELTON NÉVÉ
814
Halfway Nunatak
1061
1450±
Boomerang Range
Warren Range
2541
1180
Mount Morning 2723
Mt Tricouni 1632
Mt Cocks 2438
Clem Nunatak 1260±
Skelton Glacier
Hamner Nunatak 1620±
1050±
1049
144
2035 Escalade Pk
Swartz Nunataks
Mt Harmsworth 2765
Eastface Nunatak
1330
Northcliffe Pk
840
Worcester Range
775
1540 Mt Marvel
Ant Hill 1310±
Crevasses
107
835
Mt Speyer 2428
Shults Pen
Mulock Gl
380±
Fishtail Pt
Cape Timberlake
Teall Island
960

Emperor penguin rookery
Beaufort Island
Paton Pk
Adélie penguin rookery
Cape Bird
CAPE BIRD HUT (NZ)
Adélie penguin rookeries
Romanes Beach
Mt Bird
Lewis Bay
Cape Tennyson
Wood Pt
MC MURDO SOUND
Abbott Pk
MOUNT EREBUS
Cape Royds
SHACKLETON'S HUT (NZ)
Adélie penguin rookeries
ROSS ISLAND
Mount Terra Nova
Mt Terror
Cape Crozier
Butter Pt
CAPE EVANS HUT (US)
Cape Evans
SCOTT'S HUT (NZ)
Dellbridge Islands
Conical Hill
Windless Bight
Terror Pt
Cape MacKay
The Strand Moraines
Turtle Rock
Hut Point Peninsula
Dailey Islands
SCOTT BASE (NZ)
MC MURDO STATION (US)
Seal colonies
Ice aerodrome (with facilities) 1972
Cape Chocolate
Victoria Land Traverse 1958–59, 1959–60
Cape Spencer-Smith
Brown Pen
Mt Heine
Cape Hodgson
White Island
Black Island
Mt Aurora
Mt Nesos
Hahn I
MOUNT DISCOVERY
Minna Saddle
Minna Bluff
Victoria Land Traverse

FIGURE 2

than the cloud base prevailing at McMurdo. Thus the aircraft would be approaching under the cloud layer in clear air, at an altitude of about 2000 feet. Mac Centre replied requesting the aircraft to maintain VMC and to keep them advised as to the altitude of the DC10 as it approached McMurdo, and this message was acknowledged by the aircraft. In addition, Mac Centre requested the aircraft to report by radio when it was 10 miles out from McMurdo.

17. There followed further transmissions between the aircraft and Mac Centre and then at 12.45 p.m. the aircraft advised Mac Centre that it was now flying at 6000 feet in the course of descending to 2000 feet and that it was still flying VMC. This message was acknowledged by Mac Centre. This was the last transmission received from the DC10. The American staff at the Ice Tower therefore expected, within a few minutes, to see the aircraft come into sight as it flew along the Sound under the cloud cover at an altitude of between 2000 feet and 1500 feet.

18. Looking a little to the right of McMurdo Sound an observer on that day at the Ice Tower would note that Mt. Erebus (20 miles distant) was not visible, being surrounded by cloud. Then, looking directly up the Sound, he would observe that the 2000–3000 feet overcast extended from Ross Island over towards the centre of the Sound and some distance beyond. Then looking a little further to his left, he would have an unobstructed view of the mountains of Victoria Land 40 miles away on the far side of the Sound, and he would probably be able to see that there was no cloud at all in that area to the north-west. Therefore, looking generally northwards from the McMurdo airfield the observer could not have failed to see an aircraft approaching him under the cloud base towards McMurdo Station. Within 8 minutes or so from the last transmission it should have come into view. Visibility from the ground was quite clear. Fig. 11, page 103, shows the view looking northwards up McMurdo Sound, and the aircraft would come into view at a point above the horizon to the left of the photograph.

19. The minutes ticked by, and the time soon passed when the DC10 should have been not more than 10 miles away from the head of McMurdo Sound. But it still did not appear. For a short space of time it was assumed by the Ice Tower and by Mac Centre that the aircraft may have diverted over towards Victoria Land to take advantage of the clear skies in that direction. But by about 12.50 p.m. it was realised by the Ice Tower that there had been no radio communication from the aircraft since the transmission 5 minutes earlier when the aircraft had advised that it was descending to 2000 feet flying VMC. It will be recalled that this final message followed a previous notification from the aircraft that it would be flying in towards McMurdo.

20. The radio operators at the Ice Tower and at Mac Centre thereupon initiated a series of radio calls to the aircraft. They called on different frequencies, but there was no reply. Mac Centre radioed local aircraft to attempt to get contact with the DC10, but without success. Thereafter there were further unsuccessful attempts to locate the whereabouts of the aircraft. Neither Mac Centre nor the Ice Tower had any idea where the aircraft had gone. For all they knew, the captain may have changed his mind and flown away to the north west to give the passengers a look at the clear areas of Victoria Land, although the standard practice would have been to notify Mac Centre of that change of plan.

21. By 2 p.m. the aircraft had been silent for nearly an hour and a quarter, whereas accepted procedure required the aircraft to have

reported to Mac Centre at intervals of not less than 30 minutes. Consequently, at 2 p.m., Mac Centre radioed Air New Zealand Headquarters in Auckland, New Zealand, and advised that nothing had been heard from the DC10 for an hour and a half. Mac Centre further advised Air New Zealand Headquarters that it had therefore placed its search and rescue aircraft on stand-by.

22. I will not at this stage describe the hours which then passed with no further communication from the aircraft, and the mounting anxiety at Auckland and at McMurdo, which culminated with the non-arrival of the DC10 in New Zealand at a time by which all its fuel must have been exhausted. The United States Navy sent out aircraft on intensive searches and ultimately, after several hours, the reason for the long radio silence from the aircraft was discovered. A United States Navy aircraft found the wreckage of the DC10 on the northern slopes of Mt. Erebus at a point about 1500 feet above sea level. The aircraft had been carrying 20 crew and 237 passengers. There were no survivors.

23. The time of impact was subsequently ascertained to have been 12.50 p.m. The aircraft therefore crashed 5 minutes after the last radio transmission received by Mac Centre. Whereas Mac Centre had believed the aircraft was flying towards McMurdo down the centre of McMurdo Sound, the DC10 had in fact been flying on a course 27 miles to the east. The captain and co-pilot must also have believed that they were flying down the broad and flat expanse of McMurdo Sound, for otherwise they would not have notified their intention of approaching McMurdo Station at 2000 feet. In addition, the aircraft had informed Mac Centre that it was flying VMC. If that was so, how did the crew fly the aircraft into the side of a 12 450-foot mountain? And how did it come to be flying on a course so far distant from McMurdo Sound?

24. At the early stages of investigation the circumstances of the crash were screened in mystery. It was assumed that the aircraft was flying in cloud. Yet this in itself contained a contradiction, for it could hardly be surmised that Captain Collins, with his wealth of experience, could have been flying in cloud at that altitude, in terrain where mountains were a common feature. In addition the crew had advised that they were flying VMC. Although the state of the weather on the north side of Mt. Erebus was not precisely known, the cloud base to the south and to the west of the mountain was approximately 3000 feet. Therefore it was possible to assume that the cloud base on the northern side of the mountain was at about the same altitude. Seeing that the aircraft struck the mountain at an altitude of approximately 1500 feet, it seemed a possibility that the aircraft might have been flying in clear air. However, weather patterns in Antarctica are notoriously fickle. They change not only from hour to hour but from minute to minute. Perhaps the DC10 had become suddenly enveloped in cloud. And all these factors were compounded by the particular circumstance that no living person had seen the aircraft ever since it left the shores of New Zealand.

25. In New Zealand, the crash of the DC10 had been notified to the Chief Inspector of Air Accidents. On 29 November he arrived at Antarctica with a party of other personnel. He went to the crash site by helicopter as soon as weather conditions permitted. The first priority of the Chief Inspector on the crash site was to locate two instruments which were vital if the last course of the aircraft was to be ascertained. The first of these was the digital flight data recorder (DFDR) colloquially known as the "black box". The second was the cockpit voice recorder (CVR). With

the recovery of this equipment the hidden facts of the final stages of the flight might be wholly revealed. The black box would reproduce every detail of the aircraft's course, speed, altitude, and the manipulation of its controls throughout the whole of its journey. The CVR would contain a recording of all that had been said on the flight deck for the last 30 minutes of the flight.

26. Both these vital pieces of equipment were very quickly recovered. They were undamaged. They were flown to New Zealand and immediate steps were taken to transcribe their contents. The tapes of the cockpit voice recorder were played back in New Zealand before being sent to the United States for transcription. The black box, however, had to be sent to the United States so that the details from its computer programming could be printed out.

27. But there was present on the site of the crash a further source of information, which was almost as important as the CVR and the black box. This being a sight-seeing flight, almost all the passengers had cameras. Scores of damaged cameras were recovered from the vast expanse of debris in the snow. But in many cameras, the exposed film was intact. The film was developed at McMurdo Station and some hundreds of prints became available. The quality of the prints was not always good but on the whole they were quite clear. A pictorial record was thus obtained of the progress of the aircraft for some hundreds of miles before it collided with Mt. Erebus. Prints were developed of film which had been exposed by cameras only seconds before the crash. There was even the film of a movie camera which had been running at the moment of impact. The films showed scenes to the east, to the west, and to the north. There were no prints which showed any views to the south, this being the direction of travel of the aircraft.

28. The riddle of the weather was by this means resolved. It was apparent that the aircraft, at the time when it struck the mountain, had been flying in clear air. Photographs taken within seconds of impact removed all doubt. The "flying in cloud" theory disappeared. The view to the left and to the right of the aircraft, just before impact, was clear for many miles. To the left, clearly visible under low cloud, was the thin strip of black rock indicating the shoreline of Cape Tennyson about 13 miles away. To the right, also clearly visible under cloud, was the strip of black rock and the lower slopes of Cape Bird, indicating its shoreline about 10 miles away. It therefore followed that as the aircraft had approached Mt. Erebus it was flying in skies in which there was perfectly clear visibility for at least 23 miles. It was also apparent that the aircraft had been flying well under the cloud base when it collided with the mountain.

29. It was realised that the crew could not have recognised the distant shorelines as being Cape Tennyson and Cape Bird, for this would have told them that they were in Lewis Bay, heading directly towards Mt. Erebus. The simple explanation was that the two shorelines had been identified as Cape Royds and Cape Bernacchi. (See fig. 2, pages 6–7.) For the purpose of illustrating the very different visual appearance of the McMurdo area as opposed to the map depicted in fig. 2, reference should again be made to the photographs of the approach to McMurdo reproduced as fig. 1, page 2 and of McMurdo itself fig. 1a, page 3.

30. Within a period of days the black box was deciphered in the United States. It was found that at the time of impact the DC10 had been flying on a level and straight course and at a speed of 260 knots. The CVR tapes then provided an item of information which was entirely unexpected. On

the flight-deck there had been Captain Collins and his co-pilot, First Officer Cassin, two flight engineers, and Mr Peter Mulgrew, an experienced antarctic explorer who was the official commentator for the flight. It was clear from listening to the tapes of the CVR that not one of these five people on the flight deck had ever seen the mountain before the impact. Not a word had been said by anyone to indicate that the mountain slope was in sight. Not even in the last 2 or 3 seconds. It was clear, therefore, that the aircraft had flown on a straight and level flight at 260 knots into the mountain side in clear air, and that not one of the persons on the flight deck had seen the mountain at any juncture.

31. The most vital information retrieved from the black box was that which related to the flight path of the aircraft during its journey over the Ross Sea towards Ross Island. It is necessary, in order to make this information intelligible, to enter into a brief description of the navigation techniques used in modern aircraft of this type. Large jet airliners are navigated in these days upon a computer system. The system is technically known as the Inertial Navigation System (INS). The way in which the system operates can be explained by reference to the flight under discussion. When an aircraft is flying from one destination to another it proceeds to that destination by a series of waypoints. Each waypoint is geographically determined by its latitude and longitude. In the present case the flight started at Auckland and the next waypoint was a specific number of miles further on, and the next waypoint a similar distance further on, and this pattern was repeated until the last waypoint was reached. The second to last waypoint was Cape Hallett situated 337 miles to the approximate north of McMurdo Station. The inertial navigation system operates by typing into a computer system on the aircraft the latitude and longitude of each waypoint, and the final waypoint is of course the destination waypoint which in this case was in the McMurdo area. Once this series of co-ordinates has been fed into the aircraft's computer, the aircraft will then fly its own course from one waypoint to another. In order for the aircraft to follow this programmed flight path the navigation system must be switched into what is called the "Nav mode". The aircraft, as already stated, will then fly from one waypoint to another and if there is a change of heading or direction from one waypoint to another the aircraft will automatically turn of its own accord and follow the programmed flight path. This flight path is known as the "nav track". A pilot may, if he wishes, disengage the nav track and navigate the aircraft himself on a different course, and then if so desired he can switch the navigation equipment back again into the nav mode and, providing that sundry procedures are followed, the aircraft will lock itself back on to the nav track.

32. In the present case the black box showed that the aircraft had flown on nav track from Cape Hallett for almost the whole distance down to the point of impact. The only exception had been at a point about 40 miles from McMurdo when the aircraft had made two descending orbits. Captain Collins, in order to take advantage of a very wide cloud-break, had disengaged the nav mode of the aircraft and had himself navigated the aircraft downwards in two descending orbits. By adopting this procedure he had been able to descend from 17 000 feet to 3000 feet whilst still maintaining the same distance out from his final waypoint, namely a distance of approximately 34 miles. But once the second orbit was in the course of completion, and the aircraft was again heading in a general southerly direction, Captain Collins had "armed" the nav mode once

more. The aircraft had then, in obedience to this system of control, intercepted and locked itself back on to the nav track, and had then maintained the nav track until the point of impact.

33. The INS system of navigation is accurate to an almost incredible degree. For example, on a flight from Auckland to Honolulu, occupying a time of about 8 hours, the aircraft will be found, on destination, to be not more than a mile, if that, left or right of the track which was programmed into its computer. This is the reason why modern aircraft with this equipment no longer carry navigators as members of the flight crew. No navigator is necessary. The aircraft navigates itself and with a degree of accuracy which a human navigator could seldom hope to attain. This being the case, then the question immediately arose as to why Captain Collins had been careful to lock the aircraft back on to its nav track after completion of the second orbit when he was about 34 miles out from McMurdo. I should here make it clear that included in the navigation system of the aircraft is a print-out which tells the crew, at any given time, how far away the aircraft is from the next waypoint. Accordingly, by looking at the print-out in front of him the captain, and the co-pilot as well, could see at any moment exactly how far the aircraft was from the destination co-ordinates. This is why, in the radio transmissions earlier referred to, the aircraft was able to advise its exact distance from the McMurdo area.

34. As I have indicated already, the question arose as to why Captain Collins had re-armed the nav mode after completion of the second orbit. It was clear, beyond doubt, that he had been mistaken as to where the nav track would lead the aircraft. So here was another riddle which required solution. Why were the two pilots unaware that the nav track would guide the DC10 directly at Mt. Erebus? But as inquiries developed, the answer became readily available. Indeed, the answer had been known to the Flight Operations Division of the airline very shortly after the occurrence of the disaster had been notified. The solution to the riddle was remarkable in the extreme.

35. Nineteen days before this flight of 28 November 1979, Captain Collins and First Officer Cassin had attended an antarctic briefing by one of the airline's briefing officers. This briefing, attended also by another crew, was in respect of two impending flights to Antarctica. At this briefing there was produced a quantity of documents. Included among them were print-outs of the flight plan which had been used by the sight-seeing flight which had gone to Antarctica immediately prior to this briefing. The flight plan had contained, as is customary, a list of the co-ordinates starting at Auckland, proceeding down to McMurdo, and then proceeding back to Auckland. The pilots were aware that these co-ordinates would be standard, and would be present on any antarctic flight plan extracted from the airline ground computer. The co-ordinates printed for the McMurdo destination waypoint were 164 degrees 48 minutes east and 77 degrees 53 minutes south.

36. It became clear, as a result of the hearings before the Commission, that Captain Collins had noted down these co-ordinates, and further, that on the night before the departure of flight TE 901 for Antarctica he had plotted on an atlas which he owned, and in all probability on a map which he had procured, the actual track from Cape Hallett to McMurdo as revealed by the co-ordinates which he had noted from the briefing. That track clearly showed that the aircraft, when flying on nav track, would take it down the approximate centre of McMurdo Sound towards the final

waypoint near the Dailey Islands. When, therefore, the flight crew assembled on the morning of the flight and were handed the flight plan for 28 November 1979 extracted from the ground computer earlier in the morning, and when the flight crew inserted into the computer on the aircraft the series of latitude and longitude co-ordinates on that flight plan they believed, in accordance with ordinary and standard practice, that they were inserting the long-standing co-ordinates always used for flights to Antarctica, and which they had seen at the briefing 19 days before. But, unknown to them, there had been an alteration to the McMurdo co-ordinates. This alteration had been made by entering into the ground computer a different set of figures for the final waypoint. The figures which were changed were in respect of the longitude of the McMurdo waypoint. The longitude was changed from 164 degrees 48 minutes east to 166 degrees 58 minutes east. This had the effect of moving the destination waypoint 27 miles to the east. Instead of the flight path taking the aircraft down the centre of McMurdo Sound, it would now take the aircraft on a course directly towards Ross Island, and indeed, it would lead the aircraft into direct collision with Mt. Erebus so long as the aircraft was flown at any altitude less than 12 000 feet.

37. The astonishing fact was then revealed that the flight crew were not told that the destination co-ordinates had been changed. The ground computer co-ordinates had been altered in the manner which I have described at about 1.40 a.m. on 28 November 1979. The aircraft left at about 8 a.m. with the altered co-ordinates entered into the navigation system of the aircraft. No one in the flight crew noticed that two digits had been altered among the mass of digits which represented the flight path to McMurdo and back. The decision of Captain Collins to maintain his nav track on the approach to McMurdo was therefore explained. He believed that so long as he held the aircraft in the nav mode it would fly, without any error or deviation, along the computer track down the centre of the Sound. Unknown to him, however, the flight path had been switched to a course which now placed it on a collision course with the mountain. The omission to notify the flight crew of the change in the computer track was, of course, an appalling error. It was the originating and dominating factor behind the disaster.

38. At the briefing session attended by Captain Collins and First Officer Cassin, and by three other pilots who were also to conduct an antarctic flight that month, there had not been produced any topographical map on which the nav track had been charted. It so happened that when Captain Collins and his co-pilot and the flight engineers received their pre-flight briefing from the flight despatch officer on the morning of 28 November 1979, they were also not provided with a topographical map showing the line of the nav track. I think it a clear inference that Captain Collins, from discussions with previous flight crews, was aware that he would not be provided with such a map as part of his flight documents. So what he did, therefore, was to procure a topographical map of his own and to plot on this map, and also upon his atlas, the path which the aircraft would take when flying on its computer track.

39. Captain Collins is dead. His own account of what he had done can never be told. But there was evidence adduced before the Commission which made it certain that on the night of 27 November he had plotted the flight path from Cape Hallett to McMurdo, using the destination co-ordinates which he had noted 18 days before. But apart from that, there was the incontrovertible evidence that as the aircraft levelled out on its

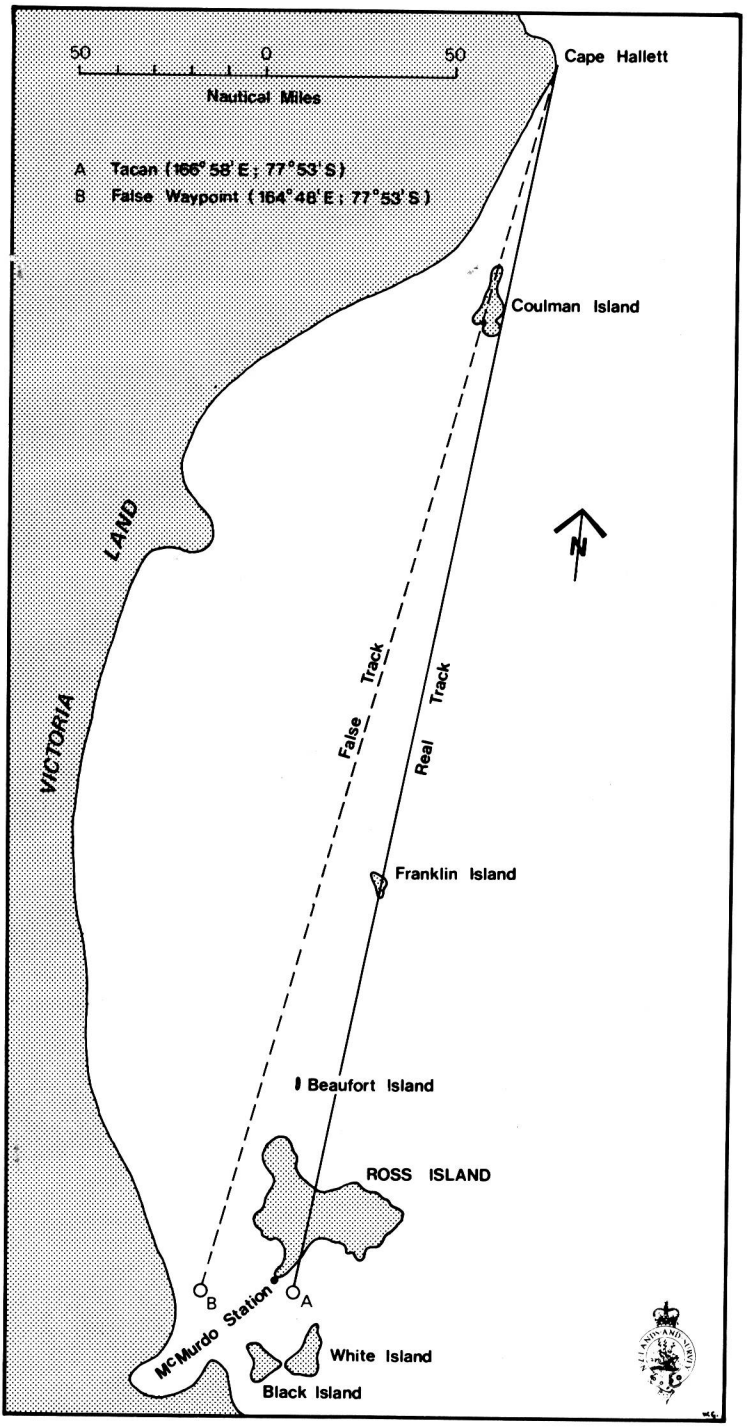

50
0
50
Nautical Miles
A Tacan (166° 58' E; 77° 53' S)
B False Waypoint (164° 48' E; 77° 53' S)
Cape Hallett
Coulman Island
VICTORIA LAND
N
False Track
Real Track
Franklin Island
Beaufort Island
ROSS ISLAND
B
A
McMurdo Station
White Island
Black Island

FIGURE 3

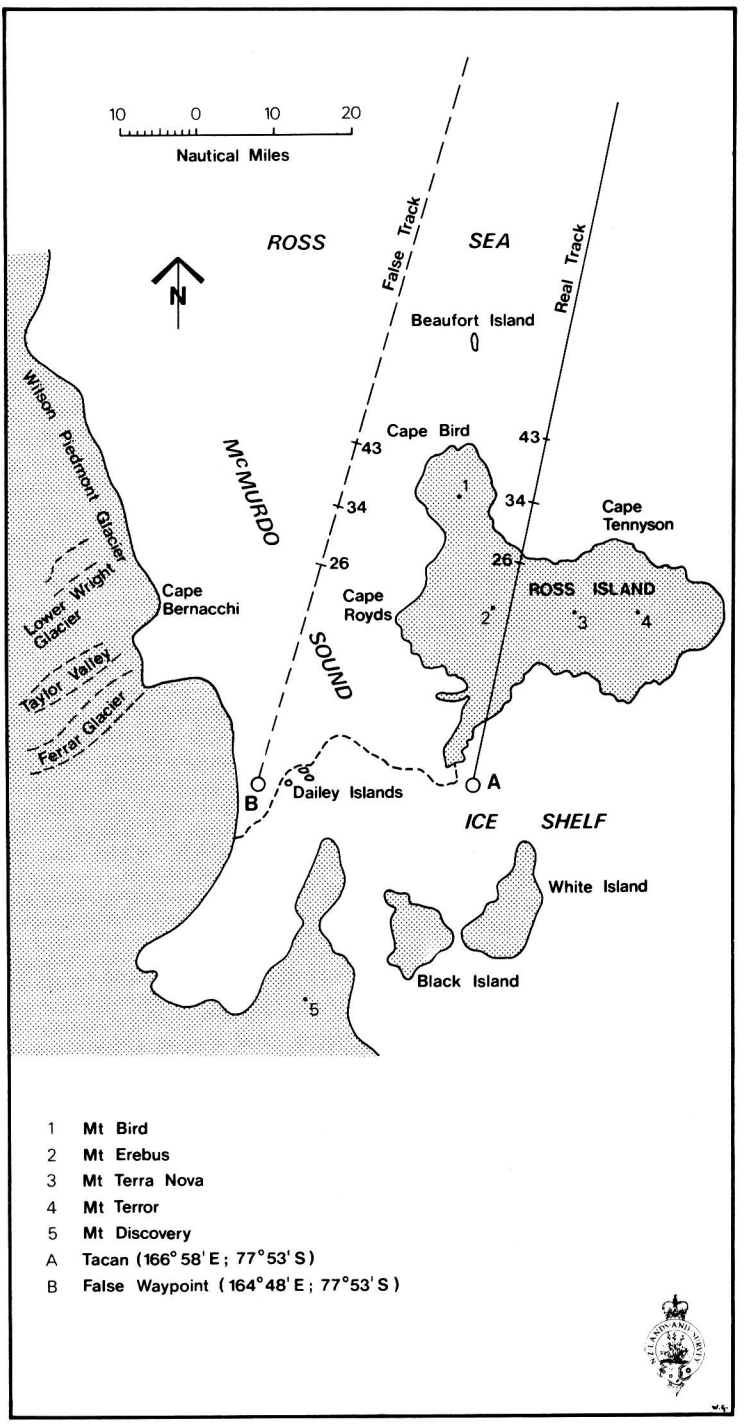

10 0 10 20
Nautical Miles
ROSS SEA
False Track
Real Track
Beaufort Island
N
Wilson Piedmont Glacier
Lower Wright Glacier
Taylor Valley
Ferrar Glacier
Cape Bernacchi
McMURDO SOUND
Cape Bird
43
34
26
Cape Royds
Cape Tennyson
ROSS ISLAND
1
2
3
4
5
A
B
Dailey Islands
ICE SHELF
White Island
Black Island
1 Mt Bird
2 Mt Erebus
3 Mt Terra Nova
4 Mt Terror
5 Mt Discovery
A Tacan (166° 58' E ; 77° 53' S)
B False Waypoint (164° 48' E ; 77° 53' S)

FIGURE 4

final approach to the mountain, Captain Collins had been careful to arm the nav track. He could not possibly have done this unless he was certain as to where the nav track would lead him, and he must therefore have been quite satisfied that the nav track would take him down the centre of McMurdo Sound, with flat terrain extending for many miles both to the left and right and ahead. How could he have been certain of this? He could only have been certain because he had himself plotted the nav track of the aircraft from Cape Hallett down McMurdo Sound to the destination point near the Dailey Islands. Reference should now be made to figs. 3, 4 (pages 14–15). The track plotted by Captain Collins is shown as the "false" track. The other track is the actual nav track about which he had not been told. The figures on each track denotes the miles to run.

40. At this stage I will pause to tabulate the four principal factual aspects of the last stages of the flight which were revealed by examination of the cockpit voice recorder, the black box, and the passengers' photographs, and which were supplemented to some extent by additional evidential inquiries. I shall also state my opinion—which will be expressed in detail hereafter—as to the causative effect of each of these four factors in relation to the occurrence of the disaster. I have adopted this course with the intention that anyone reading this prologue will be able to see in advance what I considered to be, at the close of the evidence, the points which really mattered, and the conclusions which I eventually reached on these material issues. Such a proceeding will serve to place in perspective, I hope, the variety of contentious hypothetical issues to which these major factors gave rise as the hearing proceeded. I shall now describe, and indicate my opinion of, those four major factors.

(a) *The failure of the air crew to see the mountain:*

I have already made it clear that the aircraft struck the lower slopes of Mt. Erebus whilst flying in clear air. The DC10 was at the time flying under a total cloud cover which extended forward until it met the mountain-side at an altitude of somewhere between 2000 and 2500 feet. The position of the sun at the time of impact was directly behind the aircraft, being in a position approximately to the true north of the mountain and shining at an inclination of 34°. The co-existence of these factors produced without doubt the classic "whiteout" phenomenon which occurs from time to time in polar regions, or in any terrain totally covered by snow. Very extensive evidence was received by the Commission as to the occurrence and the consequences of this weather phenomenon. So long as the view ahead from the flight deck of an aircraft flying over snow under a solid overcast does not exhibit any rock, or tree, or other landmark which can offer a guide as to sloping or uneven ground, then the snow-covered terrain ahead of the aircraft will invariably appear to be flat. Slopes and ridges will disappear. The line of vision from the flight deck towards the horizon (if there is one) will actually portray a white even expanse which is uniformly level.

What this air crew saw ahead of them as the aircraft levelled out at 3000 feet and then later at 1500 feet was a long vista of flat snow-covered terrain, extending ahead for miles. Similarly, the roof of the solid overcast extended forward for miles. In the far distance the flat white terrain would either have appeared to have reached the horizon many miles away or, more probably, merged imperceptibly with the overhead cloud thus producing no horizon

at all. What the crew could see, therefore, was what appeared to be the distant stretch of flat white ground representing the flat long corridor of McMurdo Sound. In reality the flat ground ahead proceeded for only about 6 miles before it intercepted the low ice cliff which marked the commencement of the icy slope leading upwards to the mountain, and at that point the uniform white surface of the mountain slope proceeded upwards, first at an angle of 13°, and then with a gradually increasing upward angle as it merged with the ceiling of the cloud overhead. The only feature of the forward terrain which was not totally white consisted of two small and shallow strips of black rock at the very bottom of the ice cliff, and these could probably not be seen from the flight deck seats owing to the nose-up attitude of 5° at which the aircraft was travelling, or they were mistaken for thin strips of sea previously observed by the crew as separating blocks of pack ice.

The aircraft had thus encountered, at a fateful coincidence in time, the insidious and unidentifiable terrain deception of a classic whiteout situation. They had encountered that type of visual illusion which makes rising white plateaux appear perfectly flat. This freak of polar weather is known and feared by every polar flier. In some Arctic regions in the Canadian and in the north European winter, it is responsible for numbers of light aircraft crashes every year. Aircraft fly, in clear air, directly into hills and mountains. But neither Captain Collins nor First Officer Cassin had ever flown at low altitude in polar regions before. Even Mr Mulgrew, with his antarctic experience, was completely deceived. The fact that not one of the five persons on the flight deck ever identified the rising terrain confirms the totality of this weird and dangerous ocular illusion as it existed on the approach to Mt. Erebus at 12.50 p.m. on 28 November 1979.

(b) *The low altitude of the aircraft:*

As stated already, it is beyond dispute that there is no danger in flying at 1500 feet over any flat terrain in clear weather. That altitude is in fact far higher than the minimum safe altitude prescribed for aircraft flights by regulation 38 of the Civil Aviation Regulations. But it happened that when the Civil Aviation Division of the New Zealand Ministry of Transport had approved these antarctic flights early in 1977, they had prescribed special minimum safe altitudes. The minimum safe altitude on the approach to Ross Island had been set at 16 000 feet and there was a permitted descent of 6000 feet to the south of Ross Island so as to permit sightseeing. This 6000 permission was confined to a special limited sector over the Ross ice shelf to the south of Ross Island.

But as inquiries eventually established, these limits, which may or may not have been observed by the airline for the initial two flights in February 1977, had not been observed at any time thereafter. In truth, the minimum safe altitude so prescribed by the Civil Aviation Division may have been quite satisfactory as part of an initial flight plan to be used for planning purposes on the first flight. But such minimum safe altitudes of 16 000 feet and 6000 feet, insofar as they were supposed to apply to all Antarctica flights, were misconceived. They had no relation whatever to the

realities of sightseeing flights in Antarctica. They continued to be the officially approved levels as between the Civil Aviation Division and the airline from February 1977 right through to the date of the disaster. But in practice the airline disregarded those minimum altitudes, and in my opinion were justified in doing so.

Captains of antarctic flights were specifically briefed in 1978 and in 1979 that they were authorised to descend in the McMurdo area to any flight level authorised and approved by the United States air traffic controller. When Captain Collins accepted the invitation from the United States air traffic controller to descend to 1500 feet where he would find himself in clear air, and with unlimited visibility, he was acting in compliance with authority directly given to him by the airline's briefing officer, and under conditions approved by the United States air traffic controller. The proposed over-flight of McMurdo Sound in the areas specified by the air traffic controller was at a perfectly safe altitude. Contrary to what I think has been a public misconception over this altitude question, there was at no time on 28 November 1979 any unauthorised "low flying" by the crew of TE 901.

(c) *Whether the air crew was "uncertain" as to its position:*

As will later be explained, the statutory written report of the chief inspector, when ultimately signed, indicated his opinion that the air crew was not certain of its position. This view was largely based upon fragments of conversation which took place between various people located on the flight deck behind the two pilots. The CVR picked up numerous items of cross-talk and words and phrases of people who were to a large extent not identified. There were quite clearly occasional comments and opinions as to where Mt. Erebus was. There were also two specific comments which received very considerable publicity when the transcript of the CVR was made public as part of the chief inspector's report. These two pieces of transcript are "bit thick here eh Bert?" and "You're really a long while on . . . instruments at this time are you".

These two apparent references to the weather being "thick" and to flying on "instruments" undoubtedly had a very strong influence on public opinion. They suggested that the aircraft was flying in bad visibility. But it is now clear that neither of these remarks, as set out in the transcript, was in fact made. There was no one on the flight deck called "Bert". The word "thick" was not used. The word "instruments" was certainly used but not in the context which the quoted passage suggests. Other phrases and words picked up from this very bad quality tape uttered by people (mainly unidentified) from the flight deck area behind the pilots are similarly suspect. I shall recount in due course the reasons why I have been obliged to come to these conclusions.

By contrast, because of the wiring system used in the CVR, everything said by Captain Collins and First Officer Cassin is clear and distinct on the CVR tapes. And when their conversations are heard, or read in the printed transcript, it is found that neither of them ever expressed the slightest doubt as to where the aircraft was. As stated previously, Captain Collins had been careful to chart on his own maps the exact flight path upon

which the nav track would take him. The navigation display panel on the flight deck told the two pilots at all times exactly how many miles remained before the final waypoint was reached. In order to ascertain the aircraft's position, it was only necessary to put a pencil on the plotted flight track at the point where the distance to run coincided with the distance to run as recorded by the computer print-out. The aircraft's position could thus be exactly ascertained. Given the plotted flight path and the navigation print-out, a schoolboy could have fixed without difficulty the exact position of the aircraft at any moment. The idea that the two pilots were at any time uncertain of the aircraft's position is wholly untenable.

In addition, not one word was ever addressed by either of the flight engineers to the pilots indicating any doubt as to the aircraft's position and as a matter of standard practice it was, of course, the responsibility and duty of the flight engineer sitting just behind the two captains to indicate immediately any doubt he might have as to the aircraft's position. And what is even more significant is the very clear belief of First Officer Cassin, held independently of Captain Collins, that the position of the DC10, and its course, were exactly known.

(d) *The changing of the co-ordinates on the morning of the flight was the dominant cause of the disaster:*

I have already expressed that opinion. It will be explained hereafter in further detail. The changing of these co-ordinates and the failure to notify the air crew of TE 901 represented a systems breakdown within Flight Operations Division, and accordingly was directly traceable to unco-ordination and inefficiency in this branch of the airline's organisation.

Counsel assisting the Commission, Mr W. D. Baragwanath and Mr G. M. Harrison, were obliged, in the exercise of their duties, to adopt a strictly neutral stand as between all parties, and to subject all the evidence to a rigorous and objective survey. Here is what Mr Baragwanath said in the opening stages of his final submissions:

> "Much publicity attending this accident prior to the Commission hearing suggested that the cause was simply one of pilot error. It is now clear that this conclusion substantially is wrong."

With those comments I entirely agree. Mr Baragwanath went on later to say:

> "While the accident had no single cause, the series of factors giving rise to the accident are overwhelmingly due to the absence of an adequate company organisation."

Again, I entirely agree. The evidence on this point is conclusive.

41. Having thus expressed my opinion on these four essential factual components of the series of events which led to the disaster, I will now proceed to describe, in the course of concluding this prologue, what happened at the airline headquarters at Auckland when the occurrence of the disaster became first suspected and then known.

42. As already stated, it transpired at the hearings before the Commission that the alteration of the co-ordinates had been discovered by the Flight Operations Division on the night of the tragedy. Once the

aircraft was known to be overdue there had been extracted from the ground computer at Auckland not only the print-out of the flight plan for the flight of 28 November 1979, but also a print-out of the flight plan used at the briefing of Captain Collins and First Officer Cassin 19 days previously. The Navigation Section became immediately aware that the flight path had been moved 27 miles to the east and thereafter lay on a collision course with Mt. Erebus. Flight Operations also became aware, on the same night, that the change in the co-ordinates had not been revealed to Captain Collins and his crew.

43. When the crash site was at last located by the searching United States Navy aircraft, the Americans immediately radioed to the airline in Auckland the co-ordinates of the crash site. Those co-ordinates were 77 degrees 25 minutes 30 seconds south, and 167 degrees 27 minutes 30 seconds east. This news came through in the early hours of the morning. The officials of the Navigation Section had only to check the crash site co-ordinates with the map to find that the aircraft had collided with the mountain on a course which corresponded with its programmed nav track. It did not take too much imagination to realise what had happened. The aircraft had been flying on nav track when it struck the mountain. It necessarily followed that the crew had been misled by the incorrect co-ordinates with which they had been provided at the briefing 19 days before. This conclusion was reinforced the next day when the stricken Mrs Collins was visited by various airline personnel. She could not understand how the aircraft had been on a wrong course because, as she told the airline personnel, her husband on the previous night had been working on a map and on his atlas with a ruler and with his plotting instruments.

44. By 30 November the occurrence of this mistake over the co-ordinates was known not only to the Flight Operations Division but also to the management of the airline, and in particular, had been reported to the Chief Executive of Air New Zealand, Mr M. R. Davis. The chief executive saw at once what would happen if the story of the changed co-ordinates became public. Within a day or two that story would be carried by the world's newspapers, and indeed it would be a dramatic tale. The flight path of the DC10 to be programmed into the aircraft's computer navigation equipment had first been notified to the air crew as taking the aircraft in safety down the wide flat expanse of McMurdo Sound. Then, only 6 hours before the aircraft departed, the destination co-ordinates had been changed, and the flight plan produced to the air crew on the morning of the flight now contained an altered figure which set the aircraft, unknown to the crew, upon a collision course with Mt. Erebus. A computer mistake had sent 257 people to a violent death on the distant frozen wasteland of Antarctica. Such would be the emotive content of news media headlines throughout the world. This might be the worst publicity to which any airline had ever been exposed.

45. The reaction of the chief executive was immediate. He determined that no word of this incredible blunder was to become publicly known. He directed that all documents relating to antarctic flights, and to this flight in particular, were to be collected and impounded. They were all to be put on one single file which would remain in strict custody. Of these documents all those which were not directly relevant were to be destroyed. They were to be put forthwith through the company's shredder.

46. The chief executive explained in his evidence before the Commission this extraordinary decision. He contended that his instructions were that only copies of existing documents were to be

destroyed. He said that he did not want any surplus document to remain at large in case its contents were released to the news media by some employee of the airline. The chief executive insisted that his instructions were that all documents of relevance were to be retained on the single file. He denied any sinister intent in ordering the destruction of documents.

47. These explanations were treated with scepticism, if not disbelief, by counsel for the New Zealand Air Line Pilots' Association (ALPA) and also by other counsel present at the Inquiry. They contended that there was another explanation. They suggested that it was the intention of the chief executive, at that early stage, permanently to conceal the story of the changed co-ordinates. I shall consider the chief executive's explanation later in this report. But it may be relevant at this stage to say that on 1 January 1980 there appeared a report in the *Auckland Star* to the effect that the destination co-ordinates had been changed without reference to the air crew, and it was contended that this was the main cause of the disaster. The chief executive issued an immediate public denial. He asserted that when the aircraft left Auckland the correct co-ordinates had been inserted into the computer system of the aircraft. This in fact was true. But the chief executive did not divulge the further fact that these co-ordinates had been changed at the last minute without the air crew having been told.

48. As I have said, the circumstances of the changed co-ordinates had been known to the senior officers of the Flight Operations Division, to the officials of the Navigation Section, and to the Flight Despatch Section ever since the night of the disaster. In addition, they had all been aware that the flight crew had not been told of this fundamental alteration in the flight path of the aircraft. It was inevitable that these facts would become known. Perhaps the chief executive had only decided to prevent adverse publicity in the meantime, knowing that the mistake over the co-ordinates must in the end be discovered. He believed, as did everyone at the time at Air New Zealand headquarters in Auckland, that the aircraft had been flying in cloud. The chief executive was anxious to avoid, no doubt, early and adverse publicity which would place prime responsibility for the disaster upon the airline's management procedures. He maintained the view that the mistake was not an operative factor, and that total culpability remained with the flight crew. This indeed was the case for the airline as presented before the Commission. It was based upon the proposition that the mistake over the co-ordinates had no significance. This silence over the changing of the co-ordinates and the failure to tell the air crew was a strategy which succeeded to a very considerable degree. The chief inspector discovered these facts after he had returned from Antarctica on or about 11 December 1979. In his report, which was published in June 1980, the chief inspector referred to what he termed the "error" in the McMurdo destination point, and the fact that it had been corrected a matter of hours before the flight left Auckland. Then the chief inspector went on to say in his report (paragraph 2.5):

> "The error had been discovered two flights earlier but neither crew of the previous flight or that of the accident flight were advised of the error by the flight despatcher prior to their departure."

The chief inspector did not make it clear, however, that the computer flight path of TE 901 had been altered before the flight, and that the alteration had not been notified to the air crew. Had that fact been disclosed in the chief inspector's report then the publicity attending the report would undoubtedly have been differently aligned. Instead of

newspaper headlines featuring only allegations of pilot error, the headlines might well have been dominated by the disclosure that the aircraft had been programmed to fly on a collision course with Mt. Erebus, and that the crew had not been told of the change. As will be seen, the news blackout imposed by the chief executive was very successful. It was not until the hearings of this Commission that the real magnitude of the mistake made by Flight Operations was publicly revealed.

49. A number of reasons were advanced for this latter contention. At this stage I will only refer to some of them. It was contended that there was "no evidence" that Captain Collins had in fact been misled by the altered co-ordinates. Alternatively, if he had, then he should have observed the error during the course of the flight between Auckland and Antarctica. A number of ingenious theories were advanced as to how Captain Collins or First Officer Cassin might have detected the error. A number of these suggestions were made not only by officials of the Navigation Section but also by those operational pilots who held executive positions in the airline and whom I will describe hereafter as "executive pilots". Being part of the airline's management, they gave evidence in support of the airline's case.

50. The operational pilots who did not hold executive positions, and whose evidence was led by counsel for the Air Line Pilots' Association, took the contrary view. They asserted that as a matter of ordinary practice the air crew was entitled to rely upon the flight path printed out from the ground computer because, in terms of airline routine, these would be standard co-ordinates in use for a very long time and printed into every antarctic computer flight plan during 1978 and 1979. Any change in a standard flight route was automatically notified to every flight crew. Consequently, on their view of the matter, the crew of TE 901 would be entitled to assume without further inquiry that the standard co-ordinates printed on to their flight plan from the ground computer were correct in every particular and were identical with the co-ordinates for previous flights.

51. So in the end the situation before the Commission developed into something like a union confrontation. The tactics of the management were to nullify, if they could, the effect of the altered co-ordinates as being a factor in the disaster. Consequently the conduct of the dead captain and his crew was attacked on every conceivable ground. The ALPA witnesses, in their turn, defended the dead air crew and would not accept that Captain Collins or his crew had committed any error. In this atmosphere, the disappearance through the company's shredder of unknown numbers of documents was a matter to which I was required to give very careful consideration. The chief executive had directed the appointment of an "Investigation Committee" comprised of airline officials who were charged with the responsibility of assembling all the relevant documents and they did this by impounding files held by route briefing officers and by the Navigation Section. The airline's safety officer, Mr Oldfield, was charged with the responsibility of arranging for the destruction of what were described as "surplus copies" of the documents placed upon the single file assembled by the commitee. The instructions given by the chief executive with regard to destruction of documents were verbal. The instructions given by the committee to Mr Oldfield (if there were any) were also verbal. The instructions given by the committee to those sections of Flight Operations Division which held Antarctica documents

were also verbal. There was not a single memorandum produced to me which described any of these instructions and the way in which they were carried out.

52. As will be explained later, there was at least one group of documents which certainly were in the possession of the airline as from the day following the disaster, and which have never been seen since. I am referring here to the flight briefing documents of First Officer Cassin. Whereas Captain Collins and First Officer Lucas (who was to fly as a spare pilot) brought their briefing documents to the airport on the morning of the flight and took the documents with them on the aircraft, it is known by the evidence of the flight despatch officer (at T 1143) that First Officer Cassin had left his briefing documents at home. They were recovered from his home on the day after the disaster by an employee of the airline. As I say, they have never been seen since.

53. If the explanation of the chief executive is to be accepted, then in the opinion of someone the briefing documents of First Officer Cassin, the co-pilot, were thought to be irrelevant to the disaster. That view would certainly not have been shared by the chief inspector, nor is it shared by me. Seeing that the vital question was the extent to which the flight crew had relied upon the original co-ordinates produced at the briefing, it would be of prime importance to see what briefing documents had been in the possession of First Officer Cassin, and what notes he had made in relation to those documents, whether on the documents themselves or whether in the form of separate memoranda.

54. This was at the time the fourth worst disaster in aviation history, and it follows that this direction on the part of the chief executive for the destruction of "irrelevant documents" was one of the most remarkable executive decisions ever to have been made in the corporate affairs of a large New Zealand company. There were personnel in the Flight Operations Division and in the Navigation Section who anxiously desired to be acquitted of any responsibility for the disaster. And yet, in consequence of the chief executive's instructions, it seems to have been left to these very same officials to determine what documents they would hand over to the Investigating Committee.

55. What I have endeavoured to do so far in this fairly lengthy survey of the events preceding the opening of the Commission, is to set out what seemed to have been the major areas in the Inquiry and I have also had no hesitation in stating at the outset the views which I ultimately formed on these major issues as a result of the evidence which was produced before me. I have also indicated the fundamental stance taken by the airline witnesses towards the Inquiry. That stance was to defend the airline's procedures and management decisions at every point and to lay the entire blame for the disaster, if possible, upon the air crew.

56. What I must do now is to relate in summarised form the course which the Inquiry took as from the date when hearings before the Commission commenced. But it will first be necessary, as a preliminary matter, to indicate the scope and the tenor of the chief inspector's report and to indicate its relevance so far as the Royal Commission is concerned. I shall then set out seriatim the nature of the various issues which were raised in relation to the disaster. Having covered all such aspects of the evidence which were revealed at the Inquiry I shall then proceed to answer the questions which I am required by the Crown to answer in accordance with my terms of reference.

THE CHIEF INSPECTOR'S REPORT

57. I have made previous allusion to the report which was completed and published by the Chief Inspector of Air Accidents. The chief inspector is the head of the Office of Air Accidents Investigation which is administered by the Ministry of Transport. The Office of Air Accidents Investigation is specifically declared, however, by section 18 (3) of the Civil Aviation Act 1964, to be entirely independent from the Ministry of Transport and the Civil Aviation Division. The chief inspector is at liberty, in the discharge of his statutory function, to make whatever criticism he feels is right against any party involved in an aircraft incident or accident including, where necessary, the Civil Aviation Division, which is a branch of the Ministry of Transport.

58. It was the responsibility of the chief inspector, upon being notified of this accident, to institute an inquiry pursuant to the Civil Aviation (Accident Investigation) Regulations 1978. The occurrence of the accident was notified to the chief inspector by the airline at 8.50 p.m. New Zealand daylight time on 28 November 1979. I pause to observe that this was nearly 6 hours after the airline had been notified by McMurdo Station that there had been radio silence from TE 901 for one and a half hours. His investigations commenced on the crash site after his arrival in Antarctica on 29 November 1979. In accordance with standard practice there were sundry overseas officials who accompanied the chief inspector to Antarctica. These were a representative of the United States National Transportation Safety Board, and representatives of the Federal Aviation Administration, the McDonnell Douglas Corporation which had manufactured the aircraft, and the General Electric Company which had manufactured and supplied the engines. The chief inspector was able to make some degree of progress with his inquiries at Antarctica, but the major work which he had to undertake in this very considerable task commenced after his return to New Zealand.

59. The chief inspector's inquiries, in which he was assisted from time to time by other inspectors from his office, covered an exceptionally wide assembly of facts and circumstances which all had some connection with the occurrence of the disaster. The circumstances of the case were far removed from the ordinary type of accident investigation. In most cases the immediate and indeed the controlling cause of an aircraft accident or incident is reasonably clear from the outset. Many of the world's major air disasters have not involved any great difficulty in their investigation by the appropriate investigatory authorities. There have been cases where a disaster has been occasioned by an obvious engine failure or structural defect. There have been other cases involving a sudden occurrence of a known emergency in the air notified by radio signals from the air crew. In many cases there have been eyewitnesses and, in more recent times, the presence of the CVR. In very many cases therefore, whether the originating cause was structural or mechanical failure, or whether it was the response of the air crew to some emergency, or failure on their part to observe known procedures, an investigator has not been confronted with anything like the formidable difficulties which in this case were encountered by the chief inspector, Mr. R. Chippindale.

60. As I have made clear already, this aircraft accident was the culmination of not only a succession of events but also the co-existence of contributing factors. The disappearance of any one of these causative factors from the chain of events would clearly have avoided the collision of

the aircraft with the slopes of Mt. Erebus. Added to all this was the predominant difficulty that the disaster occurred in a distant and hostile terrain in the polar regions some 3000 miles south of New Zealand, and in circumstances where no living person ever saw the aircraft from the time when it departed from New Zealand. So there was no one who had seen the aircraft, observed its course, observed the weather through which it was flying, and observed its manoeuvres during the crucial period of minutes prior to its destruction.

61. The invaluable technical data provided by the black box and, to a lesser extent, by the CVR duly answered many questions which otherwise might have been insoluble. In addition, there was the very unusual advantage that the chief inspector had at his disposal large quantities of prints of photographs taken by passengers at various stages of the flight, including (and this was a vital factor) certain photographs taken within seconds of impact. But even with these advantages, such as they were, the task confronting the chief inspector in respect of this almost inexplicable tragedy was daunting in the extreme. It involved him in hundreds of hours of work and in many thousands of miles of travel to various parts of the world. His total dedication to a task of mammoth proportions is only in part revealed by the extremely lucid and comprehensive report which he later signed and delivered to the Minister of Transport in accordance with his statutory duty.

62. The course which the chief inspector was required to follow pursuant to the Civil Aviation (Accident Investigation) Regulations 1978 was broadly as follows. First of all he had to complete his inquiries to the extent of being able to construct an interim or draft report. Then he was required, on the basis of what his draft report disclosed, to notify any appropriate party of any opinion held by the chief inspector supporting some degree of blameworthiness for the accident as against that party. On 1 March 1980 the chief inspector delivered to four specified parties a copy of his draft report, together with a statement by him of the areas in which it appeared to the chief inspector that the party in question might be held blameworthy. These areas of culpability were separately itemised and stated in each case. The parties in question were Air New Zealand Limited, the Civil Aviation Division of the Ministry of Transport, the estate of Captain Collins, and the estate of First Officer Cassin.

63. As against the airline, there were four suggested areas of blame. One of these areas, however, referred to the route qualification briefing for antarctic flights and in that respect there were said to be 10 specified omissions or mistakes. In the case of the Civil Aviation Division, there were six suggested areas of blame. In the case of the estate of Captain Collins, the representatives of the deceased pilot were advised that there were six specified areas of blame, and all of these related to the conduct of Captain Collins as pilot-in-command during the course of the flight. In the case of the estate of First Officer Cassin the areas of blame suggested by the chief inspector comprised one broad allegation. That allegation was that while acting as co-pilot he did not attempt to question the actions of Captain Collins or to advise him against such actions in respect of the conduct of Captain Collins adverted to in the notification made to the estate of Captain Collins.

64. In terms of regulation 15 of the Civil Aviation (Accident Investigation) Regulations 1978, the chief inspector was required to give the recipients of such allegations the opportunity to make a statement, examine witnesses, give evidence or produce witnesses so as to refute or

modify (if so desired) the belief of the chief inspector that a degree of responsibility for the accident might be attributable to the party against whom the allegations had been made. The four parties so notified each delivered a statement in rebuttal of the allegations made by the chief inspector, but they did not avail themselves of the further rights to which I have just referred because the Attorney-General had made a public announcement on 10 March 1980 that a Commission of Inquiry would be established to investigate the circumstances of the disaster. The parties who had received the chief inspector's allegations, although setting out in detail various factors which in their opinion effectively rebutted these allegations, nevertheless preferred to wait for the hearings of the Commission of Inquiry before going into the process of testing the evidence upon which the chief inspector had formed his conclusions.

65. The Government decided to set up a Royal Commission to inquire into the circumstances of the accident. A Royal Commission is one which is created under the Royal Prerogative, that is to say, appointed by His Excellency the Governor-General upon the advice of the appropriate Ministers of State. Whilst having many conventional and extensive powers of inquiry flowing from the direction of the Crown to inquire and report, a Royal Commission has also at its disposal statutory powers contained in the Commissions of Inquiry Act 1908 and those provisions were, to some extent, clarified and extended by the Commissions of Inquiry Act 1980 which came into force on 4 July 1980. A Commission of Inquiry, whether a Royal Commission appointed under Letters Patent from the Crown or whether a Commission appointed by the Executive under the Commissions of Inquiry Act, has a purely investigatory function. Its duty is to inquire into the events designated in its terms of reference and to report in the case of a Royal Commission to the Governor-General, and in the case of a Commission of Inquiry to the Government, its opinion on the particular points set out in its terms of reference.

66. In the present case, as in the case of many other Commissions, the inquiry was conducted by a judicial officer in the interests of giving every witness the right to state his position in public and to be cross-examined in public. The ordinary procedure was adopted of arranging for witnesses to be called to give evidence on oath and to be cross-examined and to be re-examined on the same footing as if the Inquiry had been a trial at law. But as I have emphasised already, the proceedings of this Royal Commission, as in the case of all other Commissions, do not amount in any sense to Court proceedings. I was required, in my capacity as Royal Commissioner, to investigate the circumstances of this disaster in such manner as I thought fit and, apart altogether from the powers conferred by my terms of reference, I was empowered by section 4 of the 1980 amendment to . . . "receive as evidence any statement, document, information, or matter that in its opinion may assist it to deal effectively with the subject of the inquiry, whether or not it would be admissible in a Court of law," a provision which, substantially speaking, merely re-states in codified form the powers which a Royal Commission has always possessed.

67. I have alluded to the statutory notification by the chief inspector to various parties of the areas in which he believed that they were responsible to some degree for the accident. Following receipt of written replies from each one of the four parties, the chief inspector then

proceeded to complete his final report. On 31 May 1980 he signed his final report and transmitted the same to the Minister of Transport. It was then for the Minister to decide whether he would approve the release of the report as a public document. In one sense this seemed incongruous, because a Royal Commission had been appointed to investigate the disaster, and in those circumstances the opinion of the chief inspector as to the causes of the accident, although of great assistance to a Royal Commission, could not be relevant to its final conclusions. However, on 12 June 1980, some days before the hearings of the Royal Commission were due to commence, the Minister approved for release as a public document the chief inspector's report. It naturally received wide publicity. After recounting all the circumstances the chief inspector stated as his final conclusion what, in his opinion, had been the probable cause of the disaster. His opinion on this point is contained in paragraph 3.37 of his report and reads as follows:

> "Probable cause: The probable cause of this accident was the decision of the captain to continue the flight at low level toward an area of poor surface and horizon definition when the crew was not certain of their position and the subsequent inability to detect the rising terrain which intercepted the aircraft's flight path."

It is clear from the text of the report that the chief inspector was not satisfied with the written explanations furnished to him by Air New Zealand and the Civil Aviation Division, and he held that they were in breach of sundry duties which he enumerated. But he did not ascribe any of these breaches of duty as being the cause of the accident. The Minister of Transport was strongly criticised at the Commission hearings by counsel for the estates of the two deceased pilots for his decision to release the chief inspector's report. It was asserted by counsel, and of course rightly, that the content of the report gave the impression that in the chief inspector's opinion the sole cause of the disaster was pilot error, whereas that was not the chief inspector's opinion at all. I fully agree that publication of the report led to widespread public misconception. It was popularly supposed, for example, that the aircraft was flying in cloud and that the air crew did not know where they were. But the chief inspector had not alleged in his report that the aircraft was flying in cloud. Quite the contrary. He had said that the aircraft had been flying *towards* an area of impaired visibility. Nevertheless, I do not think that the Minister's decision to release the report can be criticised. Nearly 7 months had passed since the disaster. There had been newspaper criticism of the delay in the release of any information which might throw light on what had occurred. There were hundreds of relatives of deceased passengers who were waiting to hear some official account of what had happened. The Minister's decision to release the report was, in my opinion, correct.

68. I should here say something about the form of the chief inspector's report. It was apparent from a preliminary perusal of the report that it was designed upon a stylised format, and it is in fact identical in its layout to various overseas accident reports which came into my possession during the hearings of the Commission. The form of the chief inspector's report is based upon Annex 13 to the Convention of International Civil Aviation which is printed under the heading "Aircraft Accident Investigation". The format of the final report of an accident investigation is set out at pages IV–4–1 to IV–5–2 of Annex 13. The investigator is

required to use the working language of the International Civil Aviation Organisation (ICAO) and the final report of the chief inspector in the present case followed the sequence of stating the required technical information, survival aspects, appraisal of readings obtained from technical aids such as the CVR and the black box, and followed by a series of conclusions, statement of cause or causes, and a list of safety recommendations. At page IV–4–10 of Annex 13 there appears the following sentence:

> "The expression of causes should be a concise statement of the reasons why the accident occurred and not an abbreviated description of the circumstances of the accident".

69. In the present case the chief inspector for the most part maintained in his final report his belief that the four named parties had contributed in one way or another to the occurrence of the accident. But he selected as the single "probable cause" the opinion which I have previously quoted. The selection of a single "probable cause" of this nature is in apparent accordance with the convention adopted under the ICAO format for the reporting of accidents. The investigating inspector is not required to assemble all contributing causes and then to apportion blame. The general practice, as I follow Annex 13, is to select a cause which represents what lawyers would call the "proximate" cause. That is to say, the act or omission which occurred closest to the time of the occurrence of the accident.

70. The chief inspector quite obviously considered this accident to be a combination of a series of causes and as already stated he considered that all four parties were at fault in one respect or another. But he selected as his single "probable cause" the decision of Captain Collins to fail to climb away when approaching an area of deteriorating visibility. As a matter of interest, this particular omission had not been one of the areas of fault attributed to Captain Collins when the inspector notified the Collins estate on 1 March 1980 of the suggested areas of responsibility. He had alleged in his letter of 1 March 1980 that Captain Collins had been at fault "in failing to climb to the minimum safe altitude on finding the high ground in the area ahead obscured". It is significant that in his final report the chief inspector omitted to state, as part of the "probable cause" any suggestion that Captain Collins was aware that there was any "high ground" ahead.

71. The other aspect of the chief inspector's report which is of primary significance is the conclusion expressed at paragraph 2.5, where the Chief Inspector describes the alteration to the destination co-ordinates and the non-disclosure of that alteration to the air crew. He concludes paragraph 2.5 by saying:

> "In the case of this crew no evidence was found to suggest that they had been misled by this error in the flight plan shown to them at the briefing".

With respect, the conclusion just stated is untenable. The evidence adduced before the Commission made it clear, as I have stated already, that Captain Collins had plotted, on the night before the fatal flight, certainly on his atlas and almost certainly on the other maps in his possession, the flight path upon which the erroneous nav track would take the aircraft. Apart from anything else, the decision of Captain Collins to arm the nav mode of the aircraft within a few minutes of impact

completely destroys any suggestion that he had not previously plotted the destination co-ordinates which had been produced to him and to First Officer Cassin at their briefing.

72. If all the evidence on this latter point had been placed before a civil Court and the matter determined upon the balance of probabilities, then it is inevitable that the conclusion reached by any Court would be the same as my own. But I would go further than that. Suppose that the same evidence had been presented before a Court charged with reaching a decision in which the evidence must justify a finding beyond reasonable doubt. This, of course, is a higher standard of proof than proof on a mere balance of probabilities. Again, looking at all the evidence produced before the Commission, such a tribunal would certainly find it proved beyond reasonable doubt that Captain Collins had plotted, on his own map or maps on the evening before the flight, the track from Cape Hallett down McMurdo Sound and terminating at the co-ordinates displayed to him at his briefing.

73. There was one other major conclusion, apart from the one I have mentioned, where I find myself in disagreement with the chief inspector's opinion. This conclusion was the chief inspector's belief that the crew was "uncertain" of its position. For the reasons already expressed, I think it clear beyond doubt that the two pilots and the flight engineers were each certain of the position of the aircraft at all material times, and I have emphasised my opinion in this respect because once it is shown that Captain Collins had plotted on his map or maps the flight path indicated by the flight plan produced to him at the briefing, with consequential certainty as to the position of the aircraft as it approached the McMurdo area, then the major part of the case against Captain Collins and his co-pilot vanishes away. It does not dispose by any means of a careful review of the conduct of the flight crew during the last stages of the flight, and it in no way exonerates the crew from other aspects of management of the aircraft which may well have been a contributing factor, even though a minor factor, in the occurrence of the disaster. I shall in due course be required to give careful consideration to the conduct of Captain Collins and First Officer Cassin as to the decisions which they made over the last part of the flight of TE 901. But, as Mr Baragwanath said in his closing submissions, the concept that this accident was essentially caused by "pilot error" has substantially disappeared and this is the principal area upon which I am compelled to disagree with the opinion of the chief inspector.

74. In my own review of all the circumstances of the disaster as disclosed by the evidence, I am entitled to take into account not only specific facts but inferences fairly to be taken from the establishment of specific facts. Further, I am not required to insist that some particular conclusion, whether founded on direct evidence or inference, shall be established beyond reasonable doubt. I am entitled, as part of my investigatory function, to reach conclusions based upon the balance of probabilities. This is the course which I have adopted. And in regard to allegations in respect of which the evidence seems to me to be in even balance, or not sufficiently tilted one way or the other, then I have held the truth of any such allegation, likely though it may be, to have been not established.

75. I now turn to examine each of the areas of factual inquiry which are relevant to the terms of reference as set out in the Warrant appointing me as Royal Commissioner to inquire into this disaster.

THE TYPE OF AIRCRAFT INVOLVED IN THE ACCIDENT

76. The registered designation of the aircraft was ZK-NZP. It was a McDonnell-Douglas DC10–30 wide-bodied jet airliner. It was imported into New Zealand on 14 December 1974. There was issued in respect of the aircraft at all times the necessary Certificate of Airworthiness, and it was maintained at all times in strict accordance with the manufacturer's specifications. Indeed, the maintenance schedules drawn up and adopted by the airline were regarded by the manufacturers as being exemplary. At all times throughout the flight and terminating with its impact with the mountain side, the aircraft was operating perfectly in every respect.

77. There was nothing in the design or capabilities of a DC10-30 which made it in any way inappropriate as the vehicle for these sightseeing flights. In this respect, I had the advantage of hearing evidence from Mr L. S. H. Shaddick, who is an Inspector of Air Accidents within the United Kingdom Accidents Investigation Branch of the Department of Trade. He is a qualified DC10 pilot. He regarded the DC10 as being a highly manoeuvreable wide-bodied jet equipped with one of the most advanced inertial navigation systems yet introduced, and although the aircraft had obvious limitations as a sightseeing aircraft in view of the fact that it was not designed for that purpose, he was of the opinion that the aircraft and its equipment were suitable for antarctic scenic flights. The aircraft was performing with maximum efficiency in all its systems right throughout the flight. Its design made it suitable for flights of this kind.

THE NAVIGATION SYSTEM IN A DC10-30 AIRCRAFT

78. The navigation system in this type of aircraft is a variety of the widely used inertial navigation system. But the DC10 equipment is the most advanced type of INS system in present use. The technical description of the system as installed in DC10-30 aircraft is the Area Inertial Navigation System (AINS). The nature of this system and the manner of its operation was comprehensively described by Mr W. K. Amies at paragraphs 4.1 onwards of his prepared brief of evidence.

79. The word "area" which precedes the words "inertial navigation system" means the ability of the system to navigate over pre-determined tracks within prescribed accuracy tolerances without the need to overfly navigation aids located on the ground and operated by radio transmission. The AINS can therefore navigate the aircraft from one position to another, either automatically or by providing steering signals to the pilot which he can follow when manually flying the aircraft. The system operates by inserting into computer equipment on board the aircraft a series of waypoints based upon pre-determined co-ordinates of latitude and longitude. The first co-ordinates represent the location of the airfield from which the aircraft will depart, and the final co-ordinates are the destination co-ordinates.

80. The knowledge of the aircraft's in-built navigation system as to the aircraft's geographical position in flight is achieved in this manner. The AINS components include either two or three inertial sensor units. In the case of the DC10 there are three such units. Each one operates independently. Each contains three accelerometers fitted to what is called a "platform" and mounted on a gyroscopic unit. As from the moment the aircraft moves from its starting point the three accelerometers record every subsequent movement as related to the three dimensions of space by

reference to the altered position of the aircraft in relation to its geographical starting point. The sensor unit will therefore record the distance travelled over the globe, the direction of travel, the speed of travel, and every direction of travel. As stated previously, each sensor unit operates independently. Each is therefore capable of independently determining the aircraft's position. However, the combined output of navigation information provided by the three sensor units is fed into computer units in the aircraft. These units compute the average of the three sets of navigational data being continuously received from the sensor units, and in this manner the position of the aircraft is calculated every fifth of a second. There is a reason for the installation of more than one sensor unit in the inertial navigation system. First of all, it is possible that a sensor unit may develop a malfunction. Secondly, the microscopic programming of the silicon chip, which is the basis for the whole system, may not be mathematically exact and in practice each of the sensor units will produce data which vary very slightly from each of the others. Hence the function of the computer unit which receives the product from the three sensor units and prints out the average of the three sets of calculations. In addition, if one of the units should develop a malfunction during the flight, the aircraft computer detects the malfunction, eliminates the information being received from that unit, and then notifies the pilot by a light on the instrument panel that one of the units has now been discarded for navigational purposes.

81. There is on the instrument panel a display unit which reveals to the pilot information being collected by the sensor units and monitored by the computer navigation unit. The pilot can produce a number of different displays on the control and display unit (CDU) but at the present moment I do not need to refer to the different types of information which are available to the pilot. The AINS, operating in the manner which I have briefly described, may be locked into the steering controls of the aircraft so that the aircraft can be flown automatically from one waypoint to another. In order to arm this system, the pilot pushes a button marked "nav" on a particular panel, and the aircraft will then navigate itself along the programmed flight path from one waypoint to another. As the aircraft approaches the next waypoint, the pilot can see on his display panel not only the present latitude and longitude of the aircraft, but also the number of miles before the next waypoint is reached. Then, upon arrival at the geographical position of the next waypoint and assuming that the aircraft has been programmed to then fly on a different heading, the aircraft will automatically roll in the appropriate direction and will then intercept and follow the prescribed track to the next waypoint.

82. The pilot can disengage the AINS from the steering system of the aircraft by selecting a mode other than the nav mode. Normally this is done by selecting the HDG SEL (heading select) mode and the pilot then selects a new heading which the aircraft will now follow. The pilot can then select further new headings as occasion requires, and the aircraft will then automatically follow each change of direction. One conventional circumstance in which the pilot will disengage the nav mode and instruct the auto-pilot to fly on a different heading is when he sees by his weather radar, or observes visually, a cloud formation which he desires to avoid. He will then, by using the heading select system, navigate the aircraft around the cloud formation and when he has done so he will then adjust the heading select system so as to produce a course which will once more intercept the programmed nav track. Having thus directed the aircraft

back towards the nav track he then arms the nav mode again. As soon as the aircraft intercepts the nav track it will roll towards and on to the exact course of the nav track and will thereafter maintain that course without deviation.

83. The above procedure, which I have described in simple terms and without alluding to certain refinements which form part of the system, was followed by Captain Collins as his aircraft approached Ross Island. From Cape Hallett southwards, the aircraft had been flown on nav track, this being confirmed by the print-out from the black box. Then, when the display panel told him that the aircraft was about 40 miles from its destination waypoint, he found a large break in the clouds through which the sea ice was plainly visible. Then, as duly recorded by the black box and confirmed by the CVR, Captain Collins disengaged the nav track in order to bring the aircraft down through the large cloud-break in two descending orbits, the object being to descend from 17 000 feet to 3000 feet whilst still maintaining the same approximate distance from McMurdo. By using the heading select mode, the course of the aircraft was directed into the two descending orbits, the different headings being successively set in order to bring about the two complete turns. Then as the aircraft straightened up at the conclusion of the second orbit on its heading select course, taking it approximately due south, Captain Collins again armed the nav mode. The aircraft then continued on until it intercepted the nav track and it then locked on to the nav track and stayed there until the aircraft struck the mountain.

84. The AINS navigates an aircraft, as I have said earlier, with incredible accuracy. When the aircraft is flying over terrain which contains ground stations transmitting navigation radio signals, the pilot can determine his course by reference to these radio transmissions. There are commonly two types of navigational aids available from ground stations. One is a VHF (very high frequency) omnidirectional range station which is known as a VOR station. Basically, the VOR provides 360 different courses which radiate from the station like spokes from the hub of a wheel. These courses, known as radials, are identified by the magnetic bearing of the station. A pilot can determine which radial he is flying on and his instruments will tell him not only what that radial is but whether he is heading to or from the VOR station. In addition, he is able to determine his distance from the VOR by signals received from another aid called the distance measuring equipment (DME) which is usually co-located with the VOR. When operating within the range of VOR/DME stations, the AINS is switched into what is termed the radio-inertial (R-I) mode. By this means the computer system of the aircraft may be corrected by radio signals if the geographical position which it displays is not exactly in accordance with the position revealed by the VOR/DME station. The three inertial sensor systems are not themselves affected by such signals. They continue to operate independently of any influence outside the aircraft, but the computer presentation of the average results of the three systems can itself be adjusted. In these circumstances, it is not possible for the AINS to display an incorrect position of any consequence.

85. In the case of the antarctic flights, DC10 aircraft would only be within range for a very short time of VOR/DME stations located in New Zealand. Consequently, the AINS system was in practice switched into the "I" (inertial) mode. When operating in this mode, the AINS will still navigate the aircraft with extreme accuracy. The accuracy of the system in the "I" mode is guaranteed by the manufacturers to be 95 percent. Where

there are three inertial sensor units operating, as in the case of a DC10 aircraft, the maximum possible lateral error will be 1.153 nautical miles for each hour of flight. But it is found in practice that variations, even of this slight degree, do not occur, and in the case of the fatal flight the aircraft struck the mountain at a point only 1.2 miles to the east of the programmed nav track even though there had been no VOR/DME update or corrections during the 5 -hour flight from Auckland. All this, of course, is of vital significance when it is recalled that Captain Collins relied upon the nav track to guide the aircraft on a course which he believed was taking him down the approximate centre of McMurdo Sound which is approximately 40 miles wide except at the point between Cape Royds and Cape Bernacchi when the distance narrows for a mile or two to 32 miles before again widening to 40 miles. Evidence given by operational pilots before the Commission established that on long flights from Auckland to Honolulu or from Singapore to Auckland the AINS system always brings the aircraft to its destination at a point which does not vary by more than a mile left or right of the nav track.

86. Despite suggestions to the contrary which I shall deal with in due course, there can be no valid reason, having regard to the long experience of Captain Collins in flying DC10 aircraft, for him to have been in any doubt about the accuracy of the flight path dictated by the AINS as the aircraft approached the entrance to McMurdo Sound. Past experience had demonstrated that any ultimate positional error on the part of the AINS could not be more than about a mile east or west, and such a deviation was irrelevant having regard to the flat plateau, 40 miles in width, down which the aircraft would fly towards its destination waypoint.

87. I have just referred to suggestions which were made in the course of the evidence that Captain Collins was not justified in relying upon the accuracy of the AINS as he approached McMurdo Sound when the Sound itself, and Ross Island, was entirely enveloped in cloud. In this respect, those who criticised the reliance by Captain Collins upon the AINS not only referred to the AINS not being authorised as a descent procedure for landing, but also concentrated upon the fact that the manufacturer's specifications for the equipment only provided for a system accuracy of 95 percent.

88. The accuracy of the system depends upon how many of the inertial sensor platforms are installed. Aircraft using this navigation system may be equipped with a single inertial platform or a dual platform or a triple platform. The DC10 is equipped with a triple inertial platform and the provision of a triple inertial system considerably narrows down the range of error. With a single inertial system there is a possible error of 2 nautical miles per hour, with a dual system 1.414 nautical miles per hour, and with the triple system 1.153 nautical miles per hour. These figures apply when the AINS is set in the "I" mode meaning thereby, as explained previously, that the navigation computer unit will not receive radio updates from VOR/DME stations. It was therefore suggested in evidence that after the DC10 on the fatal flight had arrived at McMurdo, it would have been flying for 5 hours and would have accumulated a potential for error of five times 1.153 nautical miles, which might be rounded off at 6 miles.

89. As Mr Amies said in his Brief of Evidence (para. 5.11) it is common for Air New Zealand DC10 aircraft flying the Los Angeles/Tahiti route, to be in the "I" mode for periods up to 7 hours but that experience shows

that it has been found normal for the system to be operating "well within the specified tolerance when operating under those conditions". This was also the experience of the pilots who gave evidence before the Commission. It will be remembered that Captain Spence reported, following the initial flight to Antarctica, that there had been a discrepancy on the return flight of only 3 nautical miles after a flight of over 3000 nautical miles "without a radio update into the AINS".

90. The Director of Civil Aviation felt himself entitled to postulate a theory that after a flight of over 10 hours' duration, pilots would have to allow for tolerance of plus or minus 20 nautical miles of cross-track error, and plus or minus 20 nautical miles of directional track error. This calculation proceeded upon the basis that there was only one inertial sensor platform in operation. When it was pointed out to the Director by Mr Baragwanath in cross-examination that the DC10 contained a triple system, the Director was thereupon constrained to agree that the maximum possible cross-track error, after a total flight of 10 hours, could only be 12 miles and that upon arriving at McMurdo from Auckland, involving a flight of 5 hours, the maximum positional error with the navigation system flying in the "I" mode could only be 6 miles.

91. I only mention this incident as demonstrating the earnest desire of the Director to rebut the suggestion that a DC10 pilot is entitled to rely upon the AINS producing a result, even in the "I" mode, which almost exactly coincides with the geographical position of the aircraft upon arrival at its destination. As I have said, it was distinctly proved that this has been the experience of Air New Zealand pilots flying on long sectors, and I have referred already to the evidence of Mr Amies in relation to the Los Angeles/Tahiti route where the "R-I" mode is not available for many hours.

92. During my visit to the United Kingdom with Mr Baragwanath I arranged to obtain, through the co-operation of Mr Shaddick of the United Kingdom Air Accidents Branch, a quantity of printed information as to extensive tests which have been made for some years involving the evaluation of inertial navigation systems. I need not go at this stage into the complex data which was recorded in respect of the North Atlantic Region and the difference between aircraft with triplicated inertial systems and those with dual systems, nor with the difference in accuracy which was ascertained depending whether a flight was east-bound or west-bound. As a matter of interest, radial error rates averaged 2.1 nautcial miles per hour on east-bound flights as compared with 1.15 nautical miles per hour on west-bound flights, even though west-bound flights were about one hour longer in duration.

93. The result of these assessments and of others which I obtained were summarised on my behalf in a memorandum prepared by the United Kingdom National Air Traffic Services. They calculated that the maximum possible radial error on the fatal antarctic flight of 28 November 1979, taking into account navigation in the "I" mode, could not exceed 4 nautical miles. Here is the final paragraph of the text of this memorandum, which is dated 6 November 1980:

> "If INS navigation played any part at all in the causes of the accident I should have expected its un-updated radial error to have been of the order suggested above (i.e. in the range of 0 to 6 or 7 nautical miles for a single INS, in the range of 0 to 5 nautical miles for a dual installation where the outputs are averaged, or in the range of 0 to 4 nautical miles for a triple installation where the outputs are averaged)."

94. In addition to summaries of the accuracy of the INS method of navigation on trans-Atlantic routes, I was also supplied with printed details of a special test run by the European Organisation for the Safety of Air Navigation which took place in March 1980. The navigational results of this special flight were distributed on 27 June 1980. The flight was made with a DC10 aircraft which left Paris on 3 March 1980 and flew to Abidjan, which is on the Ivory Coast of West Africa. The outbound flight included a landing part of the way to Abidjan. The inbound flight took place on 4 March 1980 and was made direct from Abidjan to Paris over a route involving 3000 miles. For the major part of each journey the AINS was in the "I" mode through lack of VOR/DME radio aids, and this was one of the reasons for the selection of this particular north-south route as a test of the AINS system.

95. On arrival at Abidjan the average of the differences of the three inertial sensor systems after 9 hours 25 minutes comprised 4.2 minutes of longitude and 3 minutes of latitude. On the inward flight, which was direct from Abidjan to Paris, the differences between the three platforms averaged 1.5 minutes of longitude and 2.3 minutes of latitude which, in that part of Europe and the Continent, represent approximately 1 mile and 2 miles respectively. This may usefully be compared with the flight of TE 901 from Auckland to McMurdo, involving the same distance of 3000 miles, when the NCU cross-track error was 1.2 miles and when the distance error was 3.1 miles.

96. I only refer to the Paris-Abidjan-Paris test flights as they were on a north-south axis over a 3000 mile route and confirmed, in the final result, the evidence of airline pilots in their evidence before me as to the minimal degree of radial error which their experience has led them to expect when operating flights over long sectors.

97. Captain Collins had a total flying time of 11 151 hours, including 2872 hours on DC10 aircraft. First Officer Cassin had a total flying time of 7934 hours, including 1361 hours on DC10 aircraft. Their navigation experience with the AINS, considered both separately and jointly, would have led them to check any cross-track error at Buckle Island, an exact target in the centre of the Balleny Islands waypoint, and then at the Cape Hallett waypoint, and that same experience would have led them to rely upon the aircraft developing not more than a 2 nautical mile cross-track deviation upon arrival at McMurdo. Such a deviation would be immaterial having regard to the approximate 40 mile width of McMurdo Sound. As already indicated, the actual cross-track deviation on impact was only 1.2 nautical miles. Each of the pilots was therefore, in my opinion, entirely justified in placing this degree of reliance upon the nav track as they approached the McMurdo area.

COCKPIT VOICE RECORDER SYSTEM

98. The aircraft was equipped with a recording system whereby whatever was said on the flight deck was recorded by a sensitive microphone situated in the roof of the flight deck. Its location is at a point between and fractionally behind the seats of the pilot and co-pilot. Since the flight engineer will be sitting at the instrument panel located in the centre of the flight deck just behind the two pilots, the microphone will pick up fairly clearly whatever is said by any one of the three men. In

addition there is wired into the tape system all the microphone intercommunication between the pilots and the flight engineer. Further, the tape system records radio transmissions emanating from and received by the aircraft.

99. In theory, the system ought to operate satisfactorily. With only the two pilots and the flight engineer on the flight deck, and with the door behind them closed, the system is probably adequate although not fully satisfactory. In the present case, however, there were present on the flight deck not only a second flight engineer but also Mr Mulgrew, the commentator for the flight. Therefore the total official complement of the flight deck was five and not three. Further than that, there were regular visits to the flight deck by passengers, this being authorised by the airline as part of the sightseeing flight, although pilots had been cautioned to exercise some restraint in this respect when the aircraft was flying at a low level. In addition to the complications just mentioned, the CVR microphone will pick up conversations, or parts of conversations, from persons in the galley, which is situated immediately behind the flight deck, so long as the flight deck door is open. The tape recording thus provided by the CVR system continually erases anything said further back than a period of 30 minutes, so that in the present case the total extent of the tape recording available covered the last 30 minutes of the flight.

100. A transcript of the contents of the CVR tapes was published by the chief inspector as Annex C to his statutory report. He co-ordinated with the content of the CVR tapes the recordings made on tape recorders located at Mac Centre. When I first read the published transcript of the CVR system I was under the impression that although sundry irrelevant pieces of conversation had been excluded, the resulting transcript comprised a record of exactly what had been said by different voices, some identified, some not identified, during the progress of the last 30 minutes of the flight. The contents of the transcription also received wide press publicity after the report had been released, and members of the public also thought that they were reading an accurate transcript of what had been said. However, when I discovered that the CVR tapes had been taken to Washington for the purpose of transcription with the aid of special sound-filtering devices employed by the National Transportation Safety Board, and when I discovered that it had taken no less than 5 days for a transcript to be prepared of a 30-minute tape, I assumed, correctly as it happened, that the quality of the tape recording must have been very bad indeed.

101. When I listened to the tape recording myself, which I did on two occasions in New Zealand, it became clear that the only two voices which could be heard without difficulty were those of Captain Collins and First Officer Cassin. From time to time there could be heard the voices of the flight engineer, who happened at the time to be seated at the panel behind the two pilots, this being either Mr Brooks or Mr Moloney, and on occasions the clarity of such parts of the tape reproduction was reasonable, although it was often not clear to whom the engineer was speaking. It was also the case that some comments made by Mr Mulgrew were reasonably clear, and of course whatever he said to the passengers on the public address system was quite clear because that system was also wired into the CVR system. By and large, however, I found that the volume of conversations and cross-talk on the flight deck behind the two pilots made it difficult in the extreme to ascertain what exactly was being

said. Conversations between different people tended to run together. A sentence uttered by someone would be interrupted mid-way through by a sentence spoken by someone else who was evidently closer to the microphone. Someone would give an answer to an indecipherable question. All in all, I was perturbed at the bad quality of the tape reproduction with the exception, as I say, of what was said by Captain Collins and First Officer Cassin. I should here emphasise, however, that the chief inspector had previously warned me that the task of transcribing these garbled observations at the rear of the flight deck had been difficult in the extreme.

102. When the CVR tapes were transcribed in Washington there were present Mr Milton Wylie, an Inspector of Air Accidents employed by the Air Accidents Branch, and also present were pilots from Air New Zealand who were there for the purpose of identifying, if they could, the voice which was speaking at any given time. The tapes were played through the sophisticated filtering devices used by the National Transportation Safety Board and the evidence relating to the transcription of the tapes in Washington disclose that many sections of the tapes had to be played and re-played before agreement could be reached on what had been said, or more often what had probably been said. The gist of the whole exercise really was that many sections of the transcript dealing with conversation and remarks made by people other than the two pilots were the result of combined opinion on the part of the persons who were listening. One person would have his own opinion as to what had been said in respect of a specified word or phrase. Another person would have an opinion to some extent at variance, and so on. In the end a great many sections of the transcript merely represented an agreed joint opinion, which might not be an opinion in all cases unanimous, as to what had been said on a particular occasion. Mr Baragwanath and I verified all this when we took the tapes ourselves to Washington and arranged for certain sections (which at the hearing of the Commission had been in dispute) to be played back by Mr Paul Turner, the expert who had played the tape through filtering devices when the Washington transcription was first settled.

103. The visit of Mr Baragwanath and myself to Washington was occasioned by the following submission on the part of counsel for the Air Line Pilots' Association. They drew attention to two particular extracts which appeared to refer to the weather, or to some expressed concern on the part of the flight engineers. These extracts were:

"Bit thick here eh Bert" and

"You're really a long while on . . . instruments at this time are you"

It was contended that each of these extracts had been regarded by Washington as being unintelligible or, alternatively, not sufficiently intelligible to be of any assistance, and that this had been agreed by everyone present at Washington, and accordingly these extracts had not been included in the transcript which had been agreed and settled by all parties in Washington. Mr Baragwanath and I discovered that this in fact was true. It then transpired that when the Washington transcript arrived in New Zealand the chief inspector had thereupon gone to Farnborough in the United Kingdom where there are similar filtering devices as in Washington, and that in consequence of his endeavours at Farnborough the two extracts just quoted had been considered intelligible by the Farnborough filtering expert, Mr Davis, and had thereafter been printed as part of the chief inspector's final transcript. This visit to the United

Kingdom was strongly attacked by counsel for ALPA. They contended that it was contrary to established practice for any transcription to be entered upon without representatives of ALPA being present and it is, of course, correct that the very existence of the CVR system has always been a very sore point with the International Air Line Pilots' Association.

104. When Mr Baragwanath and I listened to extracts from the tape played back at Washington by Mr Turner, we were satisfied that the original decision had been correct and that these two extracts did not represent what had been said. With reference to the phrase "a bit thick here eh Bert", neither Mr Baragwanath nor myself, nor Mr Turner, was able to pick up the word "here". There was no hesitation or pause or auditory gap between the words "thick" and "eh" into which any other word seemed capable of being interposed. There was also doubt, shared by Mr Turner, as to whether the word "thick" had in fact been used. It may well have been another word. Then there was the undisputed fact that although this observation was supposed to have been answered by flight engineer Moloney his name in fact was not "Bert", and indeed it was undisputed that there was no one on the flight deck with the name "Bert". In short, Mr Turner believed the entire sentence or phrase to be quite unintelligible, and Mr Baragwanath and I fully agreed.

105. As to the second disputed sentence referring to "instruments", it seemed clear enough that that word in fact was used. But whereas there was the expression "this time", I kept hearing it as "that time". It also seemed to me that the words after the word "instrument" might have been from a different speaker and dealing with a different subject. Mr Turner said that in his opinion the word "instruments" marked the end of a sentence and that the following words, whether spoken by the original speaker or not, appeared to relate to a different topic. In the result therefore, although the sentence as appearing in the chief inspector's report may possibly have been correctly transcribed, it was impossible to be sure. In view of the doubts as to whether one was hearing a single sentence or two parts of different sentences, possibly uttered by different voices, it was Mr Turner's opinion that the sentence should be classified as either not intelligible or not sufficiently intelligible as to be given any reliable translation.

106. At Farnborough the same extracts were played over and over again through a different variety of filters by Mr Davis, and we listened to them in the ordinary way and through ear-phones. Once again, we could not discern the word "here" as following the word "thick", and it appeared that Mr Davis had been unaware that there was no person called "Bert" on the flight deck. As to the second sentence involving the word "instruments", I came to the same conclusion as at Washington. Those listening to the tapes at Farnborough were Mr Davis, Mr Tench (Chief Inspector of Air Accidents for the United Kingdom), and Mr Shaddick together with Mr Baragwanath and myself. Mr Davis did not venture any opinion as to the interpretation of the two extracts. He merely played the part of expert technician (which he clearly is) in reproducing the two extracts in different forms from his variety of filters. The consensus of opinion among the four of us (I am excluding Mr Davis) was that the extracts were either unintelligible or not sufficiently intelligible to be given any reliable meaning.

107. I shall now turn to consider the other parts of the transcript of the CVR tapes which appear to have been relied upon by the chief inspector

as indicating either uncertainty or mounting alarm on the part of crew members other than the two pilots. The following symbols are used in the transcript to identify the person speaking, if his identity is known:

CAM – 1	is Captain Collins
CAM – 2	is First Officer Cassin
CAM – 3	is Flight Engineer Brooks
CAM – 4	is Flight Engineer Moloney
CAM – 5	is Mr Mulgrew
?	indicates that the voice is not identified.

108. The first of such additional passages occurs at page 80 of the chief inspector's report. The transcript reads as follows:

"CAM – 1	Tell him we can make a visual descent descending
(Interjection)	
CAM-?	My God
CAM – 1	on a grid of one eight zero
CAM – 2	Yes
CAM – 1	and make a visual approach to McMurdo
CAM – 2	OK"

I must say that I am at a loss to understand how the interjection "My God", presumably thought to have been uttered by a flight engineer, can be interpreted as an expression of alarm as to the decision of Captain Collins to advise McMurdo that he was able to make a visual descent. A flight engineer alarmed at such a decision would certainly not content himself by uttering a brief invocation to the Deity and thereafter remain silent. It would be his duty as one of the flight engineers, and particularly if he were the flight engineer on duty at the panel, to express a reasoned opposition to an announced intention on the part of the captain. The same interjection appears in another version of the Washington transcription of the tapes, and is to be found in a full transcription supplied to the airline by Captain Wyatt. This transcript is contained in **Exhibit 269** and comprises document J 19 of that file. The interjection is referred to at page 15, and Captain Wyatt interpolates, after the phrase "My God", that it is followed by an "irrelevant conversation". In my opinion the insertion of that interjection in the transcript is entirely unwarranted insofar as it purports to be a comment upon the stated intentions of the captain.

109. The next part of the transcript purporting to exhibit some measure of doubt on the part of the crew is to be found at page 83 of the chief inspector's report. The relevant passage reads as follows:

"?	Where are we?
(Thought to be Brooks)	
?	About up to here now?
[sound of rustling paper]"	

It is to be noted that these two questions are asked by persons not identified except that the second question was evidently thought to have been asked by one of the flight engineers. It is not known to whom the flight engineer was speaking but it seems clear that a map was being referred to. In addition, I can see no warrant for adding a question mark to the second phrase "About up to here now". I should have thought that the flight engineer, if indeed he was the person who spoke, was merely answering the question by pointing to a map.

110. The next passage from the transcript relevant in this context is at page 86. It reads as follows:

"CAM−3	Where's Erebus in relation to us at the moment
CAM-?	Left about (twenty) or (twenty) five miles.
CAM-?	Left do you reckon
CAM-?	Well I don't know --- I think
CAM-?	I've been looking for it
−2	Yep Yep
CAM-?	I think it'll be erh
CAM−3	I'm just thinking of any high ground in the area that's all
CAM−5	I think it'll be left yes
CAM−4	Yes I reckon about here
CAM−5	Yes --- no no I don't really know
CAM−5	That's the edge."

First of all, it will be observed that the second sentence referring to Mt Erebus being about 20 or 25 miles to the left would be correct, on the assumption that the crew believed they were flying down McMurdo Sound. Then there are following comments made by persons, believed to be flight engineers but not identified, which appear to now evidence doubt as to the validity of the statement that Mt. Erebus is situated to the left, about 20 to 25 miles away. As will be seen, this fragmentary discussion cannot really be reconciled with the positive answer to which I have referred. Then there follows a discussion which commences "I am just thinking of any high ground in the area that's all". This comment is identified as being made by Flight Engineer Brooks. It is obviously an explanation offered to the person who indicated the location of Mt. Erebus. Then there are the following remarks by Mulgrew and Moloney. Were they directed to the same subject matter? They may have referred to another feature, not deciphered, which was also located out to the left towards an area covered in cloud. Then the final comment "That's the edge" can only be interpreted as a reference by the commentator to the edge of Ross Island as a reference point to whatever landmark had been under discussion, which may not have been Mt. Erebus.

When this excerpt from the CVR transcript was published by the newspapers after the release of the chief inspector's report, it was naturally interpreted by the public as indicating lack of knowledge by the air crew as to the aircraft's position. As will be apparent by now, that interpretation was totally misconceived.

111. The next passage in the transcript which requires attention is at page 87 and reads as follows:

"-?	What's wrong?
-?	Make up your mind soon or ---
CAM−1	We might have to pop down to fifteen hundred here I think
CAM−2	Yes OK
CAM−2	Probably see further in anyway."

The first two phrases are uttered by persons who are not identified and, upon my own experience of listening to those same phrases, I was quite unable on either occasion to relate them to any suggested remarks being made to Captain Collins. The portion of this part of the transcript refers to

the decision of Captain Collins to move down to an altitude of 1500 feet. First Officer Cassin then expresses the view that they can probably see further in, which obviously means further up the Sound. I also note that in another version of the transcript, Captain Collins does not say that "we might have to pop down" but says that they might have to "drop down". The chief inspector seems to have criticised this decision to descend to 1500 feet because it seemed to him to indicate that there was no proper visibility at 2000 feet or that the visibility ahead was worsening. As already stated, I consider that there is no evidence at all that the visibility ahead was worsening. On the contrary, as previously indicated, the two pilots and the other three official occupants of the flight deck would only have seen a long, flat, white expanse of snow running away into the distance. I interpret the decision to descend to 1500 feet as being an attempt to discern in the far distance some sign of features like Mt. Discovery which would be nearly straight ahead, and McMurdo Station which would be forward and to the left.

112. The next part of the transcript relevant in the present context is at page 89 and reads as follows:

> "CAM−1 Actually those conditions don't look very good at all—do they?
> CAM−5 No they don't."

The first comment I would make about these two remarks, and they were certainly quite clearly made, is that no one knows what "conditions" Captain Collins was referring to. As with all attempts to interpret a transcript of this kind, the unknown factor is to identify the particular direction or view which is being referred to by the speaker. A reference to "those conditions" obviously means that Captain Collins was referring to weather conditions located a long way off. So the question is, in what direction was he pointing? I should have thought that the only reasonable inference is that he was pointing forward and to the right where he believed that he saw cloud over the area of the Taylor and Wright Valleys, it being recalled that he had been advised previously by Mac Centre that those areas were free of cloud.

113. The next relevant item from the transcript is a single phrase uttered by Flight Engineer Brooks and appearing at page 90 of the chief inspector's report. It simply reads "I don't like this". Once again, the question is whether Mr Brooks was referring to the weather conditions immediately surrounding the aircraft, or whether he was directing attention to areas of cloud located somewhere in the distance. The fact that he uses the word "this" leads, in my opinion, to the inference that Mr Brooks was referring to the present situation of the aircraft. What did he mean by that observation? According to the Captain Wyatt transcription it was also followed by an irrelevant conversation. But I will assume for present purposes that the remark did refer to the aircraft's location. Proceeding once more upon the assumption that the flight crew were looking ahead at a long vista of white ground, then the probabilities are that Flight Engineer Brooks was concerned with the fact that despite the clear visibility in front, there were no features of terrain discernible in the far distance. Only 6 seconds after Flight Engineer Brooks made the remark just quoted, Captain Collins says "We're twenty-six miles north. We'll have to climb out of this". It therefore appears that Captain Collins and Flight Engineer Brooks unaminously decided that it was time to fly away, and reached that decision simultaneously.

114. These different passages from the transcript which I have quoted are those which were relied upon by the chief inspector to support his allegation that the crew was "uncertain" of its position and that there was some degree of "mounting alarm" on the part of the crew. The answer to all this is that nowhere in the remarks passed at any stage by Captain Collins or by First Officer Cassin is there the slightest suggestion of uncertainty as to the aircraft's position, or any concern as to the circumstances in which the aircraft was flying. What has been relied upon as generating the suggested "uncertainty" are the various remarks bandied back and forth by people behind the two pilots, who certainly included passengers, venturing opinions as to the location of Mt. Erebus, and remarks of a similar kind. The only real expression of concern made by anyone is the remark of Flight Engineer Brooks "I don't like this" (assuming that it was not part of an irrelevant conversation) and, as I say, it was made only 6 seconds before Captain Collins made his decision to fly away.

It will further be observed that after making that decision Captain Collins and First Officer Cassin then began a discussion as to whether the aircraft should turn away to the left or the right. This discussion, both from the transcript and from listening to the actual voices on the tape, was very obviously a conversation containing not the slightest degree of urgency and indicating no concern whatever. It might almost be described as a casual discussion as to the direction which Captain Collins should take when he increased altitude and began to climb away from McMurdo Sound. That discussion was still continuing when the ground proximity warning device suddenly sounded 6 seconds before the plane struck the mountain. As soon as the device sounded Flight Engineer Brooks adopted the standard procedure of announcing the altitude, and then Captain Collins gave the following order "Go round power please". There is discernible, from listening to the tapes, a rising inflexion in the voice of Captain Collins as he gave this order and, indeed, that would be understandable in view of the unexpected sounding of the alarm system. But I would emphasise that the order ended with the word "please", and there was certainly no apparent indication of alarm or dismay by Captain Collins when he gave that order.

115. I have taken this trouble to examine these different sections of the transcript of the CVR because of the following four statements made by the chief inspector in his report:

(a) "There were discussions on the flight deck indicating that some of the speakers believed they were to the west of Mt. Erebus, but the two Flight Engineers on the flight deck had voiced frequent queries about the procedure and expressed their mounting alarm as the approach continued on at low level toward the area of low cloud." (paragraph 2.20)

(b) "The apprehension expressed by the flight engineers indicated that these members of the crew were endeavouring to monitor the flight responsibly but their suggestions of caution, as with the captain's decision to climb out of the area, were overtaken by the speed of the sequence of events." (paragraph 2.25)

(c) "The flight engineers endeavoured to monitor the progress of the flight and expressed their dissatisfaction with the descent toward a cloud covered area." (paragraph 3.24)

(d) ". . . the crew was not certain of their position. . ." (paragraph 3.37)

116. In my opinion none of these views expressed by the chief inspector in his report is substantiated, either by the transcript of the CVR, or by the process of listening to the playing of the tapes. The only possibility of apprehension on the part of a Flight Engineer is that referred to a little earlier when Flight Engineer Brooks said "I don't like this", always assuming that he was in fact referring to the aircraft's location, and the Captain simultaneously came to the same decision and decided to fly away.

117. Counsel for ALPA were highly critical of the approach of the chief inspector to this whole question of the transcript of the CVR. Their submission was that the chief inspector had formed a preliminary view that the crew was "uncertain" of its position and was expressing "mounting alarm" and so forth, and that he construed the transcript, wherever possible, so as to give effect to that point of view. One example which was given to me had reference to a remark by Mr Mulgrew transcribed at Washington as follows:

"Taylor on the right now".

This meant that Mr Mulgrew was pointing to the location of the Taylor Valley. In other words he was pointing to an area just south of that section of the Cape which he could see on the right. In the revised transcript published by the chief inspector, this remark by Mr Mulgrew is altered to a question by him, addressed to the captain, as to whether he will go to "the Taylor or Wright now". Then there is recorded a supposed answer by the captain "No I prefer here first." The captain's remark does not appear in the Washington transcript. In the view of counsel for ALPA the intention of the chief inspector in this respect was to avoid any suggestion that Mr Mulgrew had made a positive identification, because this ran counter to his controlling thesis that neither Mr Mulgrew nor the crew were quite sure as to the location of the aircraft. Mr Baragwanath, who as I have said heard the tapes in New Zealand, at Washington and at Farnborough, had this to say in the course of his final submissions:

> "The point is that there is no evidence that this flight crew was in doubt as to its position".

With that comment I entirely agree.

118. I think I should make it clear, although perhaps the point is obvious, that it requires no expert skill to listen to a tape recording. The expertise in this area lies in being able to play the tapes through special filters so as to make certain words and phrases more audible, if possible, than they were before. We found, when we heard portions of the tapes played through filters, that the filter mechanism did not achieve any great improvement in what could be heard when the tape was played without the aid of these devices. What the filters did was to make certain words and phrases rather more clear than as had first appeared, but there were very few cases indeed in which an indecipherable comment was made decipherable by use of the filters.

119. This view as to the limited assistance provided by the filtering apparatus is supported by some comments made to me by avionic experts from the Bendix Corporation in Florida when Mr Baragwanath and I were on our way to Washington. I had gone to see the Bendix experts, as will later appear, in order to inquire into a controversy as to whether the pilots of the DC10 could have seen the land mass of Mt. Erebus by reference to the aircraft's radar screen. But as well as discussing this theory, the Bendix experts made two observations about the CVR transcript which they had previously read. They first of all warned me

about the garbled nature of the taped version of anything that had been said on the flight deck from behind the pilots' seats for they had observed, by studying the chief inspector's report, that there were numbers of persons on the flight deck at different times. They said that one could place little reliance upon spoken words or phrases which were only partly decipherable. I said that I expected that the filtering devices in Washington and at Farnborough might clarify to some degree what had been said in the rear section of the flight deck, but the Bendix experts did not hold out much hope in this regard. They pointed out that filtered devices were only useful in eliminating to some extent background noise. Such devices in general either confirm, by the medium of increased clarity, what the listener thought had been said, or confirm the inherent unreliability of a transcript sought to be produced from listening to particular recorded comments and remarks.

120. Mr Davison, speaking in his final address on behalf of the estate of Captain Collins, and also as junior counsel for ALPA, was very critical of the use made by the chief inspector of this defective tape recording. It was his submission that the chief inspector had formed a preliminary view, never abandoned thereafter, that the aircraft had been flying in or towards diminished visibility during the latter stages of the flight, and that the flight engineers had become anxious about the situation of the aircraft and had expressed dissatisfaction with the decisions of the two pilots. Mr Davison submitted that the chief inspector had in effect edited the Washington transcript, as a result of his visit to Farnborough, and that the editing had in certain respects been controlled by that pre-determined belief of the chief inspector to which I have referred, namely the supposed reference to the weather being "thick" and a supposed connection between the use of the words "instruments" and the prevailing weather conditions.

121. Whilst paying due regard to the various transpositions which I have mentioned, and to the submissions of Mr Davison, I cannot agree that there was any deliberate attempt by the chief inspector to edit the Washington transcript so as to conform, so far as possible, with his own opinion as to the state of mind of the flight crew. In my opinion the chief inspector's rendition of the transcript represents a bona fide attempt on his part to reproduce what was said. But I find myself obliged to agree with the rather different proposition that the chief inspector adopted as being accurate certain remarks which I have already cited from the transcript when it was by no means certain whether those exact observations were ever made, and that he was persuaded to adopt that course because of his firmly held opinion that the crew had been uncertain of its position. That is to say, the chief inspector had a natural inclination to ascribe to remarks of doubtful meaning an interpretation which favoured his own theory because, believing as he did in the validity of that theory, he also believed that members of the flight crew must from time to time have expressed apprehensions. But as I say, I am satisfied that there was no deliberate editing of the transcript so as to conform with the chief inspector's opinion. All that happened, in my view, was that as a sequel to that prevailing opinion he was naturally inclined to construe a barely audible observation, which was capable of possible reference to apprehensions about the weather, as if the comments did in fact refer to the weather. This inclination to hear what the listener expects to hear is a familiar feature of the ordinary judicial process. It is a constant feature of Court proceedings when someone with an interest in the outcome is

testifying as to what he heard a party say, or as to what he thought that party meant by a comment which he made.

122. The CVR system installed in the DC10 and also installed in other aircraft manufactured in the United States is considered very unsatisfactory indeed by the Accidents Investigation Branch of the United Kingdom Department of Trade. British aircraft use a different cockpit voice recorder system. It is essentially the same system but is wired differently. Mr Tench and Mr Shaddick arranged for Mr Davis to play over for us a CVR recording involving a major incident with a British aircraft. We were able to hear without difficulty every word which was spoken by every person on the flight deck. It was even possible, if occasion required, to isolate the speech of one person and listen to that person alone. No electronic filters or other devices are necessary for the transcription of this type of tape recording. It can be transcribed by the simple process of a stenographer listening to the 30-minute tape and typing out its contents as they are spoken. A wholly accurate transcription can thus be produced within 40 minutes or less. Five days of debate and discussion, followed by a transcript partly based on guesswork, is not required.

123. There was also demonstrated in England to the chief inspector this vastly different CVR system and this is why at paragraph 5.13 of his report he recommends that the CVR circuitry on passenger-carrying aircraft be re-arranged to adopt the system which I have just described, and which the chief inspector refers to as the United Kingdom Civil Aviation Authority's "Hot Mike" system.

124. Broadly speaking, my conclusion with regard to the CVR transcript in the case of the fatal flight is that only limited reliance can be placed upon anything which is alleged to have been said by anyone on the flight deck apart from the two pilots, and it is indeed certain that such statements as can clearly be interpreted and identified as being made by people on the flight deck behind the pilots can not be construed as throwing any light on the state of mind of the pilots at any given time.

THE ORIGIN OF AND THE PLANNING OF ANTARCTIC FLIGHTS BY AIR NEW ZEALAND

125. In 1968 the airline was exploring the possibility of operating a limited number of services between New Zealand and the Antarctic for the purposes of carrying tourists, scientists, and other interested parties to that area. There were preliminary discussions on the project with the Director of Civil Aviation and some of his officers during 1969 concerning the appropriate consents needed for such flights, and at the same time technical investigations were being carried out by the airline into various operational features of the proposed flights especially the question of fuel requirements. These matters are referred to in the notes of a meeting held at the Head Office of the Department of Transport on 10 June 1969 (**Exhibit 75**) and the Antarctic Division of the Department of Scientific and Industrial Research was also involved in these discussions. Later in 1969 Captain Tredrea, who was Fleet Captain of the airline at that time, discussed the situation with the United States Operation Deep Freeze organisation in Christchurch. Captain Tredrea prepared a report and sent a copy to the Department of Civil Aviation. That report (**Exhibit 76**) contains a detailed appraisal of all operational features.

126. Between 15 and 22 November 1969 a visit was made to Antarctica by the present Director of Civil Aviation and Captain Spence, representing the Ministry of Transport, Captain Tredrea and Captain Grundy from Air New Zealand, and Mr G. Willetts from the Engineering Section of Air New Zealand. Captain Tredrea prepared a report dated 25 November 1969 (**Exhibit 77**) which summarised the essential results of that investigation. In the end the proposal to conduct this type of flight to Antarctica, which would have involved the use of DC8 aircraft intended to land on the ice runway, was abandoned. Time went by and in due course the airline acquired a number of DC10 aircraft. Towards the end of 1976 the airline became aware that QANTAS intended to conduct tourist flights which would overfly part of the Antarctic Continent early in 1977. Air New Zealand decided to institute a comparable service with their DC10 aircraft which had the fuel capacity to fly to Antarctica and back without having to land in Antarctica, the total estimated flying time being 11 hours. The proposed QANTAS flights were also known to contemplate flying to Antarctica and back without landing on the ice.

127. Captain Gemmell was at that time chief pilot of the airline and his immediate superior was Captain D. W. G. Keesing, Director of Flight Operations. Captain Keesing looked into the reports previously filed in relation to the 1969 inquiries, and then made an approach to Civil Aviation Division for consent to the flights. The first proposal was to take the flight to the South Magnetic Pole and return to Christchurch, but subsequently it was decided to proceed to McMurdo itself and to overfly McMurdo Station and Scott Base. Diplomatic approval for the flights was obtained by the Ministry of Foreign Affairs from the United States authorities. The airline had first requested approval from the Director of Civil Aviation to operate two DC10 charters on 15 and 22 February 1977, and these had been intended to operate in accordance with the first proposal, namely, a flight to the South Magnetic Pole. But it was later submitted to the Director of Civil Aviation that the overflight to McMurdo was preferable to the former proposal, and that the South Magnetic Pole destination should only be operated as an alternative if weather conditions were not satisfactory in McMurdo Sound. The Director of Civil Aviation was accordingly asked for approval to operate over the McMurdo Sound route, and by letter dated 19 January 1977 the Civil Aviation Division approved both alternative flights subject to compliance with certain operational conditions. Route feasibility studies had been made by the airline and it was clear that there was no operational difficulty in flying either of these routes. The appropriate Air Services Licence to operate the flights was obtained, and approval was also granted for the flights to make radio contact with specified stations en route to Antarctica and return.

128. On 4 February 1977 Captain Gemmell and Captain Grundy, together with Captain Young, an Airline Inspector with the Civil Aviation Division, attended a United States Deep Freeze briefing at Christchurch. This was not a full "briefing" in the technical sense. As I understand it, it was really a discussion with the American authorities, and involved the obtaining of information from the Americans relating to the routes to be flown, radio communication frequencies, search and rescue procedures, and meteorological conditions en route and at McMurdo Sound. There was discussion about weather conditions at McMurdo. The possibility of whiteout conditions was also discussed but because the flights were

planned to overfly the antarctic area the possibility of whiteout conditions, which were particularly applicable to landing operations, was not regarded as very significant.

129. I must now look at the documentation involved in the formal approach of the airline for approval of the initial flights to take place on 15 and 22 February 1977, pausing to observe that the first QANTAS flight to Antarctica took place on 13 February 1977. The initial approach to Civil Aviation Division was made by Captain Keesing, the airline's Director of Flight Operations. His first letter was dated 24 December 1976, and a copy was produced as **Exhibit 1/2**. This application involved the first proposed route to the South Magnetic Pole. The next letter is dated 18 January 1977 and is signed on behalf of Captain Keesing by Captain Gemmell. Permission was now sought to implement the alternative route to McMurdo Sound. In the context of setting out fuel calculations, it was stated that a full fuel load would be carried in order to "allow some flights at lower level—this to be completely at the captain's discretion having due regard to the operational conditions prevailing on the particular day". Captain Keesing's letter of 24 December 1976 had referred to proposed descent to 9000 feet (approximately 1000 feet above terrain) for flying over certain glaciers on the route from Auckland to the South Magnetic Pole and return. In these circumstances, I am not quite sure what was meant in the letter of 18 January 1977 by "some flights at lower level".

130. On 19 January 1977 the letter of 24 December 1976 was acknowledged by the Civil Aviation Division and approval was given for the two flights, subject to operational conditions which the division set out.

131. On 2 February 1977 Captain Keesing replied in detail to the Civil Aviation Division and he set out the proposed routing and flight plan information in respect of both routes. As to flight levels, Captain Keesing stated that there would be a flight level of 31 000 feet to Invercargill and thereafter optimum flight levels to Cape Hallett, and then "descending to maintain at least 2000 feet terrain clearance as permitted by excess fuel over mandatory reserves" and then climbing to flight level 35 000 to 39 000 feet for return to Christchurch. I should here interpolate that the reference to 2000 feet terrain clearance was based upon Regulation 38 of the Civil Aviation Regulations 1953. The relevant provisions of Regulation 38 are clauses 1, 2, 2A, and 4, which are as follows:

> Regulation 38 (1) Subject to the provisions of these Regulations no aircraft shall be flown over any city, town, or populous area except at such altitude as will enable the aircraft to complete a safe landing should engine failure or other cause necessitate a forced landing.
>
> (2) Without limiting the provisions of subclause (1) hereof, no aircraft shall be flown over—
>
> (a) Any city, town, or populous area at a lower height above the area than 1000 feet; or
>
> (b) Any other area at a lower height above the area than 500 feet.
>
> (2A) A height specified in subclause (2) hereof is the highest point of the terrain or any other obstacle thereon, within a radius of 2000 feet of a line extending vertically below the aircraft.

(4) No aircraft, unless landing or taking off, shall be flown in accordance with instrument flight rules at a lower height than 1000 feet above the highest obstacle located within 5 nautical miles of the estimated position of the aircraft in flight:
Provided that in areas of mountainous terrain a clearance of at least 2000 feet shall be maintained.

132. There was to be an attendance by the pilots-in-command of both proposed flights at the Christchurch headquarters of the United States Operation Deep Freeze where there would be a briefing on 4 February and, in addition, the airline intended to conduct a navigation briefing which would involve navigation and compass procedures. Further, arrangements were completed for an Airline inspector to accompany the flight as an observer.

133. The first Air New Zealand flight to Antarctica then took place on 15 February 1977. The pilot-in-command was Captain Gemmell and his co-pilot was Captain A. A. E. Lawson who was at that time the airline's route clearance briefing officer. He was scheduled for the flight so as to prepare an Air New Zealand Route Clearance Antarctica brief for later flights should they become a regular occurrence. Also present on the aircraft was Mr W. K. Amies, who at the time was a flight navigator with the airline and as from March 1977 became navigation services officer. Mr Amies had very extensive experience in all aspects of navigation, including the grid navigation procedure to be followed in the antarctic. He had also been navigation consultant for several overseas airlines in connection with the AINS system of navigation. The prime purpose of the attendance of Mr Amies on the flight was to check the accuracy of the AINS equipment by overflying the destination point of the flight, which was the non-directional beacon (NDB) located near McMurdo Station. At the conclusion of this flight Captain Spence, who had been on board as the airline inspector for the Civil Aviation Division, prepared a report as to the conduct of the flight and his report described the operation as satisfactory in all respects. In particular he referred to the accuracy of the AINS equipment. He said in his report that the accuracy of this navigation system in polar regions was established on the return flight when the inertial navigation system differed by only 3 nautical miles after a flight of over 3000 nautical miles without any radio update into the AINS.

134. The next flight of 22 February 1977 was commanded by Captain Grundy. His first officer was Captain Caudwell and the senior flight engineer was Mr Gordon Brooks who was on Flight TE 901 on 28 November 1979. In addition to having been to the Deep Freeze briefing at Christchurch with Captain Gemmell on 4 February 1977, Captain Grundy had attended a briefing conducted by Captain Gemmell and Mr Amies. Both Captain Gemmell and Captain Grundy testified before the Commission that on the occasions of their respective flights a minimum altitude of 16 000 feet was maintained in the McMurdo area before climbing to cruising altitude for the return to Christchurch and in each case the evidence was that the aircraft descended to 16 000 feet upon approaching McMurdo and flew over Mt. Erebus on nav track on a point just to the west of the peak.

135. I should here pause to say that there was evidence before the Commission to suggest that neither of these flights maintained a flight level of 16 000 feet over McMurdo and that Mt. Erebus was not in fact overflown. At this point, it is relevant to consider the difference between

the minimum safe altitude of 16 000 feet said to have been adopted by Captain Gemmell and Captain Grundy on their two flights of 15 and 22 February 1977, and the detailed operational conditions which had been sent by Captain Keesing to the Director of Civil Aviation on 2 February 1977. As will be recalled, Captain Keesing had indicated that there would be maintained at least a 2000 feet terrain clearance. There is not on record any written reply from the Civil Aviation Division to Captain Keesing in relation to his letter of 2 February 1977. However, Captain Gemmell, who was his immediate subordinate, had evidently arranged with the Civil Aviation Division a minimum safe altitude of 16 000 feet for the first flight which took place only 13 days after Captain Keesing's letter to Civil Aviation Division. The evidence before the Commission later disclosed that Captain Keesing, although Director of Flight Operations, never became aware that his proposed 2000 feet terrain clearance had been superseded by a Minimum Safe Altitude of 16 000 feet, and this gave rise to specific evidence by Captain Keesing at a later stage at the hearings of the Commission.

136. On 10 August 1977 Captain Gemmell, in his capacity as chief pilot, wrote to the Civil Aviation Division requesting approval to operate five DC10 charter flights to McMurdo on 18 and 25 October 1977 and 1, 8, and 17 November 1977. His letter (**Exhibit 1/8**) then went on to say:

> "The flights will be operated to the specification earlier submitted and approved in January 1977, with the following exception.
>
> It is proposed to permit descent to 6000 feet QNH in VMC conditions, or by the approved NDB procedure in IMC conditions, provided that:
>
> (1) Cloud base reported 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 area.
>
> 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.
>
> Flight in the McMurdo area below Flight Level 160 will be restricted to an arc corresponding to a bearing of 120° G through 360° G to 270° G from the NDB within 20 nms in order to keep well clear of the Mt. Erebus region."

137. As will be observed, it was now proposed by Captain Gemmell that minimum safe altitude was to be 6000 feet subject to the conditions referred to in his letter. There is reference in the last paragraph of his letter to the area within which the descent to 6000 feet would be authorised, and this refers to an arc with a radius of 20 miles situated immediately to the south of Scott Base.

138. Approval of these flights was duly given, and they were all carried out on the specified dates.

139. On 19 September 1978 the airline made a further application for approval for four flights in November 1978, indicating that the same crew training and operational procedures would be carried out. Civil Aviation Division also approved this proposal. As from 1 April 1978 Captain Keesing had retired from his position as Director of Flight Operations but was still employed by the airline as a consultant. On 27 September 1979 the airline again wrote to the Director of Civil Aviation asking for

approval for further flights to take place on 7, 14, 21 and 28 November 1979, and it was proposed to operate over the same routes as the previous year, utilising the same crew briefing, training and en route procedures.

140. On 3 October 1979 the Civil Aviation Division granted approval for these flights but in a supplementary paragraph reminded the airline that no reply had been received regarding a letter which the Division had sent to the airline on 9 August 1979 raising the question of the carriage of life-saving equipment in terms of the requirements of Annex 6 to the ICAO Convention.

141. On 10 October 1979 the airline replied to the effect that the carriage of survival suits was not warranted as there was no intention of landing at McMurdo airfield. However the mater of survival equipment continued to be informally discussed between the airline and the Civil Aviation Division up to November 1979.

142. As stated previously, approval had been obtained from the Americans who controlled the air space over the McMurdo area for these commercial overflights, and on 13 October 1977 the Commander of the United States Naval Support Force in Antarctica had notified Civil Aviation Division of certain limitations on aircraft aids at McMurdo. It had been pointed out that United States Navy weather forecasting was not provided for the benefit of commercial carriers, and that reported weather might not be reliable, with the result that any action taken by a civil airline in response to a McMurdo weather report would have to be the responsibility of the pilot-in-command. Apart from the foregoing, there seems to have been no further communication or liaison with the United States Naval Support Force in Antarctica with regard to these Antarctic flights except that in 1979 the United States authorities in Antarctica advised that the non-directional beacon (NDB) situated near McMurdo Station had now been withdrawn. As a result of this information Captain R. T. Johnson, on 8 November 1979, issued for the crew briefing sheets in respect of further antarctic flights, the following memorandum:

"McMURDO NDB NOT AVAILABLE:

Delete all reference in briefing dated 23/10/79. Note that the only let-down procedure available is **VMC** below FL 160 to 6000 feet as follows:

1. Vis. 20 km plus.
2. No snow showers in area.
3. Avoid Mt. Erebus area by operating in an arc from 120° Grid 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."

On 22 November 1979 Captain Omundsen of the Civil Aviation Division spoke to Captain Grundy by telephone and told him that reports had been received from the United States authorities at Antarctica that civil aircraft had been observed at lower than normal altitudes and at 1000 feet above glaciers.

143. After the occurrence of the disaster Captain Omundsen wrote to the Director of Flight Operations for the airline on 24 December 1979 in the following terms:

"It has been brought to my attention that news media reporting of previous antarctic DC10 flights operated at altitudes lower than 6000 feet in the vicinity of McMurdo.

Mr Thomson of DSIR is reported as having been on board an aircraft which operated at a height of 1500 feet above ground level. In addition, the news media also report other passengers as having been carried in the McMurdo area at altitudes of about 1000 feet.

It is noted that there is no mention in the captains' reports of such low altitude operations. You will recall that a report of low altitude operation was discussed with you by the writer of this letter on the 22 November 1979.

Such operations are contrary to the conditions of antarctic operations approval granted by this Ministry and your comments upon the circumstances related to such operation is requested."

On 11 January 1980 he received a reply from Captain Grundy, which reads as follows:

"I refer to your letter of 24 December 1979 (reference 98/4/76) in this matter, and in particular to your comments on the telephone conversation of 22 November last between Mr Omundsen and the writer.

Your concern during our telephone conversation was directed at separation from future helicopter operations and you offered no specific information of previous flights descending below 6000 feet on which I could inquire further.

Subsequent to our conversation I made arrangements for Captain Spence to be rostered on the next antarctic flight as you requested, and confirmed with the Flight Manager Line Operations that 6000 feet was still the minimum altitude specified in the briefing in case a change had been made with which I was unaware.

I have no personal knowledge of operations at the altitudes referred to in media reports and therefore I am unable to comment on the matter."

144. As will be observed, it was the opinion of Captain Grundy that this telephone conversation, six days before the fatal flight, was meant by Captain Omundsen only to emphasise the necessity to separate civil aircraft from low-level helicopter operations, and that Captain Omundsen did not make any point of the apparent breach of the MSA of 6000 feet. However, Captain Omundsen told me in evidence that on 6 November 1979 he discussed with Captain R. T. Johnson the recent information that the NDB was now not available, and he produced his file note of this conversation (**Exhibit 1/22**) which terminates with the following observation:

"ANZ will descend below safety height of 16 000 feet only in VMC conditions with no snow showers and with at least 20 km visibility. No descent below 6000 feet."

This, of course, is in accord with the notification issued by Captain Johnson three days later, to which I have already referred. But the reason why Captain Omundsen referred me to his above-quoted file note was for the purpose of corroborating what he said had been the reason for his conversation with Captain Grundy 16 days later, namely that there had been a report of an aircraft flying below 6000 feet. I have difficulty, however, in accepting that Captain Omundsen's file note has any corroborative effect in the manner suggested. His file note is only recording what Captain Johnson told him. It has no apparent connection at all with his later conversation with Captain Grundy.

Captain Omundsen signed on 23 November 1979 a file note of his conversation of the day before, and this file note was produced as **Exhibit**

1/25. This refers to the report that civil aircraft had been flying at 1000 feet above glacier level. Captain Omundsen's file note makes no reference at all to any criticism by him of flights below the official MSA of 16 000 feet or 6000 feet.

145. In these circumstances I am left with Captain Grundy's recollection that Captain Omundsen's telephone call of 22 November 1979 did not refer to any purported breach of the MSA rules but was only concerned with safety to helicopter traffic in the McMurdo area. I think I am obliged to take the inference that if Captain Omundsen had previously been unaware of descent below 6000 feet in the McMurdo area, then he would have constructed a file note on 22 November 1979 recording not only the transmission of the "low flying" information to Captain Grundy but also recording a request for an immediate explanation from the airline as to why flights were apparently being permitted under 6000 feet. He did ultimately ask for such an explanation but not until after the disaster. I shall deal with the point at a later stage as to whether Civil Aviation Division had any information or knowledge that the minimum safe altitude of 16 000 feet and 6000 feet were not in fact being complied with for, as I shall indicate when dealing with the question of MSA, all the Antarctic flights which went to McMurdo in the summer of 1977, in 1978 and in 1979 in fact flew at altitudes well under the minimum MSA of 6000 feet.

146. I must now pay some attention to certain features of these minimum safe altitudes which are summarised, together with the conditions of descent, in Captain Johnson's memorandum of 8 November 1979 already quoted. In the first place, the track of an aircraft which had descended to the minimum flight level of 16 000 feet on the approach to McMurdo was aligned on a direct course from Cape Hallett to the NDB located near McMurdo Station. This track took the aircraft over the peak of Mt. Erebus on a line about 2 miles to the east of the summit. Then the pilot-in-command, after this overflight of the mountain, was authorised to descend in VMC conditions to 6000 feet in the nominated sector to the south of the mountain, subject to the conditions in Captain Johnson's memorandum and, of course, they had been the operative conditions since August 1977. Then the pilot-in-command was authorised (in terms of what apparently was verbal approval from Civil Aviation Division) to fly away from McMurdo, along McMurdo Sound, at an altitude of 10 000 feet so as to give passengers a lower altitude view of the Admiralty Range to the west of the aircraft. Subsequently the aircraft would then ascend to its cruising level of 30 000 feet and higher as it returned to New Zealand. But in relation to the alternative route involving an overflight of the South Magnetic Pole, Civil Aviation Division had approved the original request of Air New Zealand for a minimum terrain clearance of 2000 feet and in this area the aircraft would, of course, be flying over mountainous terrain.

147. With these factors thus isolated, the following considerations come to mind:

(a) The aircraft was programmed to fly over an active volcano with a clearance of 3500 feet between the aircraft and the eastern edge of the crater. The volcano continuously discharges steam from the crater, and the height of the plume of steam will vary according to wind conditions. Photographs were produced to the Commission demonstrating the steam rising to a height of 5000 feet or more. On any view, this decision to programme the track of an aircraft over an active volcano seems indefensible. Apart altogether from the safety

aspect, only those passengers with a view to the right would obtain any photographs of the unique view, at close quarters, of the crater. Mr Amies, in his Brief of Evidence, first stated that the track over the volcano was only for "planning purposes" but when he gave evidence on the following day he qualified that statement—which had appeared in a very carefully prepared brief—by then stating that the flight track had been determined for "flight planning purposes". In addition, it was also disclosed during the course of the evidence that flight crews were authorised to depart from this track. In the final result therefore there was in reality no planned flight track to McMurdo.

(b) The limitation of descent to 6000 feet over the defined sector to the south of Mt. Erebus was said to be based upon a clearance sufficient to avoid the highest point of the Black and White Islands situated at the south of that sector, namely, Mt. Aurora which is 3000 feet high. It will therefore be observed that the terrain clearance over Mt. Erebus was 3500 feet but that the terrain clearance over Mt. Aurora was 2500 feet.

(c) Approval by Civil Aviation Division to fly out from the Scott Base area at 10 000 feet over the Ross Sea is not recorded in writing but evidently was regarded as an officially approved MSA for this sector. It will be noticed that whereas the MSA over the Ross Sea whilst flying towards Ross Island in VMC was set at 16 000 feet, nevertheless the MSA whilst flying the return route in VMC over exactly the same area of flat sea and pack ice was 10 000 feet.

(d) Official authority to over-fly the mountainous terrain of the South Magnetic Pole at 2000 feet may usefully be contrasted with the previous requirement that flight over the flat surface of the Ross Sea was not to be lower than either 16 000 feet or 10 000 feet.

148. I am driven to the conclusion that these officially approved minimum safe altitudes, which at the hearing were asserted in the most adamant fashion by the airline and by the Civil Aviation Division to have been applicable to all flights to Antarctic, were unrealistic, and incapable of any logical justification, and that the various altitudes were mutually inconsistent. In the event, these altitude limits were later disregarded by the airline, and in my opinion justifiably so. I think I must go further and say that the original decision to overfly Mt. Erebus and the NDB at 16 000 feet has every appearance of being an initially designated track and altitude devised (as Mr Amies said before he amended his evidence) for planning purposes only, the idea being to check the accuracy of the AINS in polar regions and, in general, to allow the airline's chief pilot and the civil aviation division's airline inspector and an expert navigator (Mr Amies) to survey the entire area. As the evidence disclosed, the programmed flight track direct from Cape Hallett to the NDB was almost immediately departed from, with the express authority of the airline, and on all flights after the second flight in February 1977 the 16 000 feet clearance over the Ross Sea and the 6000 feet clearance over the area to the south of Ross Island were each disregarded with the express authority of the officer conducting the briefing of the crews for these flights.

149. In my opinion there were a number of deficiencies in the planning of these flights. They were:

(a) The initial flight plan with its direct track over Mt. Erebus and with its minimum safe altitudes of 16 000 feet and 6000 feet was retained as the airline's official approach procedure to McMurdo when, as

from mid-1977, its inept and unjustified criteria were departed from by pilots with the express authority of the airline.

(b) The United States Naval authorities at McMurdo were never appraised of the official flight path, or of the minimum safe altitudes officially adopted by the airline and Civil Aviation Division.

(c) There was no adequate consultation with the United States Navy authorities as to the most appropriate approach route to McMurdo or as to the exact functions and capacities of the navigation aids located at McMurdo.

(d) The Royal New Zealand Air Force, which had many years of experience of flights in the antarctic area, was not consulted as to appropriate briefing of crews or as to the exact nature of weather conditions in Antarctica.

(e) There was a complete misapprehension on the part of the airline as to what was meant by "whiteout". When a visit was made to Antarctica in November 1969 by officials of the Civil Aviation Division and by Captain Tredrea and Captain Grundy from Air New Zealand, they were told about the special "whiteout" landing area at McMurdo and they understood, quite correctly, that this emergency landing area was for use when strong winds filled the atmosphere with fine particles of dry snow so that an aircraft coming in to land was flying in conditions equivalent to thick cloud. This is the reason why Captain Johnson, in his memorandum of 8 November 1979, repeated as one of the criteria for a let-down procedure to 6000 feet the condition that there should be "no snow shower in the area". No one in the airline appears to have discovered the nature and insidious dangers of that variety of "whiteout" which occurs in perfectly clear air under conditions which I have mentioned before. Yet this latter information was in the possession at all times of the Royal New Zealand Air Force and the United States Naval Support Force in Antarctica.

(f) Although it seems that the airline was aware of the requirements by the Royal New Zealand Air Force and the United States Navy that no pilot could command a flight to Antarctica unless he had flown in the area previously, such a requirement was not implemented as from the summer 1977 flights onwards, even though a flight familiarisation requirement is in fact contained in the airline's operations specifications.

(g) The direct track of the aircraft planned for the initial flight was from Cape Hallett and across Ross Island (as I have said, overflying Mt Erebus) and then overheading the non-directional beacon (NDB) situated near McMurdo Station. This flight path had special disadvantages in addition to those already mentioned, in that it was not adequately related to the navigational aids at McMurdo. The ground navigation aids were the non-directional beacon (NDB), a tactical air navigation system (TACAN) which could be interrogated by the aircraft's distance measuring equipment (DME) so as to ascertain its distance from the TACAN (as opposed to the distance from the destination waypoint inserted into the aircraft's own computer navigation system). In addition, there was the radar installation situated at the ice runway, and there was radio communication which consisted of high frequency (HF) transmissions from Mac Centre and very high frequency transmissions (VHF) from the Ice Tower.

The principal defects of this first flight path in relation to the ground navigation aids were in connection with the radar and radio transmissions. The radar was equipped with an IFF mode which could locate the position and bearing of an aircraft at ranges of up to about 150 miles but it could not be used as a basis for air traffic control. Its only use was to identify the approaching aircraft. When the radar was switched on to its primary ASR mode, meaning thereby its aircraft surveillance function, it could pick up on its screen an aircraft within an approximate range of 40 miles. However, the ASR mode of the radar was only operative on a line of sight basis. In respect of radio transmissions, HF is not dependent upon line of sight and has a very extensive range, but HF radio traffic in the Antrctic area is notoriously erratic and liable to disruption and black-out under various weather and atmospheric conditions. VHF transmissions are relatively short range with an average of about 150 miles. VHF contact is far superior to HF since VHF transmissions are typically free from atmospheric static interference. But VHF transmissions are dependent upon line of sight. It follows from this that if an aircraft approached Ross Island on the track which was programmed for this first flight piloted by Captain Gemmell, then because of the height of Mt. Erebus the aircraft, if approaching at 16 000 feet, would suffer radar and VHF radio black-out for 20 or 30 miles until it arrived over the summit of the mountain.

(h) The agreement between the airline and Civil Aviation Division in August 1977 for an authorised let-down to 6000 feet in the designated sector south of Ross Island was regarded by the Americans, when they found out about it after the disaster, as quite impracticable. In the view of Chief Warrant Officer Priest, who was chief traffic controller and Mac Centre Supervisor during the 1979/80 season, this 6000 feet sector was "absurd" because of the inability of radar control in that area. The United States authorities at McMurdo were never advised of any officially approved Civil Aviation Division flight plan or descent approach and they would have opposed from the outset the direct approach to Mt. Erebus and the subsequent 6000 feet descent clearance behind Ross Island.

150. The visit to Antarctica which was made in November 1969 by the officials whom I have described no doubt persuaded them, and I think quite correctly, that there was nothing inherently dangerous in flying in the McMurdo area in perfect weather conditions. The planning evidence disclosed, however, for reasons which I have already indicated, a serious lack of proper inquiry into the weather hazards. But the principal defect in the planning, in my opinion, was the decision to adhere to the track and flight level set for the first flight and then amended in August 1977 so as to provide for the 6000 foot minimum safe altitude under the specified conditions. As I have said, the United States authorities were at no time advised of these official flight levels and would not have approved of them. As will later be described, the airline itself very quickly abandoned the MSA requirement of 16 000 feet and 6000 feet and in my opinion was justified in doing so. But there still remained, as a matter of official record between the Civil Aviation Division and the airline the MSA levels of 16 000 feet and 6000 feet together with a flight path from Cape Hallett direct to McMurdo Station. The airline should have realigned the official flight path down the military route so as to bring aircraft down the middle

of McMurdo Sound, and should have obtained Civil Aviation Division approval, which would have been automatic. In addition, these artificial flight levels of 16 000 feet and 6000 feet should have been amended so as to permit a flight in VMC conditions down the military track at heights between 1500 feet and 6000 feet. Again, there could not have been the slightest ground for Civil Aviation Division to object to those altitudes as they would have fully complied with Regulation 38 of the Civil Aviation Regulations. The United States authorities would have approved, without question, these flight data.

151. In the final result, the omission to obtain official approval for altered flight data of this kind made no difference because, as will be shown, the airline informally varied the track and varied the altitudes in the very manner which I suggest it should have done on an official basis. But because the flight levels of 16 000 feet and 6000 feet and the flight path over Mt. Erebus still remained as part of the official approval of Civil Aviation Division as at 28 November 1979, both the airline and Civil Aviation Division immediately seized upon these official conditions as being the vital factor in the disaster. From the point of view of both organisations they could obtain, so they believed, absolution from their own numerous errors by merely ascribing the disaster to a failure by Captain Collins to observe a minimum flight level of 16 000 feet. This was the principal basis of the case for Civil Aviation Division and, as will be seen from what I have already written, it was in my view a basis without any justification whatever.

THE BRIEFING PROCEDURES FOR ANTARCTIC FLIGHTS

152. Regulation 77 (l) (a) and (b) of the Civil Aviation Regulations (which came into effect by way of amendment of previous provisions as from 12 February 1979) reads as follows:

"77. Route and aerodrome qualifications of pilot in command—

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

(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 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."

153. A method adopted by airlines throughout the world of making pilots familiar with the details of scheduled routes and landing procedures at the termination of such flights, is not only to require pilots to fly those routes as observers prior to acting as pilot-in-command on any such flights, but also to brief pilots by means of audio-visual presentation of the various data required to be known and accompanied if necessary by exercises in an aircraft simulator which will be related to the operational procedures of the flight in question.

154. In Air New Zealand there was established a Route Clearance Unit (RCU) which was under the control of the airline's Flight Operations Division, and the supervisor of this unit was charged with the responsibility of adequately briefing crews by medium of the audio-visual material and simulator training to which I have referred. Broadly speaking, the content of the audio-visual presentation will be a prepared script describing the main features of the flight and this will usually be produced by a tape recording which has been duly prepared for that purpose. Then at suitable intervals during the oral description, slides will be shown upon a screen and for the most part they will contain photographic representations of different aspects of the flight and in particular of the destination waypoint. At the conclusion of the audio-visual presentation there will be oral elaboration by the supervisor of relevant aspects of the prepared text. The simulator exercise will be devoted to whatever are the special operational requirements, in particular, the settled approach and let-down procedures at the airport of destination. Copies of the prepared text of the presentation will be distributed to crew members for their retention and use on the flight. These are called "briefing documents." In the case of Air New Zealand, the Route Clearance Unit was established in about 1974 and the purpose was to provide to crew members more comprehensive information than could be obtained merely by a previous flight under supervision over the route in question. A quantity of material, including photographs, was collected so as to form the basis of RCU briefings for the various scheduled routes of the airline.

155. There was no official supervisor of the Route Clearance Unit until 1 April 1977 when that position was given to Captain A. A. E. Lawson whilst he was still a DC10 captain. He supervised the RCU on a part-time basis until 1 January 1978 when Captain J. P. Wilson (who had retired from operational flying) was appointed full-time Route Clearance Unit supervisor.

156. When it was decided to start operating antarctic flights, Captain Lawson was directed by the chief pilot to travel on the first flight for RCU purposes. Captain Lawson therefore travelled on the first flight as co-pilot. After the first two antarctic flights in 1977, Captain Lawson began assembling an RCU antarctic brief. He obtained various photographs of Antarctica from the publicity section of the airline, and eventually selected certain slides thought suitable to depict the general topography of the area. Captain Lawson also prepared written material which was subsequently recorded and used in conjunction with the display of the slides.

157. When the new MSA of 6000 feet was decided upon in mid–1977, the procedure and the sector of permitted descent was based upon the high level NDB approach procedure used by the United States Navy aircraft. On the third flight of 1977 the amended 6000 feet procedure was now operative and Captain Lawson went on that flight and instructed

that further photographs be taken. Captain Lawson said in evidence that so far as these photographs were concerned he was concentrating in the main upon areas showing the local terrain in the safe descent sector at McMurdo, to the south of Ross Island.

158. As I have already stated, an audio-visual presentation is normally aimed at a specific airfield with particular reference to approach procedures, runways, navigation aids and the like. However, in the case of the antarctic programme no landing was intended and accordingly attention was paid during the presentations to matters such as minimum safe altitudes in flight, the details of the 6000 feet let-down procedure, alteration of altimeters so as to provide for the different atmospheric pressure in Antarctica, and there was also the very important question of conversion of compasses to the grid system of navigation.

159. This reference to grid navigation requires some explanation. At the point where the meridians of longitude reach the Pole they are, of course, all joined together and the distance between each has been progressively narrowing. If an aircraft is approaching the South Pole, it will be travelling south but the moment it has overflown the Pole it will then be travelling north. The grid system of navigation is designed to get over the unsatisfactory communication consequences of an aircraft theoretically changing its heading by 180° whilst still flying on a straight course. Grid headings supplant true headings in all areas south of 60° latitude by providing only one north and south direction which will apply over the whole of the polar area. The substitution of grid headings for true headings therefore has the effect that an aircraft on a heading of true south as it approaches Antarctica will have a grid heading of true north. In order to ascertain a grid heading, the crew adopts a meridian of east longitude and adds thereto 180°. The result therefore is that if the aircraft is flying on a heading parallel with 166° east longitude, then its true heading will be 166° but its grid heading will be 346°.

160. All McMurdo radio transmissions referring to aircraft headings are supplied in grid form, therefore one of the main purposes of an RCU Antarctica briefing was to demonstrate, both by speech and by slide representations, and by simulator exercises, the method of adjusting the compasses of the aircraft to grid navigation. The RCU briefings given to Antarctica crews were quite clearly accurate in respect of these technical requirements of compass alterations and the resetting of altimeters, but it was the opinion of the Chief Inspector of Air Accidents, when he examined all the RCU briefing material, that it contained sundry deficiencies. I agree with all that he has said on this subject in paragraph 1.17.2 of his report. The items not included in the briefing and which in the opinion of the chief inspector ought to have been included, were as follows:

(a) The authority of the United States Navy's antarctic Air Traffic Control 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), 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 condition, which might be anticipated with overcast sky and snow covered terrain below.

(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.

161. In addition, as the chief inspector went on to say in a succeeding paragraph, there were provided at these briefings two charts and a slide depicting a schematic diagram which each showed a track proceeding down McMurdo Sound. This was in conflict with a reference in the recorded text of the briefing to the actual latitude and longitude co-ordinates of McMurdo Station as being the destination point of the flight, and in view of the fact that the briefing described a track direct to McMurdo, then these three diagrams were of course, in conflict with the theoretical Cape Hallett/McMurdo track to which the briefing referred.

162. In addition to these inadequacies revealed in the report of the chief inspector, there were two other features of the antarctic briefings which were unsatisfactory. In the first place there was no photograph showing pilots a general view of McMurdo Sound and Ross Island as the aircraft approached from the north. This is of particular significance in view of the fact that the McMurdo area bears little relationship to what might be expected to be observed from a topographical map of the area. The other deficiency was that the briefing did not include a topographical map of the area upon which the flight planned track from Cape Hallett to McMurdo had been imposed. Such a map would have indicated to pilots the precise course to which the nav track of the aircraft would take them.

163. Additionally, as indicated by the chief inspector at paragraph 1.17.6, there were two mistakes in the slides which were shown. One slide purported to show Cape Hallett whereas in fact it was a slide of Cape Adare located 73 miles north-west of the Cape Hallett waypoint. The second slide showed a view of Mt. Erebus and was accompanied by the statement that the aircraft was "Now approaching Erebus at 16 000 feet the minimum sector altitude". However, the photograph of the mountain had been taken from the true south of Mt. Erebus and not from the true north, and the result was that a view of this photograph showed Mt. Erebus over to the left of the direction in which the aircraft was heading. This error accordingly coincided with the McMurdo Sound approach depicted by the three diagrams to which I have previously referred. As to the simulator exercise, this did not give the pilot any view of the terrain to be observed on the flight. It was programmed as if the flight was being made at night time. This is because the airline's DC10 flight simulator is only programmed to the night lighting of an aerodrome, and in the case of antarctic briefings the position of the runways at Williams Field were shown in the distance as two intercepting lines of lights. The simulator instruction adequately covered the compass and navigation conversion procedures already referred to. The evidence given by Captain Wilson

and by Captain Johnson as to the verbal content of the RCU briefing was not accepted by the majority of the pilots who attended the briefings. Indeed, there was one pilot who said that upon listening to the evidence given before the Commission in relation to the briefing which he had attended, he was led to wonder whether he had been at the same briefing.

164. The RCU briefing for antarctic flights was primarily inadequate, in my opinion, in that—

(a) The co-ordination of the United States Navy air traffic control system with the proposed overfly was not properly explained.
(b) The pictorial representations showed the observers that the flight path was down McMurdo Sound and these displays would, not unnaturally, take precedence over the spoken words indicating a direct track from Cape Hallett to McMurdo Station and indicating the NDB co-ordinates as the destination waypoint.
(c) The dangers of flying over uniformly white terrain under an overcast sky were not directly referred to.
(d) The prepared text of the briefing and the constant reference to minimum safe altitudes of 16 000 feet and 6000 feet were verbally contradicted by Captain Wilson in the 1978 and 1979 flights by indicating to the crews that they were authorised to descend to any altitude approved by the United States Navy Air Traffic Controller, and it is significant to point out that at the time when the chief inspector signed and published his report, he had not been told by Captain Wilson, or by anyone else, that this specific authority was orally given to flight crews during the course of the audio-visual presentation to which I have referred. Captain Wilson admitted this. (T. 1236).
(e) Captain Wilson, the supervisor of the RCU briefing procedures, had not flown to McMurdo Sound. He had applied to go on such a flight, so as to improve his knowledge of antarctic conditions, but his application had been declined by Flight Operations Division.
(f) Most important of all, crews were not shown a topographical map with the nav track plotted thereon.

THE "WHITEOUT" PHENOMENON

165. The term "whiteout" has more than one meaning as being descriptive of weather conditions in snow-covered terrain. For aviation purposes it is often described as the cause of the visual difficulty which occurs when an aircraft is attempting to land during a snowstorm. As already stated, the United States Navy maintains a special whiteout landing area situated to the south of its normal landing strips near McMurdo Station. This area is used when an aircraft, which is committed to a landing, is required to land when visibility is obscured by a snowstorm. The snow in Antarctica is perfectly dry, and a wind of only 20 kilometres can sweep loose snow off the surface and fill the air with these fine white particles. A landing on the special whiteout landing field can be accomplished only by an aircraft equipped with skis or, in the case of an aircraft without skis, then it must make a belly-up landing on this snow-covered emergency airfield. Flying in a "whiteout" of that description is no different from flying in thick cloud. The pilot cannot know where he is and must land in accordance with strict radio and radar directions. So far as I understand the evidence, I do not believe that either the airline or

Civil Aviation Division ever understood the term "whiteout" to mean anything else than a snowstorm. I do not believe that they were ever aware, until they read the chief inspector's report, of the type of "whiteout" which occurs in clear air, in calm conditions, and which creates this visual illusion which I have previously described and which is, without doubt, the most dangerous of all polar weather phenomena.

166. The chief inspector looked carefully into this variety of whiteout because as his inquiry proceeded it became apparent that although the aircraft was flying in clear air, not one of the five persons on the flight deck ever saw the mountain side with which the aircraft collided. It was quite apparent that the air crew had been deceived into believing that the rising white terrain ahead was in fact quite flat and that it extended on for many miles under the solid overcast. As a result of his investigation, the chief inspector described (at paragraphs 1.17.46 to 1.17.58) the characteristics and the supposed atmospheric causes of this visual phenomenon. His narrative consists of extracts from a special paper prepared on the subject by Robert B. Boswell, an airman who has carefully studied the phenomenon and whose paper is backed by 12 bibliographical references. Here is the opening extract from Mr Boswell's paper, a copy of which was produced as **Exhibit 44**.

> "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 whiteout, a diffuse shadowless illumination and a mono-coloured white surface. Whiteout, it must be emphasised, is not 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.
>
> 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, and horizon discrimination is lost and the ground plane disappears.
>
> Those who have not been exposed to whiteout are often skeptical 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)."

167. The reasons for the phenomenon are perhaps not of special relevance in the context of the present Inquiry. I am more concerned with the existence and operation of this dangerous visual illusion in polar regions and in all regions where there is snow-covered terrain over which aircraft are required to fly. However, it might perhaps be said that the reason for the disappearance of any deviation in ground level under whiteout conditions is considered by scientists to be due to a complex process of light diffusion. The theory is that a large percentage of the light which penetrates the cloud cover is reflected back from the ground because it strikes the myriads of ice mirrors formed by the ice crystals which are tilted in all directions on the surface of the snow. The light rays are thus deflected upwards and meet the white under-surface of the cloud and then reflect back again. This process of transmission and reflection is believed to be the reason why the forward vista of a uniform white surface, even though quite plainly visible in crystal clear air, will appear uniformly

flat even though the terrain may be undulating or tilted upwards on a steadily rising plane. There have been occasions when this spectacular illusion will prevail even though the foreground, as indicated in the previously quoted extract, contains small dark-coloured objects. But, without doubt, the illusion becomes totally deceptive when there are no dark points in the foreground to afford elements of contrast. Under such conditions aircraft accidents in polar regions and in snow-covered terrain are very common.

168. There was produced in evidence a survey of aircraft accidents in Antarctica during the period when the United States Support Force has been operating there. This is **Exhibit 39.** It analyses aircraft losses in the United States Antarctic Programme from 1946 to 1973. There were in this period a total of 50 aircraft losses in Antarctica and, in a large proportion of cases, these casualties were attributed to loss of horizon or ground definition by reason of the whiteout phenomenon which I have been describing. There were, of course, in addition to the 50 lost aircraft, a great many more incidents in which aircraft were badly damaged. In Mr Boswell's paper, it was estimated that in Antarctica between 1950 and 1960, whiteout was a contributory factor in 40 percent of the 25 flying accidents which occurred during that period. He says that in Canada during the snow-covered months, probably 8 to 10 crashes per annum are in part or completely due to whiteout and that a further 4 or 5 cases per annum of aircraft damage resulting from heavy landings are caused by the same phenomenon.

169. Where there is a solid layer of overcast and snow-covered terrain ahead, then the only effective protection against inability to detect rising terrain will be some large and distinctive dark landmark of either artificial construction or of natural geographical occurrence. In such a case the pilot then has a point of reference which will often, though not always, indicate to him that the apparently flat white ground extending far ahead is in reality on a different plane from what it appears to be. In the case of the approach to Mt. Erebus, there were three possible landmarks which were black in colour and which would have stood out as points of contrast against the broad white slopes of snow which ran upwards towards the peak of the mountain. These points of contrast all consist of areas of black volcanic rock. They are:

(a) The narrow strips of black rock which appear towards the bottom of the 300 foot ice cliff which marks the beginning of the rising snow slope. They represent areas of rock not covered by the layer of thick glacial ice which covers the whole of the lower slopes of the mountain.
(b) The rocky outcrop situated about 4000 feet above sea level to the left of the direct approach to the mountain peak.
(c) The broad exposed rock of "Fang Ridge" located not far down from the mountain peak.

170. On 28 November 1979 there were visible to the crew of TE 901, as the aircraft approached Mt. Erebus, only the narrow strips of rock at the bottom of the ice cliff referred to in paragraph (a) above, and these happened to be on the approximate flight path of the aircraft. The overcast was well below the 4000 feet level of the black outcrop to the left of the aircraft's approach and of course the Fang Ridge, along with the whole of the mountain above 2000 to 3000 feet, was totally obscured.

171. I was satisfied, after hearing the chief inspector's evidence and after studying Mr Boswell's paper (**Exhibit 44**) and the other document (**Exhibit 39**), that the characteristic conditions for whiteout must have existed in the case of the fatal flight. The cloud formation constituted a total overcast on the approach to Mt. Erebus with a base of 3000 feet, which probably gradually descended to 2000 feet or perhaps a little higher as it met the mountain, and seeing that no one on the flight deck ever saw the snow slopes into which the aircraft crashed—not even at the last second with the aircraft flying in clear air—there could be only one conclusion.

172. However, the existence of a whiteout of this kind was evidently not accepted by the Director of Civil Aviation. He declined to accept that there had been a visual illusion of this kind and, as I understood his evidence, he took the view that even if there had existed visual deception of some kind it played no part in the occurrence of the disaster.

173. Under these circumstances, it became necessary for counsel assisting the Commission to make inquiries as to whether there were expert witnesses who could verify or explain the nature of the phenomenon and who, once appraised of the cloud conditions surrounding Ross Island on the date in question, could give an opinion as to whether or not this highly dangerous visual illusion did in fact exist on the day in question.

174. Inquiries were made and Mr Baragwanath was in due course notified that there were three leading authorities on the subject in the United States and one in Canada. As the Commission was obliged in any event to travel to the United States to take depositions from the United States Navy personnel who had been at McMurdo Sound on the day of the disaster, it was arranged that the experts to which I have referred would also be interviewed during the course of our journey. In order to take the opinion of an expert in relation to this type of visual phenomenon, it was necessary to produce all the information which so far had been gathered in the course of evidence in relation to the weather in McMurdo Sound on the day of the fatal flight. In this respect we had at our disposal the following information:

(a) A photograph of the McMurdo area taken by satellite less than an hour before the time of the crash. This photograph showed the location of cloud formations and the approximate altitude of such formations.

(b) There was evidence from Flight Lieutenant McLeod of the Royal New Zealand Air Force, who had flown by helicopter from Victoria Land across to McMurdo Station during the late morning of the day in question, and who was able to describe the extent of the cloud cover over Ross Island and the approximate base of the overcast.

(c) We had evidence in the form of statements from pilots of two United States aircraft which had been approaching McMurdo Station from the true north and true south respectively not long before the occurrence of the crash. These two pilots were able to give a description of cloud formation and cloud layers both north and south of McMurdo Sound.

(d) There was evidence from Mr J. S. Hickman who is a meteorologist employed by the Meteorological Service which forms part of the Ministry of Transport. He had previously visited Antarctica and is a member of two organisations devoted to scientific research in the Ross Dependency area. Mr Hickman not only gave technical

information as to weather forecasting in general in the Ross Sea area, but he also gave his opinion as to the weather prevailing to the true north of Ross Island as revealed by certain of the passengers' photographs.

(e) I had available passengers' photographs taken during the last 2 or 3 minutes and up until the last few seconds of the fatal flight.

(f) There was no one who could describe for me the height of the cloud base to the north of Ross Island, that is, on the line of approach of the DC10. However, I had at my disposal a cloud formation chart drawn up by Mr M. R. Sinclair who is employed as a meteorologist with the New Zealand Meteorological Service, and during each of the 1978–79 seasons he was stationed at Scott Base as part of the New Zealand Antarctica Research Programme. Part of his duties were to conduct research studies of local weather in the McMurdo area. At the time of the disaster he had been at Vanda Station in the Wright Valley, about 130 kilometres to the west of the crash site. Mr Sinclair compiled a reconstruction of weather conditions from all the available information which I have previously listed, including photographs taken by passengers. He constructed a most valuable cartographic profile of the position of various shallow cloud layers in the general location of the two descending orbits of the DC10. His cloud profile indicated scattered thin cloud layers 50 miles out from McMurdo Station, wide breaks in clouds between 60 and 25 miles from McMurdo Station, and then a continuous cloud layer over Ross Island, as from about 10 miles from Mt. Erebus.

(g) We had the CVR transcript.

(h) There was evidence which had been given before me by Professor R. H. Day who, since 1965, has been the Foundation Professor of Psychology at Monash University, Australia. He has had particular experience in the field of human perception, in particular with aeronautical research organisations in the United Kingdom and in Australia. He is the author of 125 papers in technical and academic journals in the field of various types of human perception. He is recognised as a world authority in his field.

Professor Day made a close study of the chief inspector's report and made himself familiar with the known factual aspects of the disaster. In the course of his studies relating to the disaster, he discussed all aspects with Dr J. C. Lane who is the Director of Aviation Medicine, Department of Transport, Commonwealth of Australia. Dr Lane is regarded as one of the world authorities on human factors in relation to air accident causation. Dr Lane authorised Professor Day to say that he concurred with Professor Day's proposed evidence. In Professor Day's opinion, it was apparent from a study of the passengers' photographs and Mr Sinclair's evidence regarding meteorological conditions that the necessary conditions for the occurrence of the whiteout phenomenon in fact existed, and he was satisfied that loss of depth perception and lowered threshold contrast existed throughout the final period of this flight. He had this to say, as part of his evidence:

> "It cannot be emphasised too strongly that the effects of whiteout are insidious in the extreme. Even on the ground the effects are not recognised by the affected individual until a gross error has been made, such as walking into a snow bank, or falling into a hole. The effect occurs quite rapidly under the conditions of

intense light stimulation and white surfaces above and below. There is no way of knowing the visual system is grossly affected until an untoward event occurs.

I should add that I have not observed whiteout or experienced it in antarctic conditions. However, the conditions for its occurrence are now well established. They can be reproduced in the laboratory, although, there have been no systematic laboratory studies of it. It seems to me that the conditions which existed during the final stages of the flight were sufficient to produce a significant degree of visual impairment when looking ahead from the cockpit."

Professor Day then paid particular regard to what he termed as the "mental set" of the individual who is confronted by the components of visual perception. He considered all the evidence, in particular the misleading track diagrams, which suggested that the crew of TE 901 believed that the nav track was taking them down the centre of McMurdo Sound. He came to the conclusion, having regard to the topographical situation which existed, that a concerted belief on the part of the air crew, reached on the basis of the flight documents in question and by reliance upon the false waypoints, would have overcome any minor features of the view ahead which otherwise might have raised doubt as to whether the aircraft in fact was upon the supposed course. In summary, therefore his view was that the level of efficiency of the visual system of each member of the flight crew was probably markedly degraded through whiteout phenomenon, that is to say, the high intensity stimulation of rebounding light between the white land surface and the cloud above. The main consequence of this impaired visual efficiency would have been loss of contrast sensitivity and greatly impaired depth or distance perception.

In the result therefore, although Professor Day recognised that the whiteout phenomenon might alone account for the failure to ascertain the presence of rising terrain, he placed great emphasis upon the audio-visual briefing and upon the flight documents as being a systems failure on the part of the airline, which played a decisive part in accentuating loss of contrast sensitivity, as revealed by the failure of the flight crew to ascertain that the white expanse of ground in front of them was not on a flat plane as it seemed to be. The professor pointed out that the strongest evidence in support of the part played by the "mental set" was that it was not the visually perceptual system of a single member of the flight crew that failed, but that of five persons, including an experienced antarctic observer and commentator.

175. The total of the information listed above was displayed to each of the expert witnesses whom we saw. The first witness was Dr J. E. Goodson of the United States Navy Base at Pensacola, Florida. Dr Goodson has had 20 years experience in the study of vision as a psychiatric physiologist, and has made a close study of visual perception. Dr Goodson's opinion was that upon looking at the rising snow slope on this occasion, with the sun behind, and total cloud cover above, a pilot could think that he was perceiving an expanse of level ice or snow running forward for perhaps 40 miles. Without texture or contour to guide him, he would see the limits of terrain vision as being far away and not close. This opinion was backed by detailed references to which I need not now refer.

176. Captain Philip T. Briska was also interviewed at Pensacola. He is a flight surgeon and chief opthalmologist at the Pensacola base. He is also a naval aviator with over 2000 hours spent mainly on fighters. Captain Briska, having studied all the relevant material, was of the opinion that if Captain Collins had believed that he was overflying the sea ice in McMurdo Sound, and that he had in front of him 40 miles of flat ice and snow then, having regard to the weather conditions, he would believe himself to be seeing those conditions as he flew under the overcast towards the snow-covered approach to Mt. Erebus.

177. The next expert we saw was Captain A. P. Ginsburg, who was stationed at the Wright-Patterson Air Field, Dayton, Ohio. Our interview with Captain Ginsburg was highly instructive. He is a special consultant to the United States Air Force on the topic of visual phenomena, and was awarded a doctorate in philosophy by the University of Cambridge in the United Kingdom for his published work in this field. His duties in relation to the United States Air Force are directed towards the special visual problems that may occur in the handling of fighter aircraft travelling at supersonic speeds. Captain Ginsburg's special field is that of contrast sensitivity which exists as a function of sight. He successfully evolved a system of ascertaining by appropriate tests the degree of contrast sensitivity possessed by any person whose sight, as tested by conventional means, is perfect. One of the leading features of his researches has been that of two persons with perfect visual acuity, as measured by conventional means, one may have first-class contrast sensitivity whilst the other has only this latter function in an impaired state. Consequently perceptive ability of each of the two persons, particularly used in relation to moving objects, will vary to a considerable degree.

178. Mr Baragwanath and I demonstrated to Captain Ginsburg a summary of the total information which we had obtained regarding the weather conditions at McMurdo at the relevant time, and he made himself thoroughly familiar with all this information. We also asked him to take into account, but only as an hypothesis, that Captain Collins had flown on nav track southwards from Cape Hallett until orbiting through a cloud break and had armed the nav track again as the last orbit concluded because of his belief that the nav track would lead the aircraft down the centre of McMurdo Sound with many miles of flat sea or ice on either side.

179. I will now set out, in my own language, a synopsis of what we were told. First of all, Captain Ginsburg deferred his consideration of this latter evidence suggesting Captain Collins believed that by maintaining the nav track he would be keeping the aircraft many miles away from any high ground. Captain Ginsburg concentrated his attention upon what the pilot and co-pilot were likely to have seen at the conclusion of the second orbit when the plane was locked back on to nav track as it approached Ross Island. In Captain Ginsburg's opinion, having regard to the known height of the overcast—which, judging by the passengers' photographs was still well above the aircraft at the moment when it struck the mountainside—and having regard to the position of the sun and its 34° inclination, then the pilot would have seen a white expanse of flat terrain extending forwards for an unlimited distance. His point of visual reference would only have been the shallow strips of black rock some miles to the left and some miles to the right of the aircraft, representing Cape Tennyson and Cape Bird.

180. Looking forward, there would be no points of reference over the ice and snow. Not only would there be no points of contrast but there would

be no perception of depth. The fact that the flat white carpet in front was in fact rising upwards at an inclination of 13° and then 19° before meeting the overcast would not be perceived. There would be no shadows and no points of reference to terrain in a forward direction, and Captain Ginsburg expected that a pilot not familiar with this type of visual illusion would merely fly straight on.

181. We referred to the undisputed evidence that no one on the flight deck ever saw the snow-covered slopes into which the aircraft flew. Captain Ginsburg said that this was not a surprising feature at all and indeed he would expect, in the conditions prevailing, that no one on the flight deck, even flying in clear air, would detect that the aircraft was about to strike a rising expanse of white terrain. He said that the only pilot or pilots who would suspect that ocular phenomenon would be people who had flown in polar regions before. He said that pilots with arctic or antarctic experience would also not see the mountainside but, having noted the overcast, would be aware that there might be something in front of them which they could not see. The two or three pieces of rock face in the ice cliff directly ahead of the aircraft would not be identified as anything but thin black strips of sea of the type previously encountered while the aircraft was flying over floating pack ice a minute or so previously.

182. We then asked Captain Ginsburg to consider the factor previously mentioned—namely, that the pilot may have believed himself to be flying over a very wide expanse of flat ice in the approximate centre of McMurdo Sound. Having studied the maps, Captain Ginsburg expressed the opinion that the two thin strips of dark rock to left and right of the approach to Lewis Bay would coincide, in the pilot's opinion, with the entrance to McMurdo Sound, and if the captain's nav track confirmed the pilot's belief that he was in the centre of McMurdo Sound then the totality of the illusion would be complete. He said that the pilot, upon levelling out after the second orbit, and upon looking far ahead along the flat white surface, would be expecting to see the high terrain 20–30 miles away which lies approximately to the true south of the head of the Sound, and when he could not see it he no doubt decided that it was safer to climb away. Overall, Captain Ginsburg was of the opinion, having studied all the evidence which we were able to give him, that the absence of depth and contrast definitions would have produced what he described as a characteristic example of total visual deception.

183. Captain Ginsburg placed very considerable emphasis on the same point as had been made by Professor Day, namely that everything turns on the mental pre-condition of an observer. He stressed that the eye is not a camera. He said that the observation of a particular object necessarily requires a combination of the function of sight with the function of mental activity associated with the process of observation. Discrepancies between what appears to be seen and what is known to be visible are automatically cancelled out by the mind in favour of a picture of what is known to be there.

184. If Captain Collins believed, on various grounds, that he was flying down the approximate centre of McMurdo Sound then he would, as a necessary function of his intellect, relate whatever he saw to what he expected to see, and would co-ordinate objective and subjective perception. But this would only occur if he was certain of his position. If he were in any way uncertain of his position then his subjective perception would be disengaged, so to speak, and he would be guided by visual

perception alone. If certain of his position, and his course, he would automatically discount minor variations in the visual perception as opposed to what he expected to see, but only up to a certain limit of tolerance, that is to say, if visual perception suddenly appeared to present a picture which was markedly different in some respect from his expected observation, then that factor would intrude upon the pre-condition of certainty of position and, for the first time, a state of mental uncertainty would arise as to whether he was in fact upon the course or in the position previously assumed.

185. In this respect, according to Captain Ginsburg, the similarity in the approach to Lewis Bay and the approach to the head of McMurdo Sound had constantly to be borne in mind because, judging from the passengers' photographs, it was in all probability a factor confirming the mental set of Captain Collins that he was certainly in the centre of McMurdo Sound. It seemed clear from the passengers' photographs that the tip of Cape Tennyson, as seen from an approach to Lewis Bay, and the tip of Cape Bird, as seen from the same position, each revealed a very shallow line of black rock surmounted by snow. If the appearance of Cape Bird from the centre of the Sound also presented a narrow strip of black rock at sea level, and if Cape Bernacchi presented a similar picture, then the inequalities of distance would not matter. There would not be any sufficiently obtruding difference from the expected vision sufficient to cause any doubt to arise.

186. Although out of sequence in the narrative, I should here refer to another expert opinion on this topic. On 10 November 1980 we visited Farnborough and, having there listened to a reproduction of extracts from the cockpit voice recorder tape (as elsewhere mentioned), we were asked to see Mr Roger Green who is a psychologist employed in a civilian capacity with the Royal Air Force as a specialist in flight skills, including visual illusion. His attendance is required at about one-third of the Boards of Inquiry held by the Royal Air Force involving incidents in which the presence of human factors appears to have been an operative cause.

187. Mr Green laid stress upon the guides provided by visual cues, and emphasised the point that without visual cues the factors of depth and contrast substantially disappear. He gave by way of example a sudden snowfall over one of the military airfields in England which resulted in three fighter pilots landing well short of a runway of which the location was very familiar to them. What had happened was that the snow had obliterated the visual cues by which they had been guided in previous approaches, and Mr Green stressed the point that in many cases people, and especially pilots, are not necessarily aware of the fact that they are using visual cues so that the disappearance of the latter passes unnoticed.

188. In snow-covered terrain, a pilot is deprived of texture information which will alone acquaint him with slope and distance. In bright sunshine he is only deprived of that information to a partial extent. But even so, his normal appreciation of variation in terrain is adversely affected. Mr Green also stressed the importance of the mental set of a pilot, and believed that Captain Vette's comparison between Lewis Bay and the approach to McMurdo Sound was a good example. That comparison is described in para. 200.

189. Mr Green said that stereopsis and binocular cues are only of help up to relatively short distances, perhaps not exceeding 100 feet or so, and that thereafter perception depends very largely upon experience. It is for

this reason that Mr Green placed the greatest stress upon the principle that there can be no substitute, in the aviation field, for past experience of terrain. An RCU briefing should be confined, in Mr Green's opinion, to purely conventional briefings. It cannot implant knowledge in the memory in the same manner as actual experience. He pointed out that a civil pilot does not often fly purely visually, and Mr Green was of the opinion that when this occurs and a pilot is unfamiliar with the terrain, a number of dangers will instantly arise.

190. The third of the experts whom we were advised to see was Mr G. W. Shannon, Vice-President of Operations for Bradley Air Services Limited of Ontario. Mr Shannon's company flies both passenger and freight schedules up to North Canada and the sub-arctic. He was also retained some years ago to carry out a commercial contract in Antarctica. He flew from the southernmost point of South America across to Shackleton Base in Antarctica, and then across the polar continent to McMurdo. This flight, and other operations in the antarctic, was carried out in a de Havilland twin Otter, Mr Shannon's work being connected with the operations of a United States drilling site. He is reasonably familiar with the McMurdo region by reason of that particular contract which he carried out in Antarctica. Mr Shannon was recommended to us as being an expert whose knowledge and experience of flying in snow conditions is exceptional.

191. We saw Mr Shannon at his company's location at Nepean, some miles out of Ottawa. Mr Shannon had the advantage of having no prior knowledge of the DC10 disaster, except that he naturally knew of the occurrence. He had not read the chief inspector's report, and had no detailed knowledge of the circumstances. Over a period of between 2 and 3 hours we displayed to Mr Shannon all the relevant maps and diagrams, weather information, cloud locations, pasengers' photographs and so forth. We also showed him the chief inspector's transcription of the cockpit voice recorder. Mr Shannon noted all this material and paid close attention to the cockpit voice recorder transcript which he read and re-read on a number of occasions, particularly the closing stages.

192. In Mr Shannon's opinion, the prevailing weather and the location of the sun and the other factors previously mentioned would present to the pilot and co-pilot of the DC10 a forward vista of flat snow and ice extending away to the far distance, and he had no doubt that a pilot unfamiliar with polar conditions would believe that he was flying forward with clear visibility over flat terrain for many miles. Mr Shannon believes that the pilot and co-pilot would have therefore an apparent flat and clearly visible terrain definition, whereas in fact there would be no terrain definition at all.

193. We asked Mr Shannon whether the overcast extending forward would form an illusory horizon in the distance at a point where it met the snow-covered rising ground. Mr Shannon said he thought not. He said that in such conditions the almost invariable effect is that the underside of the overcast turns white so that there would be no horizon at all. He said that there was a possibility of a false horizon, but he regarded that possibility as remote. His own years of experience of flying in such conditions led him to the conclusion stated above, namely, that the overcast in front of the pilot would seem to disappear by reason of the fact that its grey undersurface would become white in colour through the multiple light reflection provided by overhead sun behind the aircraft.

194. Mr Shannon gave as an example an occurrence which often takes place at their own airport when the ground is covered with snow. He said that if there is a light overcast overhead then in daylight the underside of the overcast turns white and it is not possible from the ground to discern the height of the overcast. He said you know the overcast is there because you cannot see the sun, but it is not possible to say whether the overcast is 1500 feet high or 5000 feet high when looking upwards from the ground. He said that they are dependent upon reports from pilots as to the height of the overcast.

195. Mr Shannon said that having regard to the known weather conditions which we had exhibited to him, he would expect that as Captain Collins levelled out following the second orbit, and having dropped height to 1500 feet to try and see something in the distance but without success, that Captain Collins would then have elected to climb away because he could not see any landmarks in the distance. Mr Shannon said he noted, from his study of the cockpit voice recorder transcript, that Captain Collins decided, very soon after having levelled out, that he should fly away and he attributed that decision to the fact that although the aircraft was flying under the overcast, and although the ground seemed to stretch away for miles, nevertheless there was no terrain anywhere to be seen.

196. As with other witnesses whom we saw on our travels, Mr Shannon placed primary significance upon the adherence by Captain Collins to the nav track. He said that if Captain Collins had plotted the nav track on a map, then he would obviously have believed that there was no danger of any kind ahead, and that he was many miles away from any high ground. Mr Shannon said that one of the reasons why he had studied and restudied the closing stages of the transcript was to try and see whether there was any expressed concern or doubt on the part of the pilot or co-pilot in relation to the course or position of the aircraft. Mr Shannon was not very interested in the cross-talk which was taking place behind the pilots. He said that he drew the conclusion that neither the pilot nor the co-pilot entertained the slightest apprehension at any stage, and he drew the further conclusion that each of them was perfectly satisfied as to the course and position of the aircraft.

197. We raised with Mr Shannon the theory that a pale fog may have drifted off the ice and covered the ice cliff. We told him that a helicopter which had landed on the ice shelf below the cliff about an hour later saw no sign of the ice fog although it was observed on subsequent days to be coming off the ice. Mr Shannon said that the winds in that area are very fickle, and even a temporary breeze from the true north would instantly form ice fog the moment it reached the ice shelf below the cliff. The fog might persist with a steady breeze, climbing upwards, but if the breeze died away then the fog would disperse. Mr Shannon believed that if there were patches of black rock visible forward of the aircraft on that part of the ice cliff not covered by glacial ice, then this would have no significance to Captain Collins or the co-pilot as, from a distance, any shallow patches of black rock would merely resemble the patches of black water which they had previously observed.

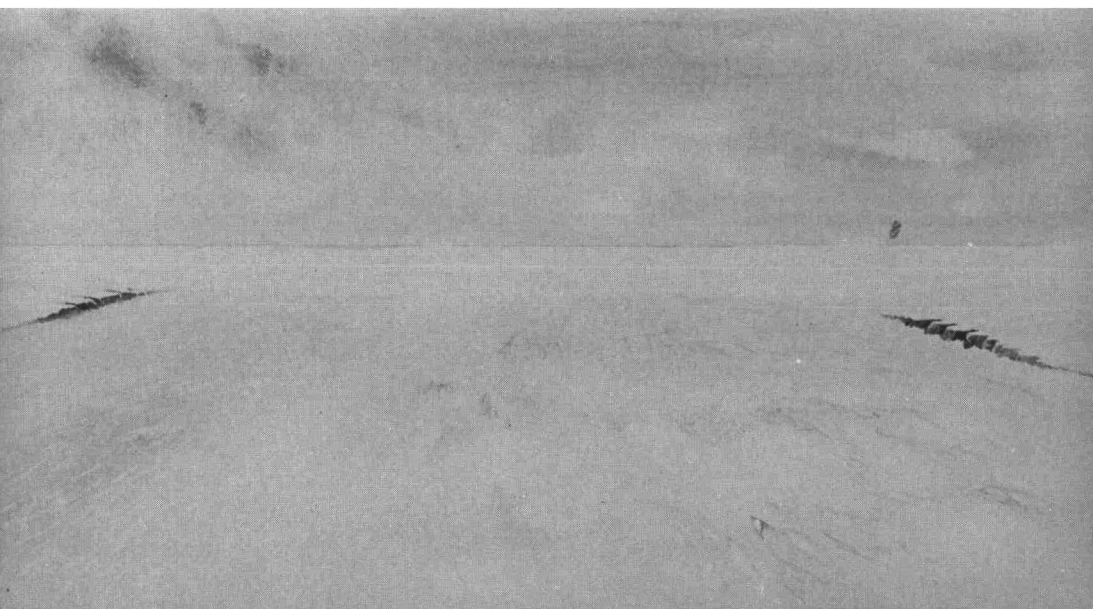
198. Mr Shannon said that the situation confronting Captain Collins as he levelled out after the last orbit would have signalled a red light to the experienced antarctic flier who would immediately have flown away. One of the last passengers' photographs had illustrated that the weather ahead was getting more solid, and in Mr Shannon's view any experienced pilot

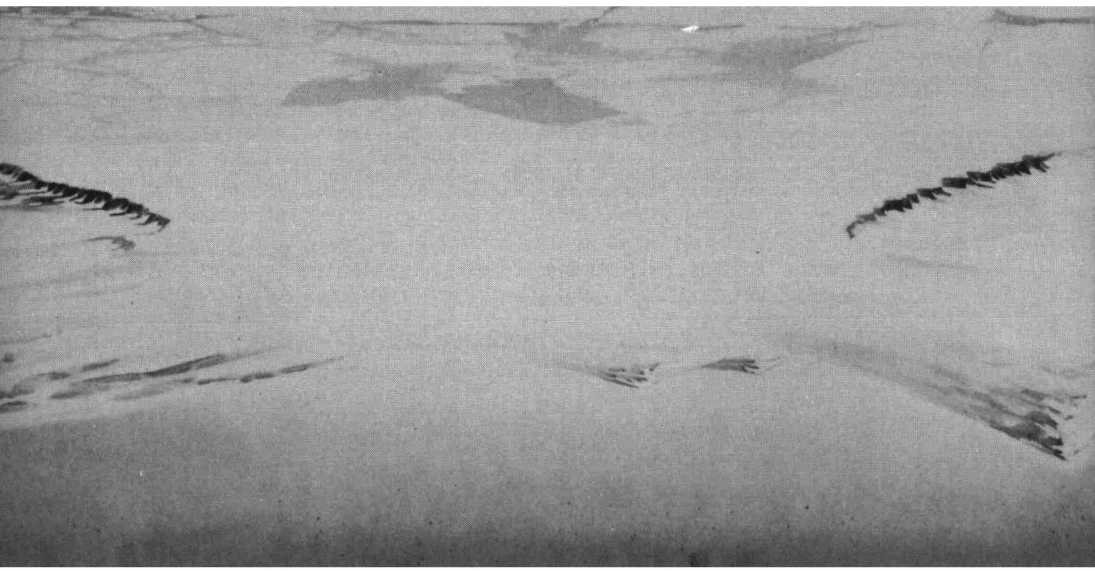
would have realised that conditions were no longer appropriate for VMC flying. But Mr Shannon again pointed out that it had taken Captain Collins only a brief interval to reach that conclusion, and he had then attempted to fly away once he could not discern the clear visibility which Mac Centre had told him would be apparent once he had descended to 2000 feet. Also, the two or three last passengers' photographs were printed off film which had been damaged by light, and the indistinct view revealed by prints would not have been the actual view.

199. It remains now to summarise the effect of all these inquiries on the facts of the present Inquiry. Cases of aircraft flying directly into snow-covered terrain in clear air, but with an unbroken low overcast, have been so numerous in aviation history as to be a matter of common knowledge among pilots who fly at low altitudes in polar regions and in northern Europe and Canada in the winter months. As I have had occasion to say already, the occurrence of this insidious and dangerous phenomenon is known and respected by all pilots accustomed to flying in such conditions. Neither Captain Collins nor First Officer Cassin had any experience of flying at low level over snow. Their long experience of flying DC10 aircraft had been confined to the temperate zones. There can be no doubt, upon all the evidence, that after the DC10 had descended in clear air and levelled out at about 3000 feet, it was still flying in clear air with unlimited visibility all around. As the aircraft approached the entrance to Lewis Bay, the cloud overhead ceased to be scattered and became a solid pale grey overcast. The pilots saw to the left the low rocky shoreline of Cape Tennyson and believed it to be the western coast of Cape Royds. On their right, some miles away, they saw the low black shoreline of Cape Bird and just above it, under the overcast, the sun shining on the snow-covered slopes of Mt. Bird. They believed they were looking at Cape Bernacchi on the eastern side of McMurdo Sound. In addition they had the remark, which in my opinion was made by Mr Mulgrew, pointing out that the Taylor Valley was on the right. Mr Mulgrew was looking at the cloud-hidden area just past the Cape Bird shoreline and believed that he was looking just past the Cape Bernacchi shoreline where the Taylor Valley begins.

200. It had been my intention during the hearing to ask for an artist's impression of the comparison between the entrance to Lewis Bay, as revealed by the passengers' photographs, and the entrance to the head of McMurdo Sound as represented by Cape Royds on the left and Cape Bernacchi on the right. But I found that Captain Vette had thought of such a presentation himself, and in fact he produced sketches and photographs as **Exhibits 233** and **234**. For the purposes of this report I have had them modified, and checked against a verified survey profile of the two entrances. The mountain features are not exactly to scale, the purpose being only to give a representation of each entrance in clear air, then in air partly obscured by either ice fog or cloud, and finally, in conditions where a low overcast entirely covers the forward area. These three stages are shown as to Lewis Bay in fig. 5, page 72 and as to McMurdo Sound in fig. 6, page 73. The presence of a visible horizon on the final stage of each figure should not be taken into account. They appear in the representations for the purpose of clarity, but as Mr Shannon said, there was probably no visible horizon on the day in question. The visual references thus established by the air crew were therefore in conformity with what their maps were displaying to them. Looking ahead, they saw the pure white expanse of snow-covered ice

FIGURE 5, page 72
FIGURE 6, page 73





running up to the 300-foot ice cliff which marked the commencement of the snow-covered slopes of Mt. Erebus. The presence of the low overcast and the uniformly white surface ahead caused the snow cliff to disappear and to become merged in a featureless white expanse. The crew may have seen a distant horizon (as depicted in the bottom photograph of fig. 5, page 72) but in Mr Shannon's view, and I attach great weight to his opinion, the snow-covered terrain most probably blended with pale overcast so as to make no horizon visible at all. Captain Collins decided to fly away, and the obvious lack of any urgency surrounding that decision makes it clear that he and First Officer Cassin believed that they had many miles of flat ice on either side and in front of them. By the time the ground proximity system suddenly sounded, nothing could save the aircraft.

201. I have dealt with this "whiteout" phenomenon in considerable length for the simple reason that this disaster transcends in magnitude all past examples of aircraft disasters caused by whiteout phenomena. If the veil of cloud had parted, even for a second, and provided a fleeting glimpse of the mountainside, then the aircraft and all its occupants could at the last moment have been saved. Without the whiteout phenomenon, the mistake made by the Flight Operations Division would have been discovered, because Mt. Erebus would have appeared in the direct path of the aircraft, but as events turned out, the mistake, aided by the weather, deceived the flight crew until the end.

COMPLIANCE BY PILOTS WITH MINIMUM SAFE ALTITUDES

202. Regulation 38 of the Civil Aviation Regulations specifies minimum safe altitudes to be observed by airline operators in respect of various types of terrain. They will apply to all flights unless, for special reason, the Director of the Civil Aviation Division specifies different minimum safe altitudes. In the case of the antarctic flights, the director did specify the minimum safe altitudes of 16 000 feet and 6000 feet which have been referred to, and these were operative as from mid-1977. The first flights to which they applied took place on 18 October 1977. It will be recalled that these altitudes were suggested by the airline and not by the Civil Aviation Division which agreed with the two suggested minimum safe altitudes.

203. Captain Gemmell who commanded the first of the antarctic flights, and Captain Grundy who commanded the second, each testified that at no time did their flights go below 16 000 feet in the McMurdo area. In respect of each flight there was evidence which suggested the contrary, but I am not going to take up time by discussing that evidence now. I am primarily concerned with flights from 18 October 1977 onwards, to which minimum safe altitudes of 16 000 feet and 6000 feet at all times officially applied, in the sense that no descent below those altitudes, under specified conditions of descent, was permissible without the prior consent of the Director of Civil Aviation.

204. There were pilots who did not interpret the 6000 feet MSA as meaning what it appeared to say. They believed it was restricted to a "cloud break" procedure and that it was permissible, in appropriate conditions, to descend below 6000 feet so long as regulation 38 was complied with. On behalf of the airline and on behalf of the Civil Aviation Division, it was naturally contended that there was no room for misunderstanding with regard to the extent of the 6000 feet limitation. It

was however susceptible, as I read it, of the interpretation placed upon it by the pilots to whom I have referred. But again I do not propose to go into this matter of misinterpretation of the 6000 feet MSA because I consider that it has no real relevance to matters which I am called upon to investigate.

205. In the first place the evidence makes it clear, in my opinion, that all Antarctica flights from and including 18 October 1977 involved a let-down in the McMurdo area to altitudes considerably less than 6000 feet, and that in the main the flights down McMurdo Sound and across the Ross Ice Shelf to the south of Mt. Erebus were conducted at altitudes ranging from 1500 feet to 3000 feet. There was one flight which diverted to the South Magnetic Pole and in this case the question does not arise.

206. The next point is whether the occurrence of flights in the McMurdo region of less than 6000 feet was known to executive pilots of the Flight Operations Division and to the management sector of the airline. Captain Lawson was called to give evidence on behalf of the airline. He had been, as will be recalled, the first supervisor of the Route Clearance Unit and he had been co-pilot of the first flight. He also flew as co-pilot with Captain Hawkins on the third flight which took place on 18 October 1977, this being the first occasion upon which the 6000 feet limitation was operative. In the course of his evidence, Captain Lawson said that although Mac Centre invited Captain Hawkins to descend below 6000 feet, that invitation was declined. In cross-examination, Captain Lawson was referred to **Exhibit 83** which is an extract from a copy of the *Auckland Star* of 22 October 1977. This is an article written by a Mr Graeme Kennedy. The article describes the progress of the flight of 18 October 1977 and it contains a reference first to the aircraft flying over Scott Base and McMurdo Station "at less than 2000 m.". Later in the text the following passage appears:

> "At the controls Captain Hawkins brings the DC10 down to 200 m over Scott and McMurdo Bases—well below the towering volcano Erebus belching smoke only 40 ks. away."

207. Mr Henry, cross-examining on behalf of the passengers' consortium, told Captain Lawson that Mr Graeme Kennedy had been interviewed and had indicated that the reference to 200 metres ought to have read 400 metres—in other words, approximately 1300 feet. Mr Henry asked Captain Lawson for his comments. Captain Lawson maintained that Mr Kennedy's report was inaccurate and that "to the best of my recollection" the flight did not descend below 6000 feet. Captain Lawson admitted that Mr Kennedy was personally known to him. The point of this cross-examination was to show that there had been published in the *Auckland Star* on 22 October 1977 a press report indicating a low-level flight down McMurdo Sound with Mt. Erebus 40 kilometres away.

208. During the course of further cross-examination, Captain Lawson was asked whether he was aware of any other written reports referring to flights in the McMurdo area at below 6000 feet. Captain Lawson said that he had read a copy of **Exhibit 148A**, which is a Newsletter published by the airline and entitled *Air New Zealand News*. The article in question is dated 30 November 1978. It consists of a brief description of the flight to Antarctica of 7 November 1978. The opening two paragraphs of the article read as follows:

> "The flight deck crew of TE 901 took the boss flying with them on November 7.

And as the DC10 cruised at 2000 feet past the antarctic's Mt. Erebus and over the great ice plateau Captain Doug Keesing, Flight Operations Director International, was as interested in sightseeing as the other 230-odd passengers aboard."

Captain Lawson said that he considered that this airline newsletter, which is distributed to all members of the airline's staff, would have provided ample evidence available to people in authority upon which such people could have acted. But Captain Lawson was the only pilot called by the airline who admitted any knowledge of the contents of the airline's newsletter to which I have just referred. There was no executive pilot called on behalf of the airline who admitted ever seeing this exhibit.

209. One of the executive pilots who testified for the airline was Captain R. T. Johnson. He is Flight Manager Line Operations DC10-DC8. Captain Johnson was in command of the flight of 8 November 1977. In his prepared brief of evidence, Captain Johnson stated that he descended to 3000 feet in the McMurdo area because of the perfect weather conditions existing at that time. In view of the solid front presented by all the executive pilots who testified, I was a little surprised at this distinct admission of flying below 6000 feet, it being remembered that it was Captain R. T. Johnson himself who sent out the memorandum to all pilots 2 years later, dated 8 November 1979, restating the conditions which must exist before a descent to the MSA of 6000 feet was permitted. I do not wish to be taken as suggesting that Captain Johnson felt himself obliged to admit flying at 3000 feet because of outside evidence which would confirm that fact. Nevertheless, Mr R. B. Thomson, Superintendent of the Antarctic Division of the D.S.I.R., had been on this flight. He had been on four flights in all, and believed that they had all flown at below the specified minimum safe altitudes. He admitted that Captain Gemmell's flight may have been at not less than 16 000 feet but in reference to the three flights other than Captain Gemmell's first flight, Mr Thomson had previously testified without qualification (T. 637) that they had all flown below 6000 feet, and of course one of these flights had been Captain Johnson's flight. In the event, Captain Johnson stated that he had consciously committed a breach of the MSA rules by descending to 3000 feet. In my opinion this was a contrived admission, bearing no relation to the true facts regarding minimum safe altitudes, but I shall return to that later. Captain Johnson went on to say that he was unaware of any flights, except his own, which had operated at less than the MSA of 6000 feet (T. 1370).

210. I now come back to **Exhibit 148A**, this being the airline's newsletter which referred to Captain Keesing having been a passenger on the flight of 7 November 1978 when the aircraft cruised to 2000 feet down McMurdo Sound. At that date, Captain Keesing was the Director of International Flight Operations. At the date when the hearings before the Commission commenced, Captain Keesing had retired from the airline and was employed as a consultant to one of the Pacific airlines. It appears that he was sent a press cutting which made allusion to his having been on this flight and to censorious comments said to have been made at Commission hearings that he should have condoned, in his capacity as Director of Flight Operations, this breach of the MSA of 6000 feet. When this was drawn to his attention, Captain Keesing travelled to New Zealand and saw counsel assisting the Commission and gave a brief of the evidence which he desired to give on this topic.

211. It will be remembered that at the beginning of 1977 it had been Captain Keesing who had set out the conditions for antarctic flights in correspondence with the Civil Aviation Division, and he had proposed that minimum safe altitudes would be in accordance with regulation 38 of the Civil Aviation Regulations. Then Captain Gemmell who, as chief pilot, had been his subordinate, had himself negotiated the minimum safe altitudes of 16 000 feet and 6000 feet which are presently under discussion. When Captain Keesing gave evidence before me, he said that he believed that he had concluded the minimum safe altitude arrangements with Civil Aviation Division along the lines of the terms set out in his letter of 2 February 1977. He had never received a formal reply to this letter, but he had been aware that antarctic flights had started 13 days later and he had assumed that the detailed operating conditions in his letter had been accepted by the Civil Aviation Division. He had been quite unaware that Captain Gemmell had been conducting independent negotiations and had settled an MSA, first of 16 000 feet and then later 16 000 and 6000 feet. Captain Keesing told me that he was not aware, until this evidence before the Commission had been brought to his attention, that there had ever been minimum safe altitudes of 16 000 feet and 6000 feet.

212. After Captain Keesing had travelled as a passenger on the flight of 7 November 1978 he had been asked by one of the editorial staff of the airline's newsletter to give his impressions of the flight, and he had done so. He had specifically referred to a flight of 2000 feet. He had been shown the draft of the article and had approved it. Captain Keesing took great exception at the suggestion which had been made to the Commission—during his absence overseas—that he had been a party to a breach of the MSA rules.

213. I pause to observe that this incident demonstrates one of the constant features of this Inquiry, namely the lack of adequate communication within the Flight Operations Division of the airline. This was certainly an extraordinary situation. Captain Keesing had never been told that his own specified operational conditions, believed by him to have been accepted by the Civil Aviation Division, had been altered by one of his subordinates. Captain Keesing was cross-examined at some length by Mr L. W. Brown, Q.C., on behalf of the airline, but he was at no time challenged on this aspect of his evidence.

214. The next feature of the evidence concerning MSA was equally surprising. The DC8 and DC10 aircraft owned by the airline had been manufactured by the McDonnell-Douglas Corporation of the United States of America. The president of the corporation in 1977 had been Mr John Brizendine. Towards the end of 1977 he had visited Auckland and at the invitation of the chief executive, Mr M. R. Davis, he had travelled on the antarctic flight of 17 November 1977. Upon his return to the United States he wrote to the chief executive and enclosed the script of an article which he had written describing the spectacular nature of the flight and the excellent service provided by the airline in relation to that flight. In that article, which incidentally described the flight path as being down longitude 165° east (that is, down the centre of McMurdo Sound), the following passage appears:

> "As we neared the Ross Ice Shelf, Captain Vette began a gradual descent which would bring us to approximately 3000 feet above the ice. Ahead could be seen 13 200 foot Mt. Erebus, a live volcano emitting clouds of white smoke.

At 2.20 p.m. New Zealand time, we were abeam of Ross Island, dominated by Mt. Erebus, flying over the Ross Ice Shelf at relatively low altitude. Surface features could be seen distinctly."

215. Seeing that this eulogistic article clearly referred to an approach down the centre of McMurdo Sound at an altitude of 3000 feet, the question naturally arose as to why the chief executive had been unaware, as from the end of 1977, that the suggested MSA of 6000 feet was not being complied with. Upon being asked about this in cross-examination, the chief executive replied to the effect that he received considerable quantities of mail and that it was his practice not to read many of the attachments annexed to his correspondence. I asked him whether this philosophy applied to the president of the McDonnell-Douglas Corporation, one of the largest manufacturers of aircraft in the world. The chief executive replied in the sense that even correspondence of this major importance was not immune from the chief executive's practice of not reading all attachments to his correspondence. Needless to say, I find myself unable to accept this explanation. I can only make the assumption that the chief executive's memory is at fault.

216. But the matter of Mr Brizendine's article does not rest there. Towards the end of the hearings before the Commission it was discovered by counsel assisting the Commission that Mr Brizendine's article had been widely distributed throughout New Zealand as part of a publication entitled *Travelling Times*. This publication was produced as **Exhibit 84.** Inquiries were duly made, and it was found that the airline itself had arranged for the distribution of the circular *Travelling Times*—which included Mr Brizendine's article—and that distribution had been effected by an organisation called Circular Distribution (New Zealand) Limited on 9 September 1978. It was further discovered that no less than one million copies of this circular had been prepared. The object of the airline had been to ensure, so far as possible, that a copy of the publication reached every home in New Zealand. Counsel assisting the Commission acquired from the distributors a complete breakdown of distribution, with itemised figures for every part of New Zealand. A total of 978 620 copies had been distributed throughout the country. The total cost to the airline was $16,008.30.

217. This revelation was greeted with some measure of surprised protest by counsel for Air New Zealand, and it is apparent that in this matter, as in some other matters which arose during the Inquiry, they had not been informed by the airline of the existence of the distribution of this circular. I asked Mr Davis how it could possibly be suggested that the airline's management was unaware of flights below 6000 feet in view of the fact that his company had seen fit to print one million copies of a printed text which established that fact. He could suggest no reasonable explanation.

218. There were other items printed from various publications which made allusion to the flight levels of antarctic flights. One of them was **Exhibit 85** which consisted of a page from an Auckland suburban newspaper containing an article by a Mr Graham McGregor referring to a flight of 7 November 1978 and describing the spectacular views obtained at 2000 feet over Scott Base. The same article was printed in another Auckland suburban newspaper, of which an extract was produced as **Exhibit 86**.

219. I only advert to this widespread publicity of the actual flight levels being conducted in Antarctica because of the steadfast denial by the airline management, by the Flight Operations Division of the airline, and

by the Civil Aviation Division, that any such information ever became known to them. As it happens, flights as low as 1500 feet are perfectly safe in clear weather and were far in excess of the minimum safe altitudes described by the regulations. They were considered safe and acceptable by the United States Navy and there is no doubt at all that no question of breach of any safety rules arose in respect of flights at this level. But the alleged contravention of the official MSA levels of 16 000 feet and 6000 feet formed the bulwark of the defence by the airline and by Civil Aviation Division to the wide-ranging attacks made upon them in respect of their organisational defects. At every point when an error on the part of their respective officials was alleged, and often identified, the answer was inevitably given that the disaster would not have occurred had the aircraft been flying at 16 000 feet. This, of course, is correct. The disaster would also not have occurred had Captain Collins been notified prior to leaving Auckland that the computer track of his aircraft, previously plotted down the safe area of McMurdo Sound, had been altered, without his knowledge, to a collision course with Mt. Erebus. Had Captain Collins even suspected that such an alteration had been made, it can safely be assumed that the aircraft would not have left Auckland until the altered track had been plotted on a topographical map.

220. As to the position of Civil Aviation Division with regard to knowledge of flights under the officially approved MSA levels of 16 000 feet and 6000 feet, the position taken by the division is that they had no knowledge that any such flights occurred. In this regard I must take into account what I have previously said about newspaper reports referring to flights under 6000 feet, and the distribution among 8000 employees of the airline of the Air New Zealand newsletter, **Exhibit 148A.** In addition, there was the nation-wide distribution in September 1978 of the circular *Travelling Times* which contained Mr Brizendine's article. Despite denials on the part of Civil Aviation Division, it seems scarcely credible that someone among their senior staff would not have become aware of what evidently had become a matter of public knowledge.

221. There is also relevant in this respect a matter to which I have referred previously, that is, the conversation on 22 November 1979 between Captain Omundsen, the controller of airline operations for the Civil Aviation Division, and Captain Grundy. I have indicated Captain Grundy's version of this discussion. He said that Captain Omundsen was only concerned with separation between civil aircraft and helicopters and that the report from the United States Antarctic Support Force referred only to altitudes over glaciers. Captain Omundsen, in the course of his evidence, maintained that he had in mind in this verbal discussion a breach of the 6000 feet MSA but the diary note which he made on 23 November 1979 (**Exhibit 1/25**) does not bear out this assertion. The only reference in the diary note to this topic is in paragraph 3 which reads as follows:

> "Report from United States Authority in the Antarctic that large civil aircraft have been observed operating at lower than normal altitudes over glaciers and in fact the height mentioned was 1000 feet above glacier level."

Nothing is said there about any breach of minimum safe altitudes of 16 000 feet and 6000 feet.

222. Had the Civil Aviation Division not been aware of flights operating at less than 6000 feet, I would certainly have expected that Captain Omundsen would have raised this specific question with Captain Grundy

on 22 November 1979, that he would have emphasised the point in his diary note, and that there would have been an immediate letter to the airline requesting an explanation. Upon the whole, I prefer Captain Grundy's version of this conversation.

223. My opinions on this aspect of the Inquiry are:

(a) The management of the airline and its Flight Operations Division were aware from November 1977 onwards that airline pilots on antarctic flights were flying at levels ranging from 1500 feet to 3000 feet, and that some flights travelled down McMurdo Sound in the direction of true south at such altitudes.

(b) Civil Aviation Division was aware, probably over the whole period of the antarctic flights, but certainly from September 1978 onwards, that the airline's pilots were flying at levels well under 6000 feet in the McMurdo area.

(c) Neither the Flight Operations Division of the airline nor Civil Aviation Division considered that there was any breach of safety requirements involved in pilots adopting flight levels in accordance with regulation 38 in view of the fact that such sightseeing flights were being conducted in VMC conditions. Both the airline and the Civil Aviation Division were correct in holding that opinion.

(d) As previously stated, the airline should have put its house in order in terms of regulation 38 of the Civil Aviation Regulations by applying for minimum safe altitudes which would reflect the known practice of pilots operating the antarctic flights. The authorised flight path should have been amended so as to coincide with the military route down McMurdo Sound and a minimum safe altitude over McMurdo Sound and the Ross Ice Shelf to the true south should have been set at 1500 feet subject to VMC conditions, with visibility not less than 20 kilometres.

(e) Such a revised minimum safe altitude would have been approved by the Civil Aviation Division and would also have been accepted by the United States Naval Support Force authorties at McMurdo.

THE CREATION OF THE FALSE McMURDO WAYPOINT AND HOW IT CAME TO BE CHANGED WITHOUT THE KNOWLEDGE OF CAPTAIN COLLINS

224. By way of preliminary, something should be said about the nature of the flight plan delivered to the crew of an aircraft just prior to departure. In an aircraft such as the DC10, with its navigation controlled by the AINS, the primary content of the flight plan is the list of waypoints running down the left hand edge of the page. In the case of scheduled routes flown by Air New Zealand the waypoints are denominated by names, and the airline's ground computer system connects those names with fixed geographical positions. The system of inserting details of the flight plan into the aircraft's own computer involves a tape cassette with which, in the present case, we are not concerned. This is because the Antarctica flights were non-scheduled and the method adopted for inserting the waypoints into the aircraft's computer system was to insert manually the co-ordinates of latitude and longitude for each waypoint. A flight plan, as well as containing these pre-determined and fixed waypoints, will also contain the distance in miles between each waypoint

and the heading along which the aircraft will fly from one waypoint to another. All these details will be constant from one flight plan to another unless for some reason it is thought necessary to change the position of some particular waypoint. Then the flight plan will also contain other material which is not constant and which must be inserted for the specific purposes of the flight in question. This will involve the different flight levels to be maintained over different sectors of the journey, and these will be determined by up-to-date weather forecasting, indicating the direction and velocity of winds at various altitudes. There are other details which also require insertion for the purposes of the particular flight, and of these perhaps the most important is the calculation of the fuel required by the aircraft on its journey. Opposite each waypoint will be printed in metric tonnes the amount of fuel then remaining at the point when that waypoint is reached. To summarise, a flight plan delivered to the crew of an antarctic flight at the pre-despatch briefing an hour or two before departure will comprise the fixed waypoints and track and distance details held in the airline's ground computer in respect of that particular route, to which has been added, for purposes of the flight, the last minute calculations to which I have just referred. During the course of the flight the aircrew will have their printed flight plan before them, and they will keep checking at all times the comparison between fuel consumed over one sector, as appearing from their instruments, with the estimated fuel components appearing on the flight plan, and they will also be checking the other operational details appearing on the flight plan.

225. In 1977 the flight plans delivered to aircrew of Air New Zealand were manually produced, that is to say, there would be a print-out document containing the fixed waypoints and track and distance details applicable to the journey, but the other details applicable to the day of the flight would be inserted by hand. In 1978 however, the decision was made that all the airline's flight plans for its different flight routes would be computerised. The ground computer unit of the airline would therefore hold a flight plan for every route, containing the fixed waypoints and track and distance details to which I have referred, but shortly before the pre-despatch briefing the flight levels and fuel calculations and other necessary data would be inserted into the ground computer for inclusion in the standard computer flight plan for that particular route. Then the Flight Despatch Section would be handed a print-out from the ground computer which would comprise the full flight plan for the journey, with all details printed thereon.

226. The alteration of the original McMurdo waypoint was said by members of the airline's Navigation Section to have originated with the decision in 1978 to computerise all flight plans, and the following narrative sets out the explanation which I was given in this respect by the Navigation Section witnesses.

227. For the first two Antarctica flights of 1977 the destination waypoint represented the latitude and longitude co-ordinates of the landing strip at McMurdo which is known as Williams Field. Those co-ordinates were 77 degrees 53 minutes south and 166 degrees 48 minutes east. However, as previously described, a decision was made in mid – 1977 that there was to be an additional MSA of 6000 feet under specified conditions. This 6000 feet cloud break procedure meant that during instrument meteorological conditions (IMC) the McMurdo non-directional beacon (NDB) had to be used in order to give the aircraft a positive confirmation of its position prior to descent. Accordingly, as from the first of the late 1977 flights,

which occurred on 18 October 1977, the McMurdo waypoint was altered so as to now coincide with the geographical position of the McMurdo NDB. This position was 77 degrees 51 minutes south and 166 degrees 41 minutes east. This geographical position for the McMurdo waypoint remained until arrangements had been completed in 1978 for the production of computerised flight plans in the manner which I have previously described. When, therefore, the waypoints for an antarctic flight to McMurdo were prepared so as to become a constant entry in the airline's ground computer, they were all repeated as used for the 1977 flights. But, so I was told, when the McMurdo destination point was typed into the airline's ground computer, a mistake was made. Instead of taking the NDB waypoint which had been operative for the last four flights in 1977, there was inserted the original Williams Field waypoint which had been discontinued as from February 1977. Therefore, instead of inserting the NDB waypoint with a longitude of 166 degrees 41 minutes east, there was inserted the out-dated Williams Field waypoint of 166 degrees 48 minutes east. This error was made, according to his evidence, by Mr C. B. Hewitt, the chief navigator for Air New Zealand. I am not quite sure whether he concedes that it was an error because he apparently based his destination waypoint upon an existing work sheet which contained the Williams Field geographical position. Nevertheless, there had been an error by someone because, as already stated, the Williams Field position had long since been discarded.

228. Then came the second error, and this is the decisive mistake said to have been discovered during the investigation of this disaster. When Mr Hewitt proceeded to type in the longitude for McMurdo as being 166 degrees 48 minutes east (being the out-dated Williams Field longitude) he inadvertently typed the longitude as 164 degrees 48 minutes east, rather than the 166 degrees 48 minutes east. He went on to say that although it was standard practice to check such figures by looking at the visual display unit on the computer, and comparing these figures with the work sheets, and although he did perform this check, he did not detect this error. The result of typing in this wrong meridian of longitude was to place the McMurdo waypoint about 25 miles to the west of the McMurdo NDB.

229. At this juncture I must pause to consider whether the Williams Field co-ordinates were in fact accidentally used. Certainly the latitudinal meridian was also the same as the Williams Field latitude. But this version of events allowed Mr Hewitt to say that he had only made a mistake in one digit, namely typing in 164° instead of 166°. If, in fact, he had intended to use the current NDB co-ordinates for McMurdo, then there would have been a mistake in two digits, namely 166 degrees 41 minutes east would have been typed in as 164 degrees 48 minutes east. Since it was the case for the airline that this alteration in the destination waypoint was purely accidental and not by design, it was therefore essential to show, if possible, that only one digit had been involved in the typing error. It was scarcely conceivable that two digits could have been mistakenly typed in out of a total of five. I have gone to some lengths to explain all this, because the explanation of the Navigation Section, based upon a mistaken alteration of the McMurdo waypoint, was not accepted by some counsel and, in particular, was doubted by both counsel assisting the Commission. In their submission, Mr Hewitt must have been fully aware of the McMurdo waypoint currently operating, that is to say, the NDB waypoint. What he could have done, so it is said, would have been

to leave the Williams Field latitude as it was, but to alter the NDB longitude so as to move it 2 degrees to the west, which would programme the aircraft to fly to a destination point just to the west of the Dailey Islands. This would conform with what was known to be the standard practice of antarctic pilots which was to fly down the centre of McMurdo Sound and then turn left into the McMurdo area at a point somewhat to the south of McMurdo Station, the purpose being to give passengers the best possible view of the McMurdo Station-Scott Base area. In other words, it was suggested that the four 1977 flights, commencing on 18 October 1977, had all flown down the Sound in approximate conformity with the military track, and the shifting of the McMurdo waypoint was done deliberately so as to conform with this general track.

230. All this was strenuously denied by the Navigation Section. I can summarise the objections in this way:

(a) A waypoint positioned in McMurdo Sound would normally have been a published position appearing on official maps, as for example the Byrd Reporting Point, of which the co-ordinates were readily available, as opposed to a random point close to West Dailey Island. Alternatively the McMurdo NDB (also a published point) would be a natural waypoint, although it was admitted that there would be no difficulty in a crew flying the aircraft from the "incorrect position" to the NDB if so required thus making it possible to use this navigational aid if such a step were necessary.

(b) Then the point was taken that if there had been required an additional sector from the "incorrect" position to the NDB, to enable flight across to the beacon—which may have been necessary in IMC conditions —an additional fuel calculation would have been required.

(c) It was pointed out that if the McMurdo waypoint had been intentionally moved 25 miles to the west, then the flight plan would have a corresponding change to the track and distance information which it previously contained. Instead of a true heading from Cape Hallett to the NDB of 188.9° and a distance of 337 nautical miles, there would have been required, in respect of the changed McMurdo waypoint, a true heading of 191° and 343 nautical miles. Similar alterations would have had to be made in respect of a return journey to the true north.

(d) It would have been unlikely for the airline to have chosen an latitude and longitude co-ordinate of such accuracy for the new position (i.e. 77 degrees 53 minutes south 164 degrees 48 minutes east). The longitude would have been rounded off, for example, to something like 164 degrees 50 minutes east or 164 degrees 30 minutes east. (Cf. Mr Amies, T.1904).

(e) It was submitted that an alteration to the McMurdo waypoint to facilitate better sightseeing was not valid because flight captains had a discretion to deviate horizontally from the flight plan track.

(f) Whilst the Navigation Section agreed that the altered waypoint would improve radio communications in that VHF transmissions and radar transmissions (both dependent on line of sight) would be unimpaired, whereas on the original flight track they would have been blocked out by the mountain for considerable periods of time, nevertheless it was submitted that this would not have been a sufficient reason and reliance was placed upon the evidence of

Captain Gemmell who had maintained that although tracking overhead Mt. Erebus there had been no communication problems. This had also been contained in the report of the airline inspector who was on that flight, Captain Spence.

231. I should now indicate my own opinion in respect of these considerations just enumerated.

232. As to (a) . . . It may be correct that on scheduled flights a waypoint is always in a published position. But these were unscheduled flights. As to the further point that it is unusual for a flight plan not to terminate over the navigational aid to be used for a particular descent procedure, it was of course possible for the aircraft to fly from a new McMurdo position towards the beacon and thus obtain a positive fix as to its position.

233. As to (b) . . . Technically speaking an additional sector from the new position to the NDB would be required to enable crews to programme the AINS to fly to the beacon. But the Navigation Section, in my opinion, knew quite well that DC10 flights were operating at low levels in McMurdo Sound and flying by Heading Select in the immediate McMurdo area. As to the fuel calculation point, the flight plans made ample provision for extra fuel to cover sightseeing in the area of McMurdo Station and that sightseeing would have started some time before the new destination point was reached. Such fuel calculations were based upon the approximate time which sightseeing would take and not upon any track from the destination point, and of course the minimum fuel which had to be available for the return from McMurdo to Christchurch was fixed in all cases.

234. As to (c) . . . I agree that there is considerable validity in this point. The track and distance details of the Cape Hallett/McMurdo sector would have required amendment in the manner indicated by the Navigation Section witnesses. As opposed to this, I observe that when the Williams Field waypoint was changed to the NDB waypoint, there was no amendment of the track and distance details, minor though such amendments would have been. In addition, the Navigation Section may have thought it not necessary to alter the track and distance criteria from Cape Hallett to McMurdo for the reason that the pilots were accustomed to flying on Heading Select down this sector and not by reference to the fixed heading programmed into the AINS.

235. As to (d) . . . No doubt it is true to say that a convenient longitudinal co-ordinate for the new waypoint could have been rounded off instead of being fixed at 164 degrees 48 minutes east, but by the same token it was an even more simple procedure merely to move the destination co-ordinate 2° to the west.

236. As to (e) . . . This is a valid objection.

237. As to (f) . . . Although the airline denied that there was any validity in the point that communications might be improved by the adoption of something very close to the military route, there can be no doubt at all that radar identification and VHF transmission would have been wholly uninterrupted in consequence of the adoption of the new waypoint. As to the evidence of Captain Gemmell and the report of Captain Spence in respect of the first of the antarctic flights when they said that communications were uniformly good throughout, I can only suppose that as they approached Mt. Erebus at 16 000 feet (if indeed that happened) they had satisfactory HF communication (which does not depend upon line of sight) because VHF transmissions could not have been received for

the last 20 or 30 miles before Mount Erebus was reached, and similarly, radar identification in the ASR mode would not have been possible at all until after Captain Gemmell's aircraft had overflown the mountain.

238. As will be seen, there was here a close and detailed conflict between the Navigation Section of the airline and those counsel who declined to accept the proposition that the transposition of the McMurdo waypoint had been a mistake. This conflict was further exacerbated when Mr Davison, on behalf of the estate of Captain Collins, produced to Mr Amies in cross-examination the document which became **Exhibit 164.** This is a track and distance diagram prepared by the Navigation Section, which contains headings and distances for the area north of the Auckland Islands down to the two alternate routes available to antarctic flights. The principal feature of this document, which it turned out Mr Amies had in part prepared, was a plotted track from Cape Hallett down McMurdo Sound on a path which appeared to lead it not only to the east of the Byrd Reporting Point but also to a position situated somewhat further to the true south. Now this flight path (making due allowance for the imperfections of what is a fairly poor photocopy of an original) appears to be indistinguishable from a flight path running from Cape Hallett down to the altered McMurdo waypoint. In addition the draftsman had run a dotted semi-circular line around the south of Ross Island, and then a straight line had been drawn back to Cape Hallett along 170° meridian of east longitude. On that line had been drawn an arrow pointing towards Cape Hallett.

239. Mr Amies, who appeared disconcerted when **Exhibit 164** was placed in front of him by Mr Davison, was cross-examined closely about its content. He asserted that it was only a draft track and distance diagram and pointed out that there was no track and distance notation for the southern or northern legs of the Cape Hallet/McMurdo sector. He also alluded to certain other slight inaccuracies in the chart. As to the arrow pointing in the direction of Cape Hallett after a presumed circuit of Ross Island, Mr Amies agreed that he had drawn this arrow but maintained that it was not intended to be an aircraft track. He maintained that he had drawn it there only to indicate the position of true north, and this was because he had been working with grid navigation when entering details on this chart. This latter assertion was certainly surprising.

240. Mr Amies is a navigation expert of great experience. He was responsible for introducing grid navigation on the North Atlantic routes and for many years used grid navigation techniques in those areas. He was associated with the production of the AINS for installation in DC10 aircraft, and he had been employed by McDonnell-Douglas Corporation to give area navigation instruction to airline crews in California; by Swissair, to instruct their crews in the same system; and he had also been retained for that purpose by British Airways in London. The arrow which Mr Amies marked on the line of 170° E longitude was naturally pointing north because all meridians of longitude point north and south. I wondered whether companies like Swissair and British Airways were aware of the fact that their navigation consultant had to plot an arrow on a map to remind himself that a meridian of longitude pointed true north. However, the principal feature of **Exhibit 164** was that it was delivered to the RCU briefing unit for inclusion in the 1978 briefings of pilots and was similar in content to other diagrams given to pilots which also showed a flight path going down McMurdo Sound. I can quite understand that **Exhibit 164** may have been originally intended as a draft working

document to indicate possible tracks from Cape Hallett to McMurdo and back, and I can also see that there are no track and distance guides from Cape Hallett to McMurdo and return, although this latter omission may have been due to the factor previously mentioned, namely that crews were authorised to deviate horizontally from the official flight paths over that sector. But for some reason **Exhibit 164** became part of the briefing material to crews of 1978 and I am not sure that it also did not form part of the briefing material for 1979. In addition, the evidence suggests that the same **Exhibit 164** was included in the flight documents taken by aircraft crews to Antarctica, and that it was included in those flight documents for 1978 and 1979. Again, in this particular context, reference must be made to what is known as "Annex J" to the chief inspector's report. This consisted of a track and distance diagram which showed the flight path as being over the centre of Ross Island. Captain Gemmell handed it to the chief inspector and told him that it had formed part of the flight documents carried by the crew on the fatal flight.

241. I have examined the exhaustive analysis of the evidence relating to **Exhibit 164** and Annex J which is contained in the closing submissions of counsel for the airline. But in my opinion, on the totality of the evidence, Annex J never formed part of the 1979 flight documents and was not on the fatal flight. Consequently there was no track and distance guide carried on the fatal flight which indicated that the nav track lay on a direct course with Mt. Erebus. On the contrary, there were three charts or diagrams (four, if I include **Exhibit 164**) which all showed a track down the centre of McMurdo Sound.

242. The next instalment of this navigational saga concerns the incident which caused the McMurdo waypoint to be moved back to a point close to its original position. Captain Simpson piloted the flight of 14 November 1979 and he had attended the briefing session with Captain Collins and First Officer Cassin five days previously. As at the date of this flight the "incorrect" McMurdo position was still contained in the airline's ground computer. When checking the flight plan co-ordinates entered into the system of his own aircraft Captain Simpson noted, by reference to a topographical map, that the McMurdo destination was well to the west of McMurdo Station. On his return to New Zealand Captain Simpson reported that the McMurdo destination waypoint was approximately 27 miles to the true west of the TACAN because when he had been overhead the TACAN he had observed a cross-track error of these dimensions. Captain Simpson was surprised at the distance between the flight plan McMurdo position and the TACAN position, and he merely suggested to Captain R. T. Johnson that crews should be notified of the distance between the TACAN and the flight plan McMurdo position. Captain Simpson said that he did not believe that the McMurdo position on the flight plan was other than a correct position, and certainly did not suggest that there had been any mistake on the part of the Navigation Section.

243. Then there seemed to follow a considerable degree of confusion. Captain R. T. Johnson said in evidence that he believed that he had been told that the McMurdo position was an error and should be at 166 degrees 58 minutes longitude east. Captain Simpson strongly disagreed with this evidence, and in particular disagreed with the suggestion that he told Captain Johnson that the McMurdo waypoint would be better positioned at the TACAN. But it appears that it was decided by someone, I am not sure whom, that the McMurdo position should be moved to the TACAN. Captain Johnson evidently did not check the actual destination waypoint.

He assumed that it coincided with the geographical position of the McMurdo NDB. His evidence was that he understood that Captain Simpson had been saying, in effect, that the McMurdo position should be at the TACAN rather than at the NDB. The difference between those two positions was only 10 minutes of longitude, representing 2.1 miles. Therefore when on the night before the fatal flight the McMurdo co-ordinates were changed to the TACAN position, it was believed by Captain Johnson, so he says, that the difference involved was only 2.1 miles and that consequently there was no need to appraise Captain Collins of the change. In order to clarify the difference of 10 minutes, I should indicate that the TACAN position was 166 degrees 58 minutes east longitude and the NDB position, as previously indicated, was 166 degrees 48 minutes east longitude.

244. Now this was certainly a most detailed and elaborate explanation for the fatal decision not to notify Captain Collins of the alteration in the McMurdo waypoint. But is the explanation true? Captain Simpson does not agree at all with the evidence that he suggested a change to the TACAN position. Nor does he agree at all with the suggestion that he reported an "error" in the McMurdo position. Why, therefore, was the position changed to the TACAN, thus representing a shift of the computer track from the centre of McMurdo Sound to a collision course with Mt. Erebus? There is no memorandum in existence which records any of the communications and decisions to which I have just referred. Captain Johnson set out in a letter, after the disaster, the explanation to which I have just referred. But there is no documentation contemporary with the various steps which were taken.

245. There seem to me to be only three possible explanations having regard to the fact that I accept without reservation what Captain Simpson had to say in evidence. He is very obviously a careful and methodical man, with no element of indecision about what he saw and did during and after his flight. The three possible explanations are—

(a) The first is that the communication by Captain Simpson was in fact misinterpreted by Captain Johnson, who directed that the computer flight track be now aligned with the TACAN in the belief—which he did not verify—that it had always been aligned with the NDB and thus the alteration would be minimal.

(b) The second explanation is that both Captain Johnson and the Navigation Section knew quite well that the McMurdo waypoint lay 27 miles to the west of the TACAN and that since his track had not officially been approved by the Civil Aviation Division it should therefore be realigned with the TACAN and then someone forgot to ensure that Captain Collins was told of the change. Such an interpretation means that the evidence as to the alleged belief of a displacement of only 2.1 miles is untrue.

(c) The third explanation is that the relocation of the McMurdo waypoint at the TACAN position was never intended and was effected by mistake, and that after the disaster it was thought better to back-date the "mistake" by 14 months as this would look a little better than admitting the occurrence of a computer error only hours before the flight departed. However, whether this in fact occurred will never be known, and I propose not to discuss this point further.

246. Concentrating now upon the possibility of (b) mentioned above, it seems to me that the evidence supports this interpretation. When the new co-ordinates of 166 degrees 58 minutes east were written into the work

sheet from which they would be typed into the airline's ground computer, there also had to be written into that work sheet a symbol which would ensure that the changed co-ordinates also appeared on the abbreviated version of the flight plan which would be radioed to McMurdo on the morning of the flight. But the witness responsible for this task testified that there was yet a further computer mistake. Instead of writing this symbol into the correct column of the work sheet dealing with geographical changes he wrote it into the column dealing with navigational aids. So when this symbol was typed into the ground computer it had the accidental effect of deleting the new co-ordinates from that part of the flight plan which would be radioed to McMurdo and replacing it merely by the name "McMurdo". The result therefore was that on the flight plan printed out for Captain Collins the longitudinal co-ordinates for McMurdo were printed as 166 degrees 58 minutes east, but the flight plan sent to McMurdo omitted the co-ordinates and merely gave the place name. All previous flight plans radioed to McMurdo in 1978 and 1979 had contained the "incorrect" co-ordinates, placing the waypoint 2 degrees to the west.

247. This explanation about the wrong symbol being typed into the ground computer seemed to me to be very difficult to accept. The operator who did this knew the printed work sheet like the back of his hand. The unfortunate inference is open that he was instructed to programme the computer so as to conceal from the McMurdo Air Traffic Controller that the destination waypoint had been changed. The McMurdo Air Traffic Control personnel had, according to the evidence, plotted the first of the 1979 co-ordinates and thereater relied on those being constant. But when they received from Auckland by radio their section of the flight plan, which would advise them of the times and flight levels and approach path of TE 901, they only saw the word "McMurdo", whereas if the new co-ordinates had been revealed then the United States Air Traffic Control personnel would immediately have identified those co-ordinates as being the co-ordinates of the TACAN.

248. Such is the nature of this shadowy and undocumented explanation conveyed to me in evidence by Captain Johnson and members of the Navigation Section. I use the term "undocumented" because, as I have said, there is not one contemporary document in the form of a memorandum either instructing what steps were to be taken with the co-odinates or confirming what steps had been taken. The only document, if I can call it such, is an extract from an informal log referring to the proposed change of co-ordinates. But that log or diary had certain unusual features which I shall later describe.

249. Here is a list of the mistakes which in some cases were admittedly made, and in other cases alleged to have been made, as appearing from the foregoing narrative:

1. The computerised flight plan prepared for the 1978 flights was intended to display as the destination waypoint the position of the McMurdo NDB. But in fact the waypoint was located at the geographical position of Williams Field. That position had been abandoned after the first two flights in 1977.

2. The typing into the airline's ground computer of the longitude 164 degrees 48 minutes east instead of 166 degrees 48 minutes east.

3. Failing to detect that error when checking the waypoint co-ordinates entered into the ground computer against the print-out of those figures as appearing on the screen of the computer display unit (CDU).

4. The mistake on the part of Captain Johnson that Captain Simpson, after his flight on 14 November 1979, had stated that there was an error of 27 miles in the McMurdo waypoint when in fact all Captain Simpson had said was that the pilots should be told that the distance from the TACAN over to the McMurdo waypoint was 27 miles.

5. The mistake by Captain Johnson that Captain Simpson had stated that the McMurdo waypoint should be shifted to the TACAN position.

6. As indicated under error No. 1, the longitudinal position of the NDB was established in the airline's computerised flight plans as 166 degrees 48 minutes east which is, in fact, the longitudinal co-ordinate for Williams Field, the correct longitudinal position of the NDB being 166 degrees 41 minutes east. As a result of this, it was estimated that the lateral distance from the supposed position of the NDB to the TACAN was 2.1 miles representing 10 minutes of longitude (166 degrees 48 minutes east as against 166 degrees 58 minutes east). There was an omission to notice, however, that the lateral distance should have been from 166 degrees 41 minutes east to 166 degrees 58 minutes east, which amounts to a variation of 17 minutes of longitude representing a lateral distance of 3.7 miles.

7. When writing the TACAN co-ordinates of 166 degrees 58 minutes east into the worksheet for the ground computer, the operator (Mr Brown) entered a symbol which had the effect of obliterating those figures from the flight plan extract to be sent to the United States air traffic controller at McMurdo and substituting as the destination waypoint the word "McMurdo". The comparison between the Air Traffic Control flight plan received on 21 November 1969 (having the same waypoints as all the Air Traffic Control flight plans transmitted for the previous flights for 1978 and 1979) and the Air Traffic Control flight plan sent in advance of the fatal flight is shown in the following tabulation:

21 November 1979		28 November 1979	
50° 42′ S	166° 10′ E	50° 42′ S	166° 10′ E
55° S	165° 28′ E	55° S	165° 28′ E
60° S	164° 32′ E	60° S	164° 32′ E
66° 45′ S	163° E	66° 45′ S	163° E
72° 20′ S	170° 13′ E	72° 20′ S	170° 13′ E
77° 53′ S	164° 48′ E	McMurdo	
72° 20′ S	170° 13′ E	72° 20′ S	170° 13′ E
70° S	170° 04′ E	70° S	170° 04′ E
65° S	160° 47′ E	65° S	169° 47′ E
60° S	169° 33′ E	60° S	169° 33′ E
55° S	169° 21′ E	55° S	269° 21′ E

I have omitted data relating to flight levels also appearing in the Air Traffic Control flight plans and have merely indicated those waypoints applicable from 50 degrees 42 minutes south back to McMurdo, and then back again as far as 55 degrees South. All co-ordinates are the same on each Air Traffic Control flight plan, except for the omission to notify the McMurdo Air Traffic Control of the new co-ordinates for the McMurdo waypoint.

8. Despite the minor distance thought to be involved by changing the co-ordinates (2.1 miles, although in reality 3.7 miles) failing to advise Captain Collins and his crew that the destination waypoint had been changed from the NDB to the TACAN.

250. This history of the computer programming of the antarctic flights from October 1977 to November 1979 is distinguished (as stated already) by an almost total lack of documents recording these navigational decisions. There is not one memorandum from the Flight Operations Division to the Navigation Section giving instructions for any change, nor is there any written report from the Navigation Section notifying Flight Operations of changes which had been made. There was no memorandum to the Navigation Section by Captain Johnson recording Captain Johnson's erroneous but vital misconception that there was supposed to be a 27 mile error in the destination co-ordinates. There is no memorandum from the Navigation Section back to Captain Johnson recording the outcome of their investigations.

251. In respect of this whole period there have been produced only two contemporary documents. One is a handwritten logbook maintained by Mr D. T. Kealey who is flight services controller (flight despatch) for the airline. This is the log or diary to which I previously referred. This logbook was produced as **Exhibit 177**. A copy of the relevant page was produced as **Exhibit 17**. Under the handwritten entry "Wed 21 11" (meaning 21 November 1979) there appears an item referring to the proposed change of the destination co-ordinates but containing the phrase "nil update of computer files tonight". This entry is timed at 1301 hours whereas it appears to be followed by other entries commencing at 1058 hours. Mr Kealey explained that these latter entries in reality referred to 27 November 1979 and that he had inadvertently recorded three entries for 27 November 1979 in a blank space which had been left for Wednesday, 21 November, this error being occasioned by the misplacement of a clip which is used to secure the pages of the notebook. Further, Mr Hewitt, the chief navigator for the airline, had originally said that this conversation with Mr Kealey referring to the computer being updated had taken place on 20 November. This appeared to be corroborated by Mr Kealey's note about not updating the computer "tonight" because the next flight to Antarctica was to leave on the morning of 21 November. The recording of the conversation as having been made at 1301 hours on 21 November therefore purported to indicate that the message had not been received until after the departure of Captain White's flight to Antarctica on Wednesday, 21 November thus justifying no action being taken on the previous night. However, Mr Hewitt later changed his recollection and said that he now recalled that the conversation was in fact on 21 November 1979.

252. This extract from the log of Mr Kealey came under the scrutiny of the chief inspector and of Captain Gemmell, the chief pilot, during their inquiries in December 1979, about 4 weeks after the date of the disaster. It appears that the chief inspector was not satisfied with the accuracy of this handwritten informal notebook which serves as a log but which contains various items of a personal nature. Captain Gemmell, on 20 December 1979, wrote to Mr Kealey requiring an explanation as to why the chief navigator had directed a change in the McMurdo position on 20 November, yet no amendment had been made to the flight plan of TE 901 which left on 21 November. On 24 December 1979 Mr Kealey replied, and stated that the requirement was not passed on to the flight planner

concerned. He then stated "I am unable to offer any explanation of this" Long after this, Mr Kealey produced the explanation to which I have just referred, but I can only say in passing that it seems surprising that the alteration of the co-ordinates, known by the Flight Despatch Section on the night of the disaster to have taken place in the early morning of that day, was not given the closest attention by Mr Kealey and Mr Hewitt on the morning after the disaster (8 days after the log entry) and the present explanation offered immediately to Captain Gemmell when he made his inquiry. So much for the first of the two memoranda produced in relation to the antarctic destination waypoints.

253. The second and last document is the notification sent out to all pilots on 8 November 1979 by Captain Johnson intimating that the NDB facility had been withdrawn and that the briefing notes were to be amended accordingly, and restating the position that MSA was 6000 feet under specified conditions.

254. In effect, therefore, there was not one document produced which verified the occurrence of the various mistakes which are said to have been made. I am compelled to stress this alarming lack of written communication between the Flight Operations Division, and Navigation Section, and the Flight Despatch Section, and the lack of written communications within each of these departments of the airline, because it was very clearly this absence of written memoranda and settled inter-departmental communication systems which was responsible for the failure to notify Captain Collins that the destination waypoint on his flight plan had been changed.

255. Before setting out my conclusions on all these matters, I must take into account the fact that the Navigation Section of the airline is staffed by personnel of extreme skill and long experience. They are noted, according to evidence given on behalf of the line pilots, for their meticulous checking and cross-checking. For this reason alone I find it impossible to accept that this remarkable list of mistakes, omissions, and misunderstandings can be totally correct.

Here are my views as to these explanations:

(a) The first question is whether the programming of the McMurdo waypoint into the "false" position before the commencement of the 1978 flights was the result of accident or design. On balance, it seems likely that this transposition of the McMurdo waypoint was deliberate. I say this because of the decision reached at approximately the same time to include in the briefing documents, and to include in the flight documents to be carried on each aircraft, the document described as **Exhibit 164.** That is the track and distance diagram which, as will be recalled, indicates a track down McMurdo Sound past the Byrd Reporting Point. I fully appreciate that it contains certain technical and minor inaccuracies, including the lack of any specific heading for an aircraft to follow when travelling towards McMurdo. But, as indicated already, this could merely reflect the knowledge of the Navigation Section (although they deny it) that pilots on the most recent flights had been flying in the area on Heading Select and with no obligation to follow any defined flight path. In addition, **Exhibit 164** coincided with the other schematic diagrams carried by Antarctica flight crews which each depicted a flight path down McMurdo Sound. As I have said, I am satisfied that the document known as Annex J—a diagram

depicting a direct path to Mt. Erebus—was not in fact carried on any of the 1978 or 1979 flights and that Captain Gemmell was mistaken when he handed a copy of Annex J to the chief inspector and told him that it had been on the fatal flight. So as I say, I think it likely that the change of the McMurdo destination point was intended and was designed by the Navigation Section to give aircraft a nav track for the final leg of the journey which would keep the aircraft well clear of high ground.

However, I propose to make no positive finding on this point. I must pay regard to the circumstance strongly urged upon me by counsel for the airline in their closing submissions, namely, that if the alteration was intentional then it was not accompanied by the normal realignment of the aircraft's heading so as to join up with the new waypoint. As I say, I think this latter omission is capable of explanation but it is a material fact in favour of the Navigation Section which I cannot disregard, and it is the single reason why I refrain from making a positive finding that the alteration of the waypoint was intentional.

(b) I believe, however, that the error made by Mr Hewitt was ascertained long before Captain Simpson reported the cross-track distance of 27 miles between the TACAN and the McMurdo waypoint, and I am satisfied that because of the operational utility and logic of the altered waypoint it was thereafter maintained by the Navigation Section as an approved position.

(c) Captain R. T. Johnson was quite wrong in his belief that Captain Simpson told him that the McMurdo position was an error and that the position ought to be switched to the TACAN. He seems now to admit that he was mistaken. But I must ask myself the question whether in the course of a conversation between these two very experienced pilots such a misinterpretation could possibly have arisen. Captain Johnson had always believed, so he said in evidence, that the destination waypoint was located at the McMurdo NDB, which is in close proximity to the TACAN, and it seems impossible to accept that he could ever had taken Captain Simpson to mean that the McMurdo position was in error to the extent of 27 miles.

On 17 October 1979 Captain Johnson wrote to the Director of Civil Aviation referring to the latest Ross Sea chart—NZ-RNC4—dated 26 September 1979, which in turn referred to the United States Department of Defence publications as to navigation aids at McMurdo. Captain Johnson pointed out that the current edition of the United States publication (of 4 October 1979) deleted any reference to an NDB approach and had published TACAN approach charts only. Following this letter, Civil Aviation Division ascertained from the United States authorities that the NDB facility had been withdrawn. This in turn was communicated to Captain Johnson. He then issued his written notice (to which I have referred already) dated 8 Novemer 1979 advising pilots that the NDB facility at McMurdo was no longer available. In the light of this sequence of events I cannot follow how, on or about 15 November, Captain Johnson would have understood Captain Simpson as saying that the McMurdo position (thought by Captain Johnson to have been at the NDB) would be "better positioned at the TACAN", and how Captain Johnson could then have passed on these comments to the Navigation Section. Captain Johnson knew that the NDB facility

had been withdrawn some time previously and if it was the airline's policy (frequently asserted before me) that a destination waypoint must be located at a published position, then the TACAN was the only other published navigational position at McMurdo. DC10 aircraft were not programmed to pick up a bearing from the TACAN but they were capable of interrogating the DME function of the TACAN. Again I prefer to make no positive finding, but I can only say that Captain Johnson's evidence as to referring to the Navigation Section an inquiry about the desirability of the TACAN becoming the destination waypoint, must be open to considerable doubt. The truth of the matter most likely is that the Flight Operations Division simply directed the Navigation Section to reprogramme the Hallett-McMurdo flight path to the TACAN because they had found out that the NDB navigational aid had been withdrawn.

(d) If, as I have held, the Navigation Section knew the actual position of the McMurdo waypoint as being 27 miles to the west of the TACAN, then why did they not submit to Captain Johnson, or to Flight Operations Division, that the waypoint should remain where it was? One view is that the Flight Operations Division expected, in terms of Captain Johnson's letter to the Director of Civil Aviation dated 17 October 1979, that the next edition of the Ross Sea chart NZ-RNC4 would contain the official Air New Zealand flight path to McMurdo, and that the safest course would be to put the destination point back to the approximate location at which Civil Aviation Division had thought it had always been.

(e) When the TACAN position was typed into the airline's ground computer in the early morning of 28 November 1979, there was also made the additional entry to which I have referred, which would result in the new co-ordinates not being transmitted to McMurdo with the Air Traffic Control flight plan for that day. It was urged upon me, on behalf of the airline, that McMurdo Air Traffic Control would consider the word "McMurdo" as indicating a different position from that appearing on Air Traffic Control flight plans despatched from Auckland during 1978 and 1979. I cannot for a moment accept that suggestion. First Officer Rhodes made a specific inquiry at McMurdo within a few days of the disaster and ascertained that the destination waypoint of the first Air Traffic Control flight plan for 1979 had been plotted by the United States Air Traffic Control personnel, and there was evidence from the United States witnesses that this would be normal practice. In my view the word "McMurdo" would merely be regarded, and was indeed regarded, by McMurdo Air Traffic Control as referring to the same McMurdo waypoint which had always existed. In my opinion, the introduction of the word "McMurdo" into the Air Traffic Control flight plan for the fatal flight was deliberately designed to conceal from the United States authorities that the flight path had been changed, and probably because it was known that the United States Air Traffic Control would lodge an objection to the new flight path.

(f) I have reviewed the evidence in support of the allegation that the Navigation Section believed, by reason of a mistaken verbal communication, that the altered McMurdo waypoint only involved a change of 2.1 nautical miles. I am obliged to say that I do not accept that explanation. There were certainly grave deficiencies in

communication within the Navigation Section, but the high professional skills of the Navigation Section's staff entirely preclude the possibility of such an error. In my opinion this explanation that the change in the waypoint was thought to be minimal in terms of distance is a concocted story designed to explain away the fundamental mistake, made by someone, in failing to ensure that Captain Collins was notified that his aircraft was now programmed to fly on a collision course with Mt. Erebus.

WHETHER CAPTAIN COLLINS RELIED UPON THE INCORRECT CO-ORDINATES PRODUCED AT THE BRIEFING ON 9 NOVEMBER 1979

256. I have already indicated my finding that it is really beyond dispute that Captain Collins plotted on a topographical map or maps the nav track of the proposed flight which would journey from Cape Hallett down to the destination co-ordinates located near the Dailey Islands at about the centre of the southern end of McMurdo Sound. This fact dominates the whole of the Inquiry. It is a fact which must always have been distinctly unpalatable to the management of Air New Zealand and to the Director of the Civil Aviation Division because it led to a conclusion which they strongly desired to avoid. But on the evidence, the conclusion is inescapable.

257. The starting point of this aspect of the Inquiry occurs towards the very end of the narrative of the flight. That starting point is, of course, the decision of Captain Collins to switch the aircraft back on to its nav track when the aircraft was turning into its final approach after completing the second orbit, and when it was only 6 minutes 15 seconds away from impact. That is to say, Captain Collins was proposing to fly the aircraft at about 2000 feet straight ahead, with the mountainside only 25 miles away. In addition, he was proposing to cover that 25 miles at 300 miles per hour. In these circumstances, it is and was folly to suggest that Captain Collins was not relying upon the false co-ordinates which had been changed without his knowledge shortly before the flight. That is why no serious attempt was made at the hearing to challenge this unassailable inference.

258. As will be recalled, the chief inspector had this to say (at para. 2.5 of his report) in regard to the false co-ordinates which had been in existence for 14 months prior to the disaster:

> "As all previous flights to McMurdo had approached the area in VMC earlier crews had not adhered to the flight plan track and hence had not detected the error. In the case of this crew no evidence was found to suggest that they had been misled by this error in the flight plan shown to them at the briefing".

The chief inspector explained this final sentence in the course of his testimony before the Commission. It turned out, not unnaturally, that he did not really mean what he had said. He agreed, in the course of his evidence (at T. 243) that in his opinion the crew had a misconception as to where their flight path was taking them in relation to Ross Island. He explained that sentence of his report just referred to by saying that he had no "evidence" in the sense of a statement by an eyewitness to the effect that he had distinctly seen Captain Collins plot on a map the erroneous path of the nav track from Cape Hallett down the centre of McMurdo Sound. In addition, the chief inspector had something further to say

during his evidence on this particular point. He made it clear during cross-examination by Mr Davison (at T. 249) that because the crew had not been provided with a topographical map upon which the nav track had been plotted, then either they should have plotted the track themselves on a map during flight or "had it been considered that such a procedure was cumbersome within the confines of the cockpit or the flight deck area, then the actual track could have been plotted on a map prior to departure". The evidence was clear that Captain Collins had in fact taken the latter course.

259. Mrs Collins testified that her husband owned a copy of a limited edition New Zealand Atlas. It had been presented to Captain Collins by the parents of Mrs Collins in April 1977. A copy of this atlas was produced in evidence as **Exhibit 46**. At page 184 of the atlas there is a detailed map setting out the area of the whole of the Ross Dependency and showing the Balleny Islands and Cape Hallett and McMurdo Sound. On page 185 is a map containing a detailed view of the area from Beaufort Island to a point about 100 miles south of McMurdo Station. The scale of this latter map is approximately 16 miles to the inch. If the last stage of the erroneous flight path had been plotted on this latter map, then in order to determine the aircraft's position a pilot could tell at a glance his exact position merely by referring to the miles to run on his instrument panel and then glancing at the map. It is common ground that Captain Collins brought this atlas with him to the RCU briefing on 9 November 1979 and that he was seen to be closely examining the two pages at a time when he was in possession of a flight plan showing the incorrect co-ordinates. It is also common ground that he took this atlas with him on the fatal flight.

260. Mrs Collins testified that from about 8 p.m. to 9.30 or 10 p.m. on the night before the flight her husband was working with a number of maps spread out over a table. She said that it was a reasonably frequent practice for Captain Collins to spend time in preparation for his flights by going over briefing materials and so forth, particularly in respect of a new route which he had not flown before or a route that he had not recently flown (Brief of Evidence pages 1 – 2). Mrs Collins herself did not pay attention to the maps or to the other materials with which her husband was working. More particular evidence was given by the two daughters of Captain Collins. Kathryn Collins (who is 17 years old) said that on the evening of 27 November 1979 her father was working at home "with a large chart of the Antarctica-Ross Sea region". She said that he had a ruler "or some measuring equipment" and was working on the chart. Kathryn Collins discussed with her father this impending flight to Antarctica and in order to explain the flight he opened the New Zealand atlas. He said that the scale (presumably referring to page 184) was a bit too small for demonstration purposes and he then referred to another larger map "which was not the one that he had been working on when I interrupted him". She went on to say that this larger map was of such extent that instead of opening it out on the table Captain Collins spread it out on the floor. He then explained to his daughter Kathryn, by reference to this map, that the aircraft would fly down McMurdo Sound near the coast of Victoria Land and he indicated that the aircraft would fly back on the same track.

261. The other daughter is Elizabeth Collins, who is 15 years old. She said that she glanced at the map her father was working on some time before her sister Kathryn had spoken to him. She asked whether the aircraft was to land on the Ross Ice Shelf which was depicted on the map.

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                CENTRE LANDING GEAR IS EXTENDED FOR TAKE OFF
OPS FLASH
NZN NZAA-NZCH RT NO      /      CAPT DALZIELL     RADIO LOG
06/11/79-1900Z  TRK.T  W/V  G/S  DIST ZEET FUELRM STN
M82  TE 901/07  TRK.M DDVVV FL   ZATA ZETA RQFUEL GMT

NZAA  AUCKLAND                                    .  FREQ P
3700.6S17446.9E                    S/H ....  101.4      S

NP    NEWPLMTH  193.6        400   123   21
3900.2S17410.9E 174.3        CLB   ....  ....  XX.X

NS    NELSON    199.3 23037 448   146   22     .
4117.8S17308.0E 179.3        FL31  ....  ....  91.3

RY    MT MARY   216.2 24037 444   208   28     .
4408.2S17016.8E 195.2        FL31  ....  ....  86.5

NV    INVRCRGL  211.8 27037 457   163   21     .
4624.8S16819.1E 189.2        FL31  ....  ....  83.1

AUKIS AKLND IS  198.4 29078 478   271   34     .
5042.0S16610.0E 173.4        FL29  ....  ....  77.5

55S   55S       185.7 29098 497   259   32     .
5500.0S16527.2E 156.2        FL29  ....  ....  72.5

60S   60S       185.7 31060 504   302   36     .
6000.0S16431.1E 150.2        FL33  ....  ....  66.8

BLYIS BALENYIS  185.7 31053 504   407   48     .
6645.0S16300.0E 349.5        FL31  ....  ....  59.6

CPHLT C HALLET  155.8 31063 532   367   41     .
7220.0S17013.0E 322.4        FL31  ....  ....  53.6

MONDO MOMNRDO   188.9 34054 517   337   40     .
7753.0S16448.0E 357.4        FL35  ....  ....  47.9

CPHLT C HALLET  008.9 34054 425   337   47     .
7220.0S17013.0E 177.4        FL33  ....  ....  41.5

70S   70S       358.8 33060 420   139   20     .
7000.0S17003.6E 168.9        FL33  ....  ....  38.8

65S   65S       358.8 31068 425   300   42     .
6500.0S16946.6E 168.7        FL33  ....  ....  33.2
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FIGURE 7

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ZKNZP ON GATE 2. CLG DOWN FOR DEPARTURE.
OPS FLASH
NZP NZAA-NZCH RT NO      /      CAPT COLLINS      RADIO LOG
27/11/79-1900Z  TRK.T  W/V  G/S  DIST ZEET FUELRM STN
M82. TE 901/28  TRK.M DDVVV FL   ZATA ZETA RQFUEL GMT

NZAA  AUCKLAND                                .  FREQ P
3700.6S17446.9E                  S/H ....  100.9      S

NP    NEWPLMTH  193.6       425   123   20
3900.2S17410.9E 174.3       CLB   ....  ....   XX.X

NS    NELSON    199.3 30027 486   146   21     .
4117.8S17308.0E 179.3       FL31  ....  ....   91.0

RY    MT MARY   216.2 31027 481   208   26     .
4408.2S17016.8E 195.2       FL31  ....  ....   86.5

NV    INVRCRGL  211.8 31029 485   163   20     .
4624.8S16819.1E 189.2       FL31  ....  ....   83.3

AUKIS AKLND IS  198.4 32029 495   271   33     .
5042.0S16610.0E 173.4       FL29  ....  ....   77.9

55S   55S       185.7 31033 498   259   31     .
5500.0S16527.2E 156.2       FL29  ....  ....   72.9

60S   60S       185.7 30034 487   302   37     .
6000.0S16431.1E 150.2       FL33  ....  ....   66.9

BLYIS BALENYIS  185.7 29026 481   407   51     .
6645.0S16300.0E 349.5       FL31  ....  ....   59.3

CPHLT C HALLET  155.8 29021 490   367   45     .
7220.0S17013.0E 322.4       FL31  ....  ....   52.8

MCMDO MCMURDO   188.5 24015 463   336   43     .
7752.7S16658.0E 357.0       FL35  ....  ....   46.5

CPHLT C HALLET  008.5 24015 483   336   42     .
7220.0S17013.0E 177.0       FL33  ....  ....   40.8

70S   70S       358.8 29024 465   139   18     .
7000.0S17003.6E 168.9       FL33  ....  ....   38.4

65S   65S       358.8 29024 465   300   39     .
6500.0S16946.6E 168.7       FL33  ....  ....   33.3
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FIGURE 8

Her father said the aircraft would not land. He then pointed out where the aircraft would be going, and said that it would be travelling down McMurdo Sound and would keep "fairly close to this bumpy lot", meaning thereby, the eastern coast of Victoria Land. Elizabeth Collins left the room and some time later returned and heard her father explaining the flight to Kathryn. Elizabeth Collins was shown a number of maps but could not identify the map her father was using that night. She said that the map her father showed her was quite a large scale map and that when opened out it was too large for the table and had to be placed on the floor.

262. Some questions were asked of Mrs Collins in cross-examination, but no counsel questioned her on the evidence that Captain Collins had been working on maps with a ruler and/or plotting instruments, and no counsel desired to cross-examine either daughter on the same topic. It therefore appears that Captain Collins had acquired two maps to which he referred on that night, in addition to the atlas which formed part of the family library. The probabilities are that Captain Collins used one or other of the large maps to plot a track from Auckland leading through each waypoint down to the termination of the nav track at the head of McMurdo Sound, and that he performed the same plotting procedure on the Ross Dependency map, illustrated at page 184 of his atlas. Finally, there can be no doubt at all that on page 185 of his atlas, which showed the McMurdo area on a scale of 16 miles to the inch, he plotted the last leg of the nav track from a point a little to the west of Beaufort Island down to the false co-ordinates near the Dailey Islands.

263. It will be noted that Captain Collins spent between 1½ and 2 hours working on these maps with the "other materials" referred to which were, no doubt, his briefing documents. If Captain Collins had plotted the complete flight path of TE 901 from Auckland to McMurdo and return, then in order to be able to refer to the various waypoint co-ordinates he would need to have had in his possession a computer print-out for the antarctic route. In my opinion he did in fact have such a print-out. Numerous print-outs have been produced in evidence, and there was evidently no difficulty in obtaining a print-out of the route if required for some particular purpose. According to Mrs Collins, her husband concluded his work with the maps at about 10 p.m. and then packed the maps and other written materials into his black flight bag in preparation for the following morning. It is clear, as I have said, that the atlas must also have been packed into the flight bag because it left the household that night and has never been seen again. The decision of Captain Collins to take with him the atlas is significant in the extreme. It could only have been taken because of the large scale data on page 185, which, with a line drawn down to the false waypoint, would show him his exact position at any moment in relation to Ross Island, Mt. Bird, Mt. Erebus, and McMurdo Station. The detail on page 184 would be available, almost certainly on larger scale, on one or other of the 2 maps, which he had been using, and the deduction is clear that the atlas was taken on the flight because of the track which Captain Collins had plotted on page 185. Fig. 7, page 96 shows the relevant section of the flight plan produced to Captain Collins at his briefing, and fig. 8, page 97 the corresponding section of the flight plan delivered to him on the morning of the fatal flight.

264. The witnesses in the case who were asked to describe the personality and working methods of Captain Collins were unanimous in their opinion. It did not matter whether they were executive pilots or line pilots. They said that he was careful, conscientious and methodical. The

latter adjective was particularly stressed. The fact was that there had been no topographical map produced at the briefing upon which the nav track had been plotted. And so Captain Collins, being a methodical man, did exactly what the chief inspector considered ought to have been done. He plotted all the waypoints on maps of his own on the night before the flight and packed the maps away, together with his atlas, and took them on the flight in his flight bag.

265. The airline, in its very comprehensive final submissions, did not touch upon the question as to whether Captain Collins had plotted the nav track in reliance upon the flight plan produced to him at the briefing. The final submissions of the Civil Aviation Division likewise omitted any specific reference to this point. No doubt the very experienced senior counsel appearing for both organisations could see that there was no point in disputing a self-evident fact.

VISIT TO ANTARCTICA 26-29 NOVEMBER 1980

266. It was apparent that for the purposes of examining all possible causes of the disaster I would need to go to Antarctica, and I decided to coincide the visit with the first anniversary of the date of the disaster so that the southern point of the ice break-up would be about the same. It was arranged through the good offices of the Royal New Zealand Air Force that I would fly down to Antarctica on 26 November 1980. I was accompanied by Mr Baragwanath and Mr Harrison in their capacities as counsel assisting the Commission, by Air Commodore David Crooks (now Deputy Chief of Air Staff) and also by Air Marshal Sir Rochford Hughes. A further member of the party was Mr Edward Davies of Air New Zealand, who was going down for the purpose of laying a wreath at the cross which had been erected on the mountain side a week or two after the date of the disaster.

267. We travelled to Antarctica on a C−130 Hercules aircraft of the R.N.Z.A.F. The pilot was Flight Lieutenant Russell, and the commander of the flight was Wing Commander Gayfer. Upon approaching the continent of Antarctica I went on the flight deck for the remainder of the journey. The aircraft was flying at 29 000 feet, and with about 250 miles to run, we had crossed the Admiralty Mountains and the Victory Mountains and had come out over the Ross Sea. The view ahead was perfectly clear. There was a very long range of vision over Victoria Land to the right. There was no cloud, and the view of the continent was composed entirely of snow-covered mountains. In the distance as the aircraft came closer, there could be detected the outline of Ross Island, and the configuration of the island had been previously picked up by the aircraft radar.

268. At about 150 miles from McMurdo Wing Commander Gayfer took over the co-pilot's seat and said that it was proposed with my approval to bring the aircraft to the track followed by the DC10 and to execute the orbit to the right and the orbit to the left which the DC10 had followed. Thereafter the wing commander said he intended to fly directly at the mountain side along the exact track taken by the DC10 and he would pull away at a fairly late stage. I said I agreed with all this.

269. First of all, the aircraft flew to the Byrd Reporting Point to establish its position with Ground Control, and then we flew over the crash site, where parts of the wreckage are still visible. The aircraft was then flown away to the true north, reaching the same altitude as the DC10 before it had commenced its first orbit.

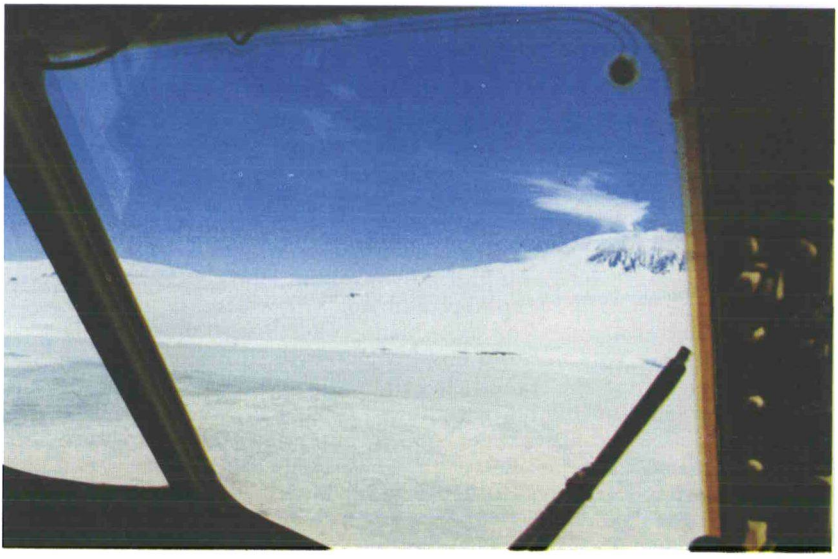

FIGURE 9

FIGURE 10

270. Wing Commander Gayfer had a map upon which had been plotted the exact location of the figure-8 manoeuvre adopted by Captain Collins as he accomplished his descent from 17 000 to 2000 and then 1500 feet. Thereafter the wing commander directed the course, speed, altitude and rate of descent so as to follow exactly the flight of the DC10. At the appropriate moment he ordered the commencement of the right-hand orbit and he controlled the descending altitude and angle of turn at each stage, with the flight lieutenant carrying out these instructions. After completion of the first orbit the aircraft commenced the second orbit to the left and the wing commander kept the aircraft on its descent at the same descending altitudes as had been followed by the DC10. From time to time, if there appeared to be slight deviations from the actual track of the DC10, the appropriate modifications were made to the heading.

271. Eventually, the second orbit was completed and the aircraft was straightened out for the run towards the mountain. The wing commander suggested to me that he flew in at 1500 feet at 260 knots with the result that we would be flying at the same altitude and speed of the DC10 and along its exact course. I agreed to this, and Flight Lieutenant Russell was then directed to drop to a flight level of 1500 feet and hold the speed at 260 knots. Wing Commander Gayfer then instructed the pilot that at the appropriate moment he would direct a left-hand 180° turn.

272. As we approached the mountain there was bright sunshine and the ice cliff could be seen in the distance without any difficulty. There appeared to be only two shallow patches of black rock visible at about the level of the ice shelf at the bottom of the cliff. These were in line with the crash site. They were not very long and on my estimation about 20 or 30 feet high. Apart from these two dark areas, and possibly one or two other smaller but similar areas well to the true east, the ice shelf in front of us was uniformly white. We could see the crash site without difficulty in the clear air. The wing commander warned the flight lieutenant that he was about to issue the order to bank left and then, at a point 2 miles from the crash site, he gave the necessary order. The aircraft banked sharply left and held a 180° turn so as to then adopt a heading of 180° grid. Since the approach speed was approximately 300 miles per hour, we had turned away when about 30 seconds from the crash site, and consequently the reconstruction of the final approach of the DC10 was suitably realistic. The aircraft was then flown on a heading of true north, turned left around Cape Bird on the military track, and thereafter adopted the glide path to the ice runway. It was Flight Lieutenant Russell's first landing on the ice runway, but the touch-down was impeccable, almost imperceptible. I remarked on this to the flight lieutenant after the aircraft had taxied to a stop. His response was non-commital. But I had the impression that his composure did not entirely conceal his satisfaction. The sequence of photographs in fig. 9, at page 100, and fig. 10, at page 101, show the line of approach to the mountain as executed by Wing Commander Gayfer.

273. On 27 November we were taken on an extensive tour, in a tracked vehicle, of the McMurdo area. The weather was quite fine in the morning with bright sunshine. In the afternoon over by the Scott Hut, a northerly front was seen to be approaching. Standing on a height near Scott Hut we could look out across the ice at the Ross Sea and at the mountains along Scott Coast, and the visibility range was more than 100 miles to the north. On the right there was seen the black outline of Tent Island and behind Tent Island, but obscured by it, was Cape Royds. When the United States Air Traffic Control say they can see 40 miles, they mean that they can see

FIGURE 11

the mountains. Visibility is then usually 100 miles or more. Fig. 11, page 103, is a view to the north from Hut Point looking up McMurdo Sound with Tent Island on the right. The expected line of approach of the DC10 on 28 November 1979 was from that part of the horizon to the left of the centre line of the photograph.

274. In the afternoon the northerly front enveloped Ross Island in accordance with an extremely accurate forecast by Sir Rochford Hughes, but still left a clear area looking down the Sound a few points to the west of true north, and Scott Coast was entirely clear. Mt. Erebus then totally disappeared in pale cloud and as one looked at it the cloud pattern which obscured the mountain kept shifting and changing. The plume of steam at the top of the crater was no longer visible. Sometimes a long streamer of cloud near the top altered from a horizontal angle to a downwards angle pointing to the true east. The light cloud patterns around the mountain kept changing both in contour and in colour throughout the afternoon. The conditions then began to resemble what they had been like on 28 November 1979, that is, a low overcast had come in with the northerly front, but as stated previously, the vision out towards McMurdo Sound into the north-west was clear and bright. To the true east, that is to say looking to the right of Ross Island, the snow now blended with the horizon so as to make the horizon invisible, and it was impossible to say where the snow ended and the cloud began.

275. A plan had been made for me to fly by helicopter on to the mountain side the next day, but this was thought to be a doubtful procedure if the cloud covering Ross Island continued to persist as it would be impossible to fly in conditions where both ground and horizon definition had entirely disappeared. In such circumstances, the helicopter pilot would not be able to tell whether he was flying into or over the slopes of Mt. Erebus. In the meantime, however, a programme was scheduled whereby the helicopter would leave at 11 a.m. next day.

276. A helicopter was provided by the United States Navy on 28 November. The low overcast still persisted. The overcast had spread over Scott Base and well to the true north. Out over McMurdo Sound, a little left of true north, visibility was still quite clear, and in particular towards the eastern border of Victoria Land. The helicopter flight to Mt. Erebus had been scheduled for 11 a.m. but had to be cancelled because the overcast and the cloud concealing Mt. Erebus made it impossible to approach the mountain from the true south. The flight was postponed on more than one occasion, but eventually we were advised that visibility over Lewis Bay was thought to be reasonably clear, and we took off at 4 p.m. in the helicopter. Those present apart from the pilot and co-pilot, were myself, Mr Baragwanath, Air Marshal Sir Rochford Hughes, Mr R. B. Thomson, and Mr Edward Davies. We flew towards the saddle which runs between Mt. Bird and Mt. Erebus. Heavy cloud concealed Mt. Bird and the cloud was drifting in a general easterly direction across the saddle. There were however certain thin breaks in the cloud which could be discerned by strips of sunlight on the snow.

277. The pilot first attempted to fly through the narrow cloud breaks as revealed by the sun, but as this seemed hazardous he elected to turn about and fly over the saddle but under the cloud base. The gap available for this purpose was minimal, but there was enough clearance between the cloud base at the top of the saddle for the helicopter to fly through.

278. It had been decided that if Lewis Bay was either in cloud or covered by low overcast, that we would have to fly away to the true north

and return to the base. However, the weather over Lewis Bay was free from cloud and there was bright sunlight, so we were able to carry on. The helicopter then flew towards the true north and turned and came back on a heading of 357° grid which put it upon the same track as the DC10.

279. As we approached the ice shelf at about 75 knots, the latter could clearly be seen as on 26 November, and the rising ground which commenced at the ice shelf was also clearly apparent in the sunlight, but the mountain itself was becoming enveloped in pale cloud, and in a minute or so it totally disappeared from sight. Even though the mountain slope began only some 2 or 3 miles ahead of the crash site, no part of the mountain could be seen, Fig. 12, page 106, are photographs taken from the helicopter which show the partial then total envelopment of Mt. Erebus in cloud. Each photograph is aimed directly at the mountain.

280. Over to the true east we could see a narrow strip of black rock at about the level of the sea ice which marked the western border of Cape Tennyson. However, in towards the bay from Cape Tennyson there could be seen an ice fog lifting off the solid ice which was drifting over the ice shelf and which was entirely concealing 3 or 4 miles of the ice shelf. Over to the right we could see the narrow strip of black rock which marked the tip of Cape Bird. The approach towards the ice shelf was made over solid ice, covered with snow, and in sunlight.

281. We flew over the crash site and made several passes back and forth at a low altitude and the pieces of wreckage previously mentioned could now be seen more exactly. We then flew on to a point about 4000 feet up the mountain and the helicopter was then landed on a rock outcrop after some delicate manoeuvring of the landing gear so as to avoid boulders. I was able to look at the whole of the area surrounding the site of the disaster and I shall at a later stage describe the various combinations of light and cloud which were present on that occasion. About 200 yards down the slope from where we landed was the small cross which had been installed there in the previous year. Air New Zealand's representative, Mr Davies, had with him a wreath and also four containers of ashes of victims which the relatives desired to be scattered on the mountain side. These victims were one American, one Australian, and two New Zealanders. The wreath was duly placed, and Mr Davies scattered the ashes. We went back through the volcanic rock and snow to where the helicopter was waiting, with its engines still prudently running, and took our departure by flying away to the true west around the steep slope of Mt. Erebus and down towards the flat land to the true south, and after a flight of about 20 miles landed at Scott Base.

282. It was then decided that Air Commodore Crooks, Mr Thomson, Mr Davies and myself would leave that night for New Zealand by a Royal Australian Air Force Hercules which was flying out at about 6.30 p.m. local time. The Australian flight crew asked me to sit on the flight deck during the take-off as there was something which they said they wanted me to see. The overcast was still low over the whole area and they said that the conditions were virtually identical to those prevailing on the same day last year.

283. The pilot told me that he would fly out to the true east and attain a height of 1000 feet, and then he would turn back and fly to the true west and pass Scott Base at 500 feet, before commencing the climb away to New Zealand. He asked me to look out for a snow ridge which we would encounter as we approached Scott Base.

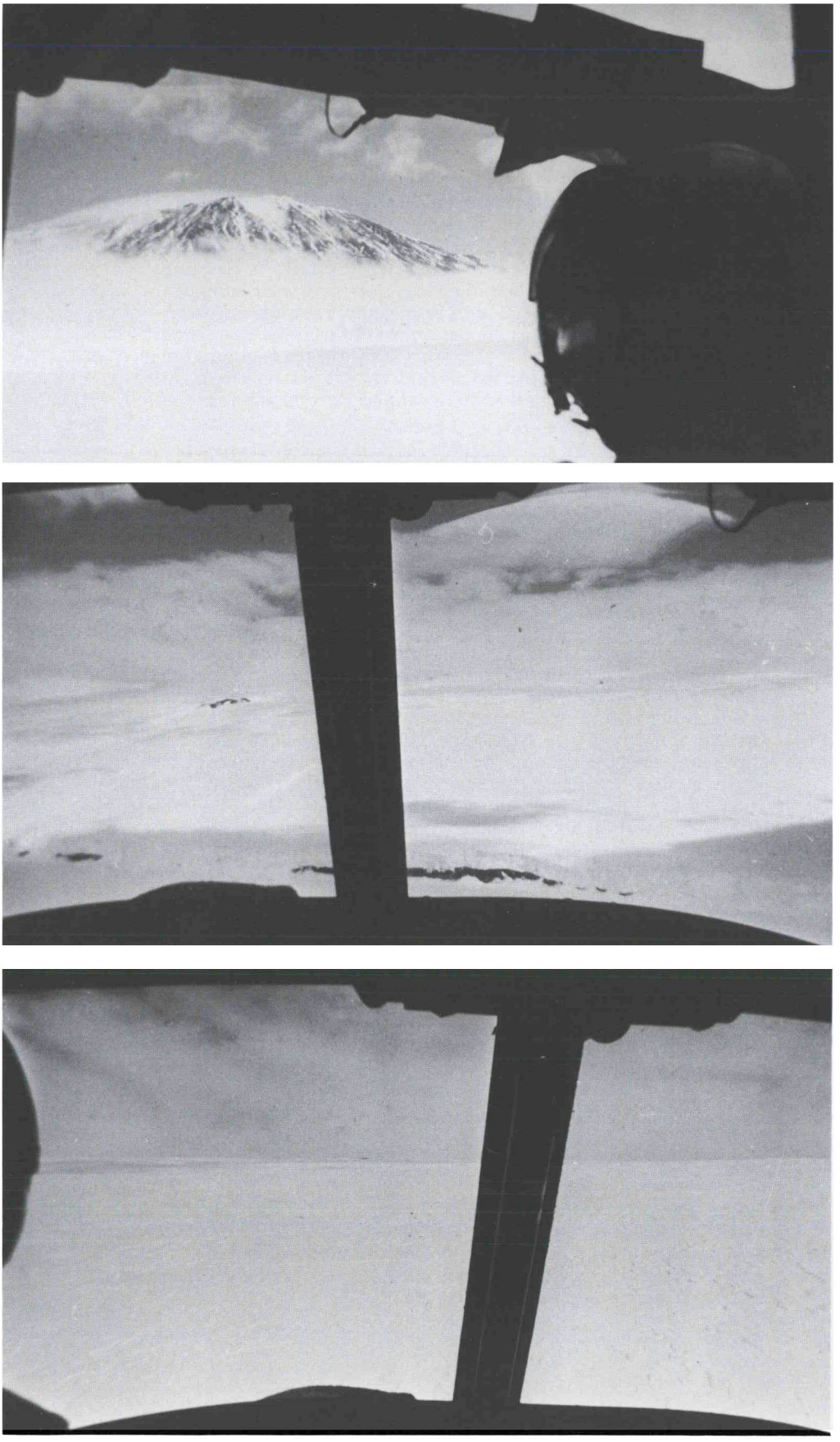

FIGURE 12

284. Near the left hand top edge of this ridge was a black outcrop of rock and the snow ridge then ran off to the right from that point. It was at a height roughly approximate to the height of the ice cliff which marks the commencement of the snow slopes running up to Mt. Erebus. The purpose of the Australian flight crew in asking me to note in advance the position of this snow ridge was to demonstrate the visual illusion which they said I would observe as we approached the snow ridge from the air. I knew that the snow ridge was present, and had seen it on the previous two days in bright sunlight, and it was a very discernible feature, but the flight crew were aware that with a low pale overcast of the kind which was then present it would be difficult to distinguish from the air the presence of this snow-covered feature. They told me that I would find it was difficult to discern in the diffused light under the overcast where the slope began and where the top of the ridge was located. The pilot radioed his intended departure course to Mac Centre and obtained their clearance. He then flew off in the indicated direction for a few miles and attained an altitude of 1000 feet, and then reversed his course and descended to 500 feet as we approached Scott Base. At this juncture I could see the snow ridge lying ahead, in that I could make out the top of the ridge, though not its base, but when I lifted up one hand and blocked out the view of the black outcrop of rock the ridge immediately disappeared. All that could be seen was a flat expanse of snow-covered ground running on for many miles ahead, and in the distance I could see the mountains of Victoria Land.

285. The crew told me that the overcast then subsisting at Scott Base was approximately the same as it had been 1 year before, and that the visual illusion to which I had been subjected was characteristic of what happened when flying over uniformly white terrain with an overcast of that nature. The flight captain and the navigator said that in their opinion this would be an exact replica of the visual deception to which Captain Collins must have been exposed as he flew under the same level of overcast approaching Mt. Erebus 1 year ago.

286. After passing Scott Base the aircraft flew out into the Sound, turned right and began its climb to its cruising altitude. I kept an eye on the altimeter, and noticed that we entered the bottom of the cloud base at 3000 feet and that we emerged from the light-coloured cloud at 5000 feet. Looking over to the right the top 7000 feet of Mt. Erebus was clearly visible. We in due course attained cruising altitude and arrived after a flight of several hours at Christchurch International Airport.

287. This had certainly been a striking demonstration of the whiteout phenomenon to which I have previously referred. As will be recalled, I had known the location and the appearance of this snow ridge. I had seen it on the two previous days in bright sunlight. Its exact configuration had been clear and unmistakeable, with the sun shining down upon it out of a blue sky. But with a low overcast—despite the clear vision which extended for something like 100 miles in all directions—all slopes and undulations in the terrain ahead of the aircraft had disappeared. This long snow ridge about 200 feet high, which lay in the direct path of the aircraft, had totally disappeared once the rock outcrop on its left-hand extremity had been shut off from view. And so, by a coincidental similarity of weather, I had been able to see and understand the dangerous visual deception with which experienced polar pilots are all familiar, and which had without doubt confronted Captain Collins 1 year ago that day.

288. As the chief inspector had said in his report (paragraph 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." I must express my gratitude to the intelligence and initiative of this Royal Australian Air Force flight crew who knew that the conditions were substantially identical with those obtaining on the day of the fatal flight, and who saw the opportunity to demonstrate this optical phenomenon which is difficult to understand unless it has actually been seen. Here are their names and ranks:

Captain—Flight Lieutenant J. R. Howie
Co-pilot—Flight Lieutenant J. G. Thyer
Navigator—Flying Officer C. J. McHugh
Flight Engineer—Sergeant J. P. Vellacott
Loadmaster—Flight Sergeant G. I. Pollard

They are members of No. 36 Squadron, Royal Australian Air Force.

AREAS OF PILOT ERROR SUGGESTED BY THE AIRLINE OR BY CIVIL AVIATION DIVISION

289. I now propose to set out the different aspects in which it was alleged that the pilots of TE 901 were at fault, and shall indicate my view in respect of each such allegation.

(a) It was suggested that the crew should have plotted in flight on a topographical map the co-ordinates for each position as they went along. But the captain in this case had plotted the flight path on a map before he left New Zealand, and I can see no justification for taking any further steps with regard to a map. The maps supplied by the company for the flight did not have any track marked upon it, and if Captain Collins had not plotted the track on his own maps and atlas the night before leaving, he would no doubt have checked his flight plan and no doubt plotted the co-ordinates during flight on the map supplied to him by the company. But for obvious reasons he did not need to do that. It was also suggested that the flight crew could have waited for each waypoint to be reached, and then verify the co-ordinates as appearing on the print-out in the aircraft instruments, and thus plot the track in flight, but I discount that suggestion for the same reason as already indicated. The crew had no need to plot their track on a topographical map or maps, because it had been done already.

(b) It was suggested that the crew could have checked their position at different times by looking at the print-out of latitude and longitude which is continuously available on an instrument panel. I quite agree that this would be a simple method of determining where the aircraft was at some particular moment. Even though there was no plotting table or other place for a navigator on the aircraft, the co-pilot or engineer could work out the last latitude and longitude displayed and then plot that on a map so as to give the aircraft's position, although by that time the aircraft would be many miles ahead of that position. Indeed, it seems a simple thing to do, and I have no doubt that it could be done so as to fix the position of the aircraft within a few miles by this method of marking the printed co-ordinates on a map. But the question arises as to why such a course would be adopted in the case of this particular flight, or in any

scheduled flight. This print-out is situated in the roof of the flight deck at about eye level. It contains the geographical position of the aircraft as ascertained by one of the inertial sensor units. Its purpose is to enable the crew to call up on the computer display unit the geographical position of the aircraft as fixed by the computer, and then to compare that figure with the continuous readout provided by one of the sensor units. Thus the correct functioning of the computer may be checked, and this is part of the comprehensive system of monitoring the functions of the AINS as a whole. The provision of a continuous display of latitude and longitude is not for the purpose of assisting the crew to keep plotting on maps their position. Their position is ascertained by the simple process of looking at the distance to run, and then pinpointing on their track and distance guide where that distance is in relation to the next waypoint. I have already found that at all material times the crew were certain as to their position. If certain as to their position, then no member of the flight crew would adopt this suggested course. To do so would be in effect to disregard the unerring accuracy of the AINS as demonstrated to these pilots for thousands of hours spent in flying DC10 aircraft, and to go back to the days of navigators.

(c) At pages 23 onwards on the brief of evidence of Mr Amies, he describes four different checks which were available to flight crews on the antarctic flights prior to the fatal flight, in respect of which there were the "incorrect" co-ordinates for McMurdo printed on the computerised flight plan. The purpose of setting out these four instrumental checks which might have been made by pilots was to answer the chief inspector's criticism that this mistake in the McMurdo co-ordinates should have gone unobserved for a period of 14 months. Mr Amies makes it clear, at paragraph 8.9 of his brief, that his detailed description of the four in-flight checks of the progress of the aircraft in relation to its flight plan, each made possible by calling up various print-outs on the CDU screens, are not applicable to the fatal flight because in the case of that flight the co-ordinates for McMurdo had been corrected. Consequently, there is no point in my discussing the four different tests which could have been applied by previous flight crews in the manner suggested by Mr Amies. I would only say that in the case of the fatal flight the crew would without question, for this was agreed by Mr Davison, have performed the first two tests. The third and fourth tests however, depended upon the existence of a non-directional beacon at McMurdo, and this beacon had been withdrawn. However, as inferentially conceded by Mr Amies, the performance of the first two of his tests by the crew of the fatal flight would have revealed nothing, because of course, the aircraft was in fact flying in accordance with the computerised flight plan which had been handed to the crew on the morning of departure.

However, despite the fact that the four tests propounded by Mr Amies were not applicable to the fatal flight, I have given careful attention to other checks which might have been made by Captain Collins and his crew in respect of the accuracy of the nav track as it approached and passed Cape Hallett. If it was shown that the crew had been able to verify the accuracy of the AINS up to and including Cape Hallett, then of course it follows that they could rightly expect that upon arrival at McMurdo there could not be a cross-track error

of anything more than 1 to 2 miles. I will now set out the nature of the consideration which I have given to this point, and the conclusions at which I have arrived.

Seeing that the AINS was set, in the case of this flight, in the "I" mode, meaning that the Navigation Computer Unit (NCU) could not receive a radio correction from a ground-based navigational station, it followed that the crew, if they visually detected a cross-track deviation from the nav track, could manually adjust the navigation computer unit so as to correct the cross-track error and relocate their position. This may only be done, however, where there is a topographical feature to be overflown by the aircraft while flying on nav track.

Since the cruising altitude of this type of aircraft will be in excess of 30 000 feet, it is not always possible to detect a cross-track error with any degree of exactness if the landmark to be overflown is not especially distinct as a landmark. Considerable emphasis was laid upon this factor by witnesses who gave evidence for the airline and for the Civil Aviation Division. An example to which they drew attention was Cape Hallett. The Cape Hallett waypoint was plotted as being the geographical location of what used to be Hallett Station which, up until some years ago, was a manned Antarctica base. The base has, however, been unoccupied for some considerable time. The waypoint immediately before Cape Hallett is the Balleny Islands and as the aircraft tracked from the Balleny Islands to the Cape Hallett waypoint it would first have to cross a considerable stretch of land known as the Pennell Coast before overflying Cape Hallett, and then turn slightly to the west to fly on nav track down to the McMurdo area. In such circumstances it might not be possible to calculate by visual reference any cross-track deviation less than 4 or 5 miles either way.

At the time when this type of evidence was being given the knowledge I had of the read-out from the black box—which would indicate whether or not the aircraft was on nav track at each waypoint—was only available for the last 30 minutes of the fatal flight. I therefore asked for information as to what had been revealed by the black box print-out in relation to Cape Hallett. The answer was that the aircraft had been flying on nav track as it approached Cape Hallett but that the pilot had switched the navigation system into heading select for a short period and had flown slightly away from nav track for the purpose, so it was thought, of providing passengers with a better opportunity of taking photographs. Then, as soon as Cape Hallett had been overflown, the nav mode had been re-armed and the aircraft had continued on nav track right on down to the point where Captain Collins had again switched to heading select in order to commence his two orbits.

The black box had also confirmed that Captain Collins had not "manually up-dated" the NCU at any time. This tended to confirm that he had identified the aircraft as flying on nav track as it approached Cape Hallett although, as the witnesses had said, it might not have been possible for him to have identified a cross-track error of more than 4 or 5 miles either way. But there were further features about the nav track which were significant. First of all, there was the Balleny Islands waypoint. As the aircraft approached the Balleny Islands the crew would see in front of them that these islands

were aligned more or less at right angles to the approach to the aircraft. The three main islands of the Balleny group, reading from left to right as viewed from the flight deck, would be Sturge Island, Buckle Island and Young Island. These islands are exactly in line. The distance from Sturge Island across to Young Island is 75 miles. Buckle Island lies between Sturge Island and Young Island at a point a little to the right of centre. Sturge Island is approximately 20 miles in length, Buckle Island about 7 miles and Young Island about 20 miles. It happened that the waypoint for the Balleny Islands was Buckle Island, being the centre one of the three. Therefore as the aircraft approached the Balleny Islands, it would be a simple matter for the crew to make a visual fix of the line of the nav track for, in the absence of a cross-track error, the aircraft would be flying directly at the centre island of the three and Buckle Island would obviously be an unmistakeable landmark. But as we know, the NCU was not manually up-dated at any stage. Consequently the inescapable inference is that the aircraft was flying on nav track as it reached the Balleny Islands waypoint.

Then the auto-pilot would alter course to the east, from a heading of 349.5° grid to 322.4° grid, and after covering 367 miles would overfly Cape Hallett. The crew would therefore be entitled to expect that after 367 miles any possible cross-track drift at the Cape Hallett waypoint would be non-existent or minimal, having regard to the absence of any significant cross-track drift at Buckle Island. When the aircraft crossed the Cape Hallett waypoint the crew no doubt could see that the track was directly over that waypoint, and this is what they would have expected in view of the fact which I have just mentioned. They would not expect any significant cross-track drift. Then after operating in heading select for the brief period disclosed by the black box, the nav mode was re-armed and the aircraft flew on towards the McMurdo area. As previously indicated, the crew would not then expect any significant cross-track error at their destination waypoint.

But I have given careful consideration to the position of Coulman Island which is located about 60 miles to the approximate south of Cape Hallett. If reference is now made to fig. 3, page 14, which shows the false track relied upon by Captain Collins as opposed to the real track, it will be seen that the false track passes directly over the centre of Coulman Island which is about 27 miles long, and which at its widest point, is about 7 to 8 miles across. Seeing that the aircraft was flying on an actual track which took it just over the eastern edge of Coulman Island, then it might be expected that the air crew would have observed that the track previously plotted by Captain Collins was different from the actual track of the aircraft. The difference at that point might have been as much as 4 to 5 miles. In addition, there seems to be clear evidence from the passengers' photographs taken in this general area, that there was no cloud. But the explanation for the obvious failure of the crew to observe the deviation from the plotted track at Coulman Island is to be found, I think, in the point that the crew did not have at their disposal any map of the large scale depicted by fig. 3, page 14. They had, first of all, the topographical map supplied to them at flight despatch on the morning of the flight, but all the probabilities are that no track was plotted on this map because of the fact that Captain Collins had the

night before already plotted the track of the aircraft, on his own maps, through all waypoints including the final leg to McMurdo. He would have used, in respect of the complete track from Cape Hallett to McMurdo, one or other of the very large maps which he had, and although I have never seen those maps, it is possible that they were of such a scale that Coulman Island would have been more or less obliterated by a line drawn through it from Cape Hallett to McMurdo.

Then there is page 184 of the atlas taken with him by Captain Collins on the flight. Here, Coulman Island is shown as something more than a dot, but unfortunately, the 27 mile length of the island runs approximately along the nav track which would have been plotted by Captain Collins, and having made the experiment myself on page 184, the track plotted on the atlas would only have shown it passing over Coulman Island at some undefined point, and the fact that the plotted track was 4 to 5 miles to the right of where the aircraft was actually flying would certainly not be apparent on this map, which is at a scale of 1:10 million. Finally there is the map of the McMurdo region shown on page 185 of the atlas, but this map of course does not commence until just north of Beaufort Island and Coulman Island is not shown.

I therefore consider that despite the most careful plotting by Captain Collins on either of his two large maps and on page 184 of his atlas, there was no means of ascertaining by checking the path of the aircraft over Coulman Island that there was in fact a 4 to 5 miles deviation off the track which Captain Collins had drawn. Then there is the point that the real track of the aircraft was directly over Franklin Island which is situated 57 miles to the approximate north of Beaufort Island. If therefore Franklin Island had been visible to the air crew they would clearly have seen that the aircraft was flying directly over Franklin Island, whereas a reference to the plotted track drawn by Captain Collins would have shown that his nav track ought to have been taking him about 15 miles to the west of Franklin Island. This point was given careful consideration by Mr R. B. Thomson, but he discovered that there were no passengers' photographs of Franklin Island, and he deduced from this that at this point Franklin Island was covered by cloud. This indeed accords with the general picture of the weather in the area at that particular time. The cloud cover was extensive from a point some distance to the north of Franklin Island and remained extensive until some distance south when it began to disintegrate, and then there occurred the thin widely dispersed layers of cloud which created the large cloud breaks which Captain Collins saw as he approached Beaufort Island.

It was not suggested to me at the hearing that the flight crew should have detected the divergence between any track which they may have plotted and the real track of the aircraft by reference either to Coulman Island or to Franklin Island, but I thought it right to make it clear that I have myself investigated these two possibilities.

So, in the final result, the evidence appears to establish that the aircraft was on nav track as it crossed the Balleny Islands, and that it was on nav track as it flew over Cape Hallett, with the result that the crew, as I have said before, with only 337 miles to run, could therefore not have anticipated any significant cross-track drift as

they flew down McMurdo Sound towards the Dailey Islands waypoint. In addition, it was not possible to detect any divergence between the plotted track and the actual track of the aircraft by reference to Coulman Island, Franklin Island or Beaufort Island, for the reasons which I have already discussed.

(d) It was contended that the crew should not have relied upon the AINS because of the tolerance of error which the system contains. The Director of Civil Aviation, for example, propounded a theory which would give the system a possible error of about 15 miles left or right, as it arrived in the McMurdo area. All such considerations, though possible in theory, are without practical foundation. I have indicated the extreme accuracy of the AINS system. Captain Collins and First Officer Cassin had flown between them some thousands of hours, and had seen the system proved to be of extreme accuracy over all that time. The crew in my opinion was perfectly entitled to rely upon the AINS to take them, on the approach to McMurdo Sound, within a mile or two either side of a line representing the nav track.

(e) It was submitted that the crew should not have relied on the AINS for any let-down procedure. In this respect reliance was placed upon that part of the operation manual for the airline which does not permit a descent for landing purposes to be made in reliance on the AINS. I should have thought that this was a superfluous indication to pilots flying into airports. The pilot in such a case flies towards the runway in reliance upon the ground aids situated at the airport, and there could surely be no question of him using the AINS in order to bring himself into a landing position in any designated airport. In the present case therefore, it was sought to assimilate this process to a let-down to an altitude which would permit the aircraft to overfly Scott Base at about 1500 feet. There is no similarity at all in the two procedures. All that was done in this case was for the crew to rely upon the AINS to take the aircraft to the 40-mile wide opening of McMurdo Sound, and then to descend under radar surveillance and in VMC, and then level out at 1500 feet in clear air. I can see not the slightest objection to using the refined accuracy of the AINS for this simple manoeuvre. It is not a question of having to fix an exact point such as a landing field. The target being aimed at, as I say, was 40 miles wide. I observe that Major Gumble (pilot of the C-141 Starlifter) says in his sworn deposition taken in the United States that he was navigating his Starlifter on the INS system as he approached Byrd Reporting Point, but that he was at the same time also utilising the radar terrain mapping system of his aircraft. He says that he would not rely upon the INS alone because it only had a dual system. I notice, however, that when Major Gumble was interviewed on the morning after the disaster, he in fact said, as appears at paragraph 1.7.2 of the chief inspector's report:

> "At the time we were navigating entirely by the INS (inertial navigation system). We maintained 16 000 feet until McMurdo picked us up on radar; as I remember, this was at about 38 miles."

As in the case of anyone who has spent all his working life in the courtroom, I am very inclined to attach more weight to what a witness says at the time of the event, rather than what he says a long time afterwards in consequence of a legal appraisal of his position or

the position of his employers. By the time Major Gumble signed his deposition in California it was, of course, very much in the interest of the United States Navy to attribute negligence to Captain Collins.

(f) It was suggested by Captain Wilson, who had been in charge of the RCU briefing, that there was a possibility that the crew knew their exact course, that is to say, they knew that the aircraft was programmed to fly on a collision course with Mt. Erebus. Captain Wilson supported this suggestion by pointing out that if Captain Collins thought he was in the centre of McMurdo Sound when he decided to fly away, then this decision would not have carried any urgency in view of the wide area of flat ground which would have surrounded the aircraft at that time. (T 1256). I said to Captain Wilson after he made this observation that I agreed with him that the decision to fly away was ultra cautious if indeed Captain Collins had believed he was in McMurdo Sound. (T 1278–9) Captain Wilson agreed with this opinion. However, I will go no further into this allegation that Captain Collins may have known the true nav track. It seemed to me to be a very remarkable thing for an experienced officer such as Captain Wilson to make the suggestion that the air crew flew deliberately at 1500 feet on a known collision course with the mountain. I need say no more about it.

(g) It was stated by the Director of Civil Aviation that in his opinion the whiteout phenomenon did not exist in this case, or if it did exist, then it played no part in the accident. This of course required him to give some explanation as to why both pilots made coincidentally the same type of gross visual error. He suggested that each may have become afflicted by some mental or psychological defect which controlled their actions. This involved the startling proposition that a combination of physical and psychological malfunctions occurred simultaneously to each pilot. I was surprised to find that a person with the status of the director should advance a suggestion which is so palpably absurd.

(h) Then it was suggested that the pilot should not have let down from 17 000 feet to 3000 feet, in an area in which there was known high terrain in the vicinity, without some visual fix. Again, this suggestion was founded upon the false proposition that the air crew were "uncertain" as to their position. If the pilots knew exactly where they were, and saw before them, as they did see, many square miles of flat sea ice visible through very large cloud breaks, then I can see not the slightest objection to circling the aircraft down one and then two descending orbits, operating all the time in clear air, so as to level out, still in clear air, in a position where they still saw on all sides many miles of flat sea ice over an area of 30 or 40 square miles which they had swept visually as they descended. That decision could not possibly have been wrong, bearing in mind the unimpaired visibility which they had. There could be no question of there being any obligation to get some visual fix prior to let-down, when they were letting down in clear air, and with this wide panorama of flat sea ice perfectly visible below them, and when indeed they were not going forward but were orbiting downwards so as to lose height from 17 000 feet to 3000 feet without progressing forward at all.

So this particular theory of pilot error, in my opinion, is also without foundation. I think it harks back to the system operated in the days before the AINS was used. It predicates the presence of a

navigator who would be seated in his plotting table, and working out as best he could the approximate present position of the aircraft. That would depend upon how right the navigator had been in his prior calculations, and what chance he had had to check succeeding positions by reference to visual landmarks and either the sun or the stars and to what extent his dead reckoning calculations had been affected by wind currents. All this has no application whatever to current navigation of jet aircraft by these unerring and sophisticated aids. The inertial sensor units cannot be wrong. The location of the aircraft is exactly where they say it is, when the aircraft is flying on nav track. On heading select, or on manual control, a visual fix or a ground-based aid is required, if the aircraft is not flying VMC. But Captain Collins was flying in VMC throughout, as even Captain Gemmell eventually accepted, and this meant 20-kilometre visibility. But as it happened, he did make a "visual fix".

The "visual fix" was obtained, in the concerted belief of all members of the flight crew, not long after the aircraft levelled out at 3000 feet, locked back on its nav track, and began to descend. Clearly visible ahead were the two black shorelines of Cape Tennyson and Cape Bird, mistaken by the pilots for Cape Bird and Cape Bernacchi. The plotted flight path on the map showed the nav track to be passing about midway between the two latter landmarks, and the crew could see that the actual path of the aircraft was similarly directed about midway between the two capes which they could see ahead. In addition to this, there was the "distance to run" figure on the HSI indicator on the instrument panel. In fact, this displayed the distance to run to the TACAN waypoint, whereas the crew believed, in terms of the information supplied at their briefing, that it referred to the distance to run to the "false" waypoint just to the west of the Dailey Islands. The figure displayed at about 5 miles from the axis of the visible shorelines of Lewis Bay would be 35 miles (there being a forward error in this respect of 3.1 miles) and by referring to the plotted track on their map or maps, the crew would see a DME of 35 miles at about 13 miles from the Cape Bird—Cape Bernacchi axis.

So when approaching Lewis Bay, the crew saw the identical land features, to the left and right, which they were expecting to see in McMurdo Sound once they descended below the overcast. And the distance out from the "false" waypoint would be sufficiently similar when visually checking the plotted track at a speed of 5 miles per minute. Thus the "visual fix" was complete.

(i) The next allegation was that the flight crew made a serious and inexplicable error in not identifying Beaufort Island during the course of the two orbits. It was alleged that the position of Beaufort Island would have indicated to the flight crew that they were on the eastern side of the island, whereas if the aircraft was flying on the course assumed by Captain Collins, then it should have been to the east of the orbiting sequence performed by the aircraft.

This submission is answered by reference to fig. 13, page 116, and fig. 14, page 117. These two diagrams show the orbiting sequence in McMurdo Sound where Captain Collins thought it was being performed, and the orbiting sequence just north of Lewis Bay where in fact it was being performed. If one looks at fig. 13, page 116, which represents the orbiting sequence in McMurdo Sound, it will be seen

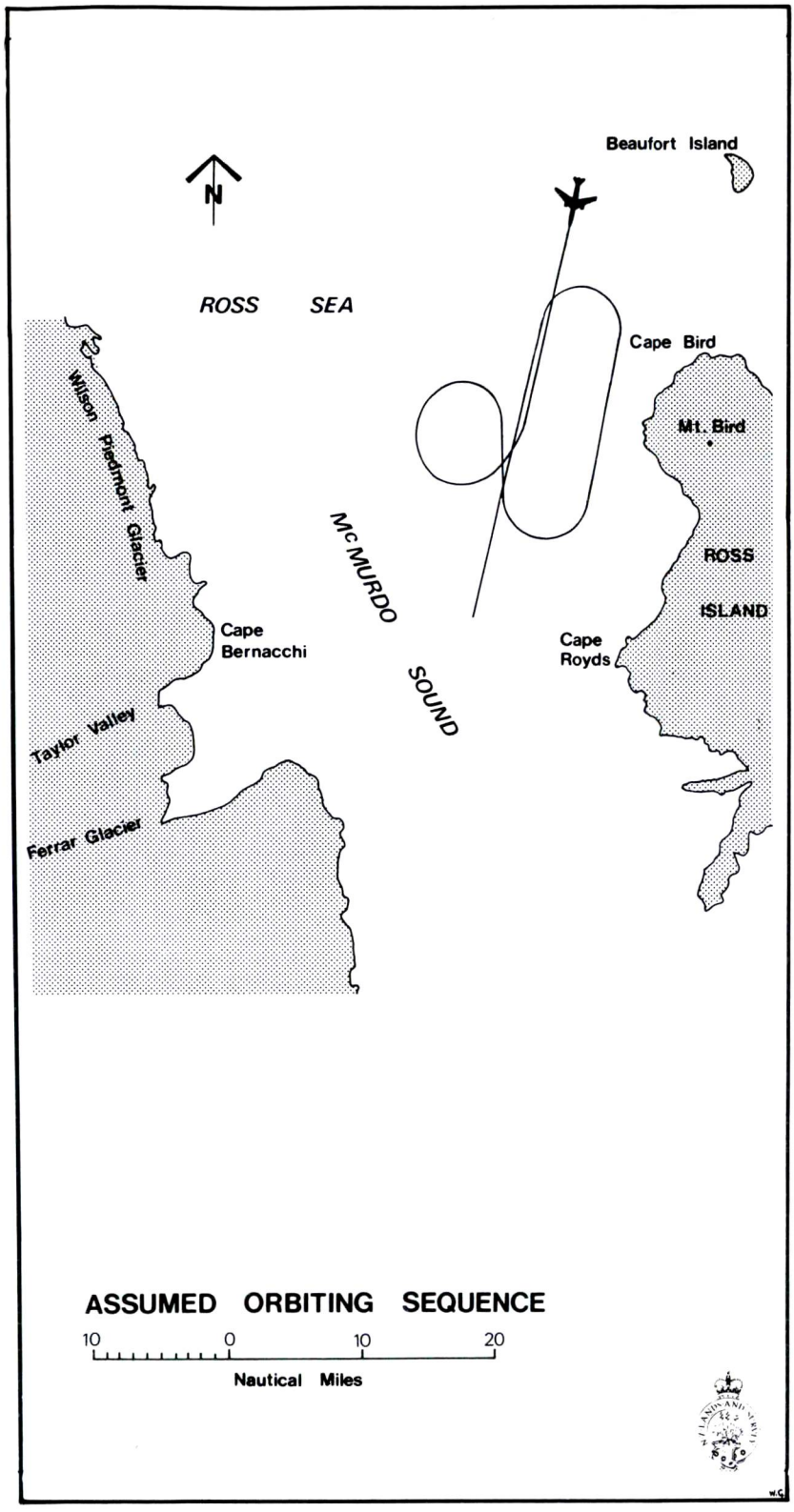
Beaufort Island
N
ROSS SEA
Cape Bird
Mt. Bird
Wilson Piedmont Glacier
Mc MURDO SOUND
ROSS ISLAND
Cape Bernacchi
Cape Royds
Taylor Valley
Ferrar Glacier
ASSUMED ORBITING SEQUENCE
10 0 10 20
Nautical Miles

FIGURE 13

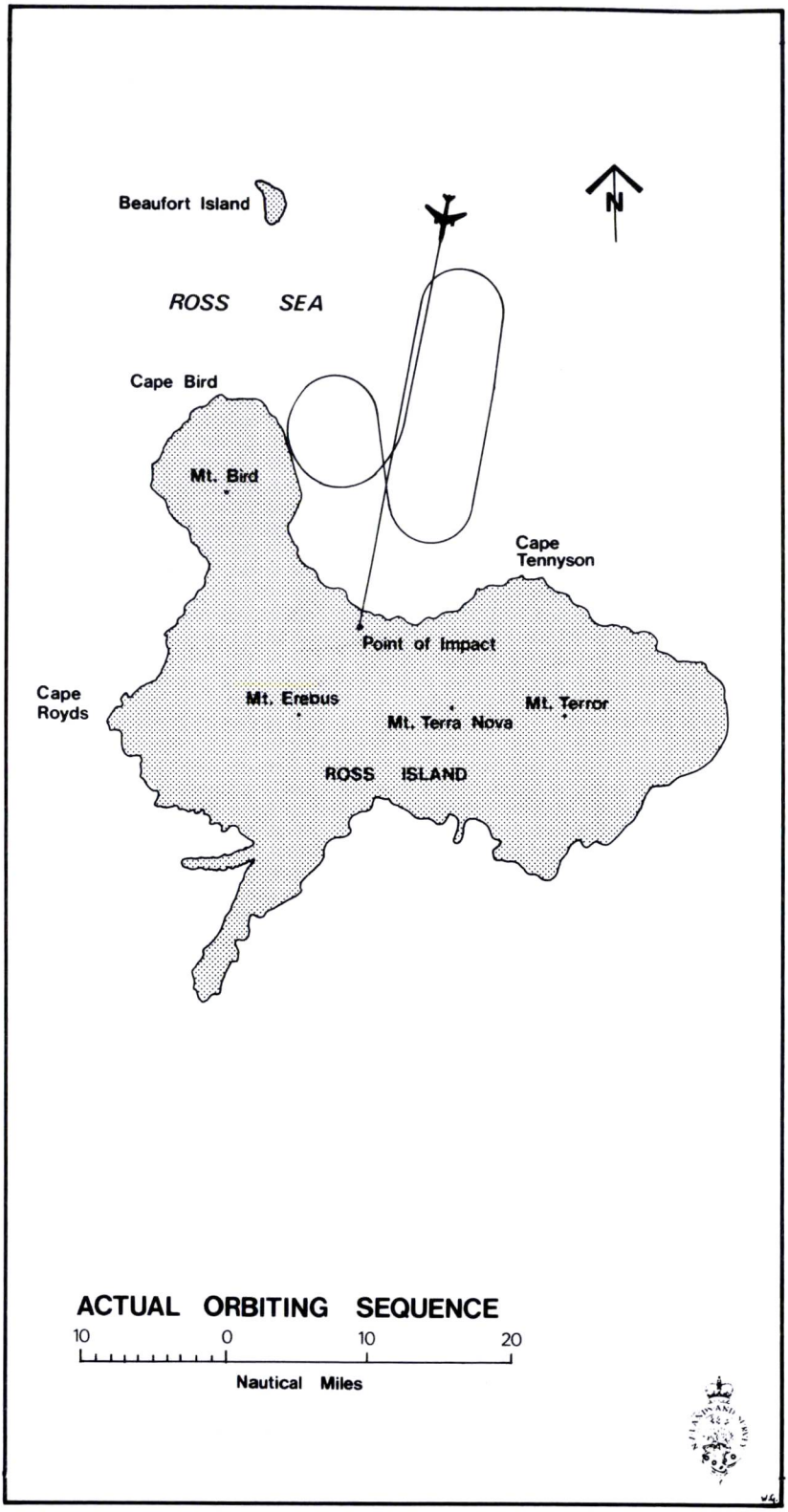
Beaufort Island
N
ROSS SEA
Cape Bird
Mt. Bird
Cape Tennyson
Point of Impact
Cape Royds
Mt. Erebus
Mt. Terra Nova
Mt. Terror
ROSS ISLAND
ACTUAL ORBITING SEQUENCE
10
0
10
20
Nautical Miles

FIGURE 14

straight away that Beaufort Island is located well to the east of the position of the aircraft. For example, at the most northern point of the first right hand orbit, Beaufort Island would be situated 27 miles to the north-east. Halfway along the northern track of the second orbit Beaufort Island would be situated 20 miles to the north-east, and even at the most northern point of the second orbit, Beaufort Island is still 13 miles away to the north-east. It therefore follows that because Captain Collins believed that his nav track was taking him down the centre of McMurdo Sound, no one on the flight deck would ever identify any island on or near their path as being Beaufort Island. They would all be aware that it was far away to the north-east, and I venture to say, that although no direct reference is made to the point in the CVR transcript apart from Mr Mulgrew's remark about "land ahead", the five persons on the flight deck undoubtedly saw Beaufort Island, and mistook it for a different island altogether, probably, as Mr Shannon thought, Dunlop Island, which is off the Victoria Land coastline. Anyhow, in the minds of the crew the island which they must have seen could not possibly have been Beaufort Island, because as previously indicated, the latter landmark would be many miles away in quite a different location.

This suggestion of error on the part of the flight crew in not identifying Beaufort Island will therefore be seen to be the result of an apparent confusion of mind on the part of its proponents.

(j) The next allegation was that having levelled out at 3000 feet Captain Collins should not have elected to fly on towards what was described as an area of poor or deteriorating visibility. This is the aspect referred to by the chief inspector in his report, as being the "probable cause" of the accident. The substance of the chief inspector's allegations in this respect is that Captain Collins should have decided to climb away about 2 minutes before he did. But again this depends upon the essential pre-condition that the crew was "uncertain" of its position, and this latter postulate is of course quite wrong. Also, it involves the equally wrong proposition that the aircraft was flying towards an area of poor or deteriorating visibility. On the contrary, as I have indicated already, the crew saw in front of the aircraft a long flat vista of snow-covered ground extending for very many miles. There was no suggestion at all in the passengers' photographs or anywhere else, that there was poor visibility ahead. Prints of those passengers' photographs taken to left and right of the aircraft only seconds before impact, showing the shorelines of Cape Tennyson and Cape Bird respectively, are very indistinct, but this does not mean that the visibility was any worse than appears in the clear view of Beaufort Island taken shortly before. The "last-second" negatives were developed from film which was still opposite or nearly opposite the lens aperture of the camera at the time of impact and was infiltrated by light when the cameras sustained damage, a point which I have verified with the D.S.I.R. What the captain saw, without doubt, was either an imperfectly defined horizon, or no horizon, and a complete absence of any landmarks in the distance. In addition, he could not raise the Ice Tower for a radar fix. That was why he decided to fly away. I therefore regard this suggested element of pilot error, and it was the one in the end fixed upon by the chief inspector, as being not supported by the evidence.

(k) It was alleged that the crew descended below the officially approved minimum safe altitude either of 16 000 feet or 6000 feet and that this was the predominant cause of the accident. Although the chief inspector referred from time to time in his report that descent to 1500 feet, even though suggested and authorised by McMurdo Air Traffic Control, was in breach of the MSA rules officially in force, nevertheless the chief inspector recognised that there were pilots who evidently had misinterpreted the conditions surrounding descent to 6000 feet as if they referred only to a cloud break procedure, and did not prevent descent to any lower altitude consistent with air safety.

The Civil Aviation Division, not unnaturally, placed the breach of its MSA conditions in the forefront of its case. The airline witnesses also, for a considerable period of time, were inclined to rely strongly upon descent below 6000 feet as being in breach of the airline's rules and consequently as amounting to a decisive cause of the disaster. However, after the Commission had been sitting for many weeks it was for the first time revealed by the evidence of Captain Wilson that when briefing air crews for Antarctica flights in 1978 and 1979 he had told them that the practice on antarctic flights was to descend to whatever level was authorised by McMurdo Air Traffic Control, and he said in his brief of evidence that he did not indicate any criticism of this course.

This new aspect of the RCU briefing was a most surprising revelation. I noticed that it occurred at the very end of Captain Wilson's prepared brief. Without wishing to appear too pedantic, I also observed that this significant concession appeared to have been added to the end of the brief with a different typewriter, so that the decision to reveal this information was not only very late in the day but also seemed to have the hallmarks of a last-minute decision. It also appeared that the chief inspector had not been appraised of this unwritten feature of the antarctic briefings. I have already referred briefly to this disclosure in paragraph 168 above, and that it had not been previously mentioned to the chief inspector. So here there had been, up until this point, a sedulous reliance by the airline and by Civil Aviation Division upon a breach by Captain Collins of the prevailing MSA rules, that breach being treated as if it obliterated each and every error that might have previously been made by the airline or by Civil Aviation Division. But as from the time of Captain Wilson's admission, the MSA defence, if I may call it that, could not prevail against Captain Collins.

In the final submissions for the airline it was admitted that there were a number of pilots who testified that in VMC conditions they considered it permissible to descend below 6000 feet outside the specified safety sector. It was submitted that Captain Wilson had been under a misconception when he appeared to share the same opinion. Captain Wilson had said:

> "In a visual strictly visual VMC letdown providing the weather was clear, very good weather, ceiling and visibility unlimited, and provided that the Captain received permission of McMurdo, he could have descended outside that particular segment." (T 1224)

The submissions for the airline went on to assert (at para. 7.85) that Captain Collins had carried out his descent outside the specified sector and below 6000 feet "which, on the face of it, constituted a breach of the briefing instructions". This latter submission is plainly

wrong. When Captain Collins decided to descend to 1500 feet in VMC conditions, with the specific authority of McMurdo Air Traffic Control, he was in fact acting in accordance with the authority given to him at his RCU briefing.

The final submissions for Civil Aviation Division proceeded upon the simple and unqualified basis that the MSA conditions laid down by the division had been contravened, not only in the present case but in previous cases. That of course may be a material factor as between the division and the airline, although I have already expressed my reservations as to the division's alleged lack of knowledge of the levels at which pilots flew in 1978 and in 1979 in the McMurdo area. But I am concerned here, of course, with the position as between the airline and its pilots and there can be no doubt, upon all the evidence, that the pilots were in fact authorised at the RCU briefings in 1978 and 1979 to descend below 6000 feet in VMC conditions to any altitude authorised by McMurdo Air Traffic Control. This allegation of pilot error must accordingly fail.

(l) It was submitted that the crew of the fatal flight would have been able to see the profile of the mountain ahead by referring to the screen of the radar installation carried on the aircraft. This suggestion had its origin in the following two excerpts from the chief inspector's report:

> "1.8.9 The aircraft was equipped with a Bendix RDR IF 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 flights 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.
>
> "3.36 The aircraft's radar would have depicted the mountainous terrain ahead."

When the chief inspector gave evidence on this aspect of the matter he was cross-examined as to the identity of the person from McDonnell-Douglas who had indicated the opinion that the high terrain of Ross Island would have been visible on the aircraft's radar. The chief inspector was not able to recall the name of the man in question, although I naturally accept without hesitation that the chief inspector was indeed given this information by a radar expert from McDonnell-Douglas.

I am bound to say that at first sight this proposition seemed perfectly sound. Everyone has a general knowledge of how radar works. A series of intermittent radio pulses are transmitted from the radar installation and as the radio waves strike an object in the distance they will be deflected back towards the radar screen and the location of the identified object will show up as a "blip" on the radar screen. The exact distance and bearing of the object can be ascertained by looking at the screen. I could not see why Captain Collins and the crew had not identified the mountain ahead of them on their radar screen. But then, as the hearings continued, there was evidence given which seemed to exhibit the theory in a new light.

This was the evidence of Captain Lawson who had been the original RCU briefing supervisor but who, at the time of the hearing before me, had reverted to the status of a line pilot. He was called as a witness by the airline for the primary purpose of explaining the original RCU briefing procedures and the manner in which the briefing material was constructed, and he had also described the two flights which he had been on to Antarctica. He had not been briefed by the airline to say anything about the radar installation with which DC10 aircraft are equipped, but he was cross-examined on the point. Here are some of the questions and answers under cross-examination:

"Q. Finally on the two flights that you made what did the aircraft radar depict as you were coming south from Hallett towards McMurdo?

A. From the best of my recollection the picture depicted ground cover and in many cases the sea ice. In all cases I believe the sea ice.

Q. Did Erebus stand out, do you remember?

A. No more than any other ground cover.

Q. Was it evident upon the radar screen as being terrain?

A. It would have been evident as terrain only, yes.

Q. And with your experience of other high ground would the shadow indicate that it would be high terrain rather than sea ice?

A. No.

Q. Do you say that no different picture is conveyed on the radar screen of a mountain like Erebus as compared with sea ice?

A. That is not uncommon.

Q. Dealing with your own experience down there, was there a difference on the radar with high terrain such as Erebus and the return from the sea ice?

A. To the best of my recollection, no.

Q. The difference between high land such as Erebus on the one hand and the sea ice or the ice shelf on the other hand, did you see a difference between them on either of the two occasions?

A. Not that I would place any reliance on.

Q. Well, radar interpretation has its problems, doesn't it?

A. Very much so.

Q. Would Franklin Island and Beaufort Island and Ross Island fall within what you have just said to us?

A. I would be surprised with the radar equipment we have on board the airplane that such definition would be able to be had with any certainty.

Q. I am not talking about radar as a primary aid. You have told us it is of some assistance for picking up coastlines and islands. Is there anything about those three islands I have mentioned that would take them outside the ambit of what you have just said?

A. No, because I believe the sea ice and pack ice would make this difficult to interpret." (T 858-860)

This evidence, given by a very experienced pilot, seemed totally at variance with the information which the chief inspector had received

from the radar expert at McDonnell-Douglas and, of course, the latter information was hearsay from an unknown person. But the Director of Civil Aviation had strongly supported the chief inspector's view. I therefore decided that because Mr Baragwanath and I were required to travel to the United States in order to interview a group of United States Navy witnesses who could not be interviewed anywhere else, we would use the opportunity of taking up this radar question with the Avionics Division of the Bendix Corporation, which is the manufacturer of the radar equipment upon DC10 aircraft.

On 31 October 1980 I paid a visit to the Avionics Division of the Bendix Corporation situated at Fort Lauderdale, Florida. I there saw the director of engineering and the manager of the design systems. I raised with them the theory advanced by the Director of Civil Aviation, the information apparently given to the chief inspector, and the current doubts expressed by at least one of the operational pilots. I also referred to the fact that Major Gumble, who was the pilot of the C-141 which was following TE 901, had said to me in California that he got a good picture of the terrain from his weather radar when set in the mapping mode although it seemed that the radar return on his aircraft had been interpreted by two experienced navigators who were on the flight deck. It seemed also that these navigators were familiar with the region.

The answer I got from Bendix was enough to clarify the situation. First of all, with regard to the C-141, I was told that the weather radar on this aircraft was not as sophisticated as the radar installed in the DC10, but gives a better mapping return. In other words, although the C-141 radar was not as efficient at detecting clouds containing rain precipitation, it gave a better terrain picture than the DC10 radar, therefore the C-141 would get a better terrain return than the DC10.

I was then given an explanation as to the function of weather radar in general. The primary purpose of this DC10 radar is to detect the level of rain precipitation in cloud because it is the water content in the cloud which warns a pilot of impending turbulence. The radio waves emanating from the aircraft's radar system are programmed towards ascertaining the presence of moisture, and if possible, moisture alone. When they strike raindrops in the cloud the radar screen on the aircraft receives a clear echo. The radar beam will give a medium return from rock or earth but the return which it gives from the sea will depend upon whether the sea is calm or disturbed. If there are waves, then the return from the sea is quite good because the beam strikes the angled surface of a wave and a reasonably good echo is received. On the other hand, if the water is calm then the radar beam tends to slide off the calm water and travel onwards, and the return received on the aircraft radar is correspondingly blurred and uncertain. When the radar beam comes upon a conjunction of land and sea, it readily distinguishes between the water and the ground and a good terrain outline is obtained, because this radar set is programmed to search for water, and also if there is a hill behind the shoreline the beam will produce a shadow effect on the screen which will indicate the presence of that hill. However, in the present set of circumstances, the conjunction of land

and ice, or shoreline and ice, raises a special problem and evidently causes a drastic reduction in the quality of the return from the radar whether in its mapping mode or in its weather mode.

When the radar beam strikes ice the quality of the return will depend upon whether there is a water film on top of the ice caused by some degree of melting. If the beam strikes ice with water on its surface then a reasonably good return will be received. If on the other hand the beam strikes ice which is totally dry then the beam, or rather the radio waves which comprise the beam, will be absorbed by the ice surface and will penetrate the dry ice. The more they penetrate the dry ice the more power they lose. If the radio waves strike a damp layer somewhere in the ice, then they will impart an immediate return to the aircraft's radar, but it will be a fairly weak return. If, however, there is no damp ice layer beneath the surface then the radio waves will continue on into the ice and be absorbed by it, and the ultimate return will be either highly attenuated or non-existent.

The reason for the difference between a return from rock and a return from dry ice is that the radio waves act rather like light waves. A light wave will not penetrate rock, but it will penetrate ice. So with a radio wave. Since there is no humidity in Antarctica, there being less moisture on that continent than in the Sahara desert, it follows that both the ice and the snow will normally be totally dry.

If, therefore, one recalls the type of antarctic terrain over which the radar beam in this case was travelling, then the radar beam would penetrate pack ice and would slide over any intervening flat water which it then encountered. Then, as the aircraft got closer to Ross Island and a solid ice shelf was encountered, the radar beam would penetrate the solid ice just as it had penetrated the pack ice. Then, when the radar beam struck the ice-covered slopes of the mountain, it would again be absorbed by the dry ice and in the result the pilot of the DC10 would get approximately the same return from the mountain side as he had been getting from the pack ice and from the ice shelf itself. In other words, the return would be substantially the same as he had been receiving from the time when the pack ice first came within range of the radar beam. Therefore, the pilot would not detect from his radar that he was approaching solid terrain. This fully accorded with the practical experience of Captain Lawson as described in his evidence, from which I have quoted.

The explanation above given is the reason why radio altimeters are unreliable in Antarctica and Arctic regions. The radio waves descending vertically will be absorbed by snow and ice, and in an area where there is very thick snow the radar beam will penetrate the snow and will give a false reading on the radio altimeter. This is also the reason why there is a special warning to pilots contained in the Bendix handbook (produced as **Exhibit 42**) which deals with the operation of the DC10 weather radar. The warning relates to the possible presence of ice crystals in the air. The pilot may see on his weather radar a clear picture of clouds ahead, and he will estimate that he can climb over the clouds. But there is a danger that the area above the clouds may be filled with ice crystals formed by the freezing of raindrops as they are propelled upwards by the wind inside the cloud. Ice crystals in the air are productive of substantial turbulence, but the radio waves from the radar will travel through

the ice crystals and not produce any return on the radar screen. The radar beam will therefore travel on, disregarding the ice crystals, until it reaches some cloud far ahead which is within its range. So, unless the pilot is alert to the ice crystal danger to which I have referred, he can fly into apparent clear air above clouds and encounter severe turbulence.

The Bendix handbook also contains the following warning, at pages 26–27:

> "Dry snowfall has not been detected with any success on weather radar. However, the lightest shade returns, under appropriate atmospheric conditions, can depict the presence of steady moderate to heavy wet snow. Such echoes are not readily obvious and require experience with the display before they can be readily identified."

The result of all this is that in the opinion of the Bendix experts, relating to the case of TE 901, the pilot may have received some kind of return on his radar (if set in the mapping mode) but the return would be so blurred and so attenuated as to give no reliable indication of terrain. If it were not for the preceding pack ice and ice shelf, then the pilot might see that there were some solid structures far below him and in his path. But, as stated previously, the prior returns off pack ice, calm water, and ice shelf, would mask any return received from the mountain because the latter would look like the previous returns from the pack ice.

It might be possible, so the experts said, for a pilot to note a slight change in the return from high ice-covered terrain as opposed to that received from adjacent shelf and pack ice by reason of the "shadow" effect, but the latter would be distorted and unclear. If the pilot had been in the area before, he might be able to discern that there was either some type of high terrain or at least suspected terrain ahead. But he would only deduce this by reason of the fact that he had flown over the area before. That is, although his eyes would see the same type of blurred return which he had been obtaining from pack ice, his pre-existing knowledge of the terrain would cause him mentally to reject those parts of the picture which did not resemble the known terrain, and his identification of terrain would therefore depend not upon his view on the screen but upon his prior knowledge of the area which he was approaching.

The same principle, so it was said, would apply to the terrain mapping described by Major Gumble. His navigators had flown towards Ross Island before. Their particular set would give a better terrain return than the DC10's set, but nevertheless it would not be very satisfactory. However the navigators, being aware of what they were approaching, would again be able to interpret what they were seeing as solid terrain, providing they disregarded those aspects of the map which did not coincide with what they knew was there.

So in the result, the effect of the Bendix evidence was that not only would the DC10 weather radar (set in the mapping mode) give a return hard to distinguish from pack ice, but that type of return would tend to confirm in the captain's mind that he was in fact flying over pack ice in the centre of McMurdo Sound, if indeed that is where he believed he was.

I asked what the position would be if the aircraft had been flying directly at Mt. Erebus at 2000 feet with the radar set in the

"weather" mode, seeing that the mapping mode would be of no assistance at that low altitude. The Bendix opinion was that because the slopes of the mountain side were covered in snow and ice which was totally dry, then the return from the mountain would be nil. This particular radar equipment is programmed, as stated already, only to detect moisture and for reasons given previously it would give a return off any high terrain composed of rock or earth, but a thick coating of dry snow and dry ice on the northern slopes of Mt. Erebus would cause the radar beam to be totally absorbed and make it impossible for any return to be received. However, I was told that there had been no specific experiments in this field and the experts were prepared to concede the possibility, although they did not really believe in it, of some kind of "shadow" effect but did not believe that this hypothetical return would represent any warning of high ground so far as the air crew was concerned.

The Bendix people also made this point. They said that in all probability the radar set on the aircraft was either in the weather mode or was on stand-by at a time when the aircraft was still a long way out from Ross Island. Then, when the captain saw the gap in the clouds and the sea below, and began his orbiting procedure to fly down to the height recommended by Air Traffic Control, there would be no point in switching the radar over to the mapping mode. He would not be interested in the mapping mode if he could actually see the area of pack ice and water towards which he was descending. But suppose that he switched the radar on to the mapping mode once he had levelled out at about 3000 feet or thereabouts. Then he would be flying too low for the mapping mode to be of any assistance because all he would get would be an insignificant return at the very bottom of his radar screen. So in the end, even if one presumed that the radar was set in the mapping mode, as from a long way back in the approach towards Ross Island, a captain who had not been in the area before would not receive any radar echo clear enough to warn him that there was any high terrain in his path.

I discovered at Bendix that this special feature of the DC10 radar in ice-covered terrain had been notified to McDonnell-Douglas when they made an inquiry of Bendix some time after the disaster. It was also ascertained at a later stage that the chief inspector had also been appraised of this information. I also found, again at a later stage, that the airline had been made aware by McDonnell-Douglas of the same information.

While I did not expect the airline to produce evidence from Bendix which tended to absolve the air crew from any degree of fault, in that radar echoes returned by this special type of radar from dry snow and dry ice are nil, nevertheless it was unfortunate, in my opinion, that the chief inspector did not disclose these special features of the DC10 radar in his report. He should not have said, as previously quoted, "The aircraft radar would have depicted the mountainous terrain ahead". In the opinion of the Bendix avionic specialists—and they are world experts—that statement was not correct.

The only conclusion I can reach upon this branch of the case is that the air crew would not have detected on their radar screen from a long way out, whether the radar was set in the weather or the mapping mode, any high terrain in their path because such terrain

was covered with snow and thick ice which is totally dry. Once the aircraft began its descending orbits and the crew could see below and ahead these expanses of pack ice many square miles in extent, their attention would presumably be concentrated on a visual lookout and they would not be concerned with studying radar returns. But even if they did look at the radar after it had levelled out on its final course towards Mt. Erebus then it is not possible to say, in the absence of actual experiment with this type of radar, whether they would have seen any return at all. All the scientific probabilities are, in accordance with the evidence of Captain Lawson, that radar in the mapping mode might detect the difference between the sea water and pack ice, but once solid ice had been reached it would not reveal the existence of any high ground ahead. Once sea water had disappeared, then the radar returns would probably be nil.

Consequently the simple thesis that the air crew could have seen Mt. Erebus on the specialised radar equipment installed in the aircraft is not established. All this shows the danger of hearsay evidence. There is no substitute for making direct inquiries from the person or persons who have the information.

(m) The final allegation of pilot error against the air crew lay in the suggestion that when manually inserting the waypoints for the flight into the aircraft computer, the crew should have noticed that there was now a difference between the destination co-ordinates and those appearing on the flight plan produced at the briefing session of which a copy had almost certainly been in the possession of Captain Collins when he plotted his flight track the night before the fatal flight. Although the meridian of longitude had been adjusted by only two digits out of five, the parallel of latitude had also been adjusted by a change of one digit and by the addition of another. Seeing that Captain Collins had been working the night before on the previous destination co-ordinates, I felt obliged to give this particular matter careful consideration.

It is perfectly true that the flight plan provided on the morning of the flight contained very large numbers of mathematical digits covering not only the geographical position of the waypoints but also track and distance information, flight levels, fuel calculations and the like. But the opportunity was certainly there for Captain Collins to have noticed that the destination co-ordinates appeared to be different from those on which he had been working the night before. He would have been required, no doubt, to have been the possessor of a very accurate memory but he was described to me as having been a very methodical man. Of course he may not himself have been concerned in the insertion of the co-ordinates. This may have been done by First Officer Cassin and First Officer Lucas, or by First Officer Cassin and Flight Engineer Brooks. This is one of the things which no one will ever know. But even if Captain Collins had himself participated in the insertion into the aircraft computer of all the figures on the flight plan, it is reasonably certain that it would never have crossed his mind that any waypoint on a standardised flight plan had been changed, and his long experience in the AINS method of navigation would render it inconceivable to him that the position of any waypoint could possibly have been changed without his knowledge. As Captain Gemmell himself said in evidence, when he learned about the transposition of the co-ordinates for the waypoint, and the non-disclosure to the air crew, it came as a "bombshell", a clear indication of the practical impossibility that

such a thing could happen without the air crew being told. In these circumstances, and bearing in mind the doubt which exists as to whether Captain Collins himself was involved in the insertion of the waypoint, I cannot accept this allegation as being an indication of error on the part of the pilot-in-command.

290. Such is the catalogue of pilot error which comprises, to the best of my recollection, a total of the acts or omissions in respect of which the air crew of TE 901 were alleged to have been at fault. I find that none of them has been established to my satisfaction.

McMURDO AIR TRAFFIC CONTROL

291. One of my terms of reference requires me to investigate and report upon whether the disaster may have been contributed to by an act or omission on the part of the air traffic controllers at McMurdo in respect of any function which they had a duty to perform or which good aviation practice required them to perform. I was therefore required to give some attention to the activities of the McMurdo Air Traffic Control on the day in question.

292. It appeared that the material witnesses who had been on duty at Mac Centre and the Ice Tower on 28 November 1979 were no longer located in Antarctica but were back in the United States. Following a series of negotiations between the New Zealand Ministry of Foreign Affairs and the State Department of the United States, it was finally settled that I could interview specified United States Navy personnel who had been members of the Air Traffic Control system at Antarctica on the date in question, but that they would only be available for interview or for the taking of evidence in the United States. Additionally, it was laid down by the State Department that these United States witnesses were not to be interviewed except in the presence of a United States Navy legal adviser. The adviser nominated for this purpose was Lieutenant-Commander E. A. Fessler, a lawyer who is a member of the Judge Advocate General's Department of the United States Navy. Lieutenant-Commander Fessler was very co-operative in arranging appointments for Mr Baragwanath and me to interview such United States Navy witnesses as were available. The witnesses were interviewed in the presence of Lieutenant-Commander Fessler at Port Hueneme, near Los Angeles, and in Washington D.C., and their statements were later reduced by Lieutenant-Commander Fessler to the form of sworn depositions and in due course the depositions were transmitted to New Zealand.

293. The content of the United States Navy evidence may briefly be stated. Technical details were given of the radio facilities available at McMurdo for air-ground communication. The high frequency radio (not dependent upon line of sight) was operated from Mac Centre, which forms part of the McMurdo Base complex. The very high frequency radio (dependent upon line of sight) was available on one frequency at both Mac Centre and the Ice Tower, on another frequency at the Ice Tower only, and on a third (guard) frequency at both Mac Centre and the Ice Tower. On the common frequencies both Mac Centre and the Ice Tower could hear communications between the other and aircraft. There also existed between Mac Centre and the Ice Tower FM links.

294. Normally, VHF contact was established at 120–125 miles but sometimes no closer than 70 miles with the aircraft flying at levels between 18 000 feet and 37 000 feet. The importance of VHF radio contact was both its freedom from static and the fact that no radar directions could readily be given on HF because the Ice Tower, where the radar was situated, would need to ask Mac Centre to communicate with an aircraft on HF transmission.

295. The radar installation at McMurdo possessed an IFF mode (Identification Friend or Foe) which only operates so as to identify an approaching aircraft, and has a range of up to 150 miles. The primary mode of the radar however was aircraft surveillance (ASR) which has a range of about 40 miles and this is the primary radar function which will show the aircraft on the screen. The radar both in its ASR mode and in IFF mode performs a 360° search.

296. It was affirmed that the McMurdo Air Traffic Control expected the DC10 of the fatal flight to arrive down McMurdo Sound, as with previous flights in 1979 and in 1978. It was evidently normal to plot the waypoints given on the Air Traffic Control flight plans telexed from Auckland on the first of each season's civilian aircraft flights which in this case had been 7 November 1979.

297. The evidence was that Air Traffic Control was not aware of the restricted sector within which the DC10 aircraft are said to have been required to fly and they never in fact flew in any defined sector. They approached at low altitudes, which were 1500 feet and in some cases lower than that, and they would always approach down McMurdo Sound. Air Traffic Control had not been told that the programmed route for the fatal flight overflew Mt. Erebus, and they would have disagreed with any such proposal. They would have also disagreed with the 6000 feet descent sector because of difficulty in radar surveillance of an aircraft flying in that sector. In the view of one of the main witnesses, such a sector was "absurd".

298. But the principal fact asserted in the evidence was that the DC10 of the fatal flight had not been seen at any time on the radar screen at the Ice Tower, and this confirmed what the chief inspector had been told at McMurdo.

299. There had been VHF transmissions between the Ice Tower and the aircraft from 12.35:27 p.m. to 12.36 p.m. in which it had been confirmed between the Ice Tower and the aircraft that the DC10 was descending from 13 000 to 10 000 feet VMC and would obtain a radar letdown through cloud.

300. At 12.38:29 p.m. there was initiated a series of transmissions between the aircraft and McMurdo on HF, in which the aircraft announced that it was 34 miles to the north of McMurdo and was maintaining the 10 000 feet level.

301. Then at 12.42 p.m there were again a series of HF transmissions in which the aircraft operator said they could not get VHF contact but they were flying VMC and would like to let down on a grid of 180° (meaning thereby to the true north) and proceed visually to McMurdo. Mac Centre instructed the aircraft to maintain VMC and to keep Mac Centre advised of its altitude as it approached. The aircraft replied that it would maintain VMC, and this series of transmissions ended with an agreement by the aircraft to report to Mac Centre when they were 10 miles out from McMurdo.

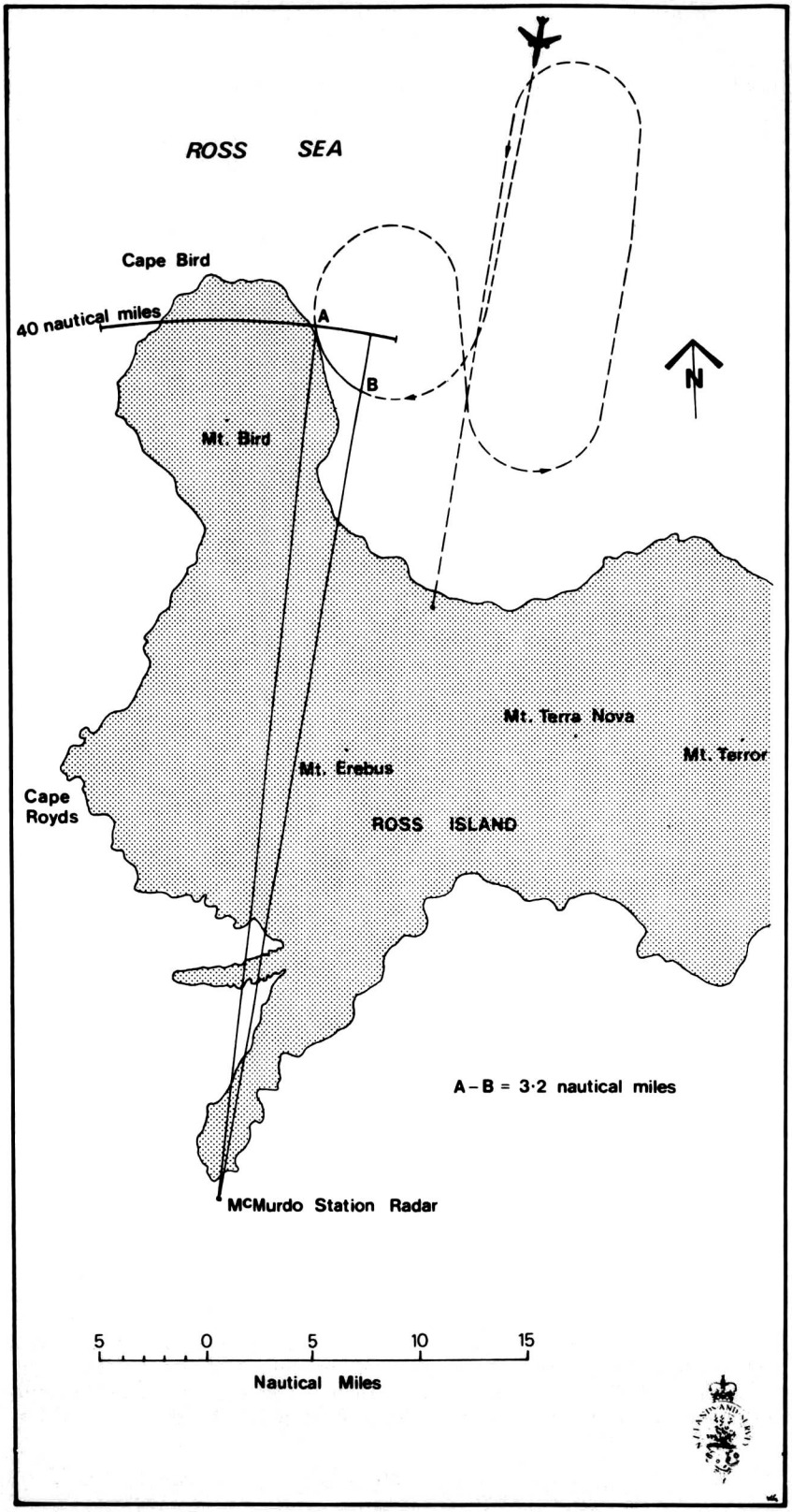
ROSS SEA
Cape Bird
40 nautical miles
A
B
N
Mt. Bird
Mt. Terra Nova
Mt. Terror
Mt. Erebus
Cape Royds
ROSS ISLAND
A – B = 3·2 nautical miles
McMurdo Station Radar
5 0 5 10 15
Nautical Miles

FIGURE 15

302. There were later transmissions on HF between Mac Centre and the ground, from 12.44:36 p.m. to 12.45:08 p.m., in which the aircraft reported that at 50 miles north the cloud base had been 10 000 feet, and in which the aircraft further advised that it was now at 6000 feet and in the process of descending to 2000 feet flying VMC. This was the last transmission received from the aircraft. Four minutes 52 seconds after that final transmission, the aircraft struck the slopes of Mt. Erebus.

303. It was clear from all this that the aircraft had first requested and obtained a radar-monitored letdown, but eventually in its final transmission it had announced that it was now flying down to 2000 feet (below the McMurdo cloud base where Mac Centre had said there was unlimited visibility) and that it was now flying VMC. This final message, acknowledged by Mac Centre, could only have meant that the aircraft was now discontinuing its request for a radar letdown and would be flying to McMurdo under the cloud base.

304. When the aircraft had previously reported that it was at 10 000 feet and flying VMC, it was then in the course of undertaking the two orbits to which I have referred, and the obvious inference is that having successfully descended from 10 000 feet to 6000 feet in clear air, the crew anticipated not requiring any further radar assistance because forward visibility was clear and the aircraft was about to descend under the cloud cover which lay over the McMurdo area.

305. I now turn to the question whether the DC10 was ever visible on the radar screen at the Ice Tower. The theory had consistently been that because the DC10 was approaching on a nav track which took it directly at the summit of Mt. Erebus, and because the track was approximately on line with the radar installation at the Ice Tower, then the height of the mountain would effectively preclude any sight of the aircraft, in view of the fact that it was approaching at altitudes progressively less than 20 000 feet.

306. All this was clear enough, but it seemed to me that the theory overlooked the point that at about 43 miles out from the Ice Tower the aircraft had begun its right hand orbit at an altitude of 17 000 feet. It reached the southern point of its orbit at 37 miles out, and continued to turn to the west and then towards the north following its circular path. By the time the aircraft had turned away to the north at a point 40 miles out, it had dropped to a height of 14 000 feet and was now at the extreme western limit of its orbit which is something like 5 to 6 miles to the west of the peak of the mountain. Then the aircraft had continued turning towards the east, and at about 43 miles out had disappeared behind the mountain peak at about 12 000 feet.

307. For radar transmissions to make contact with the aircraft at 17 000 feet, with the radar being situated 20 miles from the peak of the mountain, I made some calculations which suggested that the radar beam would need a terrain clearance of not less than 9000 feet. This seemed to show that the radar would have picked up the aircraft just after the southern limit of its right hand orbit, and as it began to turn away to the north-west.

308. I asked the New Zealand Department of Lands and Survey if they would prepare me an accurate plot to see if my conclusion was correct. Fig. 15, page 129, shows the plot which was prepared. As will be seen, taking into account the necessary ground clearance which was affirmed at being about 9000 feet, this would mean that the aircraft would become visible on the radar screen from point B to point A on fig. 15 which

represents a distance of 3.2 nautical miles. But this is postulating that the maximum range of the radar is 40 miles. Supposing that it was capable of obtaining a picture at a range of, say, 43 miles, then the aircraft would have been in line of sight of the radar and within range for over 6 miles, which represents 1 minute of flying time.

309. It is also to be noted that the only successful series of VHF transmissions from the Ice Tower to the aircraft had commenced at about point A on fig. 15 and had continued for half a minute while the DC10 moved away to the north, so that the DC10 was certainly in line of sight with the Ice Tower while it travelled at least 6 miles.

310. Even assuming that the range of the Ice Tower radar was limited to 40 miles exactly (which is unlikely), and even making allowance for any initial slight deflection off the western slope of Mt. Erebus possibly sustained by the radar beam at 9000 feet, the aircraft should have been visible on the screen whilst it travelled from a little to the left of position B on fig. 15 to position A. This represents half a minute of flying time. Assuming that the radar sweep at the Ice Tower completes a circuit once in 4 seconds, then there should have been a minimum of seven or eight consecutive "blips" on the Ice Tower radar screen up to the 40-mile limit.

311. I am aware of the apparently outmoded nature of this radar equipment as described by the United States Navy witnesses, although it must certainly have been sufficiently accurate to identify the distance and bearing of the big Starlifter jets and the C – 130 aircraft which always used that radar for a glide path. In addition, about 45 minutes after the crash of the DC10, the Ice Tower radar had picked up the approaching Starlifter of Major Gumble and according to his depositions he was told "at about 38 miles" that the Ice Tower had picked him up on radar, which would infer a pick-up some little time before, probably somewhat in excess of 40 miles out. So after making all allowances, it seems difficult to see how the DC10 did not appear on the Ice Tower radar screen for an ascertainable period of time, being not less than half a minute.

312. There is an independent factor which tends to confirm that the DC10 was in fact seen on the radar screen. This is contained in the telex messages received from McMurdo shortly after the accident, when they reported that the aircraft was overdue and then said that its last estimated position was "38 nautical miles true north of McMurdo" (Annex C to Mr Coker's brief of evidence). There is no radio transmission from the aircraft which mentions a distance to run of 38 miles. There are references in the latter stages on the CVR to other distances, but the phrase "38 miles" is not mentioned. There is accordingly a strong inference that McMurdo Air Traffic Control could not have ascertained the 38 mile distance from the Ice Tower and the exact bearing (true north of McMurdo) unless the distance and bearing had been read by the operator from the radar screen.

313. Just a little north of point B on fig. 15, page 129, the transponder of the DC10 was activated. This occurred at 12.35:15 p.m., following a request from Mac Centre at 12.33:34 pm. to "Squawk" the aircraft's transponder on Code 0400. The fact that the aircraft's transponder is recognising interrogation by ground radar is conveyed to the crew by a light on the transponder panel which remains on for 15 seconds after the last transmission from the aircraft's transponder to the ground station. The ordinary explanation as to what happened here is that Mac Centre instructed the crew to set Code 0400 on the aircraft's transponder for the purposes of ground radar interrogation. In other words, Mac Centre was anticipating a radar return from the aircraft and accordingly asked for the

aircraft's transponder to be activated. The fact that it was so activated at the time which I have stated produces the obvious answer that the DC10 had then been identified on the ground radar screen.

314. The above interpretation of the aircraft's transponder response was challenged by the United States Navy witnesses. It was contended that when the crew of the DC10 were asked to activate the aircraft's transponder this had reference not to identification of the aircraft on the radar screen, but to the radio link between the aircraft and the TACAN. In other words, it was being suggested that the request from Mac Centre referred to the DC10 establishing contact with the TACAN, it being recalled that a DC10 is not equipped to obtain a bearing from the TACAN but is equipped to communicate with the DME function of the TACAN.

315. This explanation cannot possibly be accepted. With ground radar, that radar equipment is the interrogator and the aircraft returns a radio pulse from its transponder thus confirming that radar contact has in fact been made with the aircraft. But in the case of the TACAN, the system works the other way round. The DC10 radio link with the TACAN, if successfully established, carries out the interrogation of the DME system of the TACAN and in this case it is the TACAN equipment which acts as the transponder replying to the airborne interrogation. The instruction therefore from Mac Centre to the aircraft to activate its transponder could have had nothing to do with the TACAN at all. The purpose of the aircraft being asked to activate its transponder was solely for the purposes of surveillance by the Ice Tower radar equipment.

316. It should be noted that I have been compelled to express conclusions as to what might have been seen on the Ice Tower radar because there was no direct evidence on the point from the United States Navy witnesses. Neither the radar operator nor the Ice Tower radio operator was available to give evidence.

317. From all this I draw the following conclusions:

(1) The probabilities are that the DC10 was in fact on the radar screen for something like half a minute as it emerged from behind Ross Island at about 16 000 feet travelling west on its first orbit, and it may have been on the screen for as long as one minute.

(2) Seeing that the DC10 began turning to the west on this orbit at 37 miles out (as revealed by the black box) then a pick-up at the 38 miles referred to in the United States Navy telex message would thus be corroborated.

(3) If the DC10 was observed on the screen, then the radar operator would immediately have noticed that it was on a bearing about 40° to the east of where he had supposed the aircraft to be.

(4) If the aircraft was seen and the unexpected bearing observed, then the radar operator may have been deterred from any inquiry by reason of the fact that the crew intended to fly out on 180° grid (meaning thereby true north) and proceed visually to McMurdo. That is, the radar operator may have believed that the air crew were aware of their true position and were intending to fly away to the north.

(5) In any event the last transmission from the aircraft had announced that it was in the process of descending to 2000 feet and was flying VMC. This again would justify, at least in practical terms, a lack of any further communication from the ground to the aircraft.

(6) In summary therefore, I have formed the view that the aircraft did appear on the radar screen, that it was observed by the radar operator, but that for the reasons just expressed he is not to be blamed, at least within my own terms of reference, from taking any step towards advising the aircraft (on HF through Mac Centre) as to its estimated location. In terms of the official United States Department of Defence publication covering use of the McMurdo navigation aids, there is a public notification that civilian aircraft must use these aids at their own risk. It will be understood that I am not here concerned with any question of liability of the United States Navy at common law, I am only concerned with the question asked in my terms of reference, and I do not believe that the radar operator at McMurdo, if he saw the aircraft appear on his screen, was guilty of any omission in respect of a function which he had a duty to perform or which good aviation practice required him to perform.

THE FACTUAL CIRCUMSTANCES OF THE DESCENT AS DEDUCED FROM THE AVAILABLE EVIDENCE

318. I have now reached the stage when I must indicate my view as to the nature of the descent, and what happened during the course of descent towards the ultimate flight level of 1500 feet. What I have to say is based upon the CVR transcript of communications between the two pilots, the data relating to the descent provided by interrogation of the black box, and the inferences legitimately to be derived from the known circumstances.

Pre-descent Briefing

319. In accordance with standard practice, Captain Collins would have conducted a pre-descent briefing involving not only First Officer Cassin but also Flight Engineers Brooks and Moloney. He would at that briefing have announced his intentions in regard to the descent, and stated exactly how it would be carried out. He would expect to listen to and discuss any queries from the other three members of the flight crew as to his proposed descent procedure.

320. On this topic of pre-descent briefing, there was what I might describe as a noticeable silence on the part of the executive pilots who gave evidence in support of the case for the airline. They all knew, as well as I know, that a detailed pre-descent briefing would have been carried out by Captain Collins. They would also know, as I know, that the descent procedure adopted would have been in accordance with the settled agreement by the flight crew as to the future handling of the aircraft.

321. One of the major difficulties in the Inquiry has been that this pre-descent briefing occurred at a time more than 30 minutes from the collision of the aircraft with the mountain side, and accordingly there is no taped record of what took place at that briefing. If only the tape recording of that pre-descent briefing had been available then many of the disputed questions which occurred during these hearings before the Commission would not have arisen. Since we can never know what plan was settled by the crew as a result of the pre-descent briefing, it is only possible to infer

what must have been settled by Captain Collins after consultation with his crew. But when examining the known circumstances as they must have existed during the descent, and upon examining the CVR transcript of the discussions between the two pilots as they controlled the descent it is possible, without entering into the field of speculation, to deduce that the pre-descent briefing followed along these lines :-

(1) The briefing would have taken place when the aircraft was about 200 miles out from the McMurdo waypoint and when the aircraft was flying at an altitude of more than 30 000 feet. At that time the DC10 was flying in clear air but far below, and some distance ahead, there was a solid cloud layer with a base of about 10 000 feet. In the far distance there would be seen the general location of the McMurdo area which would be totally obscured by cloud, and the cloud cover also obliterated from view Mt. Erebus and the other mountains on Ross Island. On the right, extending far away to the south, would be the clear white mountain tops of Victoria Land.

(2) Captain Collins had received earlier during the flight from Auckland a McMurdo weather forecast, transmitted by Auckland radio. The forecast over McMurdo was for a broken cloud base at 4000 feet, with visibility at 40 miles and occasional light snow.

(3) Captain Collins decided to let the aircraft down at a gradual rate of descent until he had penetrated the high cloud below him, and he would have demonstrated on a map his plotted track showing the nav track from Cape Hallett to the head of McMurdo Sound, and probably also a track plotted on page 185 of his atlas, which gave a close-up of the McMurdo Sound area. He would have said that the NDB had been withdrawn, and that the nav track must be exactly followed in the absence of navigational ground aids, until radar contact was made.

(4) Captain Collins would have said that he expected to encounter clear air after penetrating the 10 000 feet cloud layers ahead, but that the aircraft would then soon encounter the lower cloud base which extended over McMurdo.

(5) Captain Collins would announce his intention of calling for a radar letdown when the aircraft had arrived somewhere near the entrance to McMurdo Sound, as demonstrated by the track which he had drawn on the map before him. He anticipated that the radar letdown would then bring him out into clear air at about 2000 feet, at a point about midway down the Sound.

(6) The course to be then taken by the aircraft would depend on the visibility below the McMurdo cloud base. If visibility was clear in all directions then the aircraft would proceed down the Sound, would overfly Scott Base and McMurdo Station, and after circling over the Ross Ice Shelf at an altitude of about 2000 feet would then fly past Scott Base and McMurdo Station, and fly towards Victoria Land where the crew could see the sun shining on the mountains. After flying north close to the Victoria Land coast he would then increase altitude to his cruising height and fly back to New Zealand.

(7) If upon penetrating the cloud base over McMurdo Sound the visibility was not sufficiently clear or if there were snow showers of any intensity, then it was the intention of Captain Collins to abandon any attempt to overfly McMurdo Station and Scott Base, and the aircraft would fly away towards the sunlit mountains of Victoria Land.

(8) A decision was reached as to the point at which the aircraft would fly out of McMurdo Sound if conditions under the 2000 feet ceiling were found to be unsuitable for viewing, and that point was settled at some figure like 30 miles distance to run, or possibly the departure point was fixed at about the vicinity of the Byrd Reporting Point, which Captain Collins would have calculated to have been 23 miles from his destination waypoint.
(9) With this plan completed, and presumably concurred in by the crew, a decision was made to commence descent at a point some distance ahead.

The Actual Descent Procedure

322. At 12.17:13 p.m. Captain Collins said to First Officer Cassin "I think we will start down a little early here" to which First officer Cassin replied "Okay. I'll see if I can get hold of them on VHF". This remark referred to an earlier descent than had been settled at the briefing. At this stage the aircraft was about 140 miles out, and just after the aircraft had started its descent there was received an HF message from Mac Centre advising that they had a low overcast in the area of about 2000 feet and that they were having some snow, but that visibility was still about 40 miles. Immediately thereafter, First Officer Cassin obtained a clearance from Mac Centre to descend to 18 000 feet and to maintain that level. Shortly afterwards Mac Centre advised that the clear areas around McMurdo were approximately between 75 and 100 miles to the north-west of McMurdo but that an extensive low overcast still prevailed over the McMurdo area. Very shortly afterwards, Mac Centre advised that within a range of 40 miles from McMurdo they could let the aircraft down to 1500 feet on radar vectors, to which the aircraft responded by accepting that offer.

323. At this stage the aircraft was 114 miles from its destination waypoint. Captain Collins then addressed the passengers on the public address system. He said that the aircraft was going initially to 18 000 feet and that although the cloud cover at McMurdo had increased the visibility was still 40 kilometres, and that the aircraft would be adopting a radar letdown which would take it below the McMurdo cloud level and give a view of the McMurdo area. However Captain Collins added a precautionary note to the effect that there could be variations in the weather which might result in a change of course, but he said that the crew were hopeful they would be able to give the passengers "a look at McMurdo today".

324. Thereafter there ensued a number of unsuccessful attempts to contact the Ice Tower on VHF, and Mac Centre was notified on HF of these unsuccessful attempts. Mac Centre replied that the Ice Tower was attempting contact on two different frequencies and advised the crew to attempt VHF contact again when they were approximately 80 miles out. Then, with about 60 miles to run and with the aircraft still holding its altitude of 18 000 feet, the crew saw that the 10 000 feet cloud cover below them had now become disintegrated, and that there were large areas of clear sky which displayed many square miles of ice and sea, as later revealed by the passengers' photographs. The only cloud in the immediate foreground therefore consisted of some widely spaced thin patches and it was no longer necessary to hold the aircraft on nav track because the aircraft could now descend in clear visibility down to 2000 feet or 3000 feet.

325. The aircraft then notified Mac Centre on HF that they could orbit in their present position (which by that time was about 43 miles north) and could descend VMC. There was an immediate reply from Mac Centre on HF approving VMC descent, and the aircraft replied to the effect that they were now vacating 18 000 feet and would advise its later altitude. The aircraft then began the two orbits to which reference has previously been made, and the path of the two orbits was directed by the necessity to maintain VMC conditions at all times, which in terms of airline directions for these flights meant 20 kilometres of clear vision. Thus in descending from 18 000 feet to 3000 feet the track of the two orbits was arranged so as to bypass occasional thin layers of cloud, and when the aircraft levelled out at 3000 feet it was in clear air, but now approaching the edge of the solid overcast which lay ahead.

326. During the orbits there occurred further discussions with McMurdo. At 12.35:36 p.m. the aircraft obtained communication with the Ice Tower on a VHF channel. This was during the latter part of the first orbit, and the Ice Tower was advised that the aircraft was descending VMC through 13 000 feet to 10 000 feet. The Ice Tower acknowledged this and said they understood the aircraft was requesting a radar letdown through cloud (meaning thereby the cloud over McMurdo which would be lying ahead of the aircraft in due course). The aircraft confirmed this arrangement.

327. Then about 3 minutes later the aircraft notified Mac Centre that VHF contact had been lost and that they were maintaining 10 000 feet and were 34 miles to the north of McMurdo. This transmission was made at about the completion of the first orbit, when the DC10 was once more behind Mt. Erebus. The next transmission was made on HF and the aircraft reported that they still had no contact on VHF but that they were maintaining VMC and asked for a clearance to let down on a grid of 180° (meaning true north) and proceed visually to McMurdo. Mac Centre immediately authorised this proposal and then asked the aircraft to report to Mac Centre when 10 miles out from McMurdo.

328. Then came the last transmission from the aircraft, which occurred when it was completing the second orbit and was in the course of straightening up to recapture the nav track upon which Captain Collins intended to rely until he achieved radar contact. At this stage the crew could see the edge of the overcast some distance ahead, and were flying in clear air, and now expected to descend under the cloud cover and fly VMC towards the Scott Base area. They accordingly notified Mac Centre on HF that they were now at 6000 feet descending to 2000 feet and were VMC. This communication was acknowledged by Mac Centre who thereafter waited for the aircraft to appear.

329. The aircraft then descended to 2000 feet and flew under the overcast on nav track. The areas of pack ice which extended for many miles around were now starting to give way to solid snow-covered ice, and the view ahead consisted of a wide vista of flat white terrain apparently stretching many miles away under the overcast. Despite the apparent clear visibility for many miles forward, no landmarks could be seen, except in due course the distant shorelines to the left and right which were interpreted as being the shorelines of McMurdo Sound, they being located in conformity with the plotted nav track to which the pilots were referring.

330. Captain Collins then descended to the altitude of 1500 feet which had been recommended by Mac Centre, but still no forward landmark could be seen, and at this juncture Captain Collins said: "We are 26 miles

north. We will have to climb out of this". I pause to say that this reference to being 26 miles north very clearly related, in my opinion, to a decision reached at the pre-descent briefing when Captain Collins had indicated that he would climb away out of the Sound unless he had clear visibility by the time he was 30 miles out or reached the approximate position of the Byrd Reporting Point which he had calculated to be 23 miles north of his destination waypoint.

331. Then there followed the casual discussion between Captain Collins and First Officer Cassin as to whether they would climb away to right or left, and there was clearly no sense of urgency so far as either officer was concerned and they would, without doubt, have been referring to the map which contained the plotted track running down McMurdo Sound. The discussion had still not been concluded when the ground proximity warning system sounded and Captain Collins, attempted, without success, to fly the aircraft away from some presumed rising terrain which in fact was not visible at all, despite the clear air, to any member of the flight crew or to Mr Mulgrew.

332. The decision to fly away was not directed by lack of visibility. I think this conclusion is reinforced by a study of some of the final discussions which took place between Captain Collins and First Officer Cassin. At 12.48:30 p.m. Captain Collins is preoccupied with trying to obtain contact with the TACAN. He verifies from First Officer Cassin that contact with the TACAN has not been made. Then, having ascertained that the aircraft had been unable to interrogate the TACAN, Captain Collins at 12.48:55 p.m. addresses the following remark to First Officer Cassin;

"Have we got them on the Tower?"

and the First Officer replies:

"No ... I'll try again."

Then one of the flight engineers says that there has only been contact on HF. Captain Collins then says to First Officer Cassin:

"Try again."

to which First Officer Cassin replies:

"O.K."

At 12.49:25 p.m. Captain Collins inquires:

"Have you got anything from him?"

and First Officer Cassin replies:

"No."

Then Captain Collins says:

"We are 26 miles north. We'll have to climb out of this."

It will be observed that the first priority of Captain Collins was to endeavour to raise the TACAN, and it will also be recalled that the only information available from the TACAN was the distance to run. In other words, successful contact with the TACAN would have resulted in a print-out on the DC–10 panel giving the distance to run to the TACAN. But when communication with the TACAN was found to be non-existent, Captain Collins then directed that an attempt be made to contact the Ice Tower on VHF. It will be observed that he did not suggest any contact with Mac Centre on HF, even though there had been no difficulties at all with communication on that frequency. Why was it that he was intent on trying to get communication with the Ice Tower? In my opinion, it was for the same reason that he earlier tried to get communication with the TACAN. What he wanted from the Ice Tower was a report from the radar operator as to the range of the aircraft as depicted on the Ice Tower radar screen.

In other words, Captain Collins had seen that according to his own instruments he had only 30 miles to run, and despite the abnormally clear air of Antarctica he still could not see in the distance such obvious features as the long peninsula running out to the west from Ross Island. Therefore, he had come to suspect the accuracy of the DME of his aircraft, and what he wanted was confirmation from the TACAN or from the Ice Tower of the true distance to run, because he knew that the distance to the TACAN would only vary from the distance to the Dailey Island waypoint by about 2 miles. All this leads to the necessary conclusion that both Captain Collins and First Officer Cassin believed that their vision extended for at least 40 miles ahead. But they could not reconcile the absence of any landmarks with the fact that their own DME function told them that there was 30 miles to run. So the question of visibility was not involved. The visibility was clear enough. But I cannot think it coincidental that Captain Collins decided to climb away immediately after he had failed to obtain from McMurdo their information as to how far he was from the Ice Tower.

Conclusion

333. Such is the story of the descent as I deduce it from the evidence. It is not in any sense a complicated tale. This descent to a level which would take the aircraft under a cloud base of 2000 feet would have been performed by Captain Collins on hundreds of occasions when making approaches to airport runways. In this case, as I said previously, he had no need for any radio beacon when arriving at the head of McMurdo Sound because he knew that the aircraft was flying on track and must inevitably take it into the centre of the wide expanse of the Sound.

334. As I say, I can see nothing remarkable at all in the way in which this simple descent was carried out, and there are two features about it which it is essential to keep in mind:

(1) The CVR transcript records that at all times during the descent Captain Collins and First Officer Cassin were engaged in the sole task of monitoring the transitions from one flight level to another, and at a later stage, the aircraft's response to the changing headings and altitudes of the two orbits, and at the same time were keeping Mac Centre advised of every proposed change of altitude and course during the orbiting sequence. There are no less than 13 references made by one pilot to the other confirming that the aircraft was flying VMC.

(2) Neither before nor after the decision was made at 26 miles out to fly away is there any remark made by either pilot referring to worsening visibility, and indeed if they had been approaching any area of impaired visibility there certainly would not have ensued the non-committal discussion between the two pilots as to whether they would climb out to the left or to the right.

335. A study of the discussions between the two pilots and whichever flight engineer was on the panel at the time, all set out in the CVR transcript, demonstrates a most careful adherence right throughout the last half hour of the flight to every detail of flight deck discipline and procedure, except for an inadvertent delay in resetting the altimeters. Every time there was a new setting for the altitude, speed, rate of descent, adopting of heading select and subsequent re-engagement of the nav track, there is verbal confirmation from the other pilot of the changed instrumental settings. There is not the slightest indication from the

recorded communications between the pilot and co-pilot that either of them took any notice of, or even heard, the running sequence of indistinct cross-talk between the various persons at the rear of the flight deck and in the galley.

336. The fact that a visual sweep was being maintained by the pilots in all directions as the aircraft completed its orbits is verified by the constant references to flying VMC and the changes in heading which were required in order to maintain VMC. This strict flight deck discipline was being maintained by the pilots at every stage, and they were preoccupied to the exclusion of all else with monitoring and negotiating the descent from 17 000 feet to 2000 feet. First Officer Cassin certainly spent some time unsuccessfully attempting to raise the Ice Tower on VHF but this was not a continuous process and, as the evidence before the Commission demonstrated, would interfere to only a minimal extent with his other flight deck duties. No pilot who gave evidence before the Commission, whether testifying on behalf of the airline or on behalf of ALPA, has questioned in any respect the dedicated vigilance of this air crew during the last stages of its flight.

337. Those who have attempted to invest this conventional and unremarkable descent procedure with a series of clouded uncertainties and ingenious complications, are those who between them have put forward this extraordinary variety of pilot errors which they contended had been made, but in respect of which, in most cases, no decisive pilot error seemed to be alleged. I have been asked, so far as I can see, to accept any one of the many theoretical varieties which were offered. So long as I could be persuaded to accept one material theory of pilot error, the aircraft radar theory for example, then that presumably would satisfy the executive personnel of the airline and those personnel of Civil Aviation Division who wished thereby to obliterate the effect of their own mistakes.

POST-ACCIDENT CONDUCT OF AIR NEW ZEALAND

338. I have already described the decision of the chief executive, when he learned of the disaster, that all documents relating to the Antarctica flights and to this flight in particular were to be impounded. The procedure adopted to achieve this purpose was that a special committee was set up comprised of certain airline officials and they were charged with the responsibility of collecting all Antarctica documents. Mr Oldfield, the airline's safety manager, was constituted secretary of the committee. He was the man who carried out the further instructions of the chief executive that any surplus documents were to be destroyed through the airline's shredder.

339. I have already referred to the reason given by the chief executive for giving this instruction. He felt that spare copies of documents might be handed by some employee to the news media, a result which the chief executive was anxious to avoid. But he insisted that, according to his instructions, only "surplus copies" of documents were to be destroyed in this manner. As will readily be apparent, there was an inherent weakness in this system. The various divisions and departments of the airline would hand over the documents to Mr Oldfield, and, as he said, he would then attach to the committee investigation file all relevant documents and would destroy all those which appeared to be copies of existing

documents. But Mr Oldfield could not know what test had been applied by the person handing in the documents as to which of them were relevant. In other words, it was left to numbers of persons who might be anxious over their own possible connection with the disaster to select for themselves what documents they would deliver to Mr Oldfield.

340. In the result, a substantial file was accumulated by this special investigating committee convened under the instructions of the chief executive, and they accumulated a variety of documents. It appears to have been part of the terms of reference of this committee that they were to prepare for the management a "preliminary statement of facts" known in regard to flight TE 901 up to the time of the accident, then they were directed to assemble and examine all data and documents available relating to planning and training for antarctic flights, together with operational briefing and flight documentation for flight TE 901.

341. I have gone through all the documents which the committee collected over the space of a few days before its proceedings were brought to an inconclusive end when the chief inspector returned from Antarctica and commenced his own enquiries. The file consisted, for the most part, of briefing documents, operations specifications and the like, together with preliminary transcripts of the CVR tape. But apart from certain reports or preliminary reports prepared by the committee itself, I could find not one original document on its file. Every document, so carefully collected by Mr Oldfield on behalf of the committee, seemed to be a copy of some other document. In other words, the contents of this investigation file were wholly innocuous and the committee's inquiries led to nothing. If, therefore, the "investigation file" was supposed to contain all documents relevant to the Antarctica flights, then it contained nothing except a copy of RCU briefing documents which shed any light at all upon the subject matter of the inquiry, and seeing that all pre-accident documents assembled on the file were copies, then where were the originals?

342. This instruction by the chief executive for the collection of all Antarctica documents had some unfortunate repercussions. Captain Gemmell, the chief pilot, had gone to Antarctica with the Chief Inspector of Air Accidents, and with other officials, at about midday on 29 November 1979. It was alleged by counsel for ALPA that while Captain Gemmell was at Antarctica he had collected a quantity of documents from the crash site and brought them back to Auckland. It was pointed out that of the documents collected at the wreckage site and produced to the Commission, there were only three which had been part of the flight documents carried by Captain Collins. These three documents were:

(a) The RNC chart which set out track and distance diagrams for QANTAS and for Air Force flights but not for Air New Zealand, and which conveyed information as to various radio frequencies.

(b) A sample flight plan printed in October 1977 which contained among the list of co-ordinates the latitude and longitude of the NDB at McMurdo.

(c) The piece of paper containing Captain Johnson's notification on 8 November 1979 that the NDB facility was withdrawn and including a notification that the minimum safe altitude in the McMurdo area was 6000 feet.

343. It was suggested by counsel for ALPA that it was curious to find that the only flight documents recovered from the ice were each in favour of the case which the airline was now attempting to advance. The RNC chart gave information about radio frequencies. The 2-year-old sample

flight plan gave the co-ordinates of the McMurdo NDB. Captain Johnson's memorandum contained a reminder that the minimum safe altitude was 6000 feet.

344. It was pointed out that the following documents, which clearly had been carried in the flight bag of Captain Collins, along with the three just specified, had not been recovered:

(a) A map or maps upon which he had been working with plotting instruments the night before the fatal flight.
(b) The thick and heavy atlas upon which he had been working with plotting instruments the night before the fatal flight.
(c) The large topographical map issued to him by Flight Despatch on the morning of the flight.
(d) The briefing documents handed to Captain Collins on 9 November 1979, which would have contained his own notations.
(e) The notebook which he almost certainly brought with him to the briefing of 9 November 1979 along with his atlas.
(f) The track and distance diagram showing the flight path to be down McMurdo Sound (Annex G to the chief inspector's report).
(g) Another track and distance diagram also showing the flight path to be down McMurdo Sound (Annex H to the chief inspector's report).
(h) The Antarctica Strip Chart showing the military track down the centre of McMurdo Sound (Annex I to the chief inspector's report).

It was suggested that each of the documents just listed, but not located, would have tended to support the proposition that Captain Collins had relied upon the incorrect co-ordinates.

345. Captain Gemmell was cross-examined about all this. He denied that he had recovered any documents relevant to the flight which had not been handed over to the chief inspector. It was pointed out to Captain Gemmell that it was common knowledge in the Flight Despatch Section and within the Flight Operations Division of the airline on the night of the disaster that the co-ordinates for the destination waypoint had been changed without the knowledge of Captain Collins, and it was also suggested to Captain Gemmell that he knew this before he left for Antarctica at about noon on the following day. But Captain Gemmell denied that he knew about the changed co-ordinates. He asserted that he had not found out about them until after he returned from Antarctica some days later. He said that when he found out these facts upon arrival back in Auckland, that the news came as a "bombshell".

346. The suggested inference by ALPA therefore was that because there had been an instruction by the chief executive, immediately after the disaster, that all documents relating to Antarctica flights and to this flight in particular were to be impounded, that one of Captain Gemmell's duties upon arrival at Antarctica had been to carry out this very task. But, as I say, he denied all this.

347. It happened that one of the people who went to Antarctica with the chief inspector and Captain Gemmell had been First Officer Rhodes, an accident inspector who was authorised to be at the scene as a representative of ALPA. After he had given evidence as a witness for ALPA, he was recalled at a later stage by counsel for the airline. In response to questions by Mr Brown, leading counsel for the airline, First Officer Rhodes agreed that he had now offered to give supplementary evidence relating to activity at the Mt. Erebus crash site. He went on to say:

"Our discussion with Captain Eden last Friday indicated this would be appreciated."

First Officer Rhodes was then asked what he had to say regarding the conduct of Captain Gemmell in the course of Captain Gemmell's duties at the crash site. First Officer Rhodes then replied:

"I have no reason to doubt Captain Gemmell in any way, shape or form."

When cross-examined, however, First Officer Rhodes went on to add this:

"The envelopes which Captain Gemmell returned to New Zealand with may have contained some documentation from the crash site, which was beginning to return in significant quantities from the various people on the crash site including the Police.

Q. And in casual conversation some time later did you learn that Captain Gemmell had some of those documents with him which were sought then by the accident inspector?

A. Yes.

Q. Tell us about that?

A. I was asked by the Chief Inspector of Air Accidents to pursue through Air New Zealand the collation of the technical crew's flying records, the collection of log books, licences, and other relevant documentation. I did this by making a telephone call to Air New Zealand from Mr Wylie's office where I was working during this period.

Q. Did you encounter difficulty in dealing with Air New Zealand in getting consent to release these items?

A. There was reluctance initially to release this to me as it was not clear at that stage in many people's minds what my duties were. And Mr Chippindale later made my position clear, and Air New Zealand made available their facilities for me to carry out subsequent investigative duties such as the use of the computers for the calculation of weight and balance data and other information in support of Mr Chippindale's inquiry.

Q. And Air New Zealand and Captain Gemmell released to you the material which you had previously sought?

A. Correct." (T 1838)

348. Captain Eden is at present the director of flight operations for the airline. He appeared in the witness box to be a strong-minded and aggressive official. It seemed clear from this further production of First Officer Rhodes as a witness that it had been suggested to him by Captain Eden that he should either make a direct allegation against Captain Gemmell or else make no allegation at all, and that since First Officer Rhodes seemed to have no direct evidence in his possession, he was therefore obliged to give the answer which Captain Eden had either suggested or directed. However, First Officer Rhodes was not entirely intimidated because as will be observed from the evidence just quoted, he insisted on saying that Captain Gemmell had brought an envelope containing documents back to Auckland.

349. Then, as the Inquiry proceeded, there were other queries raised. It seemed that Captain Collins' flight bag had been discovered on the crash site. It was a bag in which he was known to have carried all his flight documents. It was said to have been empty when found, a fact which was incidentally confirmed by a mountaineer who had seen the flight bag before Captain Gemmell arrived at the crash site. The flight bag was

rectangular and constructed of either hard plastic or leather, and had the name of Captain Collins stamped on it in gold letters. It was evidently undamaged.

350. Then there was the question of First Officer Cassin's flight bag. It had a name tag attached by a leather buckle to its handle, and the name tag and buckle, both entirely undamaged, had been returned to Mrs Cassin at some stage by an employee of the airline. She had not been told how the undamaged buckle had come to be detached from her husband's flight bag, and under what circumstances. Neither flight bag was ever returned to the widow of the owner.

351. Then there was the question of the diaries of Captain Collins. According to Mrs Collins, her husband had two diaries. One was a small pocket diary and the other was a black ring-binder notebook. He used to carry the small diary in his breast pocket, and the ring-binder loose-leaf notebook was carried by him in his flight bag. This latter notebook was believed to have been taken by Captain Collins to the briefing on 9 November 1979. It appeared that the chief inspector had obtained possession of the small pocket diary, but it did not contain any particulars relating to Antarctica flights.

352. As to the ring-binder notebook, it had been returned to Mrs Collins by an employee of the airline, but all the pages of the notebook were missing. Captain Gemmell was asked about this in evidence. He suggested that the pages might have been removed because they had been damaged by kerosene. However, the ring-binder notebook itself, which was produced at the hearing, was entirely undamaged.

353. After the evidence given before the Commission had concluded, I gave some thought to the matters just mentioned. I knew that the responsibility for recovering all property on the crash site lay exclusively with the New Zealand Police Force, and that they had grid-searched the entire site. All property recovered had been placed in a large store at McMurdo Base, which was padlocked, and access to the shed was only possible through a senior sergeant of Police. I asked counsel assisting the Commission to make inquiries about the flight bags which had been located on the site but which had not been returned to Mrs Collins or Mrs Cassin.

354. The Royal New Zealand Air Force helicopter pilot who flew the property from the crash site to McMurdo remembered either one or two crew flight bags being placed aboard his helicopter, and he said that they were then flown by him to McMurdo. This was independently confirmed by the loadmaster of the helicopter, who recollected seeing the flight bags. The senior sergeant of Police in charge of the McMurdo store was spoken to, and he recollected either one or two flight bags among other property awaiting packing for return to New Zealand. He said that personnel from Air New Zealand had access to the store, as well as the chief inspector, and the senior sergeant said that he thought that he had given the flight bags to the chief inspector and that the chief inspector was the sole person to whom he had released any property. The chief inspector was then interviewed on 11 December 1980 by telephone, being at that time in Australia, but he said that no flight bags were ever handed to him.

355. When the Police compiled their inventory of property in the store to be sent in Police custody to New Zealand, the inventory did not refer to the flight bags which had evidently been in the store, nor did it contain any reference to the name tag of First Officer Cassin which was later returned to Mrs Cassin by an employee of the airline.

356. As for the diaries of Captain Collins, there appeared on the Police property sheet in respect of Captain Collins an item "Diaries (2)" but one of these, so it was said, in fact belonged to a deceased flight stewardess and was ultimately delivered to her family. The other diary referred to in the Police property sheet must have been the ring-binder notebook because this was handed to Mrs Collins by Captain Crosbie of Air New Zealand, who said that he obtained it from Mr Hambly (also of Air New Zealand) who signed for it on the Police property sheet when he took possession of it in Auckland. However, Mr Hambly got in touch with counsel assisting the Commission after Captain Crosbie had given this evidence, and Mr Hambly said that he had never seen the ring-binder notebook which had not been the "diary" handed to him by the Police, and he had not given it to Captain Crosbie at all.

357. Then it was ascertained that the officer-in-charge of the Police party at McMurdo, Inspector Mitchell, had been given the ring-binder notebook (which had Captain Collins' name printed on it) at McMurdo Base, and he had examined it at the base, and could remember that all the pages were missing.

358. If I had thought that there was anything conclusive arising out of these further inquiries, I would have reconvened the hearing and had the witnesses called. But I could see no point in doing so.

359. The following facts seemed to emerge:

(1) The two flight bags were lodged in the Police store at McMurdo and would have been returned in due course to Mrs Collins and Mrs Cassin by the Police. But they were taken away from the store by someone and have not since been seen.

(2) The name tag with the leather buckle belonging to First Officer Cassin had never appeared on any Police inventory or property sheet, and had been returned by an airline employee to Mrs Cassin.

(3) If Mr Hambly (who signed for the property of Captain Collins on the Police property sheet) is correct in saying that he did not obtain the empty ring-binder notebook from the Police, then this was another item returned to Mrs Collins by the airline and not by the Police.

(4) Captain Gemmell had brought back some quantity of documents with him from Antarctica, and certain documents had been recovered from him by First Officer Rhodes on behalf of the chief inspector.

360. It therefore appears that there were sundry articles and perhaps documents which had been in the possession of the aircrew which came back to New Zealand otherwise than in the custody of the Police or the chief inspector. Captain Gemmell asserted that when he went to Antarctica he was unaware of the changed co-ordinates, and the inference was that he would have had no motive for searching for any documents relating to that matter. I do not accept that Captain Gemmell did not know about the changed co-ordinates before he went to Antarctica. It was common knowledge among the flight despatch officers and among the Navigation Section, and it is inconceivable that the chief pilot would not also have been appraised of this fact. It seems clear that the chief inspector was not aware until he had returned to Auckland on about 11 December 1979 that the destination co-ordinates for the flight had been changed. I gather from his evidence that he heard about this in Auckland and then was shown **Exhibit 16**, which is Captain Johnson's explanation as to why the crew had not been told. If, therefore, Captain Gemmell knew about

the changed co-ordinates before he left Auckland, or if he was so advised by radio-telephone call to Scott Base a day or two after he arrived in Antarctica, then it is clear that he did not divulge this significant fact to the chief inspector. According to the evidence of the chief inspector (T. 128–129), he had ordered the personnel at the crash site to recover "all papers relevant to the flight" as they were "advised by Air New Zealand representatives". That is to say, the chief inspector quite correctly left it to Captain Gemmell to assess the relevance of such documents which were recovered, it being expected that all relevant documents would be handed over to the chief inspector in due course. But on this basis, there was only one person in Antarctica who knew about the changed co-ordinates, and that was Captain Gemmell. It was therefore a singular mischance that Captain Gemmell, who plainly kept this significant fact to himself, was to be the arbiter of which documents were relevant. The opportunity was plainly open for Captain Gemmell to comply with the chief executive's instructions to collect all documents relevant to this flight, wherever they might be found, and to hand them over to the airline management. However, there is not sufficient evidence to justify any finding on my part that Captain Gemmell recovered documents from Antarctica which were relevant to the fatal flight, and which he did not account for to the proper authorities.

361. I have mentioned previously the briefing documents of First Officer Cassin which he left at home when he departed to join the fatal flight. They were collected from his home the next morning by an employee of Air New Zealand, and according to Mrs Cassin, who is herself a qualified pilot, she had seen three pages of notes in her husband's handwriting which were in the same envelope as his briefing documents. First Officer Cassin's flight documents therefore, as I have previously stated, certainly found their way into the custody of the airline on the day following the disaster, and have not been seen since. Presumably they were destroyed.

362. As will be seen, it was certainly a grave error on the part of the chief executive to have directed the destruction of any Antarctica documents, whether "surplus copies" or not. An opportunity was thereby created for people in the airline to get rid of documents which might seem to implicate airline officials as being responsible for the disaster, and the whole episode very plainly engendered bitter feelings among the relatives of the dead flight crew and among their fellow pilots, particularly having regard to the character of the only three documents said to have been located. I can quite understand the difficulty in recovering loose documents from this desolate mountain side, although the heavy atlas was not in this category, but the failure to recover any of the maps and documents which would have justified the flight decisions of Captain Collins was an unlucky event. Even more so was the apparent destruction of the flight documents of First Officer Cassin which he had left at his home.

363. It is evident by now, I am sure, that all documents in possession of the airline relating to these Antarctica flights should have been retained and handed over to the Chief Inspector of Air Accidents. Likewise, all documents and articles at the crash site belonging to the flight crew or appearing to relate in any way to the fatal flight ought to have been handed over at McMurdo either to the Police or to the chief inspector and to no one else. Had these simple steps been taken, a great deal of bitterness and distress and justifiable suspicion would have been avoided.

ADMINISTRATIVE SYSTEMS OF AIR NEW ZEALAND

364. System failures within the structure of the Flight Operations Division was the originating and decisive cause of this disaster. I am therefore required to consider why this failure took place. I am in no way concerned with the general administrative systems of the airline, and if I have to say anything about the general systems then it will be only in the context of the antarctic flights, or it will represent the reason for some of the system failures which occurred in relation to the antarctic flights. The evidence which I heard seemed to me to establish two separate areas of administrative deficiencies namely, defects in administrative structure and defects in the communication system within that structure. I shall deal with these in order.

Defects in Administrative Structure

365. Keeping within the context of the antarctic flights, the branch of the airline's organisation which was immediately concerned in this Inquiry was its Flight Operations Division within which there operated as sub-departments the Navigation Section, the Computer Section, the Flight Despatch Section, and the RCU briefing system. The following defects in this administrative structure were revealed:

(1) Within the Flight Operations Division there were operational pilots who held executive positions. Captain Gemmell, for example, was chief pilot for the airline from 1975 until July 1978 when he became flight manager (technical). Captain Grundy was flight manager (training) until November 1979 when he was promoted to flight operations manager for DC10 and DC8 aircraft. Captain Johnson, since 1 September 1978, has been flight manager (line operations) for DC10 and DC8 aircraft. I have selected these three pilots merely by way of example. They were operational pilots at the same time as they occupied these executive positions. This is said to be necessary because of the aviation expertise required for persons occupying such positions and I can well see that this is so. In addition it would, of course, be very difficult to persuade an operational pilot to give up flying in order to assume an executive position of this kind when the transition would mean a heavy decline in salary and an extension of the term of years which would need to be served before qualifying for full superannuation. It was clear from evidence which I heard that while an executive pilot was away on operational flying, and he might be away for a good many days, there was no official system of recording what had happened in his particular department in his absence. Incoming documents were being dealt with and decisions made by his subordinates, and there appeared to be no filing system which could tell an executive pilot exactly what had happened within his jurisdiction while he was away.

(2) None of the executive pilots ever seems to have been given an adequate training course in administrative management.

(3) There appear to have been no written directives emanating from Flight Operations Division settling the duties and the exact nature of administration responsibility in respect of any executive pilot.

(4) In respect of other administrative sections of the Flight Operations Division, there were no written directives specifying the manner in which various duties were to be carried out. For example:

(a) There was no written instruction specifying the detailed contents of the antarctic RCU brief, nor specifying what was required for the simulator instruction.

(b) There was no written directive addressed to the Navigation Section or the Computer Section or to the Flight Despatch Section specifying the steps which must be taken to transmit adjustments to flight plans, navigational procedures, and the like.

(c) With particular reference to the Flight Despatch Section, there was no direction requiring that section to maintain an adequate written description of the documents contained in the "Antarctic Envelope" which was handed to each antarctic flight crew and returned by that crew after the flight, nor was there any instruction to Flight Despatch to maintain a file containing up-to-date copies of every document included in the Antarctic Envelope.

I digress to say that in the course of the present Inquiry there was evidence about pilots signing an acknowledgement of receipt of the Antarctic Envelope which purported to have on the outside a general description of its contents, but the precise contents of the envelope on the fatal flight were never disclosed, and I doubt whether Flight Despatch ever knew, when an antarctic flight was about to depart, what actually was in the Antarctic Envelope.

Defects in Administrative Communications System

366. I need not say too much about this within the antarctic context because, as I have made clear already, there were only two documents produced to me with reference to decisions and communications made by Flight Operations, Navigation Section, Computer Section and the Flight Despatch Section in relation to the fatal flight. One of them, as will be recalled, was the so-called "log" of Mr Kealey, which was merely his handwritten notes reminding him of verbal messages which he had received from various people. The other was Captain Johnson's memorandum of 8 November 1979 recording the advice received from the Civil Aviation Division that the McMurdo NDB had been withdrawn. This lack of documentary evidence as to administrative decisions which had been reached, and of communications which had been made, is demonstrated by the following list of particulars:

(a) Captain Keesing, when Director of Flight Operations, had submitted to the Civil Aviation Division a detailed operational scheme for the initial antarctic flights and thereafter believed that the Civil Aviation Division had approved these terms because, not long afterwards, the first flight departed with one of the Civil Aviation Division inspectors as a passenger. Unknown to him, Captain Gemmell (who was then chief pilot and a subordinate of Captain Keesing) had made an arrangement with the Civil Aviation Division which involved a minimum safe altitude totally at variance with Captain Keesing's proposals, which Captain Keesing thought had been approved. Captain Keesing knew nothing about this separate agreement with the Civil Aviation Division until after the disaster.

(b) The report of Captain Simpson after his flight of 14 November 1979, as to the distance between the TACAN and the destination waypoint (27 miles), was never recorded by Captain Johnson, to whom the report was made, and Captain Johnson then communicated his

mistaken impression of the verbal report to the Navigation Section and again, that communication was verbal. The Navigation Section then furnished its own verbal report to Captain Johnson. The consequential catalogue of mistakes and misinterpretations in this area was all directly due to the absence of any written record of these very important operational decisions.

(c) The direction to the Navigation Section to alter the destination co-ordinates was verbal, and consequently there is no record of the reason for that decision. There was no written reply from the Computer Section confirming that the instruction had been carried out. There was no written direction to the Flight Despatch Section notifying the section of the change, and directing that Captain Collins be informed.

(d) When the chief executive was called as a witness I felt obliged to raise with him the adequacy of this system of unrecorded communications between one division and another, and within each section of that division, in respect of decisions which were directly related to the safety of flying operations. The chief executive said he controlled the airline on a verbal basis. He said that when he communicated with a senior executive officer such as the director of flight operations then any instructions he gave or any decisions he made were verbally communicated, and no memorandum was drawn up recording any such decision. The chief executive asserted that many large companies were controlled on this basis. I said to the chief executive that so far as I could ascertain he had never supplied his board of directors with a report concerning this disaster and outlining its circumstances and causes as then known to him. The chief executive agreed that this was so, but said that he was in touch from time to time with the chairman of the board by telephone. It seemed to me an extraordinary thing that the circumstances of an aircraft disaster of this magnitude were not reported to the company's board in writing by its chief executive.

Position of the Board

367. It is clear enough that the original and continuing cause of the accident was a breakdown of the systems organisation of the Flight Operations Division of the airline. The various sections of the Flight Operations Division seem to have been administratively unco-ordinated. There was no proper organisation chart clearly setting out defined areas of responsibility and authority, and the failure of the communication system within the Flight Operations Division has already been exposed.

368. Another aspect of the systems failure was the lack of administrative continuity which overshadows the duties of those executive personnel within the division who were also operational pilots, in that without a proper system of filing and recording decisions they could only acquire, on a verbal basis, knowledge of what had happened within that division while they were away. In respect of the antarctic operation there was not even a control file containing all the instructions and information which related to the antarctic flights.

369. Arising from all this, it was submitted by Mr Baragwanath that it is remarkable that there is not a single document originating from the board in relation to the antarctic flights. There appears to have been no written submission lodged with the chief executive by the Commercial Division, and backed up by a brief from Flight Operations Division,

suggesting at the end of 1976 that the antarctic flights be inaugurated so as to compete effectively with QANTAS in this area. There appears to have been no written brief prepared for the board by the chief executive at that time asking for approval of the flights.

370. However, in considering the board's position, it must be borne in mind that the flights to the antarctic were only a part of the airline's operational function. The feasibility of operation and safety of such flights was a matter for the Flight Operations Division, and I can have no doubt that the proposal in 1976 to institute the flights must have been sanctioned by the board.

371. As to the failure of the board to require from the chief executive a written account of the disaster, it may have been thought that he should not put any views in writing pending the outcome of a formal inquiry, and I can not doubt that the circumstances of the disaster must have been canvassed by the chief executive with the board on the first available occasion, although there are no board minutes to that effect. Even allowing for the fact that the predominant cause of the disaster was a systems breakdown within the Flight Operations Division and consequently an administrative defect, it does not seem possible to attach any blame to the board for what occurred. No board member could be expected to investigate the day-to-day administration of flight operations. Overall, I am not satisfied that there can be any criticism levelled at the Board of Air New Zealand in respect of the organisational defects of the Flight Operations Division in so far as they related to, and were responsible for, the disaster in Antarctica.

372. I can only summarise this brief analysis of the airline's administrative and communications system by expressing my very considerable concern when I discovered the haphazard and informal manner in which the Flight Operations Division was conducted in relation to these antarctic flights. The result has been, as I have said before, that in looking into the communication lapses which led to the disastrous mistake over the co-ordinates, I have been confronted at every turn with the vague recollections of everyone concerned, unsupported by the slightest vestige of any system of recorded communication and of course it was this communications breakdown, which in turn amounts to a systems breakdown, which is the true cause of the disaster.

THE STANCE ADOPTED BY THE AIRLINE BEFORE THE COMMISSION OF INQUIRY

373. There is no doubt that the chief executive, shortly after the occurrence of the disaster, adopted the fixed opinion that the flight crew was alone to blame, and that the administrative and operational systems of the airline were nowhere at fault. I have been forced to the opinion that such an attitude, emanating from this very able but evidently autocratic chief executive, controlled the ultimate course adopted by the witnesses called on behalf of the airline.

374. The relevant evidence in this context was that given by the executive pilots and by members of the Navigation Section. The fact that the navigation course of the aircraft had been altered in the computer had

been disclosed by the chief inspector in his report dated 31 May 1980, 6 months after the disaster. But it was not until the Commission of Inquiry began sitting that the airline publicly admitted that this had occurred. Hence the tactics adopted by the executive pilots and by the Navigation Section witnesses which were designed to prove, if they could, that the computer mistake and its consequences could and should have been avoided by the crew, and that Captain Collins and his co-pilot had committed that very long catalogue of aviation blunders and malpractices to which I have previously referred. I can visualise without difficulty not only the extent but also the nature of the managerial pressure exerted on these witnesses. They all declined to admit that there had been any mistake or omission on their part which could have been a material cause of the disaster.

375. The adoption of such tactics led to the inevitable result. These witnesses were cross-examined with skilled persistence by counsel assisting the Commission, by counsel for ALPA, and by counsel appearing for the passenger's consortium. There were documents produced to the airline witnesses in the course of cross-examination, and there were facts extracted from them, which had very clearly in a number of cases not been revealed by the airline to the highly competent and distinguished counsel whom the airline had retained. In the end, these tactics of attributing everything to pilot error came to nothing, and counsel for the airline adopted, in the course of their detailed and exemplary final submissions, the very proper course of not attributing blame to any specific quarter but leaving it to me to assemble such contributing causes as I thought the evidence had revealed.

376. But I cannot let pass the nature of the evidence which the airline witnesses tried to persuade me to accept. There were aspects of that evidence which I have been obliged totally to reject, namely the assertion by the executive pilots that they had no specific knowledge of antarctic flights operating under the minimum safe altitude specified by the Civil Aviation Division, and this was also asserted by the chief executive—the allegation by Captain Johnson that he believed Captain Simpson had told him that the McMurdo waypoint was incorrectly situated—allegations by Navigation Section witnesses that they believed that the alteration to the co-ordinates only amounted to 2 miles—the explanation by a highly skilled navigational expert that he drew an arrow on a meridian of longitude so as to remind himself that the meridian pointed north—the allegation by Navigation Section witnesses that the misleading flight plan radioed to McMurdo on the morning of the fatal flight was not deliberate but the result of yet another computer mistake. These particular assertions and allegations I have been obliged to reject.

377. No judicial officer ever wishes to be compelled to say that he has listened to evidence which is false. He always prefers to say, as I hope the hundreds of judgments which I have written will illustrate, that he cannot accept the relevant explanation, or that he prefers a contrary version set out in the evidence.

But in this case, the palpably false sections of evidence which I heard could not have been the result of mistake, or faulty recollection. They originated, I am compelled to say, in a pre-determined plan of deception. They were very clearly part of an attempt to conceal a series of disastrous administrative blunders and so, in regard to the particular items of evidence to which I have referred, I am forced reluctantly to say that I had to listen to an orchestrated litany of lies.

WHETHER CIVIL AVIATION DIVISION COMPLIED WITH ITS STATUTORY OBLIGATIONS IN RESPECT OF THE ANTARCTIC FLIGHT OF 28 NOVEMBER 1979

378. Pursuant to the Civil Aviation Act 1964 the Civil Aviation Division of the Ministry of Transport has the responsibility to administer the provisions of the Act which relate to the safety of air operations. It was the view of the chief inspector, after examining the part played by the division in the planning for and the supervision of antarctic flights, that the division had been at fault in certain respects. In addition, there were other areas suggested by counsel during the hearings of the Commission where it was claimed that the division had not effectively complied with its statutory obligations relating to air safety. Some of the criticisms against the division are, to my mind, purely technical and I am not concerned with that type of suggested default because, in terms of paragraph (h) of my terms of reference, I am asked to report whether the practice and actions of the division in respect of flight TE 901 were such as might reasonably be regarded as necessary to ensure the safe operation of aircraft on flights such as TE 901.

379. The conduct of the division seems also to be relevant under paragraph (g) of my terms of reference, which relates to the question whether the disaster was caused or contributed to by an act or omission in respect of any function which any person had a duty to perform or which good aviation practice required that person to perform. The function in question must be one which relates to all aspects of the operation of the aircraft, and I am not sure whether it was intended that the division, even though theoretically within paragraph (g), was intended to have its conduct considered in that context. I shall proceed, however, on the basis that its conduct is relevant under both paragraphs (g) and (h).

380. Having studied all the allegations made against the division I propose to exclude those of a nature which are purely technical and not directly related to the safety of this particular air operation. I will discuss what I think are the relevant allegations in the paragraphs which follow and will express my conclusion as to each.

381. (a) It was contended that the RCU briefing conducted by the airline contained omissions and inaccuracies which had not been detected by the supervising airline inspectors.

The airline inspectors had in fact approved the audio-visual part of the RCU briefing for the fatal flight, and one of the inspectors had witnessed a normal audio-visual briefing for an antarctic flight, this having occurred on two occasions, but no amendments to the audio-visual briefing had been required and errors contained in the briefing (to which I have previously referred) were evidently not detected.

Conclusion

It was the responsibility of the airline to procure compliance by its pilots with regulation 77, which requires a pilot to satisfy the operator that he is familiar with the flight route. It is the responsibility of the division to take reasonable steps to see that the airline is observing regulation 77 and, in my opinion, the division failed in one material respect to comply with its duty in respect of this regulation. I do not hold any airline inspector accountable for not detecting certain descriptive errors in the RCU briefing, but I think that there was a breach of statutory obligation on the

part of the division in that it did not ensure that there was presented at the RCU briefing a topographical map upon which was accurately plotted the track and distance formula for the flight. The antarctic route involved air crews travelling to a distant, hostile terrain, and the aircraft would be navigated to its destination by its highly accurate inertial navigation system. In my view, the failure of the division to ensure that antarctic crews were aware of the exact topographical location of the nav track was a major omission.

(b) It was alleged that the airline inspectors had been at fault in not ensuring that there was a better explanation of the whiteout phenomenon at the RCU briefings.

I do not believe that the division was at fault in this respect because that phenomenon was given special attention by the United States Navy and Australian and New Zealand Air Force commanders by reason of the fact that in their case the aircraft would land on the ice. On the other hand, if the division became aware, as I think it did, that DC10 aircraft were operating in the McMurdo area at flight levels of about 1500 feet, then perhaps further attention might have been given to the dangers presented by occasional absence of surface and horizon definition in the antarctic region, but primarily this was a matter for attention by the airline.

Conclusion

In my opinion, the division was not at fault in failing to examine more closely that aspect of the RCU briefing which dealt with visual difficulties in Antarctica.

(c) It was alleged that the division had been at fault in not ensuring that the airline carried out its obligation (as required in its own operations specifications) to see that the pilot-in-command had previously carried out a previous flight in the region.

Apart from the first two flights in 1977, the airline had never complied with this obligation. I should have thought that the division would have made some enquiry as to whether this part of the operations specifications was being complied with, particularly in view of the fact that the obligation was of general application. It applied to all the airline's flights, wherever conducted. But in October 1979 the airline applied for exemption from the provision in view of the RCU briefings and flight simulator training, and the division accepted without demur the proposed deletion of this provision and after the disaster, namely on 5 December 1979, approved the appropriate deletion from the operations specifications.

I regard this failure by the division to monitor the "flight under supervision" requirement as being a serious breach of its duty. There was no evidence that it ever made any inquiry. The provision had been disregarded by the airline for 2 years before it applied for exemption and, as I say, the exemption was granted in October 1979 without demur. I can see the reasoning behind the decision to approve the airline's application. It was evidently thought that the RCU briefing was an adequate substitute, and in addition, there had been a series of successful flights to Antarctica and no landing on the ice was contemplated. However, both the Director of Civil Aviation and Captain Spence, the airline inspector, had been to Antarctica and I should have thought that these experienced pilots would have been struck by the complete lack of similarity between

the actual terrain and its appearance upon a topographical map, and that only a previous flight to Antarctica could educate the pilot-in-command as to the physical and meteorological features of the region.

It is, in my view, very probable that this disaster would not have occurred had Captain Collins flown to Antarctica on a previous occasion. Had he done so, he would have flown at some altitude between 1500 feet and 3000 feet along McMurdo Sound, depending upon whatever clearance was given by Air Traffic Control, this being in conformity with authority given to the pilot by Captain Wilson. However, the entrance to Lewis Bay and the appearance of Cape Royds and Cape Bernacchi would be very similar, as already indicated by the pictorial representations in figs. 5, 6 (pages 72-73), prepared by Captain Vette. But a previous flight under supervision would have almost certainly resulted in Captain Collins noting the distinctive feature of Beaufort Island which would have been apparent as the only identifiable island in the area. Fig. 16, page 154 consists of prints developed from passengers' cameras, in which Beaufort Island is clearly visible. The film in each case was slightly damaged, and the actual view of Beaufort Island would have been more distinct than the view displayed on the prints. Had Captain Collins seen Beaufort Island previously, and identified it on the fatal flight, he would certainly have realised that his nav track had been changed.

All inquiries which I made in connection with this particular point of a previous flight under supervision produced the same answer. The military people could not understand how a pilot-in-command could have been sent into the strange and unfamiliar area of Antarctica without having flown there before.

Conclusion

There was an omission on the part of the airline inspectors to inquire whether the familiarisation flight provision was being complied with, and apart from that, the division should not have acceded to the request made of it by the airline in 1979.

(d) It was contended that the division should not have agreed with the route selected by the airline, involving an approach to McMurdo over the top of an active volcano, and that the division should have insisted upon a route to McMurdo following the normal approach path of military aircraft.

This point was answered by counsel for the division in the same manner as so many points were answered, namely, by insisting that the defined minimum safe altitude was 16 000 feet and therefore the selected route was perfectly safe providing that the 16 000 feet, and the special conditions applying to the 6000 feet, were complied with.

Conclusion

Approval of a flight path over the top of Mt. Erebus could not be justified under any circumstances. In my opinion the division took no steps about this because it was aware that pilots were not required to follow this flight path. Nevertheless, I think it would have been more prudent for the division to have insisted upon a flight path which followed the military track and which had the advantage of allowing a DC10 aircraft to take early advantage of the NDB (when it was operating), the DME function of the TACAN, and the radar facilities at the Ice Tower.

FIGURE 16

(e) It was alleged that the division had not implemented effectively that section of the ICAO standard, detailed in Annex 6 of the Convention, which requires appropriate life-sustaining equipment to be carried on flights across terrain such as this.

The answer to this allegation is that the division had raised this point prior to the fatal flight and was still in the course of discussing the point with the airline at the date of the disaster.

Conclusion

The practical situation is that life-sustaining equipment would have been of very little use in the event of a DC10 aircraft being obliged to make a forced landing at McMurdo or in the event of it having to ditch in the antarctic waters off Ross Island. In the former event, having regard to the season of year in which the flights were being carried out, there would be no accommodation for the 260 people on the aircraft after it had landed. I do not regard this omission (if it was one) on the part of the division as involving any substantial breach of obligation on its part.

(f) It was alleged that the division had failed to re-assess the antarctic operations upon the withdrawal of the McMurdo NDB prior to the commencement of the 1979 flights.

It is correct that the withdrawal of the NDB now meant that a DC10 aircraft did not have available any means of getting a radio bearing from McMurdo. But no landing was intended, any descent to low altitude would be in VMC, and the AINS capabilities of a DC10 represented the most advanced navigation system in the world. In these circumstances the absence of a non-directional beacon was irrelevant.

Conclusion

I do not believe that this amounted to an omission on the part of the division.

(g) It was further alleged that the division failed to ensure that the airline was organised in such a way as would ensure safe antarctic flights.

Whilst accepting that there was some degree of responsibility upon the division to ensure that there was a command structure within the airline capable of administering safe flying operations, I do not think that there was any responsibility upon the division in the present case to make any investigation along the lines suggested. It was aware of the general nature of the establishment and mode of operation of the Flight Operations Division. I cannot see that it had any cause to suspect that the internal administration of this division was defective in the ways which I have previously enumerated. Further, active intervention by the Civil Aviation Division would look very like interference by a Government agency with the internal administrative structure of an airline with a perfect safety record.

Conclusion

I do not believe that the division was at fault in this suggested respect.

(h) It was alleged that the division had failed to ensure observance of the specified height restrictions comprised in the MSA conditions.

Although the division relied, as its first and paramount defence to almost all allegations against it, on the breach by the pilot of the specified

minimum safe altitude provisions of 16 000 feet and 6000 feet, I find myself unable to accept that there were not some responsible officers of the division who were aware of the actual flight levels at which these flights were being conducted in McMurdo Sound. The flight levels were a matter of common knowledge. I have already gone through all the evidence on the point. These MSA conditions of 16 000 feet and 6000 feet were quite unrealistic and, as I have said before, I consider that the airline was perfectly entitled, in terms of practical considerations, to authorise pilots to descend to whatever flight level was thought appropriate by McMurdo Air Traffic Control, providing that flight at such levels was in VMC. It is impossible to infer that McMurdo Air Traffic Control would ever suggest to any pilot that he let down to altitudes like 1500 feet or 2000 feet unless visibility at that altitude was perfectly clear for many miles. Nor would any pilot of the airline consider descending to any such level unless he was satisfied, by information from McMurdo Air Traffic Control and by his own observation, that he would be flying at such levels in VMC.

Conclusion

The division may be entitled to assert as against the airline that the official MSA figures should not have been varied by the airline without the division's consent. But in the context of the present inquiry, I am satisfied that there were responsible officials of the division who were well aware of the actual flight levels being maintained by pilots in McMurdo Sound. What the division should have done was to consult with the United States authorities in Antarctica, and with the airline, and then set new flight levels on realistic terms. The minimum safe altitudes thus adopted for VMC conditions should not, on any basis, have been different from those set for general aircraft operations by regulation 38 of the Civil Aviation Regulations. Within the context of this inquiry, the failure by the airline to enforce the official minimum safe altitude conditions has no relevance and the division, in my opinion, is not at fault in the manner suggested.

382. I have now concluded my appraisal of what in my view were the substantial allegations against the division, and I have expressed my conclusions. There are two respects in which, in my opinion, the Civil Aviation Division contributed to this disaster by an omission in respect of a function which it had a duty to perform, and the omission in each case also related to a duty of which the execution was necessary in order to ensure the safe operation of flights such as TE 901. These two omissions are those to which I have referred in subparagraphs (a) and (c) above.

383. When I consider all the evidence relating to Civil Aviation Division participation in these antarctic flights, it seems to me that the division was always too ready to approve whatever proposal was put to it by the airline. It seems as if the division adopted as its controlling policy the opinion that the operational proposals of Air New Zealand would always be satisfactory and did not require close scrutiny. I believe that the adoption of such a policy on the part of the division was unwise.

384. I have no doubt that in the great majority of cases any operational proposal placed before the division by Air New Zealand would be totally sound, having regard to the very experienced and skilled operational personnel who are employed by the airline. But, as this Inquiry has shown, there were substantial defects in the administration and communication procedures of the Flight Operations Division, and one of the reasons for the continuation of this loose system of administrative

control within the Flight Operations Division might well have been the failure of the airline inspectors to examine in detail the proposals made to it in respect of this very unusual and unscheduled series of flights. It is even possible that the sheer size of the airline has come to overshadow and dominate the personnel of the division.

THE CAUSE OF THE DISASTER

385. The occurrence of any accident is normally due to the existence of a variety of factors. Sometimes the factors are co-existent, sometimes they occur in sequence. In that sense the existence of any one factor can be described as a "cause" of the accident, because were it not for the existence of that factor at a particular time or in a particular locality, the accident could not have occurred. It is therefore not quite right to refer to each and every contributing factor as a "cause", even though its existence was a necessary pre-condition of the occurrence of the accident. In the field of negligence litigation, this problem of identifying and assessing causative factors leading up to the event constantly presents a problem, and leading textbooks which refer to the legal elements of causation tend to classify co-existent causes into two categories. The first category involves those causes which only bear that name because without their existence the accident could not have occurred. The second category consists of what lawyers describe as "effective" or "contributing" causes, meaning thereby those factors which are to be taken into account when assessing legal responsibility for the event which occurred.

386. In the case of this Royal Commission, I am required to report as to whether the disaster was "caused or contributed to" by any person as the result of an act or omission in respect of any function in relation to the flight which that person had a duty to perform, or which good aviation practice required that person to perform. Therefore, although I am not concerned in any way with legal responsibility for the disaster, I am required to identify any culpable act or omission which in my view was either a cause or a contributing cause of the disaster.

387. For the purposes of determining whether there was a culpable or blameworthy act or omission, I must take into account the existence of the following factors or circumstances which preceded the occurrence of the disaster:

(1) Captain Collins had complete reliance upon the accuracy of the navigation system of his aircraft. He had a total flying time of 2872 hours in DC10 aircraft and the AINS had demonstrated to him its extreme accuracy on countless occasions.

(2) There was not supplied to Captain Collins, either in the RCU briefing or on the morning of the flight, any topographical map upon which had been drawn the track along which the computer system would navigate the aircraft.

(3) Captain Collins plotted the nav track himself on the night before the flight on a map or maps and upon an atlas.

(4) The direction of the last leg of the flight path to be programmed into the aircraft's computer was changed about 6 hours before the flight departed.

(5) Neither Captain Collins nor any member of his crew was told of the alteration which had been made to the computer track.

(6) Checks made in flight at the Balleny Islands and at Cape Hallett demonstrated to the crew that the AINS was operating with its customary extreme accuracy, and that any cross-track drift upon arrival at the destination waypoint would not be greater than about 1 mile, or 2 miles at the most.

(7) McMurdo Air Traffic Control believed that the destination waypoint of the aircraft was 27 miles west of McMurdo Station, and that the aircraft would approach at a low altitude down McMurdo Sound.

(8) Mac Centre invited the aircraft to descend to 1500 feet in McMurdo Sound for the reason that visibility at that altitude was 40 miles or more.

(9) Captain Collins accepted this invitation and made the decision to descend to that altitude.

(10) The nature of the cloud base in Lewis Bay and the unrelieved whiteness of the snow-covered terrain beneath the overcast combined to produce the whiteout visual illusion.

388. If any one of these 10 factors had not existed, then there would have been no disaster. It therefore required the coincidental existence of no less than 10 separate factual circumstances to make the disaster possible at all. The collision of the aircraft with the mountain slopes was a million to one chance.

389. The 10 factors which I have isolated are all contributing causes to the disaster, and I was invited by counsel for the airline, in the course of their final submissions, merely to identify the contributing causes and to let the matter rest there. That submission was based upon the very proper philosophy that the prime purpose of aircraft accident investigations is to secure avoidance of similar incidents in the future, and not to identify and apportion culpability or blame for what occurred.

390. I entirely agree that a mere recital of the ascertained contributing causes, which in the present case in my opinion amount to ten in number, is fully adequate in respect of the accident avoidance feature of accident investigations. But my terms of reference preclude me from adopting that course. I am required, in terms of paragraph (g), to answer the question whether this disaster was caused or contributed to by blameworthy acts or omissions by any person or persons.

391. I must now look at the contributing causes which I have identified, and see whether any one or more of them is the result of a culpable act or omission. In my opinion the only contributing causes which I have listed which were created by blameworthy acts or omissions are those which I have identified as Nos. (2) and (5). They each result from culpable acts and omissions on the part of the airline, and in the case of No. (2), on the part of the Civil Aviation Division also.

392. As a result of forming that opinion as to contributing causes I am able to reach a decision as to whether or not there was a single cause of the disaster. In my opinion there was. The dominant cause of the disaster was the act of the airline in changing the computer track of the aircraft without telling the aircrew. That blend of act and omission acquires its status as the "dominant" cause because it was the one factor which continued to operate from the time before the aircraft left New Zealand until the time when it struck the slopes of Mt. Erebus. It is clear that this dominant factor would still not have resulted in disaster had it not been for the coincidental occurrence of the whiteout phenomenon. But the conditions of visual illusion existing in Lewis Bay would have had no effect on flight

TE 901 had the nav track of the aircraft not been changed, for it was only the alteration to the nav track which brought the aircraft into Lewis Bay instead of McMurdo Sound.

393. In my opinion therefore, the single dominant and effective cause of the disaster was the mistake made by those airline officials who programmed the aircraft to fly directly at Mt. Erebus and omitted to tell the aircrew. That mistake is directly attributable, not so much to the persons who made it, but to the incompetent administrative airline procedures which made the mistake possible.

394. In my opinion, neither Captain Collins nor First Officer Cassin nor the flight engineers made any error which contributed to the disaster, and were not responsible for its occurrence.

EPILOGUE

395. The circumstances of the final stage of the approach of Flight TE 901 towards Ross Island will never be fully known, and without the advantage of the CVR and the digital flight data recorder (the "black box"), would never have been known at all. The airline witnesses who appeared before me were intent, as I have indicated before, upon establishing pilot error as the effective cause of the accident. This is a conventional stance adopted by airline operators, and sometimes aircraft manufacturers, when an inquiry like the present is convened. In most cases the object is to persuade the tribunal that despite some technical malfunction of the aircraft which originated the chain of events, the pilot had the chance, even at the last minute, of avoiding the accident. The types of pilot error suggested in such cases normally include flying on a course or at an altitude which in the circumstances was unsafe, or was not authorised by the airline operator, or was forbidden by aviation regulations, and in suitable cases it may be alleged that the pilot was too slow in his response to an emergency. When the air crew has been killed in a flying accident, allegations of "pilot error" require careful consideration, for they will mainly depend upon inferential conclusions rather than direct evidence. It is a mistake to draw conclusions or to make deductive inferences without assessing all the known facts, and in the present case I think this error was made by the chief inspector when he deduced that Captain Collins was "uncertain" of his position, and I think the same error coloured a good deal of the evidence adduced on behalf of Air New Zealand.

396. The principal factors relied upon by these witnesses were altitude, speed, heading, terrain, and weather. But a conclusion based upon those five factors alone involved the omission of an additional and perhaps paramount factor, and that was the skill and experience of the two pilots. This was not the case of a top-dressing aircraft or deer-hunting helicopter in which a degree of risk is undertaken by the pilot as part of his operational duties. Nor is it the case of an amateur pilot flying a light aircraft in a manner suggesting or establishing his folly or his ignorance of sound aviation practice. The pilot and co-pilot of the DC10 were commercial pilots of long experience. Neither Captain Collins nor First Officer Cassin would consciously take the slightest risk in the course of

flying the aircraft. Once due weight is given to that factor then it becomes difficult to infer that the pilots were uncertain as to their position. But one can go further than that. Why did Captain Collins bring the aircraft back on to its nav track at the conclusion of the second orbit? This has been the continuing obstacle to any suggestion that the crew were "uncertain" as to their position. The re-arming of the nav mode could only mean that Captain Collins had in front of him a plotted track showing exactly where the nav track would take him, and this wholly negates any suggestion that he or First Officer Cassin were "uncertain" as to their position. On this basis the cornerstone of the whole allegation of pilot error begins to crumble away, because every alternative course of conduct which it is suggested the pilots ought to have adopted, and every additional monitoring precaution it is suggested they should have taken, is based upon the primary and false thesis that the crew were not sure where the aircraft was.

397. It is instructive to consider what might have happened had the altered co-ordinates in the flight plan not resulted in disaster. Suppose that as Flight TE 901 approached Ross Island the cloud obscuring Mt. Erebus had been dissipated for a moment, either by sunlight or by the wind, so as to reveal to the air crew the presence of the mountain in their path, and the aircraft had then climbed safely away. In due course there would have been instituted in New Zealand a public inquiry into the incident. At that inquiry the persons placed on the defensive from the outset would have been the relevant personnel of the Flight Operations Division of the airline. Captain Collins would have produced the whole of the contents of his flight bag, and they would have included his maps, his atlas, all his flight documents, and possibly his black ring-binder notebook (**Exhibit 251**) with all its pages intact. The crew would have testified as to the pre-descent briefing, and the pilots would have been able to say exactly what they saw on the approach to Ross Island. I doubt very much if there would have been too much heard at such an inquiry, with Captain Collins and First Officer Cassin present and listening, about wrongful reliance on the inertial navigation system, unlawful descent below minimum safe altitude, flying towards an area of deteriorating visibility, and the like. On the vital question of visibility there would have been, I need hardly say, the evidence not only of the flight crew but also of large numbers of passengers who must have looked at Ross Island in the course of the orbiting turns which the aircraft made. All this no doubt is obvious enough, but I only stress the point that there are areas of fact in this investigation which will always remain unknown simply because all the occupants of the aircraft lost their lives, and that inferences of "pilot error" should not too readily be drawn when the circumstances are equivocal, and when the tale of the air crew themselves can never be told.

398. I had these reflections in mind as I stood with my companions on the slopes of Mt. Erebus on the first anniversary of the disaster. Four thousand feet below were the ice cliffs which marked the frozen coastline of Lewis Bay, and over to the north-west, 12 miles away, the slopes of Mt. Bird were enveloped by streams of pale cloud which were drifting towards us. The northern aspect of Mt. Erebus was wholly concealed by cloud as from a level of about 1000 feet above us. But now and then, for a few seconds, the breeze would disperse the cloud and expose the wide buttress of black rock below the crater. Sometimes the drifting clouds from Mt. Bird would obscure the sun, and when this happened the bright

foreground of the snow below us would lose its shape and contour and appear only as a featureless white expanse. Towards the north, where the sunlight was sharp and clear, the flat ice shelf and pack ice stretched away into the far distance, and this had been the approach path of the aircraft towards the mountain. I could see the area about 25 miles to the north, where Captain Collins had re-armed the nav mode so that the aircraft would return to its nav track and thus fly, as he thought, down McMurdo Sound. At that time, there had been patches of cloud above the aircraft which therefore was flying over landscape of alternate sunlight and shadow. But further on, the cloud base had been lower and unbroken and there was no sunlight on the snow. Visual contrast had entirely disappeared, and the air crew could not discern that the white landscape ahead was sloping upward to meet the cloud. This could not have happened on the day of my inspection, but only because the cloud across Mt. Erebus was drifting, not static, and its base was high enough to reveal the rock outcrop on which we were standing. But the shifting variations of cloud and light demonstrated to us the simple fact that in Antarctica the occurrence of visual deception is not a phenomenon, as it might be in a temperate zone. It is part of the ordinary weather pattern of the region. On the day of the disaster there had been a solid and stationary low overcast over the whole of the McMurdo area, but it only created visual deception in those areas where landmarks had disappeared from view. Lewis Bay had been such an area. McMurdo Sound was not. By a navigational error for which the air crew was not responsible, and about which they were uninformed, an aircraft had flown not into McMurdo Sound but into Lewis Bay, and there the elements of nature had so combined, at a fatal coincidence of time and place, to translate an administrative blunder in Auckland into an awesome disaster in Antarctica. Much has been written and said about the weather hazards of Antarctica, and how they may combine to create a spectacular but hostile terrain, but for my purposes the most definitive illustration of these hidden perils was the wreckage which lay on the mountain side below, showing how the forces of nature, if given the chance, can sometimes defeat the flawless technology of man. For the ultimate key to the tragedy lay here, in the white silence of Lewis Bay, the place to which the airliner had been unerringly guided by its micro-electronic navigation system, only to be destroyed, in clear air and without warning, by a malevolent trick of the polar light.

399. I now proceed to summarise my report upon the matters specified in the terms of reference:

(a) The time at which the aircraft crashed:
— The aircraft crashed at 12.50 p.m. (McMurdo time) on 28 November 1979.

(b) The cause or causes of the crash and the circumstances in which it happened:
— The circumstances of the crash are described at length in the foregoing sections of my report. My opinion as to the cause of the crash is set out in paragraphs 385–394 of this report.

(c) Whether the aircraft and its equipment were suitable for Flight TE 901?
— The answer to this question is "YES"

(d) Whether the aircraft and its equipment were properly maintained and serviced?
— The answer to this question is "YES"

(e) Whether the crew of the aircraft held the appropriate licences and ratings and had adequate experience to make Flight TE 901?

— The answer to this question is "YES"

(f) Whether in the course of Flight TE 901, the aircraft was operated, flown, navigated, or manoeuvred in a manner that was unsafe or in circumstances that were unsafe?

— The answer to this question is "NO"

(g) Whether the crash of the aircraft or the death of the passengers and crew was caused or contributed to by any person (whether or not that person was on board the aircraft) by an act or omission in respect of any function in relation to the operation, maintenance, servicing, flying, navigation, manoeuvring, or air traffic control of the aircraft, being a function which that person had a duty to perform or which good aviation practice required that person to perform?

(1) The single effective cause of the crash of the aircraft was the act of personnel in the Flight Operations Division of the airline in altering the latitudinal and longitudinal co-ordinates of the destination waypoint without the knowledge of the air crew and in omitting to notify the air crew, either before departure or during flight, of the fact that an alteration had been made. The said act and omission each related to a function which the Flight Operations Division had a duty to perform.

(2) Although the single effective cause of the crash of the aircraft was as stated above, there were two contributing causes and they were:

(a) The failure of the Civil Aviation Division of the Ministry of Transport to ensure that the pilot-in-command of unscheduled flights to Antarctica was always provided at his pre-despatch briefing with a topographical map on which the programmed flight path of the aircraft had been plotted.

(b) The act of Civil Aviation Division in dispensing with the requirement that the pilot-in-command of a flight to Antarctica must have flown on that route before.

(h) Whether the practice and actions of the Civil Aviation Division of the Ministry of Transport in respect of Flight TE 901 were such as might reasonably be regarded as necessary to ensure the safe operation of aircraft on flights such as TE 901?

— The practice and actions of the Civil Aviation Division in respect of Flight TE 901 fell short of what might reasonably be regarded as necessary to ensure the safe operation of aircraft on flights such as this, only in the two respects described in my report as to paragraph (g) of these terms of reference.

(i) The working and adequacy of the existing law and procedures relating to:

(i) The investigation of air accidents; and

(ii) In particular, the making available to interested persons of information obtained during the investigation of air accidents.

With reference to this particular term of reference I had the advantage of detailed submissions made by Mr Connell, on behalf of the Civil Aviation Division, and by the chief inspector himself. Mr Connell adverted to certain aspects of regulation 15 which required minor amendment in order to achieve clarity, and in my opinion he is correct in his views but I do not make any positive

recommendation on this point. Having considered submissions made to me on this term of reference, and bearing in mind the evidence which I have heard during the hearings of the Commission, my opinion is as follows:

(1) Regulation 17 should be amended so as to provide that the Attorney General can reach a decision at any time after the accident as to whether he should direct a public inquiry. Further, the regulation should be amended so as to clarify the exact role of the chief inspector in a public inquiry, and that role should be that the chief inspector acts as the agent of the pending inquiry in collecting the facts, and that following the completion of his process of fact-gathering, he does not notify any party under regulation 15. He gives evidence at the inquiry, testifying as to the facts and circumstances which he has discovered, and any persons alleged to have been at fault in respect of the accident will then have the opportunity to present a case in rebuttal of such allegations. In other words, regulation 15 should not apply once a public inquiry has been ordered. Such a procedure would be in conformity with the practice of the Accidents Investigation Branch in the United Kingdom in carrying out its obligations under the Civil Aviation (Investigation of Accidents) Regulations 1969. The practice in the United Kingdom is that the Secretary of State (Trade) makes a decision, normally within 2 or 3 days after an accident, as to whether there shall be a public inquiry. If he decides upon a public inquiry then the Chief Inspector of Accidents, either personally or through his staff, does not proceed with the preparation of a report but acts as a fact-finding agency for the pending inquiry.

(2) The question of release of information to interested parties needs to be considered under two headings. First, there is the case where a public inquiry is directed. The inquiry itself will convey to interested parties such information as has been collected, and no difficulty seems to arise. Secondly, there is the case where a public inquiry is not directed by the Attorney General and the chief inspector and his staff proceed in accordance with regulation 15, which involves preparation of a draft report, notification to parties considered to be blameworthy, consideration of their submissions in reply, and then the preparation of a final report for delivery to the Minister of Transport, these being the steps taken by the chief inspector in the present case. At first sight, it seems as if the only information available to interested parties, apart from those who receive the statutory notice from the chief inspector, will only become available when and if the Minister decides to make the report a public document, and in the present case, owing to the periods of time which the chief inspector was obliged to allow for submissions by the persons who received his notification, his report was not signed until 31 May 1980 and was not approved for release as a public document until 12 June 1980, which meant that the information in the report did not become public until more than 6 months after the occurrence of the disaster. The occurrence of this long delay was due, without doubt, to the nature of the disaster itself and to the comprehensive and world-wide inquiries to which the

chief inspector became committed in the course of his statutory duty, it being remembered that he was obliged to give notified parties a period of 3 months within which to furnish their replies.

But as I read the provisions of regulations 15 and 16 I can see no case for recommending legislation requiring the chief inspector or his staff to make available information to interested parties during the course of his investigation. Under regulation 6 (3) the chief inspector has a discretion as to whether, after completion of his investigation, he will report to the Minister or whether he will refrain from that course and release a statement of his views to the aviation industry or to interested parties. Whichever course is taken, it is clear that the chief inspector must complete his investigation and elect not to furnish a report to the Minister before he can release a statement of his views under regulation 6 (3). I should think it inadvisable to give any person the right of access to information in the possession of the Office of Air Accidents Investigation prior to the completion of an investigation. The inspectors are required to obtain evidence from various persons in the course of their inquiries and may compel such persons to answer a summons, if necessary, so as to provide the inspectors with information. It would, I think, be an inhibiting factor if persons supplying information to the Office of Air Accidents Investigation were to do so on the basis that an inspector was to be obliged to pass such information on, at the request of persons who might have an interest in the accident, especially when his inquiries are not even completed. In short, the chief inspector and his staff should be protected against any obligation to supply information during the course of investigation. I do not believe that information supplied to an inspector should be the subject of privilege in the sense that he cannot be required to divulge, in litigation, what he was told. But I am not prepared to recommend any legislative measure which would enlarge the present avenues of inquiry available to persons interested in the outcome of inquiries into an air accident.

(3) The chief inspector has himself raised the question whether his office is sufficiently removed from the area of responsibility of the Civil Aviation Division, bearing in mind that his office and the division are each under the administrative control of the Ministry of Transport. The same situation obtains in the United Kingdom where the Chief Inspector of Accidents at the Department of Trade is required to report to the Secretary of State, who is the political head of the Department of Trade, and if it becomes the duty of the chief inspector to criticise any official of the Department of Trade then he does so as an independent officer not subject in any way to the influence of any official of the Department of Trade.

I can see the advantages of removing the Office of Air Accidents Investigation from the ambit of the Ministry of Transport so as to separate the chief inspector and his staff from any presumed or suggested influence which might be exercised by the Civil Aviation Division. On the other hand, there was not in the present case the slightest suggestion of any such influence exerted or attempted to be exerted by Civil Aviation Division,

and indeed the chief inspector levelled against the division a series of detailed allegations that the statutory duties of the division were not complied with. Further, there was no evidence before me to suggest that there has ever been any interference in the past by any Government agency aimed at deflecting the chief inspector or his staff from the proper discharge of their duties. I have had to consider in this respect the distinctive qualities of ability and independence which characterise the current holder of the office of chief inspector, and the possibility that a successor might not be cast in exactly the same mould. Nevertheless I see nothing to suggest that the Civil Aviation Division would ever depart from its strict compliance with the statutory role which preserves the independence of the Office of Air Accidents Investigation, and in my opinion no alteration is required to the status and administrative position of the chief inspector or his office.

(4) The Civil Aviation (Accidents Investigation) Regulations 1978 do not prescribe detailed procedures or methods of air accidents investigation. The practice of the Office of Air Accidents Investigation is to follow the investigatory procedures summarised in Annex 13 of the Convention on International Civil Aviation. The methods used to implement these procedures are set out in an International Civil Aviation Organisation (ICAO) document entitled *Manual of Aircraft Accident Investigation.* These procedures are the result of international experience and have been adopted by 168 countries. The chief inspector takes the view that the ICAO rules ought to be implemented in New Zealand by enactment of appropriate regulations to form part of the present 1978 regulations. In my opinion it is desirable that the powers and functions of the chief inspector and his staff in the carrying out of their statutory duty ought to be defined by law in terms which will impose a legal obligation on all persons to comply with the chief inspector's authorised statutory directions. In other words, it is my opinion that the investigative procedures entrusted to the Office of Air Accidents Investigation by the regulations ought themselves to be particularised and disclosed in the regulations so as to give public notice of the rights and responsibilities of the chief inspector and his staff.

(j) Any other facts or matters arising out of the crash that, in the interests of public safety, should be known to the authorities charged with the administration of civil aviation in order that appropriate measures may be taken for the safety of persons engaged in aviation or carried as passengers in aircraft:

— There are no facts or matters within the context of this term of reference to which reference has not already been made in this report.

APPENDIX

As to costs, section 11 of the Commissions of Inquiry Act 1908 provides as follows:

> "11. The Commission, upon the hearing of an inquiry, may order that the whole or any portion of the costs of the inquiry or of any party thereto shall be paid by any of the parties to the inquiry, or by all or any of the persons who have procured the inquiry to be held:
>
> Provided that no such order shall be made against any person who has not been cited as a party or authorised by the Commission, pursuant to section 4A of this Act, to appear and be heard at the inquiry or summoned to attend and give evidence at the inquiry."

The consortium, representing estates of deceased passengers, was not made a party to the Inquiry but in terms of section 4A of the Act I was and am satisfied that the consortium was entitled to appear and be heard as if all its members had been cited as parties. The consortium has lodged a claim for costs in terms of section 11. The claim for costs by the consortium only covers counsel's fees and disbursements, other legal expenses relating to prospective damages claims having been met, so it appears, by contributions made by the consortium members. I therefore must allow this claim for costs relating to the Commission hearings which in my view is a reasonable claim.

Claims for costs have also been made on behalf of the estate of Captain Collins and the Airline Pilots' Association, who were represented by the same counsel but who have made separate claims for costs. The separate claims arise because the Airline Pilots' Association decided that the fees and disbursements of counsel for the Collins estate, even though he was also appearing as junior counsel for ALPA, should be met by the Collins estate. ALPA in my opinion was entitled to appear in terms of section 4A, and is entitled to an order for costs. Although the evidence supplied to the Commission by the ALPA witnesses was of very great assistance in that they took a major part in presenting what might be called the obverse side of the case presented for the airline and for the Civil Aviation Division, I think I should take the course of making an order for costs in favour of ALPA at a figure which may only be a contribution towards the legal costs which they incurred.

As to the Collins estate which was a formal party to the Inquiry, and as to the Cassin estate which was also a formal party, I think that there should be an order in each case which amounts to a complete indemnity. That would be the right order to make, in my opinion, irrespective of whatever findings were made in respect of the conduct of either pilot. The widow of Captain Collins and the widow of First Officer Cassin are each entitled to a full indemnity for costs. I asked the airline for its submissions on the question of costs. The general tenor of the submissions is that the establishment of this Royal Commission was directed by the New Zealand Government and that the airline should not be ordered to meet any part of the public expenditure so incurred. As a statement of general principle, this is correct. But there is specific statutory power to order that a party to the inquiry either pay or contribute towards the cost of the inquiry, and that power should be exercised, in my opinion, whenever the conduct of that party at the hearing has materially and unnecessarily extended the duration of the hearing. This clearly occurred at the hearings which took place before me.

In an inquiry of this kind, an airline can either place all its cards on the table at the outset, or it can adopt an adversary stance. In the present case, the latter course was decided upon. The management of the airline instructed its counsel to deny every allegation of fault, and to counter-attack by ascribing total culpability to the air crew, against whom there were alleged no less than 13 separate varieties of pilot error. All those allegations, in my opinion, were without foundation. Apart from that, there were material elements of information in the possession of the airline which were originally not disclosed, omissions for which counsel for the airline were in no way responsible, and which successively came to light at different stages of the Inquiry when the hearings had been going on for weeks, in some cases for months. I am not going to burden this recital with detailed particulars, but I should have been told at the outset that the flight path from Hallett to McMurdo was not binding on pilots, that Captain Wilson briefed pilots to maintain whatever altitudes were authorised by McMurdo Air Traffic Control, that documents were ordered by the chief executive to be destroyed, that an investigation committee had been set up by the airline in respect of which a file was held, and that one million copies of the Brizindine article had been printed, a fact never revealed by the airline at all. So it was not a question of the airline putting all its cards on the table. The cards were produced reluctantly, and at long intervals, and I have little doubt that there are one or two which still lie hidden in the pack. In such circumstances the airline must make a contribution towards the public cost of the Inquiry.

The costs of the consortium should in my opinion be paid out of public funds. The costs of ALPA and of the estates of the deceased pilots should in my view be shared by the airline and Civil Aviation Division who each adopted an unsuccessful adversary stance as against the pilots.

For the reasons given, I make the following orders:

1. I fix the costs and disbursements of the consortium at $72,461.64.
2. I fix the costs and disbursements of the Airline Pilots' Association in the sum of $31,675 for costs and $5,123.89 for disbursements.
3. I fix the costs and disbursements of the estate of Captain Collins at $61,709.76.
4. I fix the costs and disbursements of the estate of First Officer Cassin in the sum of $55,808.53.
5. I order that the whole of the costs referred to in paragraphs (2), (3), and (4) above to be paid as to two-thirds by Air New Zealand Limited, and as to one-third by the Ministry of Transport on behalf of its Civil Aviation Division.
6. The costs incurred by the Government in respect of this Inquiry have been calculated by the Tribunals Division of the Department of Justice at $275,000. A substantial liability for the burden of such costs must lie upon the State but in my opinion the State ought to be in part reimbursed in respect of the cost to the public of the Inquiry, and I accordingly direct that Air New Zealand Limited pay to the Department of Justice the sum of $150,000 by way of contribution to the public cost of the Inquiry.

BY AUTHORITY:
P. D. HASSELBERG, GOVERNMENT PRINTER, WELLINGTON, NEW ZEALAND—1981

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