TRANSPORT ACCIDENT INVESTIGATION COMMISSION

TE KOMIHANA TIROTIRO AITUA WAKA

AIRCRAFT ACCIDENT REPORT

No. 89-064

CONVAIR 340/580 ZK-FTB

Manukau Harbour

31 July 1989

Transport Accident Investigation Commission
Wellington · New Zealand

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Transport Accident Investigation Commission
Wellington

Chief Commissioner
Transport Accident Investigation Commission

The attached report summarises the circumstances surrounding the accident involving Convair 340/580 aircraft ZK-FTB at Manukau Harbour on 31 July 1989 and includes suggested findings and safety recommendations.

This report is submitted pursuant to Section 8(2) of the Transport Accident Investigation Commission Act 1990 for the Commission to review the facts and endorse or amend the findings and recommendations as to the contributing factors and causes of the accident.

1 July 1991

R CHIPPINDALE
Acting Chief Executive

APPROVED FOR RELEASE AS A PUBLIC DOCUMENT

16 July 1991

M F DUNPHY
Chief Commissioner

AIRCRAFT:	Convair 340/580	**OPERATOR:**	Air Freight New Zealand
REGISTRATION:	ZK-FTB	**PILOT:**	Mr P H Johnson
PLACE OF ACCIDENT:	Manukau Harbour, Auckland	**OTHER CREW:**	Two
DATE AND TIME:	31 July 1989, 2200 hours	**PASSENGERS:**	Nil

SYNOPSIS:
See page 4.

1.1 HISTORY OF THE FLIGHT:
See page 4.

1.2 INJURIES TO PERSONS:
Crew: 3 Fatal

1.3 DAMAGE TO AIRCRAFT:
Destroyed

1.4 OTHER DAMAGE
Nil.

1.5 PERSONNEL INFORMATION:
See page 5.

Flight Times (Captain)

	Last 90 days	Total
All Types	51.4	3760
On Type	51.4	140.6

Flight Times (Co-Pilot)

	Last 90 days	Total
All Types	6.1	1086
On Type	6.1	6.1

1.6 AIRCRAFT INFORMATION:
See page 7.

1.7 METEOROLOGICAL INFORMATION:
See page 9.

1.8 AIDS TO NAVIGATION:
See page 9.

1.9 COMMUNICATIONS:
See page 9.

1.10 AERODROME INFORMATION:
See page 9.

1.11 FLIGHT RECORDERS:
See page 10.

1.12 WRECKAGE AND IMPACT INFORMATION:
See page 11.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION:
Post-mortem and toxicological investigations revealed no abnormalities which might have affected the crew's ability to conduct the flight.

1.14 FIRE:
Fire did not occur

1.15 SURVIVAL ASPECTS:
See page 13.

1.16 TESTS AND RESEARCH:
See page 13.

1.17 ADDITIONAL INFORMATION:
See page 20.

1.18 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES:
Nil

2. ANALYSIS:
See page 23.

3. FINDINGS:
See page 29.

4. SAFETY RECOMMENDATIONS:
See page 31.

5. REGULATORY:
See page 31.

6. APPENDICES:
Nil

* All times in this report are NZST (UTC +12 hours)

SYNOPSIS

Shortly after a night take-off from Auckland Airport the aircraft descended to collide with a bank at the aerodrome boundary before a second collision with the water surface of Manukau Harbour. The three crew were killed in the accident.

The Office of Air Accidents Investigation was advised of the accident at 2225 hours on 31 July 1989. The State of Manufacture of the airframe and engines was advised of the accident on the following day. No accredited representative of the United States was appointed, but representatives from the engine manufacturer, the Australian Bureau of Air Safety Investigation and the New Zealand Civil Aviation Authority assisted with the initial investigation. Mr J.J. Goddard, of the Office of Air Accidents Investigation was appointed Investigator in Charge.

1. FACTUAL INFORMATION

1.1 History of the flight

1.1.1 On 31 July 1989 a Convair 580 aircraft, ZK-FTB of Air Freight New Zealand, was operated as "Air Freight One". This was a scheduled night freight flight between Palmerston North (the company's base), Auckland and Christchurch. The airline was in its second week of operation.

1.1.2 The crew consisted of a training captain and two new co-pilots who were to fly alternate legs as co-pilot and observer.

1.1.3 The first leg, Palmerston North to Auckland, was flown without any reported incident; the aircraft arrived at about 2030 hours. It was unloaded and reloaded with 11 pallets of cargo and was refuelled with Jet A1.

1.1.4 On the next leg, to Christchurch, the handling pilot was to be the other co-pilot. Although she had completed her type rating on the Convair 580 this was her first line flight as a crew member.

1.1.5 After normal checks of the aircraft and cargo the doors were closed and the captain, who was handling the radio telephone (RTF), obtained clearance from Auckland Ground to start engines at 2145 hours.

1.1.6 An Airways' clearance for the flight to Christchurch was issued at 2146 hours and after engine starting was complete the aircraft was cleared to taxi to the holding point for runway 23 at 2149 hours.

1.1.7 At 2152 hours, while the aircraft was taxiing, Auckland Tower cleared it to line up and then at 2153 hours cleared it for take-off with the instruction to contact Control on 126.0 MHz when airborne.

1.1.8 The aircraft was taxied along the main taxiway to the threshold of runway 23 while the co-pilot did the take-off checks. The captain spent some time monitoring and discussing these checks in detail with the co-pilot. The detail of the final checks was not established because the tape recording from the cockpit voice recorder (CVR) ceased at 2156 hours, at the check item "RPM", when the number one engine rpm was upshifted to high speed ground idle (HSGI). No subsequent CVR record was made on this flight.

1.1.9 The aircraft was lined up normally on the threshold of the runway where it held position. At 2157 hours Auckland Tower confirmed that the aircraft was cleared for take-off. The reply from Air Freight One was "We'll be rolling in thirty seconds".

1.1.10 The aircraft commenced the take-off at 2159 hours. A normal ground roll, rotation abeam the control tower and initial climb were observed by witnesses. The last sighting of the aircraft lights was when it had travelled about 2/3 of the runway length as it apparently flew through a patch of drizzle.

1.1.11 The aircraft was not seen or heard subsequently by any witnesses at Auckland Airport. Two remote witnesses, on the west and south sides of the harbour, heard an isolated explosion just after 2200 hours but were unable to see what caused it because of the poor visibility.

1.1.12 No RTF call from Air Freight One was received by Auckland Control and no radar return was observed when it was expected to depart from the aerodrome. At 2201 hours Auckland Control queried the departure with Auckland Tower. After RTF and visual checks were made without result, Auckland Tower assumed that the aircraft had been involved in an accident and commenced their emergency procedures.

1.1.13 The aerodrome Rescue Fire Service was advised at 2204 hours and the formal emergency was declared at 2205 hours. The Rescue Fire appliances and marine equipment were mobilised at 2206 hours and a boat was launched at 2212 hours. Debris and fuel were located in the harbour at 2214 hours, confirming that the aircraft had descended into the water off the end of runway 23. The location of the submerged wreckage was established at 2255 hours.

1.1.14 Royal New Zealand Navy divers arrived at 0019 hours. The bodies of two crew members had been located in the separated cockpit wreckage by 0113 hours. The third body was found on the west side of the harbour some two weeks later.

1.1.15 The accident occurred at night at 2200 hours NZST. The accident site was on the tidal floor of Manukau Harbour. National Grid Reference 674 633 (NZMS 260 Sheet R11 "Auckland"). Latitude 37° 01'S, longitude 174° 46'E.

1.5 Personnel information

1.5.1 Pilot in command Peter Hadlow Johnson, 41, held Airline Transport Pilot Licence (Aeroplane) number 13382 valid to 16 November 1989. He held a "D" category Instructor Rating and Aircraft Type Ratings for the Bristol 170 and Convair 580 types. The licence included no limitations or endorsements.

1.5.2 He had been medically examined for the renewal of his licence on 10 May 1989 and assessed as fit.

1.5.3 His total flying time as a pilot was 3760 hours of which 3087.9 hours was in heavy (over 5700 kg) multi-engined aeroplanes. 601.7 hours had been flown at night and his logged instrument flight total was 477.6 hours. He had flown 140.6 hours on the Convair 580 type. In the previous 90 days he had flown 51.4 hours, all on the Convair 580, with 35.2 hours on ZK-FTB. He had last flown, in ZK-FTB, on 21 July 1989.

1.5.4 No instrument flying time had been recorded in his pilot logbook during the previous 90 days. It was probable that he had some recent instrument flying experience in ZK-FTB, however, as he had flown the aircraft from Canada and had flown it for 4 hours on line operations at night during July 1989.

1.5.5 His principal flying background had been with the Royal New Zealand Air Force as a Lockheed P3 Orion captain. He had subsequently flown Bristol 170 aircraft in freight airline operations in New Zealand and Canada until 1988.

1.5.6 He was qualified as a "D" category flying instructor on 22 December 1988 but was not very experienced in that role. He had not received any training as a civil or military flying instructor and his instructor rating was issued by the Civil Aviation Division without a flight test, following a written reference from Canada, after he had successfully reintroduced the B170 type aircraft to service with a Canadian operator in 1988. The introduction of the B170 aircraft involved some 136 hours as a company, check and training captain authorised by Transport Canada.

1.5.7 He was Operations Manager and a training captain with Air Freight New Zealand. His type and line training on the CV 580 was carried out in Canada in March/April 1989 by the airline company supplying the aircraft to Air Freight New Zealand. Three other captains were similarly trained to enable the airline to commence operations with a nucleus of qualified crew.

1.5.8 His last Instrument Rating annual check was completed on 26 August 1988 on a PA31 aircraft. His Canadian training had included, essentially, an Instrument Rating check on the CV 580 in March 1989.

1.5.9 He had been off duty since 28 July. On 31 July, his duty period commenced at 1800 hours.

1.5.10 Co-pilot Kirsty Theresa Kennedy, 28, held Commercial Pilot Licence (Aeroplane) number 14524, valid to 31 January 1990. She held an Instrument Rating, Aircraft Type Rating for the Convair 580 and "C" Category Instructor Rating. Limitations on her licence only related to the Instructor Rating.

1.5.11 She had been medically examined for the renewal of her licence on 11 January 1989 and assessed as fit.

1.5.12 Her total flying time was 1086 hours which included 215 hours on light multi-engined aeroplanes. 32 hours had been flown at night and 101 hours on instruments. Her total on the Convair 580 type was 6.1 hours of dual training in May 1989, which she completed for the Type Rating. This flying comprised the total for the previous 90 days. 5.6 hours of this was by day and 0.5 hours by night. The records showed that the night flying part of the company training syllabus had not been completed, however. She had not flown since 29 May. She had not flown ZK-FTB.

1.5.13 In the previous 90 days she had logged 4.7 hours of instrument flying, during the Convair training in May 1989.

1.5.14 Supernumary crew member John Leslie Milne, 41, was observing the flight, seated in the jump seat between and behind the captain and co-pilot. He had flown the aircraft as co-pilot on the first leg from Palmerston North. He held Commercial Pilot Licence (Aeroplane) number 14760 valid to 17 August

1989, with an Instrument Rating, Aircraft Type Ratings for the Beech 300 and Convair 580 types and "C" and "D" Category Instructor Ratings.

1.5.15 His total flying time was 2604 hours which included 795 hours on multi-engined aeroplanes. 221 hours had been flown at night and 391 hours on instruments. His Convair 580 experience consisted of 6.8 hours of dual training in May 1989.

1.6 Aircraft information

1.6.1 ZK-FTB was constructed by the Consolidated Vultee Corporation as a Convair 340, serial number 180, in 1954. Subsequently it was redesignated as a Convair 580 model when it was modified by the installation of Allison turbine engines. Other modifications carried out before it was imported into New Zealand were related to its conversion to a freight aircraft. All were in accordance with Supplemental Type Certificates.

1.6.2 It was exported to New Zealand from Canada and registered on 18 July 1989. A Certificate of Airworthiness in the Standard Category was valid until 17 July 1991. Maintenance Release number 301803, for air transport operations, was issued on 20 July 1989 and was valid until 30249.7 hours in service. The aircraft had flown a total of 29999.4 hours, of which 49.7 hours were flown by Air Freight New Zealand pilots.

1.6.3 The two engines were Allison model 501-D13D. The left engine was serial number 501770 and the right engine was serial number 501773. Both engines had run 5882 hours since new.

1.6.4 The two propellers were Aeroproducts model A6441FN-606. The left propeller was serial number 284 and the right propeller was serial number 692. Times since overhaul were 5428 and 436 hours respectively.

1.6.5 The aircraft was refuelled at Auckland with 1440 litres of Jet A1 fuel. The total fuel on board was approximately 4000 litres at take-off.

1.6.6 The take-off mass of the aircraft was calculated to be 25401 kg and the zero fuel mass 22181 kg. The centre of gravity was calculated to be 28% mean aerodynamic chord (MAC). The respective limits were 26 375 kg, 22 675 kg and between 24.5% and 34% MAC.

1.6.7 The trim sheet was prepared and signed by the co-pilot before departure at Auckland. She had used incorrect empty aircraft weight and index figures. The result of this error was to place the calculated centre of gravity at 27% MAC. The error was apparently undetected by the captain, who was required to check the trim sheet.

1.6.8 The cargo consisted of 11 "cargons" which were individually numbered and loaded according to a load plan prepared by the crew. These were restrained in the aircraft by two metal fittings between each cargon which were pinned to floor rails. The load occupied the total cargo floor space.

1.6.9 The aircraft flight instruments included a dual Sperry "Stars" flight director instrument system which provided an independent attitude direction indicator (ADI) and radio navigation instruments for each pilot. Separate directional and vertical gyros provided attitude signals to each pilot's instruments. A separate stand-by artificial horizon was also fitted to each pilot's instrument panel alongside each ADI. *(Figure 1)*.

1.6.10 The aircraft was equipped with a radio altimeter system, but not with a ground proximity warning system (GPWS).

1.6.11 During the ferry flight from Canada and on several subsequent occasions, an intermittent defect had occurred with the attitude information on the co-pilot's ADI. When the defect occurred it generally appeared after about 30 minutes flying, but it had also been noticed during take-off. On each occasion the pitch attitude indication drifted to indicate a nose-up error of between 5 and 10 degrees and on at least one occasion an erroneous indication of bank was displayed. The error was evident in comparison with the two stand-by artificial horizons and the captain's ADI and from the "pitch" warning light on the comparator monitor.

1.6.12 This defect had been traced by the Airline's avionics maintenance engineer to the vertical gyro driving the co-pilot's ADI, but had not been rectified because a replacement was not available. A new vertical gyro had been ordered from overseas and the "action taken" entry of 27 July 1989 on the aircraft maintenance log was "deferred for parts".

1.6.13 The Airline's approved CV 580 Minimum Equipment List (MEL), stated:

"Horizon Indicator Systems . . . * One may be inoperative provided:

- the flight is made in day VMC, and
- the third self-contained gyro horizon indicator is operative and useable from the pilot station with the inoperative indicator.

Note: One independently slaved attitude indicator is required at each pilot station for night VMC and IMC." and,

"2. An asterisk * symbol . . . indicates the listed item, if inoperative, must be placarded to inform and remind the crew members and maintenance personnel of the equipment condition. Placards are wherever possible to be attached so as to prevent reading of indicators or operation of control devices.

A Dyno tape machine is provided to each aircraft for this purpose.

Note: Unless otherwise specified, placard wording and location will be determined by the flight crew."

1.6.14 The co-pilot's ADI had not been marked "unserviceable" or placarded in any other way. The defect had first occurred when Mr Johnson was in command of the aircraft and he was well aware of it. He had discussed it with the airline's maintenance staff, with the result that the ADI remained in service and that all pilots who flew ZK-FTB were briefed about the defect. There was a general understanding, however, that the defect only appeared after some 30 minutes flying. The operator considered the defect was not critical in this aircraft because of the proximity of the stand-by artificial horizons on each pilot's main instrument panel.

1.6.15 Miss Kennedy had been briefed on the ADI defect.

1.6.16 Other deferred defects involved a limitation on the display of "Nav" information on each pilot's RMI (radio magnetic indicator) which required a wiring modification to rectify, and a partial failure of some instrument back lighting. Separate red and white floodlighting of instruments was serviceable, however.

1.6.17 A number of defects had occurred, on the ferry flight and subsequently, with instruments, radio navigation equipment and with the autopilot. These had been rectified, with the exception of those described above.

1.6.18 The aircraft was not equipped with a crew intercom system.

1.7 Meteorological information

1.7.1 A slow moving anticyclone centred near the Chatham Islands extended a broad ridge of high pressure across central New Zealand. A weak easterly flow covered the north of North Island bringing a few showers.

1.7.2 At Auckland Airport the wind was calm throughout the evening with cloudy skies and generally good visibility. However there was a period of precipitation from 2130 to 2315 hours with visibility reducing to 5000 m.

1.7.3 A special aerodrome report (SPAR) issued at 2130 hours by Auckland Tower gave the visibility as 15 km reducing to 5000 m in drizzle.

1.7.4 "Information Juliet" broadcast on the Auckland automatic terminal information service (ATIS) from 2142 hours and acknowledged by Air Freight One, was:

"Runway in use 23, wet. Surface wind calm. Visibility 15 km reducing 5000 m in drizzle. Four octas 2500, 7 octas 4000. Temperature 10, dew point 8. QNH 1026. Expect ILS approach. 2000 foot wind 045 magnetic 10 knots".

1.7.5 The 2200 hours' routine weather report (METAR) was:

"Wind calm. Visibility 12 km in light showers. 2/8 cumulus at 1500 feet, 3/8 cumulus at 2000 feet, 7/8 stratocumulus at 3500 feet. Temperature 11, dew point 9. QNH 1026.3. Precipitation like (sic) drizzle."

1.8 Aids to navigation

1.8.1 All pertinent ground lighting for operations on runway 23 at Auckland Airport was functioning normally. This included taxiway, runway, approach and T-VASIS lights and the aerodrome and hazard beacons.

1.8.2 The primary surveillance radar at Auckland was serviceable and functioning.normally as evidenced by traffic before and after this accident.

1.9 Communications

1.9.1 Normal radio communications between Air Freight One and Auckland Tower/Ground were maintained, but no contact with Auckland Control was made. The latter contact would normally have been made shortly after take-off.

1.9.2 The tape recording of Air Traffic Service's communications was used to make a transcript of relevant items.

1.10 Aerodrome information

1.10.1 Auckland Aerodrome had a single runway 3291 m in length and oriented 052°/232° magnetic. The western 2 km of the runway and associated clearway was built on reclaimed land extending into Manukau Harbour.

1.10.2 Manukau Harbour extended some 10 km to the south-west beyond the departure end of runway 23. The land bounding the harbour was mainly rural with a low density of housing. Few ground lights were visible in clear conditions for visual reference after a night take-off from runway 23; and in conditions of substantially overcast sky and reduced visibility in drizzle as at the time of the accident, no external visual reference could be expected as soon as the aerodrome lighting passed from the pilots' view.

1.10.3 The primary surveillance radar at Auckland was sited 875 m south of the threshold of runway 23. Returns from departing aircraft normally became visible at or just beyond the departure end of the runway.

1.11 Flight recorders

1.11.1 ZK-FTB was equipped with a United Data Control cockpit voice recorder (CVR), model V557, serial number 1349 and a United Data Control flight data recorder (FDR) model FA542, serial number 3097.

1.11.2 Both the CVR and FDR were recovered from the wreckage in reasonable condition and were taken to the Australian Bureau of Air Safety Investigation for analysis and transcription of the recordings in their flight recorder laboratory.

1.11.3 The CVR tape contained an adequate quality recording of crew conversation, recorded at the cockpit area microphone, commencing prior to the "before start" checks but terminating during the "take-off" checks. The CVR had ceased to function as the number one engine rpm was shifted from low to high speed ground idle and no record of the subsequent flight was achieved.

1.11.4 The "take-off" checks done before the end of the recording occupied 4 minutes 11 seconds. Six items had been accomplished, with detailed discussion. Four items remained to be completed before take-off.

1.11.5 The relevant electronic circuits and components in the CVR were examined to ascertain if a fault was present. No fault was found to explain the cessation of recording. However some evidence of component overheating was found, and the bulk erase facility was unserviceable.

1.11.6 Another accident involving a Norwegian CV 580 occurred shortly after that which involved ZK-FTB, where the CVR was found to have failed similarly, at upshift of the number one engine. Checks with other CV 580 aircraft then disclosed the same defect with several other CVRs. In these aircraft the cause was faulty operation of electrical relays which were actuated at upshift when number one alternator came on line. This caused the power supply to the CVR to cease.

1.11.7 The installation was the subject of a Supplementary Type Certificate (STC) issued by the United States Federal Aviation Administration. After the FAA became aware of the widespread nature of the defect they commenced an investigation which was expected to result in the withdrawal of the STC and the taking of appropriate corrective action.

1.11.8 The routine functional checks on the other CV 580 aircraft in New Zealand were modified to ensure continued operation of the CVR. The checks had previously been required only with the engines in low speed ground idle (LSGI).

1.11.9 The FDR recorded by engraving traces onto stainless steel foil. The rate at which the foil medium travelled through the magazine was controlled by a gear train driven from a synchronous motor which in turn was driven directly from the power system of the aircraft. The movement of the foil was essentially continuous at six inches per hour. There were no clutches or disengaging devices in this unit that could have interfered with the continuous movement of the foil.

1.11.10 Included in this drive was a device which sensed the tension of the foil continuously. If anything interfered with the motion of the foil either by a jamming of the take-up drive, or the foil tearing or the spool of medium being exhausted, the tension as measured by this drive decreased at this point, and a worm sliding on a shaft was caused to change its position thereby opening a microswitch. This connected the heater winding of a time-delay relay into the power circuit and after 15 seconds, if the condition had not corrected itself, should have opened the main power circuit into the recorder, causing the function relay to be de-energized which in turn would have shut off the recorder system and operated the "Inop" light.

1.11.11 The FDR had failed to record during this flight and for some 10 hours previously, because the foil had torn diagonally across its width and could not wind onto the take-up spool. As the foil was fed from the supply roller it had bunched up at the scribe bar, with any recordings superimposed.

1.11.12 Examination of the foil showed that it had run normally for about 4 hours, and had then been rewound. The resulting second set of traces were not active during the next 4 hours, in a manner consistent with static running on the ground. The tear had then occurred at the end of the first set of traces, commencing at a sprocket hole in the foil.

1.11.13 Rewinding the foil would have necessitated removing the foil magazine from the FDR. The magazine contained enough foil for 400 hours' operation.

1.11.14 The maintenance schedule prescribed an inspection which would detect the torn foil at each 100 hour inspection of the aircraft. The last such inspection had been done by the Canadian airline company before handover to Air Freight New Zealand.

1.11.15 The New Zealand airworthiness requirements did not require a cockpit voice recorder to be fitted to any New Zealand registered aircraft.

1.12 Wreckage and impact information

1.12.1 The first evidence of ground impact along the flight path of ZK-FTB was a series of propeller slash marks in loose soil in the low embankment at the south-west end of the aerodrome. A blade tip embedded between rocks at the fourth slash was identified as being from the right propeller. These marks were located 387 m beyond the end of runway 23 and 91 m left of the extended centreline.

1.12.2 The only other ground mark was on a large rock in the embankment which was 3.5 feet above the aerodrome surface. It was approximately 6 m to the right of the propeller slashes and 6 m further along the flight path. This mark was evidently produced by a heavy impact, from the lower surface of the right wing just inboard of the aileron, which caused the separation of the outer 6 m of that wing.

1.12.3 These ground marks and corresponding aircraft marks gave the only evidence of the aircraft's attitude at impact. The sequence of propeller slashes did not significantly deepen, indicating that the descent angle was shallow or level and the absence of rear fuselage impact marks suggested that the pitch attitude was not markedly nose-up. It was banked some 5° to the right and yawed 4° to the right when the wing struck the rock.

1.12.4 The fragmented wreckage lay in the tidal waters of Manukau Harbour, commencing at the shoreline below the propeller slash marks and spread along a track of 237° magnetic for a distance of 335 m. It was generally off the southern side of the pier which supported the approach lights for runway 05.

1.12.5 The next item on the wreckage trail was a blade from the right propeller, followed by the separated right wing section. The empennage, sections of rear fuselage, propellers with reduction gearboxes and engines within their nacelles were scattered along the trail leading to the cockpit section. The propellers were on the left and right sides of the trail, as appropriate. The complete left wing outboard of the nacelle was off the trail, against the pier where it was probably set by the current before sinking. The major wing centre section structure was substantially fragmented. Many small fragments of structure, cargo pallets and cargo items lay over the whole area and to the north-west, in the direction of the current.

1.12.6 The wreckage was recovered to a hangar and laid out flat in an approximate formal relationship. The completeness of the structure, control surfaces and hatches was established. All hatches were confirmed as closed at impact. The right side forward cargo door was separated, with the handle in the "open" position. However, the fragment of fuselage structure which comprised the door sill showed from a matching damage pattern, that the door had been closed at impact.

1.12.7 The undercarriage and flaps were fully retracted. The flight control gust lock pins were withdrawn from each system. The trim tab controls were each set close to zero and their screw-jacks were in appropriate positions. The control positions at impact were not determined, but the continuity of each system was established and the control surface hinges were verified. It was not possible to establish if any control obstruction had occurred, because of the structural fragmentation. The autopilot servos were free. The servo and trim tabs, elevator down spring and aileron/rudder interconnect showed no evidence of pre-impact failure.

1.12.8 Instrument indications found included:

CAPTAIN'S PANEL
ADI 10° nose down, 8° left bank, both warning flags
Clock 10.00 o'clock
HSI Heading 230°
Instrument power indicator white, power switch normal

CO-PILOT'S PANEL
ADI 0° pitch, 0° bank, both warning flags
Clock 09.59 o'clock
Instrument power indicator white, power switch normal

ENGINE PANEL

	Left	Right
TIT	908°C	918°C
HP	3450	3060
Fuel Flow	1430	1230

1.12.9 The cockpit section did suffer significant further damage during the recovery operation. However a photograph taken some 12 hours after the accident, before recovery damage occurred, did show both ADIs in these same positions.

1.12.10 Control positions on the centre pedestal included:

Hydraulic by-pass lever	Up (by pass)
Auto feather switch	"OFF"
Propeller synch selector	"SYNCH"
Landing gear selector	"UP"

1.12.11 No significant or abnormal control or switch selections were found on the overhead panels.

1.15 Survival aspects

1.15.1 Although the aircraft was severely fragmented in the water impact, the separated cockpit section retained its structural coherence in spite of substantial bottom and left side damage. The crew seats had broken away from their attachments, suggesting that the forces involved had been beyond the design criteria.

1.15.2 The right seat and jump seat occupants received incapacitating injuries which would have prevented their escape from the submerged wreckage. The left seat position was probably unsurvivable because of the left side damage to the structure of the cockpit.

1.15.3 The five minute time lapse between the accident and the formal alerting of the Rescue Fire Service was a result of there being no witnesses and no visible evidence of the accident. The water search, based on an assumed location only, was commenced seven minutes later and located the wreckage 55 minutes after the accident.

1.15.4 In these circumstances there was no practicable opportunity for an underwater rescue of the injured occupants within any feasible time of survival.

1.16 Tests and research

1.16.1 The two Allison engines and reduction gearboxes were stripped and inspected at an approved facility. The fuel control units were functionally tested on a bench rig. Damage found was consistent with the accident impact, but there was no clear evidence of the power at impact. No defects were found which could have prevented normal operations of either engine.

1.16.2 The two propellers were sent to the manufacturer in the United States, for disassembly and measurement of the blade angles at impact. These blade angles averaged 48.5° and 47.4° respectively.

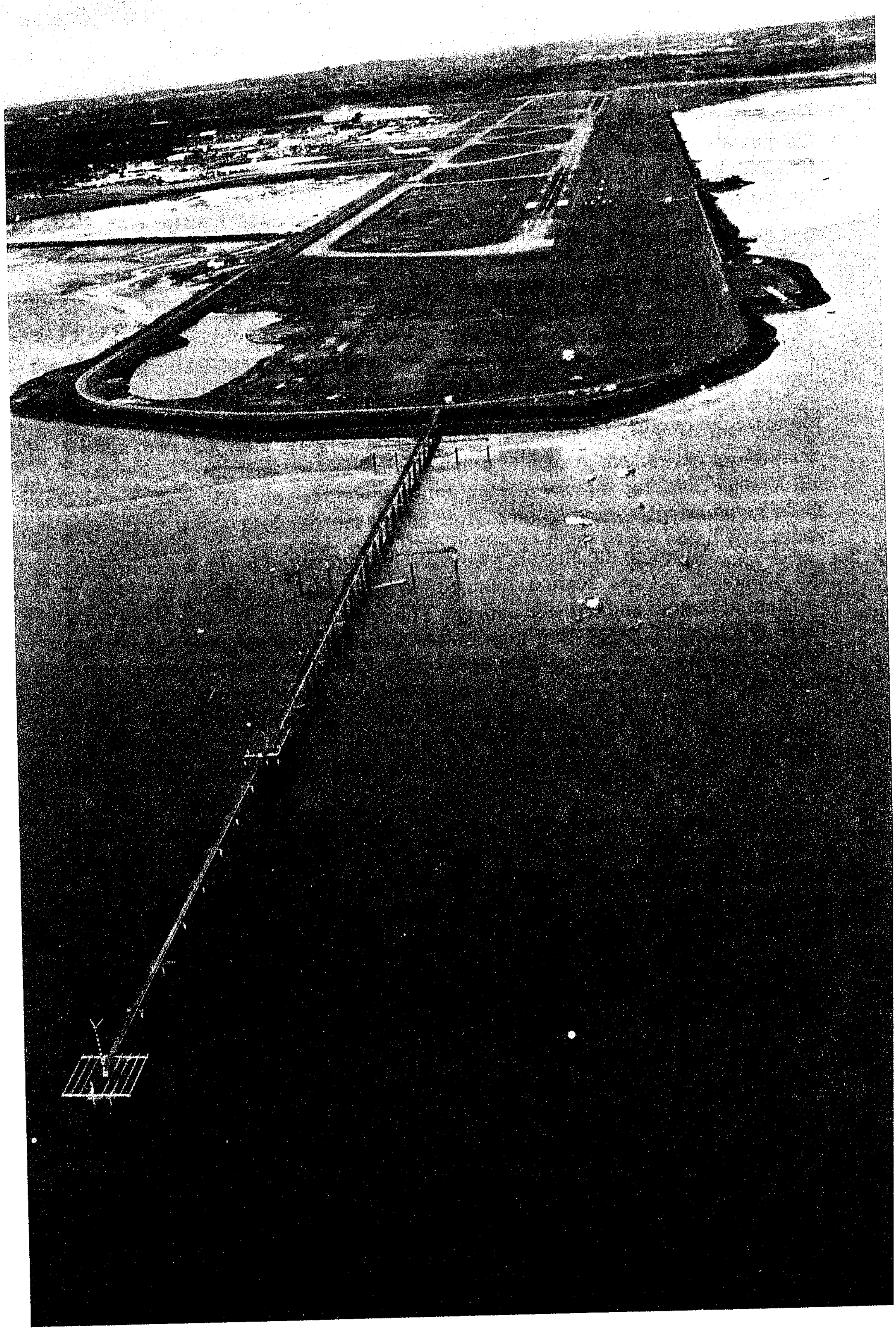
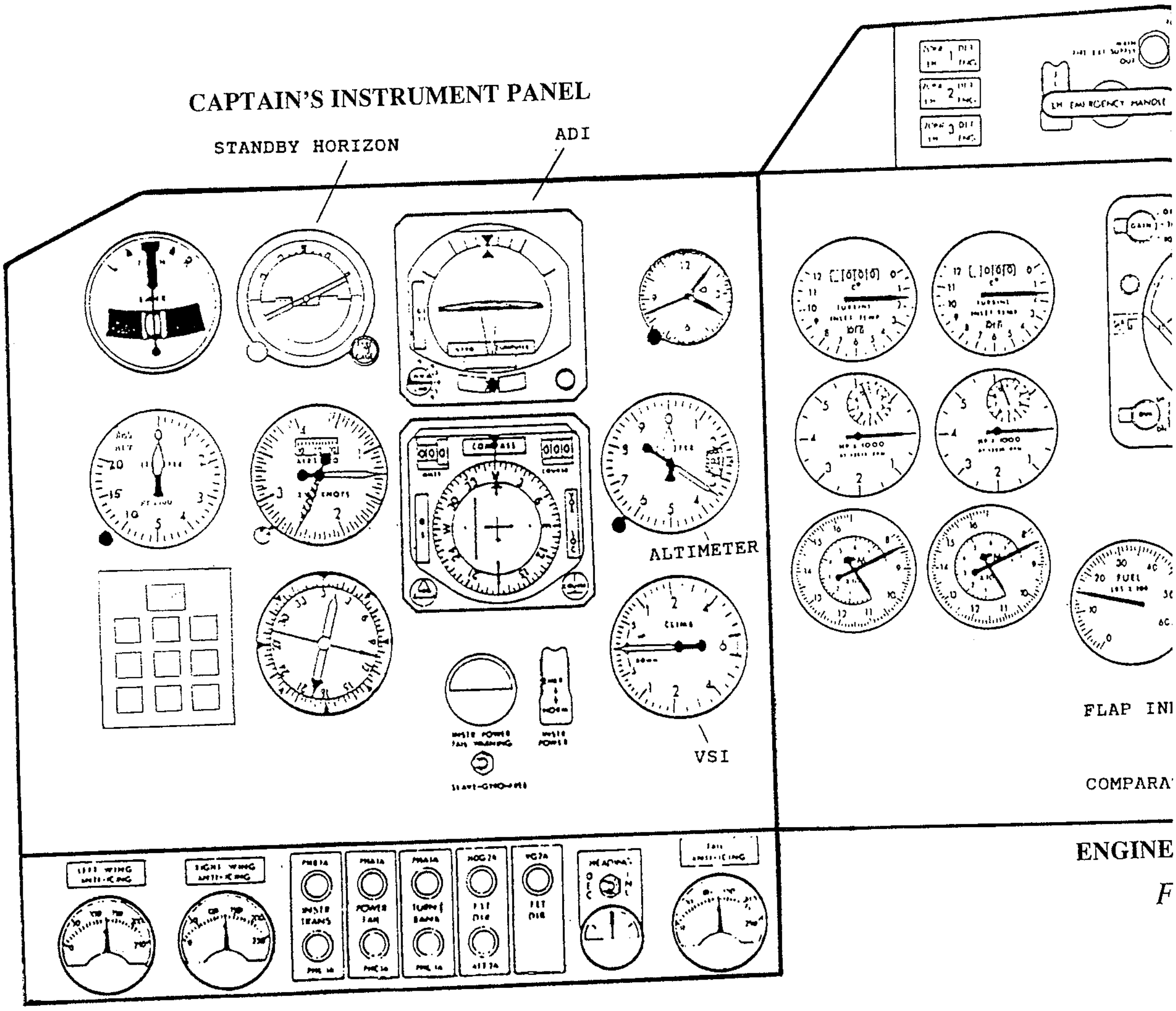


PHOTO 1

PHOTO 2

CAPTAIN'S INSTRUMENT PANEL



ENGINE

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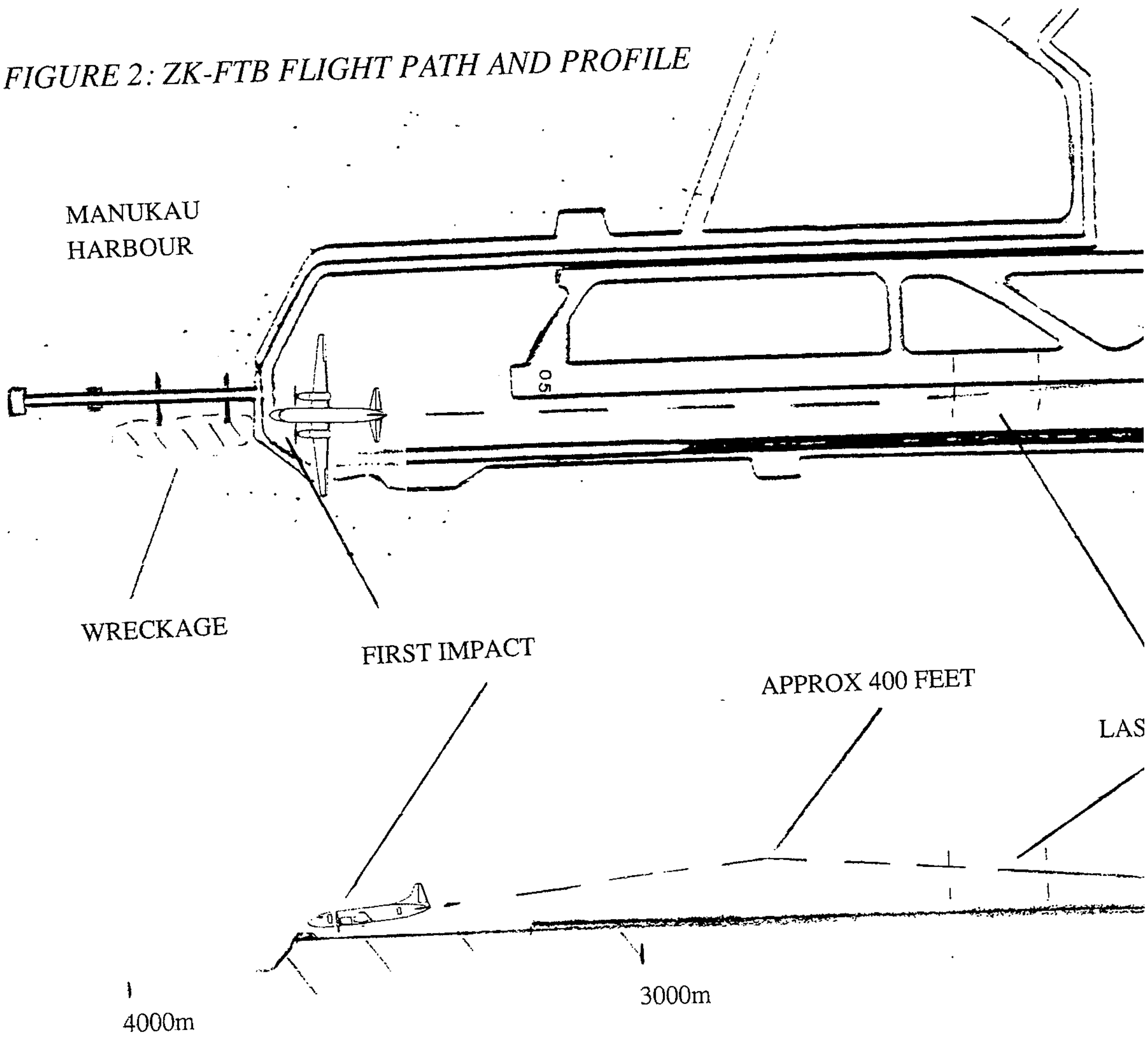
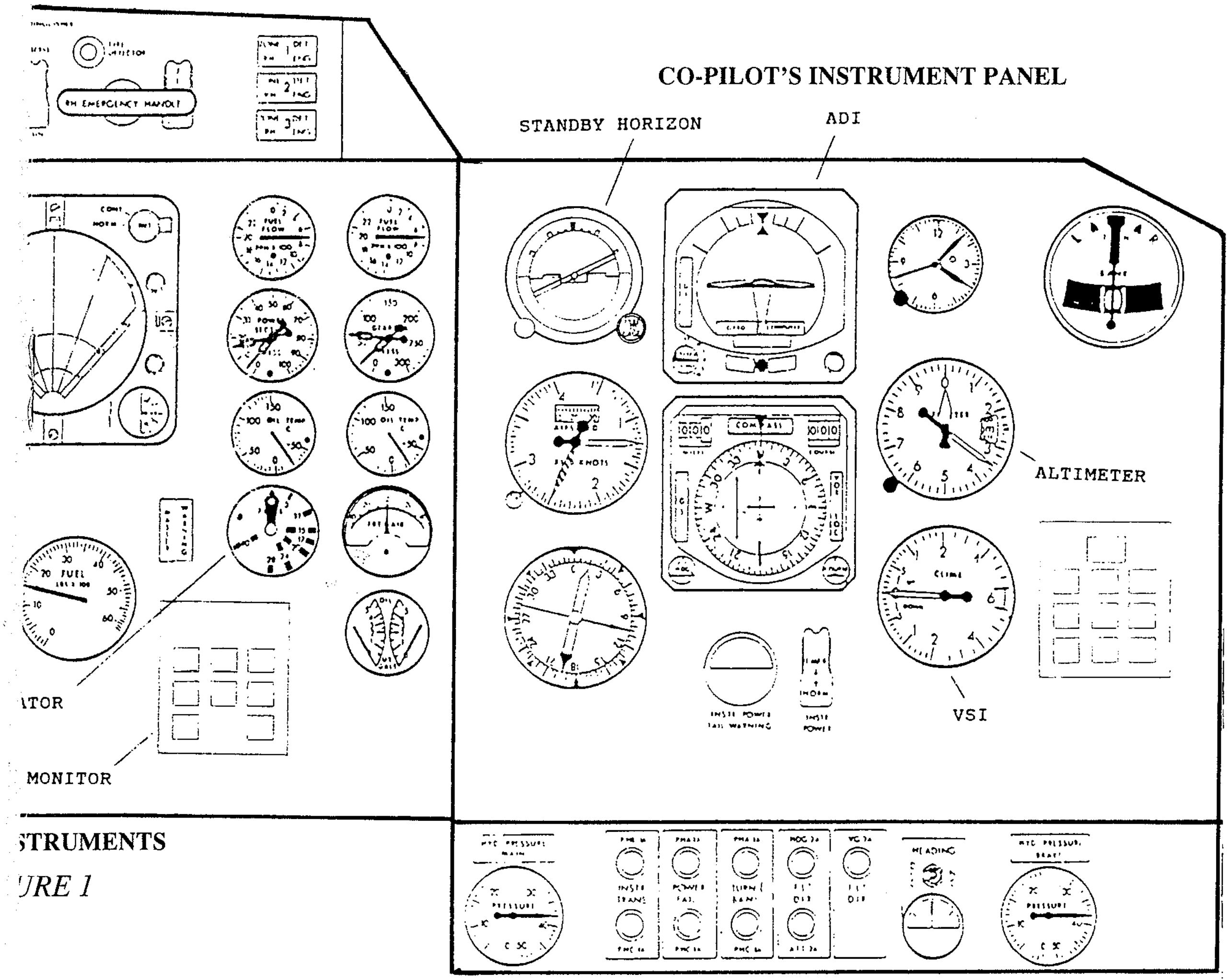
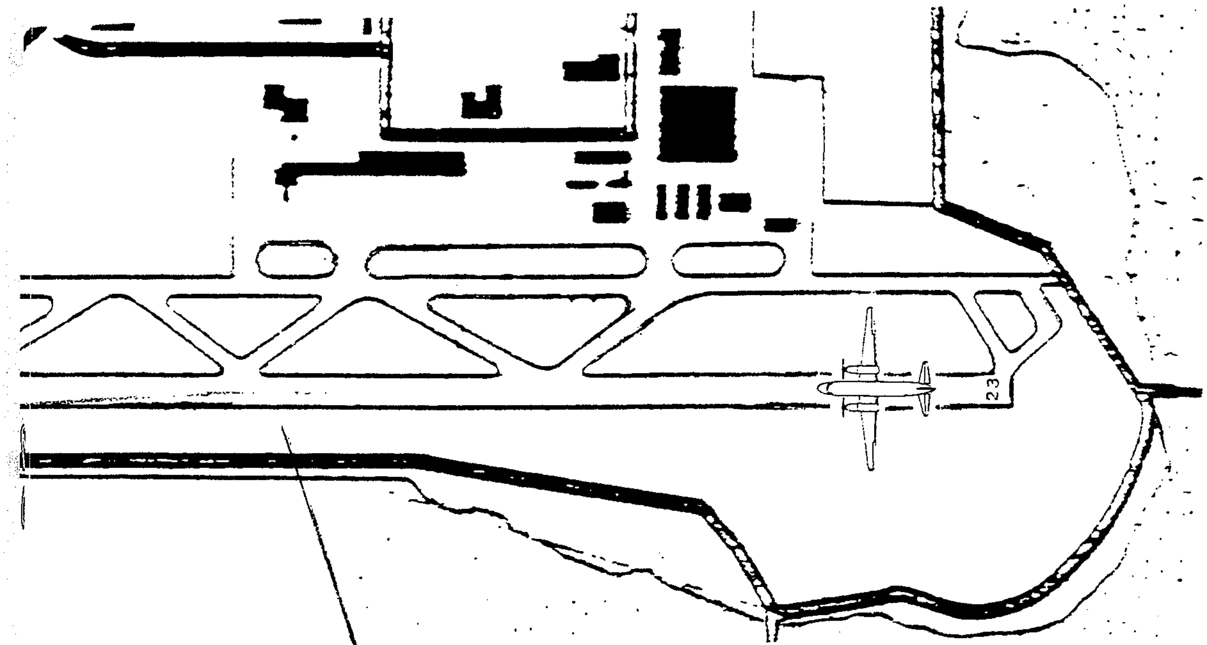
FIGURE 2: ZK-FTB FLIGHT PATH AND PROFILE





STRUMENTS

URE 1



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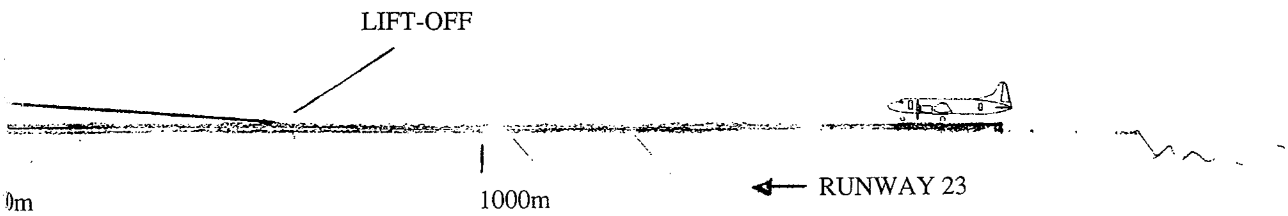

PHOTO 3

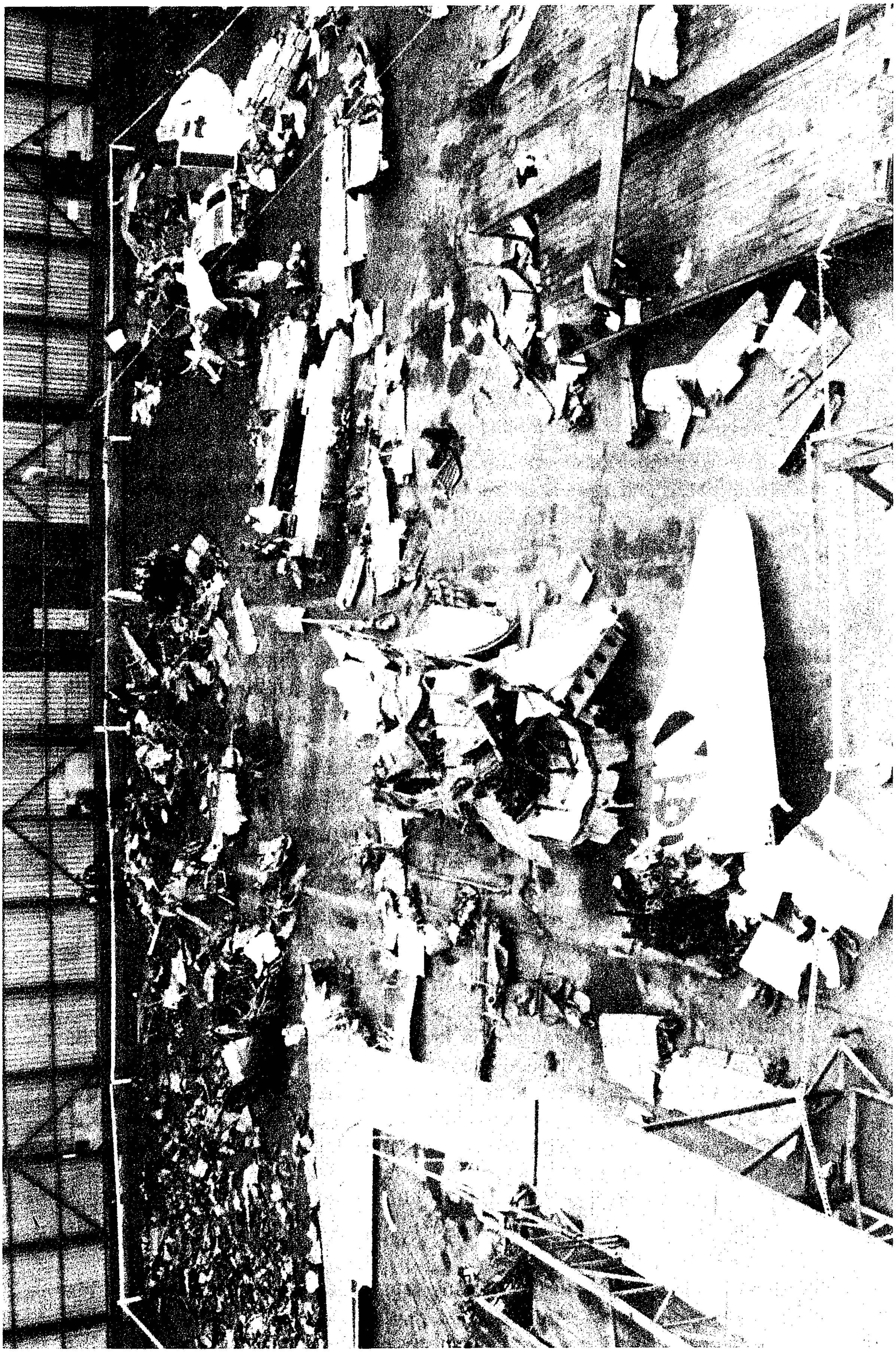

PHOTO 4

1.16.3 A blade angle of 48° at an IAS of 170 knots (normal climb speed) corresponded to a thrust of 6000 lb, or a THP of 3142 HP.

1.16.4 The distance between the propeller slash marks on the ground was used to calculate the aircraft's ground speed, assuming the governed propeller speed of 1020 rpm. This gave a speed of 178.5 knots.

1.16.5 A microscopic examination of light bulbs from the cockpit was undertaken. Good evidence of hot stretch of the filaments at impact was found on the left, centre and right glare shield instrument floodlights and also in the NAV and COMM radio control boxes.

1.16.6 Intact filaments, with no evidence of hot stretch, were found on the warning light and annunciator panel bulbs. All bulbs were complete except for the "ALTERNATOR INOP" bulbs, which were broken away.

1.16.7 Hot stretch can be a good indication that a bulb was illuminated at impact and hence that it was switched on and had electrical power. Absence of hot stretch, however, is not a reliable indicator that the bulb was not illuminated.

1.16.8 The positions and angular elevations where witnesses saw the aircraft at lift-off and at last sighting were plotted in relation to the runway and impact site. This suggested that the aircraft became airborne after a ground roll of 1400 m and disappeared from view at a height of between 237 and 258 feet, 2200 m to 2400 m along the runway, while climbing at an angle of 4.5° to 5.2°. The ground impact occurred at a distance of 3678 m from the start of the take-off *(See Figure 2)*.

1.16.9 The operator conducted some tests with a similarly loaded CV580 to determine elevator trim settings required after take-off. In each case forward trim of 1.75 to 2.75 units was initially required. After flap retraction, rearward trim wheel movement of 0.75 units was required on one occasion; no change on another.

1.16.10 Three segments of line operations, at varying aircraft weights, were also flown, with the trim settings recorded by an observer. Initial climb required 1.5 to 2 units forward; flap retraction 0.5 units rearward and accelerate to climb speed 0.5 units forward. It was concluded that the aircraft trim change at flap retraction was nose-down.

1.17 Additional information

1.17.1 The airline operation was under the surveillance of a Ministry of Transport Civil Aviation Division Airline Inspector and Maintenance Inspector. Each had attended the relevant training courses in Canada and oversaw the development of the airline's operations and maintenance procedures. The Airline Inspector had flown on several training and line flights and had planned to do so on the accident flight until called away at short notice to relieve a crew on a Civil Aviation Flying Unit flight. He had observed the ADI defect occur during his last flight and checked that it had been entered on the aircraft maintenance log.

1.17.2 Pilots who flew with Mr Johnson during their conversion said his philosophy in relation to check lists was that they were provided to check that actions had been completed by a certain stage of the operation rather than a list of actions to be completed at a particular stage of the flight. As an example he often selected the hydraulic by-pass lever "UP", the Auto Feather switch "OFF" and the Propeller Synch selector to "SYNCH" before the after take-off check list was referred to.

1.17.3 The Convair 580 Pilot's Handbook included, in the "Normal Procedures" Section:

"NOTES AND CAUTIONS: the following apply to . . . the take-off:

The Captain should be extremely alert to any change in aircraft body angle during this period if his attention is diverted away from his ADI . . .

The aircraft requires substantial elevator control pressure changes to maintain its attitude as flaps are retracted and power is reduced."

1.17.4 The disorientation potential during the acceleration after take-off was assessed by the Head of Behavioural Science Division of the RAF Institute of Aviation Medicine. It was concluded that the resultant accleration vector was inclined about six degrees from the vertical. Such a modest somatogravic illusion should not have caused serious disorientation, but would have masked the crew's vestibular sensations of a nose-down attitude of five or six degrees.

1.17.5 In the course of the investigation the procedure for the making up of the loads for the company's cargo flights was reviewed. From this study it was apparent that there could be no effective check of the contents of the numerous parcels which comprised the load of each container. These were collected from customers who presented them already packaged to be within a certain weight. While customers were advised of the nature of unacceptable items for air freight this was the only precaution taken against the infiltration of dangerous goods. No manifest of individual items by weight or content was available to the freight handlers who provided the aircraft captain with a declaration that no dangerous goods was included in his load. On the accident flight there was a consigment of motor cycle lead/acid batteries.

1.17.6 The New Zealand Civil Airworthiness Requirement (NZCAR) DCA/GEN/13A required the installation of an approved ground proximity warning system in turbo jet aircraft with a maximum certificated take-off weight exceeding 15 000 kg, or having flight manual authorisation to carry 30 passengers or more, by 31 December 1985.

1.17.7 CAIC AIR 3 dated June 1986 stated in Part:

"B. GROUND PROXIMITY WARNING SYSTEMS (GPWS) FOR TURBO-PROP AIRCRAFT

1. In April 1979, ICAO introduced a standard which required all turbine engined aeroplanes with a take-off weight in excess of 15000 kg, or authorised to carry more than 30 passengers, to be equipped with a GPWS.

2. Almost all ICAO countries have now adopted this operational standard. After discussion with industry the standard was finally adopted in New Zealand by means of Airworthiness Directive DCA/GEN/13 with compliance date 31 December 1985. The directive applied to aircraft used on domestic operations as well as to those flying internationally, except that provision was made for aircraft used mainly for domestic freight operations to be exempted.

3. The decision to adopt GPWS was not taken earlier mainly because of the high incidence of nuisance warnings produced by first generation equipment. Adoption was initiated when second generation equipment became available since overseas experience had suggested that false warning problems had largely been overcome.

4. Results from recent evaluations on typical turbo-prop operational profiles in New Zealand show however, that the frequencies of nuisance warnings from mode 2 (excessive closure rate to terrain) are not acceptable. Such nuisance warnings are a counter to safety because of distraction, often at a time of high flight deck activity. Common occurrence of false warnings would also ultimately negate the value of the system.

5. For the above reason Airworthiness Directive DCA/GEN/13 will be amended so that it does not apply to turbo-prop aircraft.

6. Efforts to overcome the problems will continue. Should GPWS develop to the point where it can be shown to be suitable for turbo-prop operations in New Zealand, the question of whether fitment should be mandatory will be re-examined in consultation with industry."

1.17.8 New Zealand Civil Airworthiness Requirements (NZCAR) Airworthiness Standard F1 stated in paragraph 10.1 and 10.2:

"10. DAMAGE AND DEFECTS

10.1 Damage and defects occurring between scheduled periodic maintenance shall be rectified before the next flight, except that:

(a) Rectification of damage or defects may be deferred if an appropriately licensed or approved aircraft maintenance engineer is satisfied after inspection that airworthiness is not impaired and issues a Certificate of Compliance attesting to that effect. Unserviceable equipment and indicators must be appropriately placarded. Deferment is not permissible if it conflicts with the provisions of an approved Minimum Equipment List.

(b) An aircraft may fly with prescribed components or systems unserviceable in accordance with the provisions of an approved Minimum Equipment List.

(c) An aircraft may make an emergency flight with a temporary repair made but not certified, subject to compliance with the provisions of Regulation 174(f).

10.2 Deferment of rectification of damage or defects shall be notified to the pilot in command by the engineer certifying the deferment. For an air transport operator this shall be done in compliance with procedures prescribed in the approved Operators Maintenance Manual."

1.17.9 NZCAR Airworthiness Standard F9 Maintenance Requirements, required at paragraph 3.2 that a gyro instrument "shall be removed from the aircraft and tested or repaired as necessary ... whenever a defect is suspected or observed."

1.17.10 NZCAR Airworthiness Standard F12 stated in paragraph 4:

"INVALIDATION OF MAINTENANCE RELEASE

4.1 The Maintenance Release becomes invalid if:

(a) The aircraft suffers defect or damage which may affect the safety of the aircraft or its occupants, or cause the aircraft to become a danger to other persons or property. . . .

4.2 An invalidated Maintenance Release which still has an unexpired period of validity will be deemed re-instated when all work attributable to the cause of invalidation has been completed and all necessary certificates of compliance given.

4.3 The owner, operator and Licenced Aircraft Maintenance Engineer/ Approved Firm shall ensure that a Maintenance Release invalidated in terms of paragraph 4.1 is removed from the aircraft and kept in a secure place until such time as the Maintenance Release is deemed to be reinstated in accordance with paragraph 4.2 above."

2. ANALYSIS

2.1 The absence of any information from the flight data recorder or the cockpit voice recorder during the brief flight before this accident caused a substantial limitation to the available evidence. As a result some analysis of events or crew actions cannot be corroborated. The failure of both recorders from maintenance-related causes was regrettable.

2.2 The CVR failure was probably from interruption of its power supply following faulty relay operation when number one engine was upshifted to HSGI. This was not verified from the wreckage, but the failure did occur at that moment and an exactly similar defect was found subsequently in several other CV 580 aircraft overseas. The routine checks in use did not verify operation in both LSGI and HSGI, but have since been amended.

2.3 The FDR failure was from the recording foil tearing and then bunching up. The magazine had to be removed from the FDR in order to rewind the foil. This had apparently occurred some 10 hours running time before the accident. As the tear commenced at a sprocket hole at the end of the first set of traces, some damage may have been caused to the foil at that time. Rewinding the foil was not an approved maintenance action. Normal maintenance had not required removal of the magazine since the last 100 hour check, 49.7 hours before the accident. The inference was that the FDR had been interfered with by a person not familiar with the equipment, separately from normal maintenance. It was probable that the warning light intended to draw attention to a malfunction did not operate as it was operated by the same relay which was intended to stop the foil from feeding in such an event.

2.4 The duration and path of the flight, between the last witness sighting and the initial impact point, were consequently not established by the flight recorders or by witnesses. As a result, the possibility of alternative flight paths was considered. The only plausible alternative to achieve the impact location and heading was for the aircraft to have flown a circuit around the aerodrome.

Such a circuit should have been visible to eye witnesses in the prevailing weather, unless the aircraft's external lights had failed. Light bulb evidence indicated that filaments were illuminated at impact. In addition, a radar return of the aircraft would have been present during a circuit. No radar return was observed. It was concluded that ZK-FTB had made an essentially straight climb and descent between take-off and ground impact.

2.5 The lateral offset of the wreckage from the runway centreline was not considered to be significant, in view of the clear evidence that an asymmetric power loss had not occurred. The offset of 91 m in a total distance of 3678 m represented a track error of less than 1.5° and was probably a result of a small handling inaccuracy.

2.6 The impact sequence comprised a number of collisions with the ground and water. First were the right propeller slashes on the ground, culminating in a blade fracture between rocks. Next was the collision between the right wing and a rock which separated the outer wing. This was followed by a major collision or collisions with the water, where fragmentation of the aircraft structure occurred.

2.7 The available evidence of attitude at impact was only related to where each event occurred. The propeller slashes indicated a shallow descent angle while the wing collision which occurred shortly afterwards indicated 5° of bank and 4° of yaw to the right.

2.8 The ADIs were probably not trapped until the major water collision. The distance and hence time, from the first impact was not established but was probably about one second. Because the attitude of the aircraft had almost certainly changed in this period, the ADIs did not represent the attitude at the first impact. The difference between the two ADIs was likely to be of significance, however.

2.9 The aircraft's known climb flight path was extrapolated on the flight profile diagram (Figure 2) to establish a likely descent path to the known impact point. The climb had probably continued normally for a short time after the last sighting; in addition, evidence from the wreckage and propellers showed that flaps had been retracted, power probably reduced and that some items from the normal "CLIMB" checklist had been completed. Normally these actions would not be commenced until the aircraft had reached 400 feet.

2.10 The descent angle required from the 400 foot point to the impact point was approximately 7.5°. While this does not establish the actual descent path, it was probably not much steeper because of the evidence from the ground marks of a shallow impact angle, with a substantially level aircraft attitude. Descent from an extrapolated 500 foot point required 14.5°, while from 600 feet it required 36°. The aircraft probably commenced a descent from no more than 400 feet.

2.11 Possible reasons for the aircraft's descent straight ahead shortly after take-off were considered. Evidence from the propellers and engine instruments was consistent with normal climb power from both engines and ground slash marks suggested a ground speed slightly greater than normal climb speed. It was evident that a loss of engine power had not occurred. The only other reason for the descent, given that the aircraft had taken off and climbed normally and had achieved normal (flaps-up) climb speed, was that it had been pitched nose-down from the climb attitude, either deliberately or inadvertently.

2.12 Examination of the elevator control system in the wreckage established its continuity and completeness. The gust locks were withdrawn, the autopilot was not engaged and the trim was in a neutral position. It was unlikely that a control jam had occurred as there were no witness marks to such an event and the take-off and initial climb, which would have required considerably more up-elevator control movement than that needed to maintain normal climb, had been apparently normal. It was considered unlikely that a mechanical control system problem had caused the pitch down.

2.13 The loading of the aircraft, with the CG at 28% MAC, was normal and unlikely to cause handling difficulty. The undetected trim sheet error was not significant and had not prescribed an erroneous elevator trim setting for take-off. Standard practice was to set 0° trim for take-off, at all weights and CG positions.

2.14 While the pre-impact location of the cargo could not be verified from the wreckage, the loading system precluded any significant cargo shift provided the full complement of 11 "cargons" was loaded as in this case. A trim change caused by cargo shift was unlikely.

2.15 There was no evidence of fire or explosion in the wreckage, which made the possibility of crew distraction by fire, or structural failure from dangerous goods unlikely.

2.16 Evidence of hot stretch from instrument floodlight and radio control box bulbs indicated that electrical failure had not taken place to deprive the crew of instrument illumination.

2.17 The aircraft hydraulic system evidently did not fail, because of the evidence of retracted undercarriage and flaps. No other hydraulic operating system was relevant to the climb after take-off. It could not be ascertained if the flap retraction was by the crew or was uncommanded, by a system malfunction. A premature flap retraction, for either reason, could have resulted in the aircraft sinking especially if airspeed was low. The apparently normal take-off and initial climb did indicate that normal flap remained set at that stage. It similarly indicated that the take-off was not made with an incorrect flap setting.

2.18 The post mortem and toxicological investigation disclosed nothing to suggest that pilot incapacitation occurred.

2.19 The ability of the pilots to be alerted to the attitude change by their vestibular senses would have been reduced by the longitudinal acceleration of the aircraft during the take-off and initial climb, creating a false perceived nose-up sensation of about six degrees. While it was considered unlikely that serious disorientation was caused by this somatogravic illusion, it may have contributed to their non-recognition of the pitch-down.

2.20 The elapsed time of 10 minutes between starting to taxi and the take-off roll was unusually long, since there were no traffic delays. However, 4 minutes was accounted for by the CVR record of the captain discussing six take-off check items in detail with the co-pilot. The remaining 3 minutes between check item "RPM" and take-off were unrecorded and unaccounted for. Four items remained on the check list, which would normally require less than one minute to accomplish. If they had been done with similar detailed discussion, however, they would have occupied almost 3 minutes.

2.21 The handling pilot on this leg was probably the co-pilot, Miss Kennedy. This had been intended and the detail and time spent by the captain on discussing take-off procedures, as recorded before the CVR ceased, was consistent with this. The initial climb after take-off from Auckland in the prevailing weather would have been in IMC and it was probable that all night departures in the CV 580 type would be flown principally by instrument reference because of the limited view of external references in the climb attitude.

2.22 The weather at the time was probably not a factor because a runway 23 departure even on a clear night would have provided little or no more visual reference for the pilots. Turbulence was unlikely in the light wind conditions.

2.23 The principal attitude reference instrument for the co-pilot was her ADI. This ADI had a known intermittent defect in that it sometimes indicated a nose-up error of 5 to 10 degrees, generally after some 30 minutes flying, but which had also been noted during take-off. The trapped instrument indications from the wreckage showed that the captain's ADI indicated 10° nose down while the co-pilot's ADI indicated 0°. These trapped indications were probably reliable because the attitude information was signalled electrically from remote gyros and would have ceased when the power supply or the wiring was broken. It was concluded therefore that the pitch error defect could have occurred to the co-pilot's ADI during the accident flight.

2.24 The normal initial climb attitude for this weight and power setting was 6° to 8° nose-up. If the aircraft was being flown solely with reference to the co-pilot's ADI and the defect occurred, the handling pilot would have pitched the aircraft nose-down by the amount of the error, to retain the same attitude indication. Such a pitch-down could have resulted in a descent of sufficient magnitude to achieve the path of the accident flight. No attempt has been made to correlate or quantify a pitch-down with the probable flight path, because of the unknown timing of other variables such as undercarriage and flap retraction and power reduction, as well as the approximate estimation of the probable flight path itself.

2.25 Such a failure of the co-pilot's ADI should not have resulted in this accident. This was firstly because the defect was well-known and should have been anticipated at least by the captain. Secondly a competent, current and fully trained pilot could be expected to scan and cross check several instruments to confirm the attitude information from the ADI; in the initial climb the altimeter and the VSI would be particularly included because of their prompt information about climb or descent. Thirdly the aircraft had a crew of two pilots; the non-flying pilot was a training captain acting in that role with a new co-pilot and should have known that he needed to monitor her actions closely during critical flight stages and be prepared to take over control.

2.26 Any lack of anticipation by the captain may have resulted from the general understanding that this intermittent defect only occurred after some 30 minutes flying. While it was subsequently discovered that the defect had also occurred during take-off, it was not established whether Mr Johnson knew of this.

2.27 The co-pilot was appropriately licensed and type rated on the CV 580. However, her only experience on the CV 580 or on any heavy aeroplane type, was her type rating training some 9 weeks earlier. That flying was on the other company aircraft, which had a different instrument panel layout and different type ADIs. She had done no flying at all in the 9 weeks before the accident flight. Her instrument flight total for the 90 days before the accident was 4.7 hours, so she did not meet the regulatory minimum of 6 hours in the last 90 days.

2.28 The low experience, minimum experience on type, marginal currency and lack of instrument currency of the co-pilot when applied to an aeroplane which she had not previously flown and which had a different and unfamiliar instrument panel meant that during an instrument take-off - her first few seconds of handling the aircraft - her instrument scan would have been minimal. It would have been probably focussed on her principal attitude instrument, the ADI. As a result she could not reasonably be expected to detect, analyse and compensate for an ADI failure.

2.29 The failure of the captain to cope with the problem was less readily explained. The lack of evidence from the wreckage of a recovery manoeuvre such as a nose-up attitude, or increase in power, suggested that the aircraft's descent had not been detected at all. It was unlikely that the aircraft reached more than 400 feet, and descent from 400 feet would have occupied between 12 and 20 seconds, with an indicated rate of descent of between 1200 and 2000 feet per minute. A possible explanation lies in the evidence that the flaps were retracted and the power had been reduced to climb power. These actions would have been carried out by the captain and would have required monitoring of the flap gauge and the engine instruments located on the centre panel. As a result, he could have allowed his attention to be channelled away from his own flight instruments for a sufficient and critical period to allow the descent without his knowledge.

2.30 While the captain was carrying out these actions, it was probable that he would have scanned the co-pilot's ADI rather than his own, as the engine and flap instruments were closer to the co-pilot's panel. He could have thus been misled by the same erroneous ADI indication.

2.31 The retraction of flaps and the reduction of power were surprising events to have occurred within the brief time span and height achieved on the accident flight. 400 feet was the minimum height to commence flap retraction, but no urgency normally existed and prudent airmanship would defer such action, especially in a training situation, to a substantially greater height. Because of the failed CVR recording it could not be determined if this action had been in response to a standard "Flap Zero" call from the co-pilot or initiated by the captain.

2.32 The trim change with retraction of flaps on the CV 580 was nose-down. Such a trim change could have initiated the pitch-down and been undetected by the co-pilot because of an ADI error. The warning in the CV 580 Pilot's Handbook that the captain be extremely alert to any change in aircraft body angle after take-off if his attention was diverted from his ADI suggested that the aircraft was susceptible to sinking if allowed to pitch down at flap retraction. It cautioned that substantial control pressure changes were required at flap retraction and power reduction.

2.33 The captain's decision that the co-pilot should be the handling pilot was understandable in view of the training requirement of his new co-pilot. It was probable, however, that the training value of her first line flight would have been as great had she acted as a non-handling co-pilot. Given that she had little recent relevant experience and had not flown ZK-FTB before, it would have been prudent for the captain to have performed the take-off and handed over to her at a later stage. The added knowledge of the intermittent ADI defect should have reinforced the desirability of such a course of action.

2.34 The captain was qualified as a "D" category flying instructor but was not very experienced in this role, and had no background of formal training or supervised practice as an instructor. His judgement concerning his co-pilot's skills and his monitoring of her performance may have been influenced by his limited experience.

2.35 The second co-pilot seated in the jump seat might have been in a position to observe the pitch-down or the descent and alert the captain. Although his view covered only part of each pilot's instrument panel, he should have been able to see either the co-pilot's standby artificial horizon or the captain's ADI, VSI and altimeter. His ability to communicate would have been limited by the absence of an intercom system between crew members.

2.36 The aircraft was not equipped with a ground proximity warning system (GPWS). Although the fitting of such a device was recommended by ICAO for this class of aircraft on international operations it was not required for New Zealand registered turbo prop aircraft as a trial period of operating turbo prop aircraft with GPWS in New Zealand had demonstrated that the false warning rate was unacceptable. A GPWS might well have provided a timely warning to avoid the accident had one been available.

2.37 As Operations Manager and because he had flown the majority of the company's 49 hours on the aircraft, Mr Johnson had a significant involvement in the decision to keep the aircraft in service with the intermittent fault on the co-pilot's ADI. The fault had not caused a significant problem when it occurred on previous occasions. It had been positively diagnosed, but the required replacement vertical gyro was not available. By the nature of the system, the fault was isolated to the co-pilot's ADI and could not affect the captain's ADI or either of the two standby artificial horizons. Nevertheless, because of the provisions in the Minimum Equipment List and Civil Airworthiness Requirements, Airworthiness Standards, the aircraft should not have been in service on an IFR flight with the unserviceable ADI. The MEL also required that the instrument be placarded to prevent inadvertent reference to its unreliable indications should it be flown on a VFR flight.

2.38 By not implementing such a measure the captain created a potential for an ADI error to cause an accident. By requiring or allowing the inexperienced and uncurrent co-pilot to perform the take-off he made it likely that some mishandling of the aircraft would occur. By not detecting or correcting the pitch-down, he allowed it to develop into a major flight path deviation which resulted in the collision with the ground.

2.39 The company's role in these two areas, the operation of the aircraft with the intermittent ADI defect and the training of new pilots was considered. The airline management consisted of a General Manager, Operations Manager (who was the captain of ZK-FTB), Chief Pilot and Chief Engineer.

2.40 The airline was in its second week of operation and although a nucleus of captains had gained experience in Canada, overall experience of both the operation and the aircraft was low. The aircraft, although recently overhauled were old, differently equipped and with numerous initial defects.

2.41 The ADI problem was best known to the Operations Manager but the airline's engineers were aware of it as they had investigated the problem and established its cause. As they were unable to remedy it until a part arrived from overseas the airline management and particularly the Chief Engineer should have countermanded the Operations Manager's decision and grounded the aircraft in the circumstances in view of the Civil Airworthiness Requirement Airworthiness Standard F9. No such action was taken nor did they ensure that the Operations Manager took the appropriate precautions to mitigate the consequences of his decision to fly the aircraft with an unserviceable ADI.

2.42 The best and safest response to the ADI defect was to acknowledge its unserviceability, mark it accordingly, and accept that this precluded operation of the aircraft in other than day VMC, as required by the MEL. The ADI was a primary flight instrument; any defect, no matter how intermittent, which produced an incorrect indication with no warning flags to alert the pilot immediately, was clearly sufficient cause to reject the instrument.

2.43 In the early stages of the new airline's operation, it was likely that the levels of experience of the aircraft and the operation by management, flying and engineering staff alike would be low. In such circumstances, a cautious approach to problems was essential to ensure a basic level of safety was maintained. This accident suggested that less than prudent caution had been exercised concerning the defective ADI.

3. FINDINGS

3.1 The flightcrew were appropriately licensed for the flight.

3.2 The pilot-in-command was a line training captain, training a new co-pilot. He was moderately experienced.

3.3 The co-pilot had only basic type experience, and was not in current flying or instrument flying practice.

3.4 The aircraft's mass and centre of gravity were within authorised limits.

3.5 The co-pilot's ADI had a known intermittent defect, but had been retained in service.

3.6 The aircraft's MEL did not permit this flight to be undertaken with an unserviceable ADI.

3.7 The MEL required that the inoperative ADI be placarded so as to prevent the reading of its indications.

3.8 The inoperative ADI was not placarded as required.

3.9 The validity of the aircraft's Certificate of Airworthiness and Maintenance Release was compromised by flying with an unserviceable ADI, IFR at night, contrary to the requirements of the MEL and Civil Airworthiness Requirements.

3.10 The ADI defect may have recurred during the take-off, presenting an incorrect pitch attitude display to the co-pilot who was handling the aircraft.

3.11 No other defect was found which might have contributed to the accident.

3.12 The aircraft was allowed to pitch down from the normal climb attitude, without correction.

3.13 The ensuing flightpath deviation led to the collision with the terrain.

3.14 The co-pilot may not have been capable of detecting incorrect attitude information because of her inexperience and uncurrency.

3.15 The co-pilot should not have been handling the aircraft during this take-off.

3.16 Apart from the co-pilot's ADI the flight instruments displayed correct and adequate information to enable the crew to detect and remedy the pitch-down.

3.17 The captain probably misdirected his attention from monitoring the aircraft's attitude at a critical time after take-off by prematurely completing the "climb" checks.

3.18 The requirement of NZCAR, Airworthiness Standard F9 was not complied with.

3.19 The Operations Manager should not have allowed the aircraft to be flown on a scheduled IFR flight with an unserviceable ADI.

3.20 The Airline Management should have challenged the Operations Manager's decision to fly the aircraft IFR at night with an unserviceable ADI.

3.21 Both the FDR and the CVR failed to function, from maintenance-related causes.

3.22 The determination and analysis of events during the flight was limited as a result of the failure of the CVR and FDR to function.

3.23 There was no requirement for New Zealand registered aircraft to have a cockpit voice recorder fitted for domestic operations.

3.24 The declaration made to the captain of the aircraft that no dangerous goods were carried on the aircraft was not based on any realistic check that such was the case.

3.25 An undetected pitch-down after take-off resulted in a flightpath deviation and collision with the terrain.

3.26 The probable cause of this accident was the training captain's failure to monitor the aircraft's climb flightpath during the critical stage of the climb after take-off.

4. SAFETY RECOMMENDATIONS

4.1 As a result of this investigation it was recommended to the General Manager of the Air Transport Division of the Ministry of Transport that he:

Review the action taken in respect of the Office of Air Accidents Investigation's recommendation that unserviceable flight instruments be removed or covered over so that inadvertent reference cannot be made to them in flight.

Require airline inspectors charged with the supervision of the introduction of new airlines, to ensure that training captains demonstrate by flight test that they are competent for the duties required of them particularly if they have not had training as flying instructors.

Require airline inspectors to ensure pilots complete the approved training programme and meet the appropriate currency requirements before being rostered for training on scheduled services.

Institute a requirement in the Certificate of Airworthiness inspection of refurbished aircraft that all flight instruments shall have been overhauled or are within their approved "shelf" life if the aircraft have not been operated for a significant period before the refurbishing was completed.

Review the requirements for the installation of Flight Data Recorders in aircraft to recognise the latest ICAO recommendations on this subject.

Introduce a requirement for cockpit voice recorders to be fitted and maintained in a serviceable state in those New Zealand registered aircraft which would be included in the ICAO recommended criteria for the fitment of a CVR.

Review the dangerous goods procedures for freight offered by courier companies.

Align the requirement for the fitting of ground proximity warning systems with the ICAO recommendation on this topic.

5. REGULATORY

5.1 Pursuant to Section 14(5) of the Transport Accident Investigation Commission Act 1990 the legal personal representatives of the crew and representatives of the other parties concerned were invited to avail themselves of the opportunities afforded to them thereunder.

5.2 As a result of representations received the report was amended and amplified to clarify some of the points raised.

5.3 The operators advised that they considered that the requirement, in the MEL, for one "independently slaved" attitude indicator at each pilot station, was met by the standby artificial horizon fitted alongside each pilot's ADI.

5.4 The representations made to the undersigned are not to be taken as an admission of liability on the part of the parties concerned and their statements are without prejudice to their right to act in any way they may consider fit in any proceedings or action which may be based on the events to which this report refers.

16 July 1991

M F DUNPHY
Chief Commissioner