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 brieling 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 brielings 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