



AIRCRAFT ACCIDENT INVESTIGATION

Report 852-1056

Israel Aircraft Industries
1124 Westwind
VH-IWJ
Near Sydney, New South Wales

10 October 1985

BUREAU OF AIR SAFETY INVESTIGATION

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PEL-AIR AVIATION PTY LTD
ISRAEL AIRCRAFT INDUSTRIES 1124 WESTWIND
VH-IWJ
NEAR SYDNEY, NEW SOUTH WALES
10 OCTOBER 1985

The Secretary to the Department of Aviation authorised the investigation of this accident and the publication of this report pursuant to the powers conferred by Air Navigation Regulations 278 and 283 respectively.

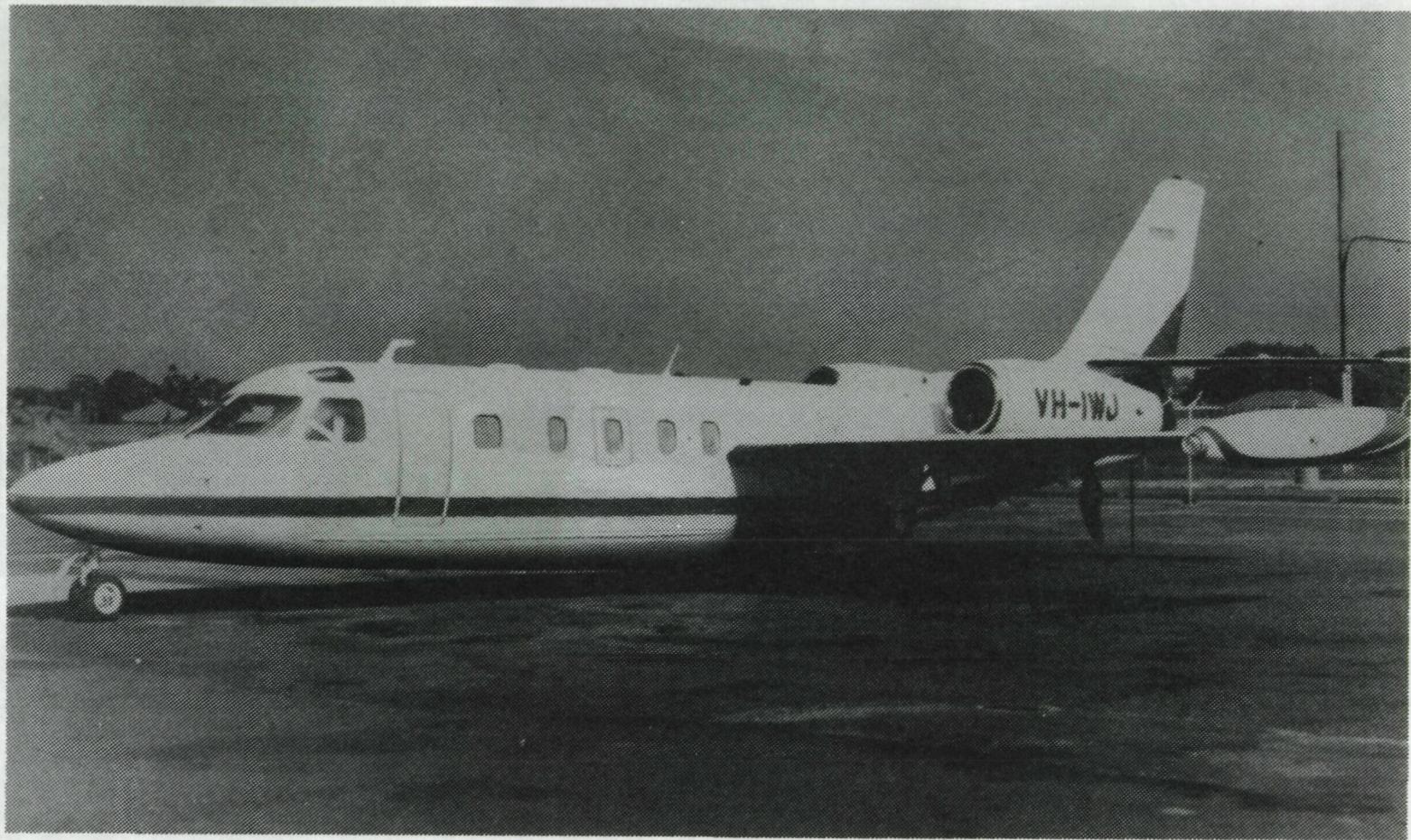
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Note : All times shown are Australian Eastern Standard Time (Greenwich Mean Time plus 10 hours), and are based on the 24-hour clock:

THE ACCIDENT

At approximately 0059 hours Eastern Standard Time (EST) on 10 October 1985 Israel Aircraft Industries (IAI) 1124 Westwind aircraft, registered VH-IWJ, crashed into the sea off the South Head of Botany Bay, New South Wales (NSW). The wreckage came to rest in 92 metres of water.

VH-IWJ was engaged in operating a cargo flight with a crew of two pilots and carrying no passengers. Both members of the flight crew received fatal injuries and the aircraft was destroyed.

1. FACTUAL INFORMATION

1.1 HISTORY OF THE FLIGHT

IAI 1124 Westwind aircraft, registered VH-IWJ, was operating under a current Certificate of Registration, the holder of which was Pel-Air Aviation Pty Ltd (Pel-Air). The aircraft was operated by Pel-Air and, at the time of the accident, it was engaged on a regularly scheduled cargo service. This service was operated under the terms of a current Charter and Aerial Work Licence, and was flown on behalf of Ansett Air Freight, a subsidiary of Ansett Transport Industries Pty Ltd. The particular flight, designated Flight 474, was operated on 4 nights each week from Sydney to Brisbane and Cairns, Queensland.

The aircraft had departed Cairns earlier in the evening and had flown via Brisbane to Sydney, arriving at 2336 hours. The arriving crew reported that the aircraft was performing normally. A total of 1350 litres of fuel was added to the aircraft tanks and loading of general cargo was carried out by Ansett Air Freight personnel.

The flight plan submitted to Air Traffic Control (ATC) indicated that the flight would follow the normal Instrument Flight Rules (IFR) procedures. The estimated time interval to Brisbane was 70 minutes at planned Flight Level 370 (approximate altitude of 37000 feet). The aircraft carried sufficient fuel for 164 minutes of flight, and refuelling was planned to take place at Brisbane prior to departure for Cairns.

Pel-Air intended to use the flight to assess the performance of the rostered co-pilot, who was being considered for upgrading to command status. He was to occupy the left hand control seat, while the right hand seat occupant was the Chief Pilot of the company.

At 0033 hours the crew established radio contact on the Sydney ATC Clearance Delivery frequency, and were given a "16 West Maitland One" Standard Instrument Departure (SID). The flight pattern associated with this clearance requires the aircraft to maintain heading after take-off on Runway 16 until reaching a height of 500 feet, when a left turn is made to intercept the 126 radial of the Sydney VOR (Very High Frequency Omni-directional Range). At a position of 6 nautical miles by Distance Measuring Equipment (DME) from the aerodrome, a left turn onto 357 degrees is made in order to continue tracking with reference to the West Maitland VOR. A copy of the applicable SID chart is shown at Appendix A.

Shortly before 0049 hours the crew contacted Sydney Control Tower, and the aircraft was directed to taxi for a departure from Runway 16. At the time the wind was light and variable. After receiving the appropriate clearance, an evidently normal take-off was made, and at 0056 hours contact was established with Sydney Departures Control. The pilot in command advised that the aircraft was on climb to Flight Level 370, and requested the direct track to Brisbane. This was a standard request, to allow the aircraft to proceed directly to the destination rather than follow the various radio navigation aids along the route. Such a request was normally granted by ATC if the general traffic situation permitted use of the direct track, and provided the aircraft was equipped with a suitable navigation system. VH-IWJ was fitted with a VLF/Omega navigation system which was capable of direct tracking. After ascertaining this, the Departures controller advised the aircraft that the direct track to Brisbane would probably be available. The acknowledgment of this comment was the last recorded transmission from the aircraft.

Shortly before 0059 hours the Departures controller broadcast the clearance for the aircraft to track direct to Brisbane at the planned cruising level. No response was received from the aircraft, although the controller noted that radar returns were still visible on his screen. Shortly afterwards, these returns faded, and the Distress Phase of Search and Rescue procedures was instituted at 0100 hours.

At about this time, a number of persons observed what appeared to be the lights of an aircraft descending rapidly towards the sea. The lights maintained their position relative to each other, indicating that the aircraft was not rotating as it descended.

The aircraft had faded from the radar screen at a point about 11 kilometres south-east of Sydney Airport. A search of the area was commenced using helicopters and boats. Wreckage identified as being from the aircraft was sighted by a helicopter at 0245 hours. Recovery of pieces of the aircraft structure, freight and human remains was effected by Police and Department of Aviation launches. The degree of destruction indicated that the aircraft had struck the water while travelling at high speed.

The bulk of the wreckage was presumed to be lying in about 85 metres of water about 5 kilometres out to sea from Botany Bay. An intensive search was carried out by vessels from the Royal Australian Navy, later assisted by a vessel from the NSW Department of Fisheries and Agriculture. Use was made of various underwater detection devices. Search efforts were hampered by persistent unfavourable sea conditions and no trace was found of the wreckage. Operations were finally suspended towards the end of

November 1985. An internationally recognised underwater location and salvage expert was then employed, and the wreckage was ultimately located and identified in 92 metres of water on 20 January 1986. Recovery of the Flight Data and Cockpit Voice Recorders, the major portions of both engines, and sundry other pieces of the aircraft structure, was effected the following month.

1.2 INJURIES TO PERSONS

Injuries	Crew	Passengers	Others
Fatal	2	-	-
Serious	-	-	-
Minor/None	-	-	-
Total	2		

1.3 DAMAGE TO AIRCRAFT

The aircraft was destroyed.

1.4 OTHER DAMAGE

No other property was damaged during the accident sequence.

1.5 PERSONNEL INFORMATION

The pilot in command of the aircraft, , age 40 years, was the Chief Pilot and the Chief Check and Training Pilot for Pel-Air. He was the holder of a Senior Commercial Pilot Licence which was current to 28 February 1986. This licence was appropriately endorsed to permit him to operate as pilot in command of the IAI Westwind type. He was also the holder of a First Class Instrument Rating, endorsed for appropriate navigation aids, which permitted him to operate aircraft under IFR procedures. , total flying experience at the time of the accident was 9881 hours, of which 3101 hours had been gained in the Westwind type. 2973 hours of these had been accumulated while acting as pilot in command of the type. His most recent proficiency check had been successfully completed on 21 May 1985 and his most recent pilot's medical examination had been completed on 28 August 1985. In the 90 days preceding the accident he had flown a total of 195 hours, all on the Westwind type. In the 7 days preceding the accident he had flown 16 hours 15 minutes on 4 separate flights. 157 of the hours in the 90 day period had been flown at night, and the accident flight was to be his third consecutive night of duty. He had been off duty since 0930 hours on 9 October and did not return to duty until approximately 0020 hours on 10 October.

The co-pilot of the aircraft was , age 37 years. He was the holder of a current Senior Commercial Pilot Licence, which was valid to 30 November 1985. This licence was appropriately endorsed to permit him to act as a co-pilot on the Westwind type. He also held a Second Class Instrument Rating, endorsed for appropriate navigation aids, which permitted him to operate under IFR procedures. At the time of the accident he had accumulated 8091 hours flying experience, of which 500 had

been gained as a co-pilot on Westwind aircraft. His most recent proficiency check had been completed on 3 October 1985, and his most recent aircrew medical examination had been conducted on 29 May 1985. In the 90 days preceding the accident he had flown 190 hours, all on Westwind aircraft, 154 of these were flown at night. In the preceding 7 days he had flown 19 hours 50 minutes during 3 flights. He had been off duty since completing a return flight from Darwin in the early hours of 9 October 1985.

A vacancy existed within Pel-Air for a pilot in command for Westwind aircraft. [redacted] had indicated his desire for this position, and had undergone an appraisal flight on 2 and 3 October 1985. The flight had been under the command of [redacted], who subsequently advised the company management that Mr Jackson had not performed to a satisfactory standard. Mr Jackson had been counselled on his performance, and had then spent a considerable amount of time studying the appropriate books and manuals, in preparation for a further appraisal on the flight on which the accident occurred.

1.6 AIRCRAFT INFORMATION

1.6.1 History

VH-IWJ was an IAI 1124 Westwind aircraft, the construction of which had been completed early in 1982 by Israel Aircraft Industries. It had been allotted the manufacturer's serial number 371. The aircraft was purchased by the original owner, Resources Jet Charter, and was flown to Australia in April 1982. It had then been operated by a number of charter companies until Peldale Pty Ltd acquired it in November 1984. In February 1985 Peldale Pty Ltd became Pel-Air Aviation Pty Ltd. This company continued to hold the aircraft Certificate of Registration, and operated and maintained the aircraft. At the time of the accident it had flown a total of 3105 hours since new.

1.6.2 Loading

The maximum permissible gross weight for take-off for the aircraft, having regard to structural limitations, was 10660 kilograms (kg). Runway 16 at Sydney Airport was sufficiently long for the aircraft to be able to operate at this weight. The actual weight of the aircraft at take-off was calculated to have been 8234 kg, including 1047 kg of cargo. Much of the cargo was of a bulky nature, and the freight carrying capacity of the aircraft was limited by volumetric, rather than weight, considerations. The centre of gravity of the aircraft was within the specified limits and there was adequate fuel on board for the proposed flight.

1.6.3 Fuel Considerations

The total fuel capacity of the aircraft was 3959 kg. At the time the aircraft landed at Sydney Airport there was approximately 509 kg of fuel remaining in the tanks. Under instructions from Mr Haskett, 1100 litres (870 kg) of aviation turbine (Avtur) fuel was added by the BP company refueller. The crew then became aware from the Briefing Office that the weather at Brisbane was expected to deteriorate shortly after the planned arrival time. Although there was no requirement for extra fuel to be

carried, the pilot in command elected to uplift a further 250 litres (198) kg, making the total fuel load 1577 kg.

The tanker used to dispense the fuel into VH-IWJ had been checked for water contamination earlier in the day. None had been found, and four other aircraft had been refuelled prior to the initial 1100 litres supplied to VH-IWJ. The tanker had subsequently been replenished from depot stocks and again found free of water contamination. Another aircraft had then been refuelled from the tanker prior to the final 250 litres added to VH-IWJ.

Immediately following notification of the accident, the fuel batch was quarantined. Preliminary, and subsequently extensive, quality control checks confirmed that the fuel as supplied was uncontaminated and met the appropriate product specifications.

1.6.4 Maintenance and Serviceability.

There was a current Certificate of Airworthiness for the aircraft, and required maintenance had been carried out in accordance with a system which had been approved by the then Department of Transport in 1979. The system called up various items for maintenance and servicing each 150 hours of flight time, plus additional checks which were required every 75 hours.

A number of documents were used to record and control maintenance activity. These were as follows:

- (a) Scheduled Maintenance and Rectification Sheets (SMRS). These forms are used to call up the maintenance required at a check inspection and to record and certify the action taken. They are also used to record defects found during the maintenance, and corrective action taken.
- (b) Component History (CH), and Overhaul and Special Inspection Period (OSIP) cards. The CH cards record the movement and time in service of interchangeable components, while the OSIP cards specify the maintenance required on interchangeable components and record maintenance carried out on these items.
- (c) Aircraft Maintenance Log. This is a booklet containing numbered coupons, which are used to record defects occurring between scheduled inspections and any rectification action taken.
- (d) Deferred Log. This is a booklet, carried in the aircraft, which contains details of any entries in the Aircraft Maintenance Log on which action has been deferred.
- (e) Permissible Unserviceability Schedule. This document forms part of the company operations manual for the aircraft type. It contains a listing of the various components which are not considered to be critical for normal flight operations, and may be temporarily unserviceable. The schedule is approved by the Department of Aviation, and may be varied on application by the operator.

The aircraft had flown a total of 59.5 hours in service since the last scheduled maintenance inspection, which had been completed on 26 September 1985. Two reported defects had not been rectified during this inspection,

and entries in the Aircraft Maintenance Log indicated that the details had been transferred to a SMRS. One concerned spurious warnings being given by the altitude alerting system, and a note on the SMRS indicated that spare parts were awaited for this equipment. This particular defect was not considered to be relevant to the circumstances of the accident. The other defect concerned the rate of turn indicator fitted to the Flight Attitude Director Indicator on the left instrument panel. The rate of turn indicator was known to be operating in the reverse sense i.e., with the aircraft turning to the left the indicator showed that a right turn was taking place, and vice versa. This defect is discussed at paragraph 1.6.4.2.

1.6.4.1 Attitude Instruments Required for Flight

The cockpit configuration of VH-IWJ provided 3 separate flight attitude indicators. These were:

- a) the pilot's Flight Attitude Director Indicator, which incorporates a flight director facility and provides flight attitude, as well as other information to the pilot. The attitude signals are provided by the flight guidance computer which is powered by the No.1 AC Bus at 115 volts alternating current (115Vac). A full-scale diagrammatic illustration of this instrument is shown at Figure 1.
- b) the co-pilot's flight attitude indicator which is a self contained instrument and is powered by the No.2 Instrument Bus at 26Vac.
- c) the emergency attitude indicator which is also self contained and is powered from the No.2 Communications and Accessories Bus at 28 volts direct current (28Vdc). This instrument is located on the left instrument panel. It is also fitted with an emergency battery which will power it for 30 minutes after any interruption to its principal power supply.

To avoid confusion, these three attitude instruments will be referred to throughout this report as Flight Attitude Indicators (FAI).

1.6.4.2 Instrument Unserviceability.

Under the terms of the relevant Air Navigation Orders, as the aircraft was fitted with three independently powered attitude indicators, there was no requirement for it to be equipped with a rate of turn indicator. However, as the indicator was fitted, and was not included in the aircraft Permissible Unserviceability Schedule, it was required to be operating correctly prior to take-off.

The rate of turn indicator, which formed part of the pilot's FAI, had first been reported as operating in the reverse sense on 23 October 1984. This report had been entered in the aircraft maintenance log by Mr Haskett. At that time the aircraft was being operated by Wings Australia Pty Ltd and had accumulated 1487 hours time in service since new. Maintenance personnel had been unable to isolate and rectify the fault, which was reported in the log on three further occasions.

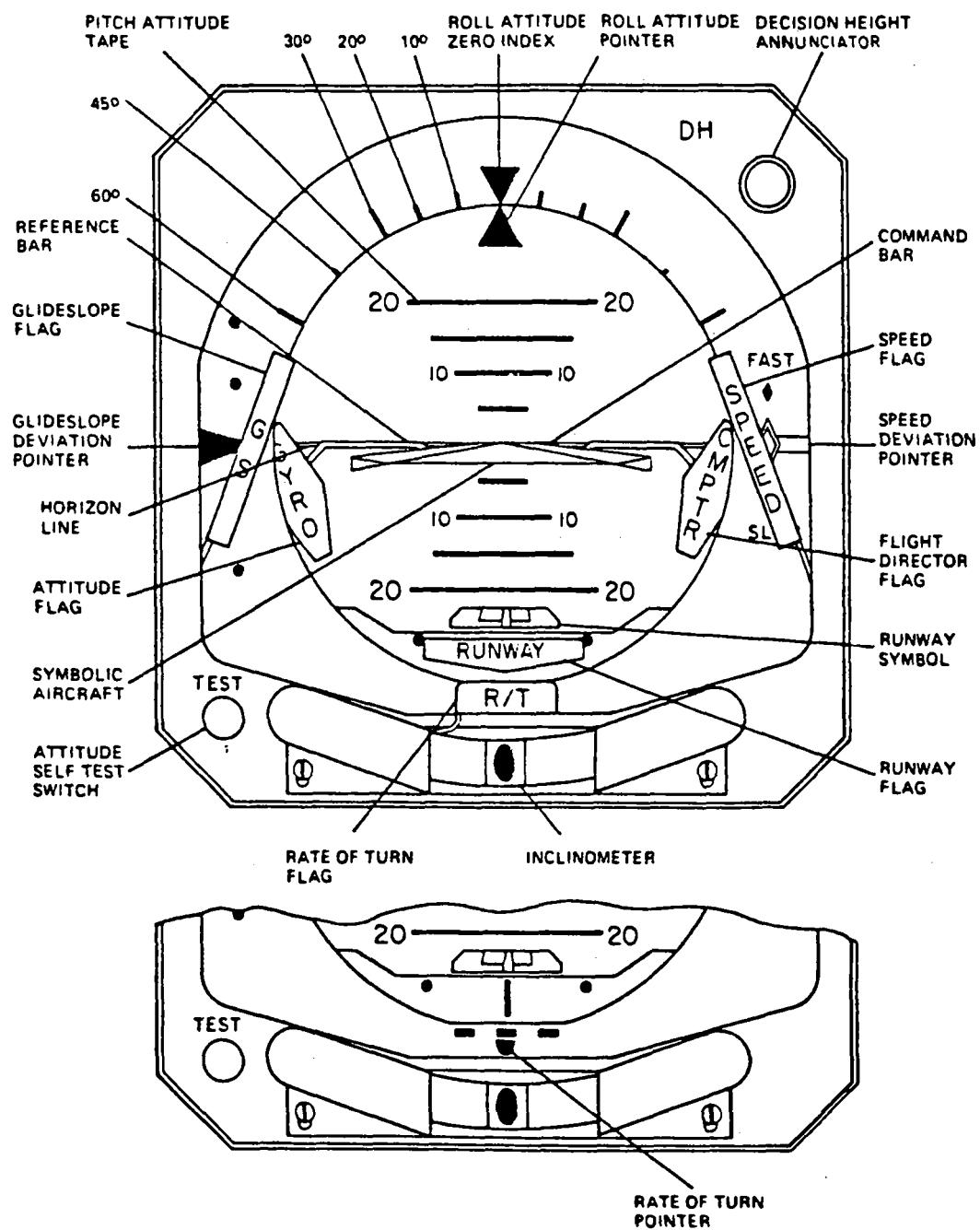


FIGURE 1

The rate of turn system has three main components. These are:

(a) a sensor, which is a gyro that senses the direction and rate of turn of the aircraft and converts this information into electric current for transmission to the rate of turn indicator. This sensor is mounted beneath the cabin floor.

(b) a rate of turn indicator, which is a simple ammeter calibrated to indicate the degree and direction of turn of the aircraft. It achieves this by responding to the electric current originating from the sensor referred to above. It is mounted on the lower casing of the pilot's FAI.

(c) the interconnecting wiring between the sensor and the indicator.

After the first report of the unserviceability of the system the relevant engineering staff carried out a number of checks and component changes to rectify the fault. Three different indicators and two different sensors were fitted to the aircraft at different times during the period of the reports. All of these units when fitted to other aircraft operated correctly, but when fitted to VH-IWJ the rate of turn indicator operated in the reverse sense. The engineering staff reported that they had carried out continuity checks on the wiring between the two components and those checks had confirmed that the aircraft was wired in accordance with the aircraft wiring diagrams. Nevertheless, it was considered likely that a fault had existed in the aircraft wiring, but the investigation was unable to determine the precise circumstances under which such a fault might have occurred.

1.7 METEOROLOGICAL INFORMATION

At 0100 hours a meteorological observation was taken at Sydney Airport. This recorded the surface wind as 158 degrees magnetic at 2 knots, visibility 30 km, cloud one octa (eighth) of strato-cumulus at 5000 feet, temperature 17 degrees Celsius (C) and QNH (altimeter sub-scale setting) 1020 millibars (mb). The Pilot Balloon flights from Sydney Airport conducted 4 hours prior to, and 2 hours after the accident recorded nothing that was considered of causal significance. On that morning, the moon did not rise until 0315 hours.

Recorded weather information was available via the Automatic Terminal Information Service (ATIS). The information current as the aircraft was prepared for departure was coded Alpha, and advised that the wind was light and variable, with a downwind component of 2 knots on runway 34. The QNH was 1019 mb, temperature was 16 degrees C, and there was one octa of cloud at 2500 feet.

1.8 AIDS TO NAVIGATION

All of the departure aerodrome and relevant en-route navigation aids were serviceable at the time of the accident.

1.9 COMMUNICATIONS

All the required transmissions to and from the aircraft were made on the correct frequencies. Neither the flight crew nor ATC reported any

difficulty with communications until the aircraft failed to reply to the ATC instruction to track direct to Brisbane.

1.10 AERODROME INFORMATION

Sydney (Kingsford-Smith) Airport is located on the Northern shore of Botany Bay and has two intersecting runways. Runway 16 was in use for departing aircraft at the time. This is the preferred runway for night operations, in order to minimise the effects of aircraft noise on suburbs adjacent to the airport. The runway has dimensions of 3962 x 45 metres and extends into the Bay for some 2000 metres. It is aligned in a direction of 156 degrees magnetic.

The Sydney Control Tower is located to the south-west of the runway intersection and affords an unobstructed view of the runways and taxiways to the tower controllers. The Surface Movement Controller and Aerodrome Controller are located in the Tower. The Departures Controller who monitors the path of aircraft, primarily by radar, is located in the Area Approach Control Centre (AACC) at the base of the Tower. The returns received by the radar antennae heads are processed and transmitted to the screens in the AACC. These radar antennae, for the Terminal Area and Route Surveillance Radars, are located East of the runway intersection. The Senior Area Approach Controller confirmed the serviceability of the radar equipment with the technicians on duty at the time of the accident.

1.11 FLIGHT RECORDERS

1.11.1 Cockpit Voice Recorder

The aircraft was equipped with a Fairchild A100 Cockpit Voice Recorder (CVR) of conventional configuration applicable when the aircraft was first registered in Australia. The CVR system is an audio recording system which uses magnetic tape to retain the last thirty minutes of information. The tape is a continuous loop whereby previous information is progressively erased as new recording takes place. Recording is commenced when power is selected on to the No.2 AC Bus and the Avionics Master Switch is on. The CVR system fitted to VH-IWJ allowed for the recording of radio and cockpit intercom transmissions. A separate track on the tape was used to record the sounds detected by a remote cockpit area microphone (CAM). The CAM was situated on the CVR control panel, which was in the centre console between the two crew seats. This CAM track was the source of all recorded conversation between the pilots and the various background noises heard during the flight.

The CVR was recovered relatively intact. Although mounted in the tailcone area it had suffered substantial damage to the front of its case at the time of impact. Water had penetrated the tape mechanism protective case and corrosion products had attacked the tape where it was in contact with the recording heads. The tape itself had been broken by impact forces at the point where it crossed from the inside of the reel to the recording heads. The tape covered 30 minutes of aircraft operation, 12 minutes of which related to the accident flight, beginning at the time of the first engine start. The last half second of the accident flight recording was degraded due to the tape being affected by corrosion products.

All air/ground transmissions were recorded satisfactorily and the CAM provided a good recording of the total audio environment in the cockpit.

Crew conversation recorded by the CAM was readily intelligible during the ground operation of the aircraft. However, after take-off power was applied a high level of background noise tended to mask the comments made by the pilots. Considerable effort was required, including spectral analysis, signal enhancement and test recordings made in other Westwinds, in order to complete a transcript of recorded information. Extracts from this transcript are reproduced at Appendix C.

The CVR was not fitted, and was not required to be fitted, with an underwater locator beacon (ULB).

1.11.2 Flight Data Recorder

The aircraft was fitted with a Fairchild 5424-501 Flight Data Recorder (FDR) in accordance with requirements applicable at the time the aircraft was entered on the Australian Register. This FDR is an analogue type that records pressure altitude, indicated airspeed, magnetic heading, vertical acceleration and VHF radio keying, against a time base. This information is recorded by inscription on a stainless steel tape. Power is supplied to the FDR from the No.2 Inverter via the Avionics Master Switch No.2. The operator normally selected the Avionics Master Switches "ON" after starting the first engine. The FDR was installed in the tailcone section of the aircraft, however it also suffered substantial damage at impact.

After recovery of the FDR the tape was withdrawn from the unit and although it had been torn during impact, which precluded an exact mating of the torn ends, the recorded data was extracted. A detailed read-out of all recorded information was conducted for a period of 10 minutes up to, and including the impact sequence. This period covered approximately seven minutes of ground operation and about three minutes from the start of take-off to the end of reliable data.

The pressure altitude trace indicated that after becoming airborne the aircraft climbed initially at 1700 feet/minute (fpm). The rate then increased and stabilised at 3300 fpm which was maintained to the maximum recorded pressure altitude of 4700 feet, which corresponded to a height of approximately 5000 feet above sea level. This was reached just over two minutes after take-off, after which the aircraft entered a rapid descent until impact occurred. The average rate of descent over the last 9 seconds of recorded data was in excess of 20,000 fpm.

The airspeed trace indicates that the aircraft accelerated normally and stabilised at a climb speed of 240 knots. At 2 minutes 8 seconds after take-off the airspeed increased rapidly and there was some indication that it may have been stabilising in the region of 420 knots at the time of impact. The recorder is calibrated to register indicated airspeed up to 450 knots.

Magnetic heading data was consistent with the aircraft taxi path and take-off on runway 16 and the subsequent interception of the 126 radial of the Sydney VOR. A left turn was commenced about two minutes after take-off, which corresponds to the aircraft passing the 6 DME Sydney position. However, after turning about eight degrees to the left, the heading change stopped. After remaining steady for about 4 seconds the aircraft heading commenced to change rapidly to the right. Heading information was lost as the turn continued, with the last reliable

recording being obtained 15 seconds before the loss of reliable data from the other parameters.

Estimates of the angles of bank achieved during the turn were computed. During the initial turn to the left the bank angle reached 20 degrees. The aircraft then rolled to a wings level attitude before the angle of bank rapidly increased to the right, reaching in excess of 90 degrees.

The vertical acceleration force was normal until the point at which the aircraft commenced the turn to the right. At this time it commenced to increase progressively, until shortly before impact when the recorded value exceeded the calibrated limit of 6g. The recorded increase had been in the positive sense, i.e. following take-off the aircraft did not encounter a vertical acceleration of less than the normal 1g.

The recorder was subject to annual and 1000 hour calibration checks. As it was last calibrated on 20 February 1985 it was within the annual limit. However, the aircraft had flown a total of 1146 hours since that date. It could not be established from the operator's records for how many of these hours the particular recorder had been fitted to VH-IWJ, therefore its calibration compliance status could not be determined. All recorded information was found to be within required tolerances and the data recovered was considered valid. Graphical presentation of the data is shown at Appendix B.

The FDR was equipped with a ULB, which was mounted on the front of the FDR casing. No signals had been received from this device during the search operation. When the FDR was recovered, it was found that the ULB had been disabled as a result of a localised heavy impact, which distorted the case of the unit and damaged the electronics module.

1.12 WRECKAGE AND IMPACT INFORMATION

The first pieces of wreckage were recovered less than 3 hours after the accident at a position 116 degrees magnetic and 7 nautical miles by DME from the Sydney navigation aids. The largest part of the aircraft to be recovered was the outer two-thirds of the right wing including the tip-tank. From the appearance of the items recovered on that morning it was evident that the aircraft had contacted the surface of the sea at very high speed and had been violently destroyed. On 20 January 1986 the remainder of the wreckage was located on the seabed about 1.5 km from the position where the floating debris had been recovered. Information obtained via a video camera confirmed the degree of destruction suffered by the aircraft at the time of initial impact. Despite the recovery of various components from the seabed, it was not possible to establish the precise attitude of the aircraft at the time it struck the water.

1.12.1 Search and Recovery

The Distress Phase of Search and Rescue (SAR) procedures had been declared at 0100 hours. Within 9 minutes of the disappearance of VH-IWJ, another Pel-Air Westwind, which had been preparing to depart for Melbourne, was despatched to the last observed position of VH-IWJ. This aircraft was in the area a short time later but was unable to detect any trace of the missing aircraft. Meanwhile, the Senior Operations Controller (SOC) at Sydney Airport had arranged for three SAR equipped helicopters to assist in the search for the aircraft. The NSW Water Police supplied two

launches and the Department of Aviation crash launch was also requested to assist. An offer of help was also received from the Royal Australian Navy, with advice that a helicopter had been launched from a vessel which was in the vicinity.

The first helicopter was in the designated search area within 43 minutes of the aircraft's disappearance and was joined a short time later by the other elements of the search effort. Debris was first located at 0245 hours and the launches were directed to that location. The flotsam consisted of the outer section of the right wing; items of freight; seat cushions; life jackets; oxygen masks and tank; portions of both elevators and other small pieces of the aircraft structure. A small quantity of human remains was also recovered.

A combination of eyewitness evidence, the recollection of the Departures Controller as to the last observed radar position, and the location of the flotsam, was used to determine the most probable position of the remainder of the wreckage. At the request of the Department of Aviation the Royal Australian Navy provided a minehunter vessel, which was to be used to locate the wreckage. Suitable equipment was carried to permit the reception of signals from the ULB. The vessel arrived on-station at 1526 hours on the day of the accident and immediately commenced a search pattern, utilising the ULB signal receivers in addition to the hull mounted sonar equipment. However, throughout the entire search operation, no signals were received from the ULB.

Searching continued until the afternoon of 12 October when adverse weather and sea conditions halted operations for 3 days. During this period a side-scanning sonar device, which was more suitable for the task, was obtained and fitted to the minehunter.

A number of sonar contacts had been made during the early stages of the operation. Water depth in the area precluded the use of conventional diving techniques to obtain positive identification of the various contacts. Use was therefore made of two remote operated vehicles (ROV). These were capable of diving to the depths required, recording the contacts via television cameras, and capable of carrying out limited recovery operations.

Searching activities continued, however a combination of adverse sea states and equipment unserviceability frustrated the effort. Naval support was ultimately withdrawn, but side-scan mapping was continued, using a research vessel, until 22 November. At this time the operation was suspended because of the lack of success in positively locating the wreckage.

Arrangements were made for an American expert in the field of underwater search and recovery of crashed aircraft to travel to Australia, in order to advise on the usefulness of further searching. As a result of this visit, a Sydney based towing and salvage firm was contracted to continue the operation. Specialist men and equipment were provided from the USA, and the Royal Australian Navy again supplied a minehunter vessel. On 20 January 1986, the wreckage of VH-IWJ was located at a depth of 92 metres in position 118 degrees magnetic and 7.3 nautical miles by DME from the Sydney navigation aids. The wreckage formed an elliptical pattern, some 200 metres long and 50 metres wide, aligned in a direction of 328°M. The location was within the original search area. It was evident that the

degree of fragmentation of the aircraft; the limitations of the sonar equipment used; and the lack of local expertise in the interpretation of sonar information had precluded its earlier discovery.

Recovery of the wreckage was co-ordinated by the towing and salvage company, with additional vessels provided by the RAN and the Department of Transport. This particular operation was commenced on 20 February 1986, and both the FDR and the CVR were recovered that afternoon. Major portions of both engines and various pieces of the aircraft structure and components were recovered during the following two days. However, the principal recovery vessel dragged its moorings during a period of adverse weather, and the cost and effort required to re-moor the vessel was considered to be uneconomic. All recovery activity ceased on 23 February 1986.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

1.13.1 Medical Reports

Records maintained by the Department of Aviation showed that both crew members had completed regular six-monthly medical examinations without problems. The only item of significance in [redacted] s records related to a long standing mild electrical conduction defect of the heart, which could cause an irregularity of the heart beat. This conduction defect could possibly have been associated with ischaemic heart disease, which results from a restriction of blood vessels supplying the heart. Such a condition places the person at a slightly greater risk of heart attack than the average. No abnormality or irregularity was noted during [redacted] last medical check, which was completed seven weeks prior to the accident.

[redacted] had suffered a fractured skull in 1966, but there were no associated problems arising from that particular injury and he had no significant medical history.

1.13.2 Pathology

There were insufficient remains recovered for detailed pathological examination. The autopsy was necessarily limited to the identification of the crew members.

1.14 FIRE

There was no fire associated with the development of the accident.

1.15 SURVIVAL ASPECTS

The accident was not survivable.

1.16 TESTS AND RESEARCH

1.16.1 THE CREW

1.16.1.1 The Pilot in Command

Comprehensive interviews were conducted with all the company Westwind pilots and various management personnel. was evaluated by other company pilots as having average manipulative and instrument flying skills for his level of experience. However, they considered that he excelled as an instructor by virtue of his personality, lecturing technique and thorough knowledge of the aircraft and its systems. He was a loyal and hard working employee who disliked inefficiency and laziness, and expected nothing less than 100% effort from other company personnel.

Several company pilots reported that on check flights, in his role of check and training pilot, would introduce simulated systems failures at any stage of the flight. Which systems were involved and the extent of the failure was mostly graded to take into account the experience of the pilot undergoing check. A point made by almost all of the company pilots was that could be relied upon to introduce a unique or obscure failure that had not been covered previously with the candidate. It was also his habit to require the candidate to handle simultaneous systems failures but this was also graded to the experience of the particular pilot. An example of the types of simultaneous and complex failures given related to the loss of various navigation and attitude instruments, coupled with an engine failure, while the pilot was carrying out an instrument approach at night.

It was expected the company co-pilots to demonstrate their ability to safely control the aircraft by reference to the emergency FAI, following simulated failure of the FAI on the right instrument panel. Some command pilots were expected to make use of the rate of turn indicator, following simulated failures of both FAIs on the left panel. To prevent the pilot obtaining attitude information from the co-pilot's FAI, this instrument was covered, or the cockpit lighting on that side was extinguished. Some of the company pilots had been expected to cope with this emergency exercise immediately after a take-off at night.

1.16.1.2 The Co-Pilot

had previously been based in Darwin with Pel-Air, where he acted as pilot in command on Shorts 3-30 type aircraft. He had applied to be transferred to Sydney when a vacancy became available. After arriving in Sydney to take up the position offered, he had apparently shown little interest in the company. He seemed to be having difficulty in reverting from a pilot in command to a co-pilot, even though the company pilots considered that the Westwind was a more desirable type to operate. Company policy required a co-pilot to have accumulated a minimum of 500 hours on Westwinds before being eligible for command upgrading. When a vacancy for a pilot in command had become available, had lodged an application for the position. He was to be the first co-pilot to be considered for the particular vacancy, because of his overall seniority in the company.

undertook an appraisal flight with on 2 and 3 October 1985. assessed his performance as unsatisfactory, on

the grounds of lack of knowledge of the various emergency procedures and the aircraft systems. Counselling was given on these aspects by [redacted] was also reminded that it was company policy to permit a first-officer two attempts to upgrade to captain, and should the second attempt be unsuccessful, the candidate remained as a co-pilot indefinitely. At the same meeting he was also counselled by the General Manager on his overall attitude towards the company.

On 7 and 8 October, [redacted] had flown with another company check pilot, who subsequently reported that in his opinion [redacted] had made noticeable improvement. However, he had still displayed some lack of knowledge of various procedures, and the actions required in the event of failures of some of the aircraft systems. During the flight was required to control the aircraft using the emergency FAI for attitude guidance, following the simulated failure of the primary FAI. The check pilot reported that [redacted] handled the exercise without difficulty, and considered that he would make a suitable command pilot, following a period of supervision.

[redacted] had recently been informed of the unserviceability of the rate or turn indicator in VH-IWJ by one of the company pilots. The flight on which the accident occurred was only the third occasion he had occupied the left hand side control seat, and was the first occasion he had flown VH-IWJ from that seat. It could not be determined whether [redacted] had required him to fly using the rate of turn indicator during the appraisal flight on 2 and 3 October. However, there was no doubt that [redacted] had little or no recent experience in the use of this instrument.

[redacted] had a disturbed sleep on the night preceding the accident flight. This was evidently unusual for him as he was normally able to relax quickly and he had adjusted well to the varying sleep patterns imposed on pilots who must work at night. He had spent most of the previous day studying for the coming flight and he was aware that this was probably his last chance to convince the Chief Pilot of his suitability for upgrading. As he had not complained of any health problem, it is likely that this caused his unrest.

1.16.2 THE AIRCRAFT

1.16.2.1 Structure

The section of right wing recovered on the morning of the accident was examined and determined to have failed in upward bending overload. The wing mainspar failed just inboard of the rib at Wing Station (WS) 93. This position was about 4.5 metres from the outer edge of the wingtip fuel tank. There was no damage to the wing leading edge. However, the trailing edge and the lower rear section of the tip-tank displayed damage consistent with the wing striking the water trailing edge first. No evidence of any pre-existing damage to the wing could be found.

1.16.2.2 Engines

Examination of engine components confirmed that both engines were operating at the time of impact. The compressor blades of both engines showed gross bending against the direction of rotation. This is consistent with high rotational speed of the blades as they came into contact with the diffuser casing. The combustion casing of the right

engine was torsionally buckled in the direction of rotation consistent with gross braking loads as the compressor contacted the casing. The left engine tailpipe was subjected to metallurgical examination to determine its temperature when buckled at impact. This was determined to have been in excess of 500°C and is also consistent with the engine operating at high speed at impact.

1.16.2.3 Control Surfaces

Although sections of the both elevators were recovered in the same location as the other flotsam on the morning of the accident, little else of the control surfaces or systems was recovered. Due to the other evidence available, it is considered however that these components were not of causal significance.

1.16.2.4 Stabiliser Trim

The horizontal stabiliser jack was recovered attached to a section of the fuselage rear bulkhead and part of the support structure. The right hand screwjack was broken at about half its length and was missing. The left hand screwjack rod end was torn from the horizontal stabiliser front spar attachment point. The distance between rod ends on the left screwjack was measured to determine the stabiliser position before impact. It was established by reference to the maintenance manual that the stabiliser was in a position of -2.6 degrees, which was appropriate for the gross weight and speed of the aircraft at the time.

1.16.3 OTHER RESEARCH

1.16.3.1 Birdstrike

The services of an ornithologist were enlisted to ascertain the likelihood of the aircraft being disabled as a result of a birdstrike. The information obtained revealed that many species of migratory birds fly at night, up to an altitude of about 20000 feet. Although over forty species of shorebirds migrate between Asia and Australia, mainly in October, there is greater movement across Australia from the northwest rather than down the Eastern seaboard. The largest bird likely to be encountered off the East Coast at night during October is the Black Swan whose maximum weight for an adult is 8.75 kg. These are common in southeastern Australia and travel considerable distances at night up to altitudes of 10000 feet. The conditions prevailing at the time of the accident would not have impeded bird flight in any significant way.

After recovery and transcription of the CVR tape it was evident that the aircraft had not suffered a birdstrike.

1.17 ADDITIONAL INFORMATION

1.17.1. Criminal Allegations.

At the time of the accident a number of allegations had been made in the various news media that Pel-Air was involved in the transportation of drugs. Because of these allegations, investigations were carried out by elements of the NSW Police Department. These investigations were carried

out with the co-operation of, but independent from, the Bureau of Air Safety Investigation.

A comprehensive forensic examination carried out by the Police found no evidence to support any suggestion that any criminal attempt was made to destroy the aircraft or its crew.

1.17.2 Recorded Radar Information.

When VH-IWJ became airborne from Runway 16, the Departures controller was able to monitor its progress on radar by reference to the primary return from the skin of the aircraft, and a secondary return generated by a transponder in the aircraft. A primary return is generated each time the radar antenna at the Airport receives a skin paint from an aircraft, and the array completes one rotation in approximately 6 seconds. The antenna which receives secondary returns is mounted on the Route Surveillance Radar installation, which takes about 12 seconds to complete each rotation. Information relating to the position and height of the aircraft is updated at this rate.

Considerable difficulty was experienced in determining the exact position at which the returns from the aircraft faded from the radar screen. The last recorded secondary return was received before the aircraft commenced its left turn at about the 6 DME position. However, the controller had observed primary paints from the aircraft as it made the turn. The loss of secondary radar information during a turn is a known phenomenon, occurring as the transponder antenna is shielded by the aircraft structure. At the present time at the major airports in Australia, only the secondary radar information is recorded. As a result, the point at which the controller assessed the aircraft returns had faded depended on his recollections, and could not be positively verified. The likely area in which the aircraft struck the water was therefore unable to be defined as accurately as desired. This in turn led to a dilution of the search effort, with the available resources requiring to be spread over a larger area.

1.18 NEW INVESTIGATION TECHNIQUES

1.18.1 Use of Hypnosis.

One of the principal eye witnesses was a gaol warder. His initial statement on his recollection of the manoeuvres of the aircraft was clear and apparently accurate, however he was unable to recall the whole of the flight path. He agreed to be placed under hypnosis to ascertain whether his memory of the event could be improved.

The exercise was carried out by a NSW Police Department Scientific Squad officer specially trained and approved to place subjects under hypnosis. The interview was conducted by this officer in the presence of investigators. The witness took some time to relax sufficiently to allow himself to become hypnotised, however he then showed graphic recall of the accident. His initial statement had referred only to the observed descent of the aircraft, but he was now able to remember events leading to that descent. He described that he saw the aircraft commence a turn to the left, then roll to the right past the vertical position before diving towards the sea. This was the first indication available to the

investigation that the aircraft had rolled into the descent, rather than pitched nose-down from a wings-level attitude. This aspect provided valuable assistance to the investigation, at a time when there was considerable doubt that the flight recorders would be recovered.

Following the recovery of the FDR, the sequence of events as described by the witness was proved to be accurate. This was further confirmed by the results of the experiments carried out in the flight simulator, as described at Para 1.18.2.

A considerable amount of research has been carried out into the use of hypnosis during criminal investigations. Similar research is being undertaken for its use in aircraft accident investigations. There are conflicting reports of the usefulness of the technique, as it has been shown scientifically that hypnosis rarely enhances memory. However, there is evidence that hypnotic interviews are most likely to reveal significant information when witnesses are genuinely motivated towards the use of the technique. This was the first occasion in which hypnosis had been applied in this country to assist an aircraft accident investigation, and the results were encouraging.

1.18.2 Pilot Performance Experiments in Flight Simulator.

It became apparent during the investigation that the check pilot had possibly simulated failures of all FAIs shortly after the aircraft was established in a steady climb. This would leave the pilot flying the aircraft with no direct attitude instrument reference, and commit him to fly the aircraft with no gyro attitude instrument, in an environment where there were no external visual references. Such a task, while difficult, should be within the capabilities of a properly trained pilot, providing the remaining instruments are functioning correctly. However, the rate of turn indicator in this aircraft was operating in the reverse sense. The effects on pilot performance under these demanding circumstances was unknown.

In order to obtain specific information on the difficulties of maintaining aircraft control under the described circumstances, a series of experiments was carried out in a flight simulator. The results of the experiments were then used to animate an aircraft image on the Bureau's computer graphics system in order to observe the flight paths in three dimensions and in real time.

The simulator used was a Boeing 707-338 model. It was configured with a similar instrument panel to that in VH-IWJ, except that the rate of turn indicator was a separate instrument with a considerably larger pointer. For the purpose of the exercise, a 7 channel pen recorder was installed, and modifications were made to enable the sense of the rate of turn indicator to be reversed as desired.

The program for the experiment was devised by the Bureau's human performance experts, in conjunction with flight recorder and simulator specialists. The pilots used were 9 qualified Boeing 707 pilots. They were each required to execute a take-off followed by a "16 West Maitland One" departure from Sydney, with the introduction of limited panel operation shortly before the required turn at 6 DME. The exercise was then repeated, but with the sense of the rate of turn indicator reversed at the point of introduction of the limited panel condition.

The results of the study showed that all of the pilots maintained adequate control of the aircraft when the rate of turn indicator was operating correctly. However, with the sense of this instrument reversed, 3 pilots lost control and "crashed" the simulator. In each case, control was lost after the commencement of the left turn, with the aircraft finally executing a steep turn to the right. The final impact was at an angle in excess of 50 degrees nose down, and at an airspeed in excess of 500 knots. None of the pilots made any attempt to reduce engine thrust, and all impacts were with climb thrust still applied.

The average time taken for the aircraft to descend from about 5000 feet to sea level was 12 seconds. In addition, 4 other pilots entered a right turn following their initial turn to the left. These pilots were able to retain control, and subsequently were able to turn again to the left. It was noted that all pilots who turned to the right did so an average of 6 seconds after commencing the planned turn to the left. This finding was of considerable interest, as it had been believed that with the turn indicator showing a right deflection when the left turn was commenced, the pilot would naturally apply more left bank input to achieve the desired result. It was therefore expected that if control were lost, it would involve an increasing bank to the left. The simulator experiments showed unequivocally that this was not the case.

2 ANALYSIS

2.1 General

The initial preparations for the flight were apparently normal. The unserviceabilities listed in the maintenance documentation relating to the rate of turn indicator and the altitude alerting system would not, in themselves, have affected the ability of the crew to safely conduct the flight. The take-off and initial climb also appeared to be normal. However, control of the aircraft was lost just over 2 minutes after take-off, as a turn, which should have taken the aircraft left through 129 degrees, was commenced.

This analysis evaluates the relevant areas of the witness, engineering and flight recorders evidence and examines the possible operational reasons for the loss of control and the subsequent descent into the sea.

2.2 The Aircraft

Appropriate maintenance documentation relating to the aircraft was in order, and all mandatory maintenance and inspections were recorded as having been carried out. There was no evidence that the aircraft was other than serviceable prior to the flight, with the exception of the altitude alerting system and the rate of turn indicator. The aircraft had operated satisfactorily with a defect in the rate of turn indicator for almost 12 months.

Despite the fact that the indicator was faulty, no effort had been made to positively alert the pilots to its continuing presence. This could have

been achieved by the placing of a placard near the face of the instrument, or by the pulling and locking of the appropriate circuit breaker.

The examination of the wreckage recovered together with the information obtained from the FDR and CVR did not reveal any evidence to indicate that the aircraft was not capable of normal operation at the time of departure from Sydney. Both engines were operating at high rotational speeds at the time of impact, and it was considered that the circumstances of the accident were not consistent with those that might be expected with an engine related problem.

2.3 The Crew

Both pilots were suitably licenced and qualified to undertake the flight. [REDACTED] had considerable experience on the aircraft type both in the normal operating and training roles. [REDACTED] had substantial experience on the type as a co-pilot, although this was to be only his third flight while occupying the left control seat. On the previous occasions he had not been flying VH-IWJ.

With the exception of [REDACTED] disturbed sleep pattern on the evening of the flight, neither pilot had any known medical or psychological problem which might have affected their ability to safely operate the aircraft. The cause of [REDACTED] sleeping difficulty was not determined, but may have been related to some perceived stress, with reference to the importance of the flight on his future progress in the company. There was evidently nothing in his manner or appearance during the period before or on the night of the flight to suggest that he was not capable of performing his assigned duties.

There were insufficient human remains recovered to allow any detailed information to be obtained from the autopsy examinations.

2.4 Meteorological Conditions

The sky in the area was relatively free of cloud, winds were light and visibility was unobstructed. There was no known turbulence or other meteorological phenomena that might have affected the aircraft. Weather conditions were therefore not considered to have had any bearing on the development of the accident.

2.5 The Accident Sequence

The evidence obtained from eye witnesses, recorded radar information and the FDR indicated that the aircraft was tracking in accordance with the assigned airways clearance. Shortly after commencing a turn at 6 DME, control of the aircraft was lost and a steep descent followed. Sudden loss of control of an aircraft under the circumstances was considered likely to have been caused by one of the following influences.

- (a) Structural failure of the airframe
- (b) Uncommanded elevator trim inputs.

- (c) Sabotage
- (d) Collision with another aircraft or object
- (e) Pilot incapacitation
- (f) Suicide
- (g) Spatial disorientation

2.5.1 Structural Failure of the Airframe.

The aircraft type did not have any history of structural problems. VH-IWJ had been maintained in accordance with the approved schedules, and had flown a lower number of hours than its contemporaries in Australian operations.

Eye witness evidence indicated that the aircraft descended steeply but without noticeable movement about the longitudinal axis. The landing lights were visible, and formed the basis of this evidence. The lights were located on the front of the wing tip fuel tanks, thus it was apparent that neither wing had failed in flight. Portions of both elevators were recovered in the main area of floating wreckage, indicating that they had been attached to the airframe at or close to the point of impact. In addition, no sounds that could possibly be associated with an in-flight structural failure were detected on the CVR tape, nor was there any comment from the crew to indicate a sudden control problem. None of the components recovered showed any sign of failure other than by overload forces.

2.5.2 Uncommanded Elevator Trim Inputs.

There are known cases of aircraft accidents resulting from a situation known as "runaway elevator trim". Typically, the trim runs away to the full nose-up or full nose-down position, leading to loss of control and/or overload failure of the structure. None of these accidents have involved the Westwind type.

In the case in point, the most serious situation would result from a nose-down trim input. Such an input would result in a strong negative "g" acceleration as the aircraft pitched down. The FDR foil indicated that there was a progressive increase in positive "g" loadings, and eye witness evidence indicated that the aircraft rolled, rather than pitched, into the descent. In addition, the horizontal stabiliser jack was found to be in the mid-range of its travel. Again, no comments were recorded from the crew to indicate such a problem occurred.

2.5.3 Sabotage.

The most likely methods for any sabotage attempt were considered to be an explosive device or a toxic chemical or gas container concealed in the freight. The investigation disclosed no reason for any such attempt on this aircraft or crew, and the CVR tape did not record sounds of an on-board explosion or unusual comment from the crew. Forensic testing carried out by the NSW Police Department also failed to reveal any evidence to support a sabotage attempt.

2.5.4 Collision with Another Aircraft or Object.

The analysis of recorded radar information together with evidence from the various ATC personnel on duty indicated that no other aircraft was in the area at the time. The sounds of a bird or other object striking the aircraft with sufficient force to disrupt the structure would have been recorded on the CVR tape. No such noises were recorded.

2.5.5 Pilot Incapacitation.

Both pilots were apparently in good general health, although on the evening prior to the flight had not slept as well as normal. It was considered possible that one of the pilots may have suffered a sudden illness or incapacity, such as a heart attack, and had slumped forwards onto the controls. Such a movement would result in a similar movement to a runaway trim situation, with a large negative "g" input. As previously mentioned, the "g" forces were positive, and there was no recorded comment or exclamation as might be expected if a crew member collapsed. The majority of Pel-Air pilots also believed that if either pilot slumped forward, the other had sufficient strength to pull him clear of the controls.

2.5.6 Suicide.

No evidence was found to suggest that either or both pilots had contemplated such an attempt.

2.6 Spatial Disorientation.

In the absence of any evidence to indicate that the loss of control was related to any of the previous considerations, it seems likely that the accident resulted from the crew losing their awareness of the attitude of the aircraft.

Spatial disorientation describes a situation in which a pilot fails to sense correctly the position, motion or attitude of his aircraft. It results from a conflict of information from his senses, primarily those of vision and balance. Alternatively, where there are insufficient visual cues, the information from the sense of balance is all that is available to determine orientation. The sense of balance is extremely unreliable and, depending on the circumstances of flight, may provide erroneous information to the pilot. If there is no visual means with which to cross-check the information from the balance senses, the pilot may be unaware that it is in error. His perception of the aircraft orientation in space may thus be incorrect, and he will not be aware that this is so.

Both pilots were qualified to operate the aircraft under Instrument Meteorological Conditions. The night was dark, and there would have been no visible horizon as the aircraft tracked out to sea. Under these conditions the crew would have been required to monitor and control the attitude of the aircraft solely by reference to the flight instruments. The aircraft had a comprehensive array of instruments, including two FAIs on the left panel and one on the right. On a routine flight it would be expected that if both indicators on the left side failed, or if the pilot had difficulty with control, the pilot in the right seat would monitor the situation or assume control if necessary. The FAIs were powered from separate sources, and the simultaneous failure of all three was extremely

unlikely. No evidence was found to indicate that any of the FAIs had failed for technical reasons.

It is difficult to conceive how two experienced pilots would lose control of the aircraft in normal flight conditions if all the instruments usually available for attitude control were functioning properly.

2.6.1 Simulation of Flight Instrument Unserviceability.

Information recovered from the CVR indicated that soon after the required checks following take-off had been completed and the aircraft was established in a normal climb, the check pilot stated his intention to simulate an emergency instrument situation. The simulation was probably intended as a test of the ability of [redacted] to operate the aircraft under limited instrument conditions. Evidence obtained from other company pilots indicated that [redacted] was known to introduce such an exercise by failing both FAIs on the left instrument panel. This would require the pilot being checked to assess the attitude of the aircraft by integrating the information presented by the remaining flight instruments, in order to give a mental picture of the position of the aircraft with reference to the natural horizon. To counter any tendency on the part of the pilot to glance at the FAI on the right instrument panel for additional guidance, [redacted] was known to cover this instrument, or to turn the lighting down on that side of the cockpit. Although this ensured that the pilot flying the aircraft had no single attitude reference instrument, it also deprived [redacted] of an instant check of aircraft attitude. If he had adopted such a procedure on this occasion, he lost the ability to readily monitor [redacted] performance of the task, because of the lack of a natural or artificial horizon reference.

If the limited panel situation had been simulated as discussed above, [redacted] would have had to make use of the rate of turn indicator in order to assess the bank angle of the aircraft during the turn. Although he had recently been informed by another company pilot of the defect in the instrument, it was likely that he inadvertently overlooked it under the high workload involved as he concentrated on the handling of the aircraft. It was apparent that the loss of control occurred shortly after the planned turn to the left had been commenced, and followed a steep bank to the right. It was likely that neither pilot was aware of the attitude of the aircraft until it had reached an extreme point, possibly at or about the inverted position and with the nose well below the horizontal. From this position, there was evidently insufficient height remaining in which the pilots could effect a recovery.

3. CONCLUSIONS

Findings.

1. The pilots were correctly licenced and were suitably experienced and qualified to undertake the flight.
2. There was no evidence that either pilot suffered any sudden illness or incapacity which might have affected his ability to safely control the aircraft.

3. The aircraft had been maintained in accordance with the approved schedules, and there was nothing to suggest that it was not capable of normal operation at the time of departure from Sydney Airport.
4. The weight and centre of gravity of the aircraft were estimated to be within the limits specified in the approved Flight Manual.
5. The provision of air traffic control services was not a factor in the accident.
6. There were no meteorological conditions that might have contributed to the accident.
7. The aircraft was technically rendered un-airworthy by virtue of a defect in the rate of turn indicator, which formed part of the FAI on the left hand side instrument panel. The presence of the defect had been known for almost 12 months, and all attempts to rectify the deficiency had been unsuccessful. The operating company had not made application to have the defect incorporated into the approved Permissible Unserviceability Schedule.
8. The operating company had made no effort to alert pilots to the continuing presence of the above defect, by placarding or removing the electrical power supply to the instrument.
9. The presence of the defect did not compromise the ability of the crews to operate the aircraft safely under normal conditions.
10. The pilot in command intended to use the flight to assess the performance of the co-pilot, who was being considered for up-grading to command status.
11. The pilot in command was known to simulate emergency instrument flight conditions while checking company pilots. These simulations took the form of failures to the FAIs on the left instrument panel, and the masking of the indicator on the right by covering or the removal of instrument lighting.
12. It was likely that on this occasion that the simulated failures referred to above were given shortly before the aircraft reached a position of 6 DME from Sydney. At this time the pilot in command had no external reference by which to monitor the attitude of the aircraft in relation to the horizon.
13. Shortly after commencing a planned turn to the left at a height of about 5000 feet, the aircraft entered a rapid turn to the right and rolled, probably to a nose-down inverted position, before entering a steep descent.
14. The pilots did not recover control of the aircraft before impact with the water.
15. Experiments conducted in a simulator confirmed that the observed loss of control was typical of that which could occur when the pilot had no single attitude reference instrument, and at a time when the rate of turn indicator was operating in the incorrect sense.

Relevant Events and Factors.

1. There was a known malfunction of the rate of turn indicator.
2. The pilot in command possibly simulated simultaneous failures of all three flight attitude indicators.
3. There were no external references by which the crew could assess the attitude of the aircraft.
4. A loss of control of the aircraft occurred at a height of about 5000 feet.
5. The crew did not recover control of the aircraft prior to impact with the sea.

4. SAFETY RECOMMENDATIONS

4.1 When the likely circumstances of the accident had been established, the following recommendation was made to the Department of Aviation:

"That consideration should be given to prohibiting comprehensive simulated flight instrument failures while training and checking at night and in non-Visual Meteorological Conditions."

The Department of Aviation subsequently advised that the recommendation had been accepted, and appropriate steps had been undertaken to alert the aviation industry.

4.2 Because of the difficulty in determining the final flight path and subsequently locating the wreckage of the aircraft, due in part to the failure of the Underwater Locator Beacon on the Flight Data Recorder, and the lack of recorded primary radar information, the following recommendations were also made to the Department of Aviation:

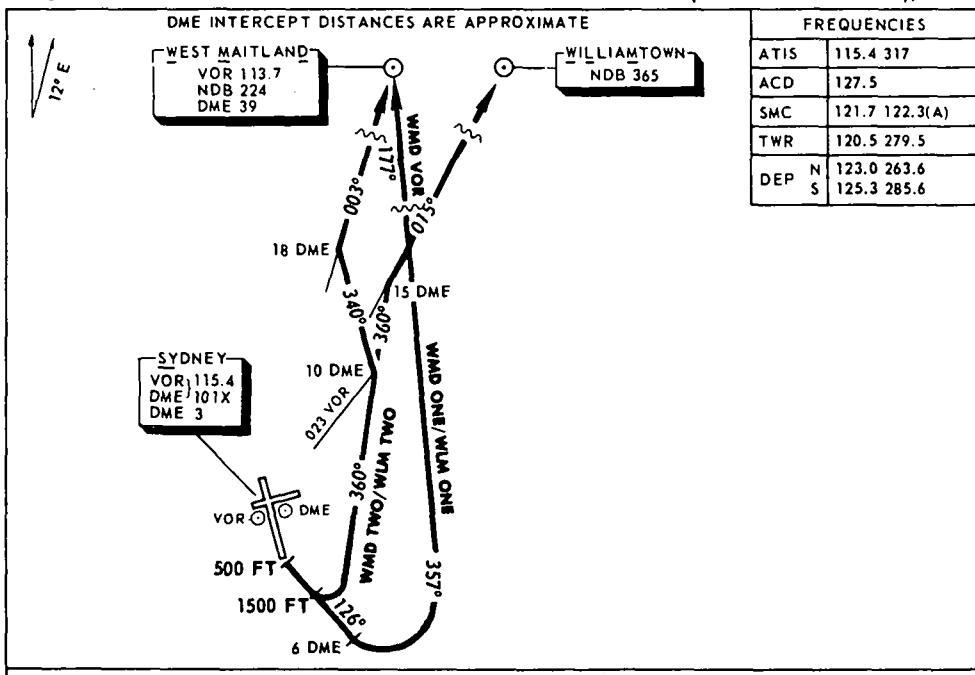
- (a) "That consideration should be given to requiring the fitment of Underwater Locator Beacons to Cockpit Voice Recorders as well as to Flight Data Recorders in aircraft required to carry such devices."
- (b) "That consideration should be given to the provision of suitable equipment to permit the recording of primary radar information from Terminal Area and Route Surveillance Radar installations."

APPENDIX A

Department of Aviation, Australia

Changes: WLM SID'S

RWY 16 NORTH SYDNEY (KINGSFORD SMITH), NSW



STANDARD INSTRUMENT DEPARTURES

16 WEST MAITLAND (WMD) ONE

- Maintain runway heading
- As soon as possible after leaving 500 FT turn LEFT and intercept 126 SY VOR
- At 6 DME SY turn LEFT heading 357°
- Intercept 177 WMD VOR
- Track to WMD and as flight planned

16 WEST MAITLAND (WMD) TWO

- Maintain runway heading
- At 500 FT turn LEFT heading 120°
- At 1500 FT turn LEFT heading 360°
- When crossing 023 radial SY VOR turn LEFT heading 340°
- Intercept 003 SY VOR
- Track to WMD and as flight planned

16 WILLIAMTOWN (WLM) ONE

- Maintain runway heading
- As soon as possible after leaving 500 FT turn LEFT and intercept 126 SY VOR
- At 6 DME SY turn LEFT heading 357°
- Intercept 015 SY VOR
- Track to WLM and as flight planned

16 WILLIAMTOWN (WLM) TWO

- Maintain runway heading
- At 500 FT turn LEFT heading 120°
- At 1500 FT turn LEFT heading 360°
- Intercept 015 SY VOR
- Track to WLM and as flight planned

AIP AUSTRALIA

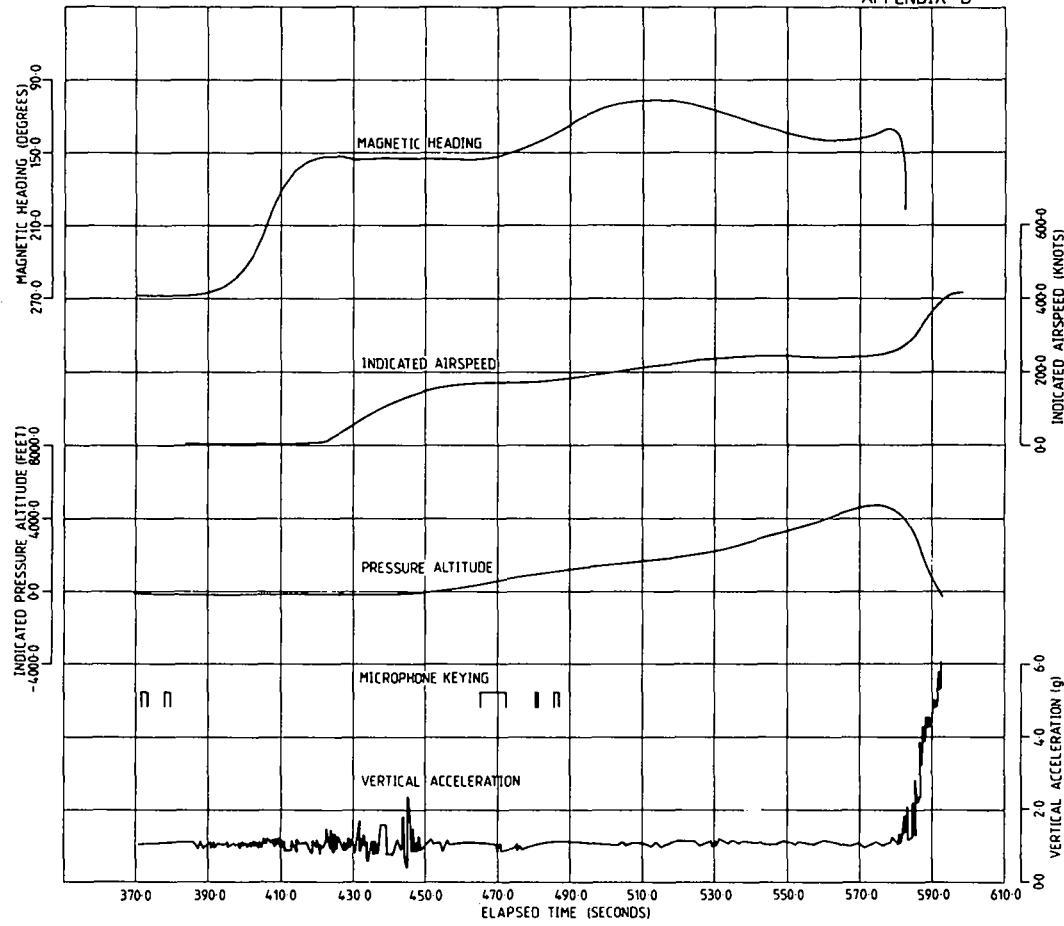
29 AUG 1985

S I D

RWY 16 NORTH
SYDNEY (KINGSFORD SMITH), NSW

VH-IWJ FAIRCHILD 5424 F.D.R. DATA READOUT
FROM TAKE-OFF CLEARANCE TO IMPACT

APPENDIX B



APPENDIX C

TRANSCRIPT OF COCKPIT VOICE RECORDER, RECOVERED FROM IAI WESTWIND VH-IWJ
AND RELATING TO AN ACCIDENT ON 10 OCTOBER 1985

LEGEND

CAM	Cockpit area microphone voice or sound source
CAM - 1	Occupant in right hand seat
CAM - 2	Occupant in left hand seat
CAM - ?	Voice not identified
SY TWR-	Sydney Aerodrome Controller
SY DEP-	Sydney Departure Controller
(---)	Unintelligible word(s)
// //	Explanatory note
()	Words open to other interpretation
.....	Significant pause

INTRA-COCKPITAIR-GROUND COMMUNICATIONS

Time GMT	Source	Content	Source	Content
1454:38			CAM-1	India Whiskey Juliet's ready
1454:40			SY TWR	India Whiskey Juliet contact one two six decimal one airborne clear for take-off
1454:45			CAM-1	India Whiskey Juliet
1454:47	CAM-1	anti-skid		
1454:48	CAM-2	is on lights out		
1454:49	CAM-1	pitot and angle of attack		
	CAM-2	is on		
1454:52	CAM-1	annunciators panel		
1454:56	CAM-2	is clear apart from the pitot light and (---)		
1454:59	CAM-1	landing lights and strobes are on radar er we wont worry about transponder is on radars to standby transponder is on thanks I forgot it		
1455:09	CAM-2	yep		
1455:10	CAM-1	um VLF I'll engage your headings one ninety now		
1455:18	CAM-2	yep		
1455:19	CAM-1	.flight control sorry		
	CAM-2	full and free		

INTRA-COCKPITAIR-GROUND COMMUNICATIONS

Time GMT	Source	Content	Source	Content
1455:22	CAM-1	checks are complete and we are clear for take-off		
1455:25	CAM-2	okay thirteen twenty-five thirty three and ninety six four maximum (level) ninety eight		
1455:31	CAM	//engine noise increases//		
1455:38	CAM-2	set the power		
1455:43	CAM-2	eighty knots		
1455:44	CAM-1	you have control		
1455:50	CAM-1	V one		
1455:54	CAM-1	rotate		
1455:58	CAM-1	positive climb		
1455:59	CAM-2	brakes on gear up		
1456:04	CAM	//reduction in noise as undercarriage is retracted//		
1456:07	CAM-2	yaw damper		
	CAM-1	is in		
1456:10			CAM-1	Goodday Sydney Departures India Whiskey Juliet is climbing to flight level three seven zero and ah looking for a short cut to Brisbane
1456:21	CAM-2	and flap away		

INTRA-COCKPITAIR-GROUND COMMUNICATIONS

Time GMT	Source	Content	Source	Content
1456:22			SY DEP	India Whiskey Juliet good morning you're identified have you got Omega
1456:26			CAM-1	Affirmative sir
1456:28			SY DEP	Ok ah probably get direct Brisbane will advise
1456:31			CAM-1	India Whiskey Juliet
1456:35	CAM-2	and after take-off checks when you're ready		
1456:39	CAM-1	and er um away we go gear		
	CAM	//background noise - altitude alert//		
1456:45	CAM-2	is up and indicating		
1456:47	CAM-1	flaps		
1456:48	CAM-2	up and indicating		
1456:49	CAM-1	yaw damper		
1456:50	CAM-2	is engaged		
1456:52	CAM-1	anti-ice		
1456:55	CAM-2	is off		
1456:57	CAM-1	climb power		
1457:02	CAM-2	set		
1457:04	CAM-1	pressurisation		
1457:07	CAM-2	set and climbing		

INTRA-COCKPITAIR-GROUND COMMUNICATIONS

Time GMT	Source	Content	Source	Content
1457:12	CAM-1	checks complete		
	CAM	//background noises - altitude alert//		
1457:31	CAM-1	well we will just do some emergency er (flying checks)		
1457:36	CAM-2	okay		
1457:49	CAM-2	six DME it was left on three five seven wasn't it		
1457:52	CAM-1	that's right just coming up to six now		
1457:59	CAM-1	you've lost (these two)//(this thing)?//		
	CAM	//background noise - altitude alert//		
1458:05	CAM-?	(Yeah I know where are we ----)		
1458:13	CAM-?	(pull)		
	CAM	//airflow noise increases//		
1458:24		END OF RECORDING		

