

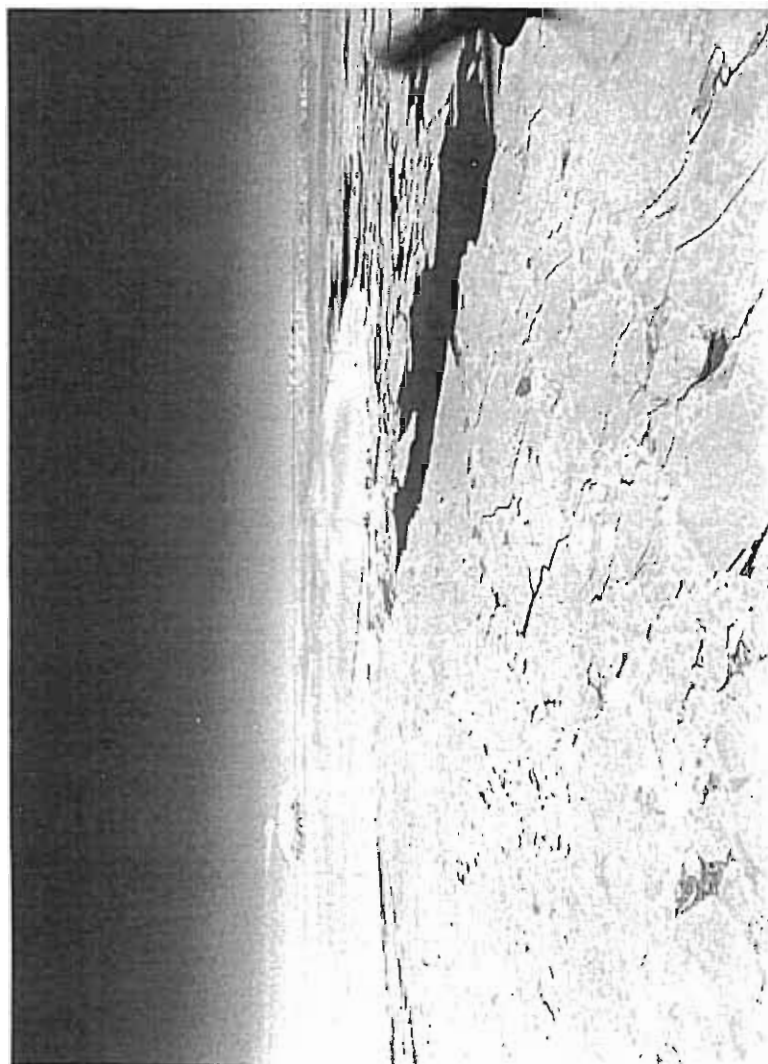


N. 2. Report of the Royal Commission
to inquire into
The Crash
on
MOUNT EREBUS, ANTARCTICA
of a
DC10 AIRCRAFT
operated by
AIR NEW ZEALAND LIMITED
1981

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

BY AUTHORITY:
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Price \$8.60



View of Mount Erebus during an approach from the north

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

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 Daryl 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:

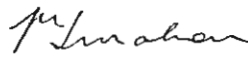
MAY IT PLEASE YOUR EXCELLENCY,

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

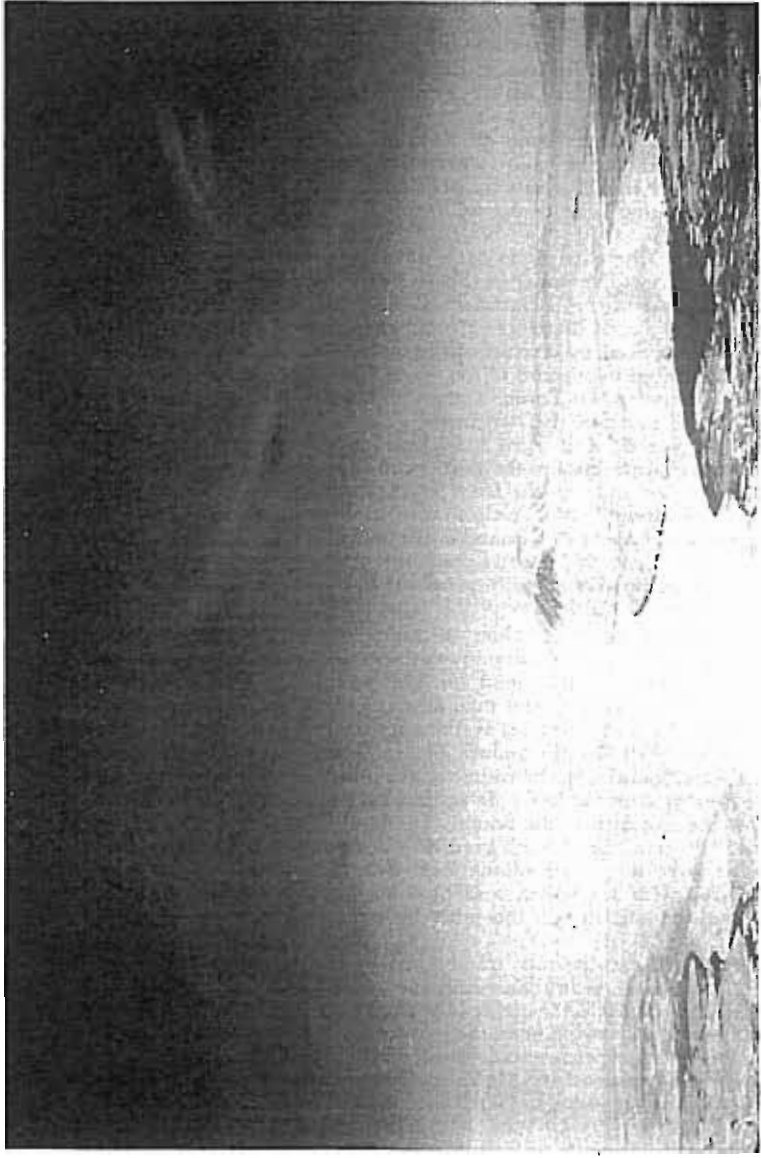


FIGURE 1

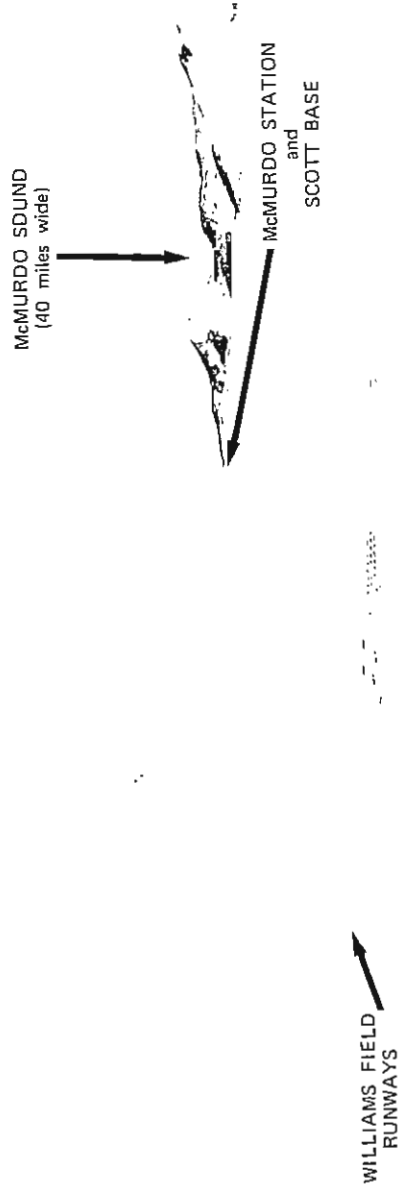


FIGURE 1A

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 to 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

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

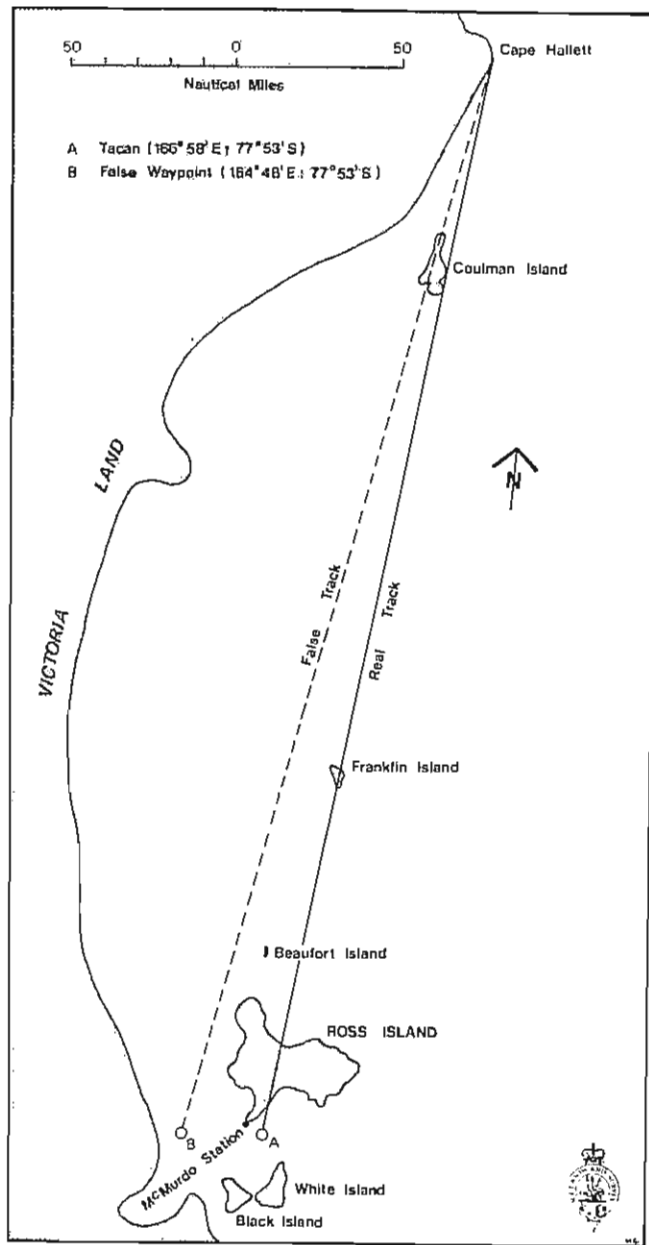


FIGURE 3

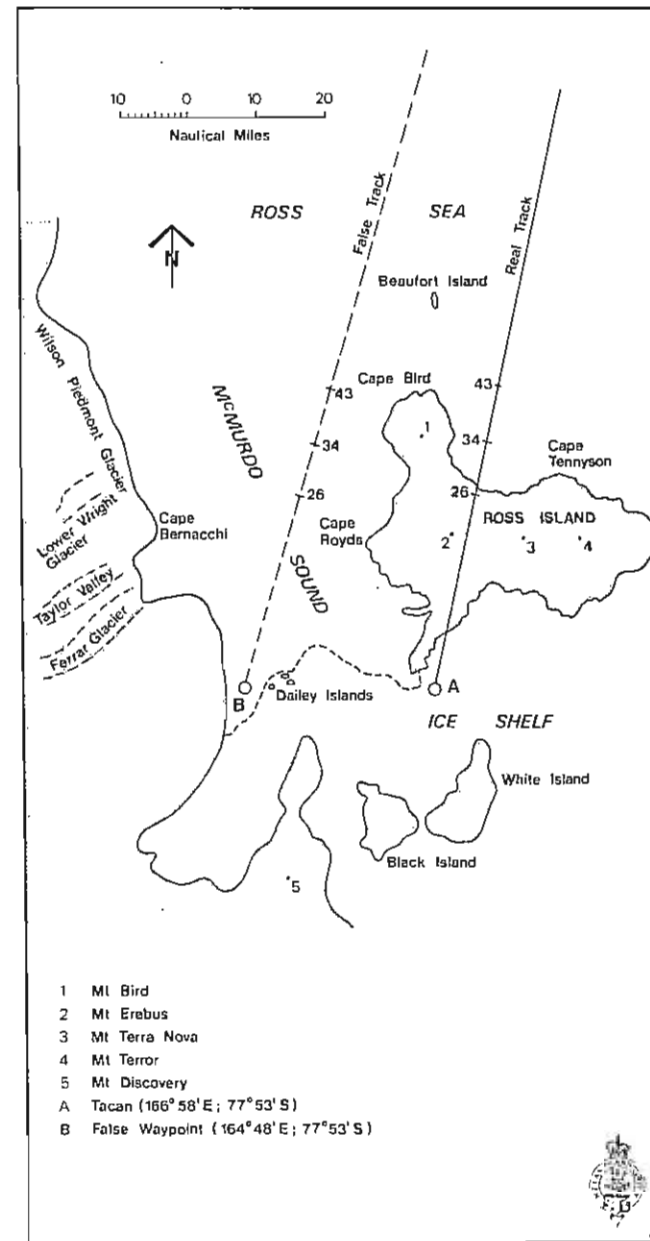


FIGURE 4

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 dispatcher 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 committee. 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 copilot, 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.