THE TYPE OF AIRCRAFT INVOLVED IN THE ACCIDENT

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

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

THE NAVIGATION SYSTEM IN A DC10-30 AIRCRAFT

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

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

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

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

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

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