



Report 97-012

Beechcraft BE58 Baron

ZK-KVL

in-flight loss of control

Tararua Ranges, 21 km south-east of Paraparaumu

11 June 1997

Abstract

At about 0130 hours on Wednesday 11 June 1997 ZK-KVL, a Beechcraft BE58 Baron twin-engined aircraft, on a night freight flight from Palmerston North to Christchurch, disappeared from radar. The aircraft wreckage was subsequently located in the Tararua Ranges 21 km south-east of Paraparaumu. The aircraft had struck a wooded slope at high speed in a steep spiral dive, and fragmented. The pilot was killed on impact. The aircraft had probably encountered severe in-flight icing at 10 000 feet, in the area of a convective cell, resulting in a loss of control. An ingress of carbon monoxide to the cabin of the aircraft probably impaired the pilot's mental functioning and induced a loss of situational awareness. Factors contributing to the accident included a flawed operational environment, inadequate flight planning by the pilot to minimise the exposure to icing conditions and the lack of an appropriate safety culture within the operating company. The performance of the Civil Aviation Authority conducting its audits and subsequent supervision is critically examined.

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Transport Accident Investigation Commission
P O Box 10-323, Wellington, New Zealand
Phone +64 4 473 3112 Fax +64 4 499 1510
E-mail: reports@taic.org.nz Web site: www.taic.org.nz

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Wreckage of ZK-KVL

Transport Accident Investigation Commission

Aviation Accident Report 97-012

Aircraft type, serial number and registration:	Beechcraft BE58 Baron, TH492 ZK-KVL
Number and type of engines:	Two Continental IO-520-C
Year of manufacture:	1974
Date and time:	11 June 1997, 0130 hours ¹
Location:	Tararua Ranges, 21 km south-east of Paraparaumu Latitude: 40° 58.5' S Longitude: 175° 12.5' E
Type of flight:	Air Transport, night freight
Persons on board:	Crew: 1 Passengers: 0
Injuries:	Crew: fatal
Nature of damage:	Aircraft destroyed
Pilot-in-Command's licence:	Commercial Pilot Licence (Aeroplane)
Pilot-in-Command's age:	27
Pilot-in-Command's total flying experience:	1024 hours 150 hours on type
Investigator-in-Charge:	K A Mathews

¹ Times in this report are NZST (UTC plus 12 hours)

1. Factual Information

1.1 History of the flight

- 1.1.1 Shortly after 2300 hours on Tuesday 10 June 1997 the pilot of Beechcraft BE58 Baron ZK-KVL, operated by United Aviation Limited (United Aviation), was advised by the United Aviation Operations Manager of the need to make an air transport night freight flight from Palmerston North to Christchurch. The pilot had been informed about the possibility of the flight earlier that evening, and had agreed to take it.
- 1.1.2 The pilot telephoned the Airways Corporation National Briefing Office in Christchurch at 17 minutes past midnight on 11 June and advised the Flight Briefing Officer that he wanted to activate a standard instrument flight rules (IFR) flight plan from Palmerston North to Christchurch. The standard route chosen by the pilot would initially take the aircraft directly to overhead the Wellington very high frequency omnidirectional radio range (VOR), via Otaki reporting point. The standard level of 8000 feet was confirmed by the pilot, and he advised a departure time of 0045 hours. The pilot asked the Flight Briefing Officer to fax to him at United Aviation, the north and south General Aviation Area Weather, Terminal Area Forecasts (TAF) and routine Meteorological Aviation Reports (METAR) for Palmerston North, Christchurch and Wellington.
- 1.1.3 The pilot asked what the weather was like in Christchurch. The Flight Briefing Officer, reading from the Automatic Terminal Information System (ATIS) report, said the weather was calm with a visibility of 40 km in smoke haze with a few clouds at 5000 feet, and a temperature and dew point of plus four degrees. At this point the pilot asked for the Auckland TAF and METAR, and the Notices to Airmen (NOTAMs) for the area from Palmerston North to Christchurch.
- 1.1.4 The pilot prepared ZK-KVL for the flight. He fuelled the aircraft with an additional 235 litres of Avgas and the load sheet total fuel weight was recorded as 650 pounds (295 kg), giving an endurance of some 3.5 hours. The United Aviation Chief Engineer, who was working late at the hangar, assisted the pilot to position the aircraft for fuelling. All the passenger seats were removed.
- 1.1.5 The aircraft was taxied to the freight company. Freight weighing 425 kg as recorded on the air freight waybill, consisting mostly of mail and documents, was loaded on the aircraft by two freight handlers. The freight handlers advised that the pilot supervised and checked the loading of the aircraft prior to departure. About 50 kg of smaller mail packs were placed in the nose locker and the remainder in the cabin behind the pilots' seats. The heavier items were located as far forward as possible, aft of the pilots' seats, and some lighter items were placed toward the rear of the cabin. The freight handlers said the freight was stacked so that it was unlikely to move in flight. Cargo nets separated the freight from the cockpit area and rearmost cabin area. The handlers said no other method of restraint was used. No dangerous goods were recorded or were reported as being on the aircraft.
- 1.1.6 Another United Aviation aircraft, a Piper PA31 Chieftain, had returned to Palmerston North around 0040 hours from Christchurch, via overhead Paraparaumu. The Chieftain had departed for Christchurch about four hours earlier. A brief discussion took place between the two pilots, and the Chieftain pilot believed he suggested to the pilot of ZK-KVL to go high as there might be a tail wind to Christchurch. The Chieftain pilot thought he might have said that the weather was "Sweet" going to Christchurch. No further discussion occurred.

- 1.1.7 At 0054 hours the Flight Briefing Officer was advised of a new facsimile number to send the earlier requested meteorological and NOTAM information. The new number was that of the freight company. The Flight Briefing Officer asked, "Have you not already got this?" The caller said, "Yep", and the Briefing Officer asked, "Do you want it again?". The caller replied, "Yep". The Briefing Officer believed that a different person telephoned the second time to advise of the new facsimile number.
- 1.1.8 The Airways Corporation advised that the north and south General Aviation Area Weather was not sent to the pilot, as the validity period for that meteorological information had expired at midnight. The National Briefing Office was not able to provide valid route weather information for flights between midnight and 0500 hours, as the Meteorological Service of New Zealand Ltd (MetService) was the only provider during that period. The pilot however did not request or receive any information from the MetService.
- 1.1.9 At 0108 hours the pilot contacted Christchurch Control advising, "KVL at the hold on the ground Palmerston, request airways for Christchurch 8000 feet with Wellington, POB [persons on board] one." The aircraft was cleared to Christchurch at 8000 feet via the flight planned route, and the pilot read back the clearance correctly.
- 1.1.10 The aircraft departed from runway 25 at Palmerston North Aerodrome and turned left to intercept track. At 0113 hours, when the aircraft was climbing through 2000 feet, the pilot gave a departure call to Christchurch Control and advised the aircraft was climbing to 8000 feet.
- 1.1.11 The aircraft correctly intercepted track, and at 0119 hours, as the aircraft was climbing through 7400 feet, the pilot asked for clearance to climb ZK-KVL to 10 000 feet. No reason was given for the request. The aircraft was cleared as requested by the pilot who read back the clearance correctly. This was the last communication received from the pilot.
- 1.1.12 At 0123 hours the aircraft levelled at 10 000 feet on track, and at 0125 hours crossed Otaki reporting point, slightly right of track. The groundspeed of the aircraft was some 179 knots. Once the aircraft had passed Otaki it made a small course alteration to the left, regaining the track. The aircraft remained on track for a short period, and around 0127 hours veered some 6° and 0.5 nm left of track. The aircraft remained on this heading for around one minute then, about 0128 hours, veered further to the left, altering its heading some 50° over a 30 second period, while essentially maintaining 10 000 feet.
- 1.1.13 The aircraft straightened on this new heading for approximately 45 seconds. The aircraft groundspeed increased some 20 knots, and its altitude fluctuated up and down some 100 feet before the aircraft turned sharply to the right. The altitude and groundspeed began to decrease and the turn steepened. Shortly afterwards ZK-KVL spiralled to the ground at a high rate of descent, in excess of 8000 feet per minute.
- 1.1.14 The radar return was lost during the descent and Christchurch Control tried to establish contact with ZK-KVL without success. Another pilot flying from Palmerston North to Blenheim via Paraparaumu, at the time of the event, was also unsuccessful in establishing contact with the pilot of ZK-KVL. That pilot reported being in instrument meteorological conditions (IMC) at 6000 feet.
- 1.1.15 The Rescue Co-ordination Centre was notified of the missing aircraft and soon afterwards a search was initiated. During daylight, the following morning, a rescue helicopter located the wreckage of ZK-KVL, at an elevation of around 2500 feet above mean sea level in the Tararua Ranges, 21 km south-east of Paraparaumu, latitude 40° 58.5' S, longitude 175° 12.5' E.

1.1.16 The aircraft had collided with the eastern face of a densely wooded steep slope at high speed, in a steep nose down right spiralling attitude. The aircraft fragmented on impact, and the pilot was killed. No fire occurred.

1.2 Personnel information

1.2.1 Pilot: Male, 27 years of age
Licence: Commercial Pilot Licence (Aeroplane)
Aircraft Type Ratings: PA28, PA38, C152, C172, C206, BE58 and PA31
Instructor Rating: "C" Category, single and multi-engine (Aeroplane)
Instrument Rating: Multi-engine, single pilot (NDB, VOR, DME Arc)
Medical Certificate: Class 1 valid till January 1998, no restrictions
Last Instrument Rating Check: 21 September 1996, multi-engine single pilot
Last IFR Regulation 76 Check: Recorded, 27 May 1997
Last Biennial Flight Review: Not recorded
Flying experience: 1024 hours, all types
150 hours, on type
111 hours, total at night
43 hours, on type at night
63 hours, actual instrument
59 hours, simulated and ground instrument
257 hours, total multi-engine
83 hours, total multi-engine at night
Total flying, last 90 days: 165 hours
Total flying on type, last 90 days: 49 hours
Total flying, last 30 days: 42 hours
Total flying on type, last 30 days: 4 hours

1.2.2 The pilot began flying full-time for United Aviation about 16 months before the accident as a pilot and instructor and was paid a salary. He first flew the Beechcraft BE58 Baron in February 1996. During August and September 1996 he trained for a type rating on the Baron and was issued a rating on 18 September. On 21 September he successfully completed a multi-engine instrument rating flight test in the Baron, endorsed for single pilot operation.

1.2.3 The Baron was the first multi-engine aircraft the pilot had flown. In October 1996 he gained a multi-engine rating on a Piper PA31 Chieftain.

1.2.4 After gaining his instrument rating the pilot had flown the Palmerston North to Christchurch route return 13 times under IFR, in either the Baron or the Chieftain. The first time was in October 1996. He had flown the return trip five times in the Baron and eight times in the Chieftain. This amounted to a total of 41 flying hours, of which 40 hours were flown at night. Only one return trip was recorded as having been carried out during winter months. This was six days before the accident, and was flown in the Chieftain.

- 1.2.5 The pilot was held in high regard by his associates and peers. He was thought to be diligent and thorough, and familiar with Civil Aviation Authority (CAA) and United Aviation requirements. He was the United Aviation Quality Control Manager.

1.3 Aircraft information

- 1.3.1 ZK-KVL was a Beechcraft BE58 Baron, serial number TH492, twin engined aircraft, constructed in the United States in 1974.
- 1.3.2 The aircraft was registered to United Aviation on 12 December 1996, and was issued with a non-terminating Certificate of Airworthiness in the standard category on 18 December 1996.
- 1.3.3 Prior to registration in New Zealand the aircraft was operated in Australia, and was deregistered from the register of Australian aircraft on 28 November 1996.
- 1.3.4 There was no documentation detailing the avionics equipment and instrumentation fitted in the aircraft. The aircraft Flight Manual was not recovered from the wreckage, and the CAA registration file for ZK-KVL did not contain any information regarding the instrumentation and avionics equipment installed. The aircraft reportedly had sufficient avionics and instrument equipment fitted to enable it to be flown under IFR.
- 1.3.5 The maximum allowable all-up-weight of the aircraft was 5400 pounds (2450 kg). At this weight the forward centre of gravity (cg) limit was 78 inches aft of datum, and the rearward cg limit was 86 inches aft of datum. The recorded weight of ZK-KVL at take-off was 5390 pounds (2445 kg), and the cg was subsequently calculated to be about 83 inches aft of datum. The load sheet signed by the pilot recorded the cg as within limits.
- 1.3.6 The freight reportedly was stacked to minimise its movement in the cabin. Had the freight moved, its bulk and the rear cargo net would have prevented it from sliding beyond the aft limit of the cargo area. Even if it had moved to that limit the cg would have been about 86 inches aft of datum. The forward net arrangement was not specifically approved by the CAA but the restraint was similar to installations it had approved for other freight operations carrying similar types of loads. Despite a thorough search at the accident site conditions precluded recovery of more than 217 kg of weighable cargo.
- 1.3.7 The maintenance records indicated that the aircraft had been maintained by United Aviation in accordance with an approved maintenance schedule since its registration in New Zealand. The last recorded inspection was a 50 hour check carried out on 28 May 1997, at 8361 airframe hours. At the time of the accident the aircraft was recorded as having flown 8382 hours. The next inspection due was a 100 hour inspection on 28 November 1997 or 8411 hours, whichever occurred first.
- 1.3.8 During the last inspection a number of maintenance items were recorded as being repaired or rectified. Eighteen outstanding items however were recorded as being deferred. Those items were essentially of a minor nature and were unlikely to have affected the airworthiness of the aircraft.
- 1.3.9 Following the inspection, and up to the time of the accident, maintenance was carried out on a number of further items recorded as needing action. These included: cleaning and adjusting the pressure regulators (suction system) and internal regulator, adjusting the automatic pilot electrical contacts to ensure it engaged correctly, ensuring the serviceability of the left alternator, installing a new post light for the right alternator gauge, and adjusting the flight

reference instrument lights to operate on bright only, as a rheostat was on order. The Chief Engineer advised that the rheostat was bypassed to ensure it would not affect the lights. Outstanding items included: spongy brakes and binding of the right brake, the right alternator warning light remaining off, the ammeter showing intermittent readings and a flickering left engine oil temperature gauge.

- 1.3.10 A standby artificial horizon on the right side of the instrument panel was removed as it was unserviceable. This was not required for flight. There was no record or report of other flight instruments being unserviceable. The automatic pilot, cabin flood lighting and flight reference instrument lighting (apart from the rheostat), electrical system and navigation instruments were all reported to have been functioning prior to the accident flight.
- 1.3.11 A United Aviation engineer reported that on the afternoon before the accident he was asked by the Chief Engineer to clean any dust from the regulator seats on each of the two pressure pump regulators in ZK-KVL. The regulators helped to control air pressure to the gyroscopic flight reference instruments. He subsequently ran the engines, which operated normally, and noted that the gyroscopic pressure indicator showed higher than maximum pressure. He reported this to the Chief Engineer who advised him that the (rubber) pressure line to the co-pilot's (right hand standby) artificial horizon had been plugged and that a small hole had been drilled in the plug to help relieve excess air pressure.
- 1.3.12 The Chief Engineer subsequently advised that the pressure was only about one half inch of mercury above the maximum. He said the pressure line was securely plugged and that the plug was retained by a hose clip normally used to secure the line to the artificial horizon. As the gyroscopic pressure instruments normally vented used air to atmosphere the hole was there to help replicate that action.
- 1.3.13 Apart from pitot head heating, the aircraft was not equipped with any anti-icing or de-icing equipment, or ice detection lights.
- 1.3.14 A cabin heater, reportedly a Janitrol model, was installed in the nose of the aircraft. The combustion chamber exhaust for the heater was recorded on 15 May 1997 as being "Completely eroded through". However, on 16 May 1997 the heater was cleared by the Chief Engineer as being satisfactory for operation. The Chief Engineer said that the erosion was some four centimetres from the end of the exhaust, which protruded outside the fuselage. Around the exhaust and combustion tube was a stainless steel shroud. He said he visually checked the heater system, including the combustion chamber, and was satisfied it was serviceable and safe for use.
- 1.3.15 An Airworthiness Directive (AD), DCA/GEN/26, effective 22 November 1996, required the combustion tube of some models (including model B4050) of Janitrol heaters to be pressure tested and the air pressure switch checked for correct operation. The AD did not apply to those heaters with a ceramic combustion tube and upgraded air pressure switch installed. The AD was issued to prevent an aircraft fire or explosion, resulting from failure of the heater combustion tube assembly or combustion air pressure switch. The aircraft manufacturer advised that the "AD was instigated because heaters were found to have cracks in their burners. These cracks could not be detected by external inspection, and these cracks would allow exhaust gases to get into the airplane cabin. The pressure check procedure was developed to detect internal cracks." The aircraft manufacturer also said that model B4050 was the Janitrol heater authorised for fitment in ZK-KVL.

- 1.3.16 There was no record of a ceramic combustion tube and upgraded pressure switch having been installed in the heater on ZK-KVL, or of the heater make or model number. The heater was in the aircraft when it arrived from Australia, and the Chief Engineer believed the heater did not have a ceramic combustion tube or upgraded air pressure switch fitted. He could not recall if the heater was one of those requiring inspection. The Chief Engineer advised that a heater hour meter was used to record heater hours. The aircraft records however did not show the total heater hours. At the time of registration in New Zealand the heater was recorded as having 37 hours time in service since overhaul. The last overhaul and installation of the heater was on 6 April 1995, as recorded in the Australian log book.
- 1.3.17 The aircraft records showed ZK-KVL had flown 272 hours since it arrived in New Zealand.
- 1.3.18 Compliance with the AD required any affected heater with less than 450 hours time in service, since the last overhaul or new installation, to be inspected when it accumulated 500 hours time in service, or within 12 calendar months, whichever occurred first. Alternatively, an affected heater had to be inspected at initial installation, and thereafter within 100 hours time in service or 24 calendar months, whichever occurred first.
- 1.3.19 The records for ZK-KVL did not show the AD as having been complied with or being non applicable. The records did not show the status of the heater. The last recorded overhaul was 26 calendar months before the accident.
- 1.3.20 The AD was effective at the time ZK-KVL was issued with its Certificate of Airworthiness. If applicable to ZK-KVL the final compliance date for the AD was 6 April 1997.
- 1.3.21 The extent of the destruction of the aircraft during impact made it impossible to establish the status and serviceability of the heater.
- 1.3.22 The Chief Engineer believed a carbon monoxide detection tablet had been attached to the instrument panel of the aircraft, and the tablet did not indicate the presence of any carbon monoxide prior to the accident flight. However, the Chief Pilot said he was not aware of any carbon monoxide detection tablet in ZK-KVL, and other United Aviation engineers said there were no carbon monoxide detection tablets in any United Aviation aircraft including ZK-KVL. There were no pilot reports of headaches or nausea from using the heater. The heater was functional and reportedly did not emit any noticeable fumes into the cabin.
- 1.3.23 A review of defect reports by the Federal Aviation Authority (FAA) on various models of Janitrol heaters showed numerous instances where combustion tubes had eroded, cracked or burned through allowing carbon monoxide to enter various aircraft cabins. In some instances defects in the combustion tube were discovered during the pressure testing required by the AD. In a case involving a Piper PA30 twin engined Comanche, a crack was discovered about half the circumference of the exhaust pipe, about two inches (5 cm) from the output end. The exhaust was surrounded by a stainless steel shroud but exhaust fumes containing carbon monoxide had seeped into the nose cowl and cabin of the aircraft. This defect and heater arrangement appeared similar to that in ZK-KVL.
- 1.3.24 Two Continental IO-520-C engines were fitted to ZK-KVL. The records for the left engine indicated it had 353 hours to run until overhaul, and the right engine 1371 hours until overhaul. A new impulse coupling had recently been installed on the left magneto of the left engine. The records showed the number five cylinder on the left engine had been replaced two months before the accident, due to low compression.

- 1.3.25 Pilots who had flown the aircraft up to and during the night before the accident advised that the aircraft, including its engines and systems, was functioning normally in all respects. The pilot on the night of the accident reportedly did not advise of any aircraft defects to personnel with whom he had contact with, including the Chief Engineer. Nor did he inform Christchurch Control of any defects or problems with the aircraft.

Approvals

- 1.3.26 ZK-KVL was not listed in the United Aviation Operations Specifications or the Maintenance and Engineering Procedures Manual for air transport operations. To be approved to carry out air transport operations, normally a technical assessment of the suitability of the aircraft and the operator to conduct these operations had to be carried out by CAA. The aircraft would need to be maintained in accordance with specific requirements detailed in the approved Maintenance and Procedures Manual. Once approval was given the aircraft registration would be recorded in both manuals.
- 1.3.27 United Aviation had other Beechcraft BE58 Baron aircraft approved for air transport operations, and ZK-KVL was reportedly maintained in accordance with the same requirements for those aircraft. Approval would therefore normally be given on application to the CAA to have ZK-KVL approved for air transport operations. The Managing Director of United Aviation advised that application had been made to the CAA for this approval. However, there was no record with the CAA of an application having been made. The Chief Pilot advised that despite knowing the aircraft was not approved for air transport operations the Managing Director failed to advise staff it could not be used on those operations.
- 1.3.28 The aircraft was not approved for flight in forecast or known icing conditions. The BE58 Flight Manual stated that if an aircraft was not approved for flight in icing conditions it “Must not be exposed to icing encounters of any intensity”.
- 1.3.29 The Flight Manual stated that if icing was detected, the pilot must make an immediate diversion by flying out of the area of visible moisture or go to an altitude where icing was not encountered. In such cases a minimum indicated airspeed of 130 knots was to be maintained. Ice build-up on unprotected surfaces will increase drag, add weight, reduce lift, and generally adversely affect the aerodynamic characteristics and performance of the aeroplane. The ice build-up can progress to the point where the aeroplane is no longer capable of flying.

1.4 Wreckage and impact information

- 1.4.1 The wreckage of ZK-KVL was located on the eastern face of a steep mountainous slope in the Tararua Ranges, at an elevation of around 2500 feet, 21 km south-east of Paraparaumu, latitude 40° 58.5' S, longitude 175° 12.5' E. The area was heavily wooded. The aircraft first struck a large tree on the edge of a narrow gully, and observation of the swathe cut by the aircraft through the trees plus the wreckage and its pattern showed it was in a steep nose down and right turning attitude at the time of impact. The aircraft fragmented during impact, indicating it was travelling at high speed. The wreckage was confined within the gully and some 80 metres below the tree.
- 1.4.2 All major components of the aircraft were accounted for at the site. Subsequent examination and piecing together of the wreckage confirmed the aircraft was intact prior to striking the tree. No evidence was found of any structural or systems failure that could have caused the accident. There was no evidence of any fire. Control continuity could not be positively established due to the fragmentation that occurred. Nor could it be established whether a systems failure, such as electrical or instrument, had occurred.
- 1.4.3 The wings main spar and rear spar carry-through sections were pieced together and examined. Some previous cracking was evident in each lower main spar carry-through web radius, around

the huckbolts, as well as around the huckbolts in the web radius in the right rear spar lower carry-through section.

- 1.4.4 The main spar carry-through section had been repaired with approved repair kits before the aircraft arrived in New Zealand. The rear spar carry-through section had two separate cracks about one centimetre each in length around different huckbolts. These cracks had not been repaired and there was no entry in the aircraft records about the cracks. The Chief Engineer advised that he did not know about the cracks in the rear spar carry-through section. Other engineers however advised that they knew about the cracks and that the cracking had been reported and recorded in the defect log. Structural failure did not occur in any area of cracking or as a result of repairs to the main spar carry-through section.
- 1.4.5 The rudder trim was in the neutral position. The measured elevator trim screw jack positions on each elevator indicated the aircraft was trimmed 5° to 6° nose up. According to the manufacturer this equated to a slower than normal cruise speed of about 120 knots indicated airspeed for the estimated weight and cg of the aircraft.
- 1.4.6 Both engines had suffered extensive damage during the impact, and the propellers had separated from their respective engines. Neither propeller was in the feathered position. Both propellers had similar damage and showed evidence of being driven under some power and probably high revolutions per minute during impact. Examination of the remains of the engines suggested they were capable of normal operation prior to impact.

1.5 Meteorological information

- 1.5.1 The MetService provided an aftercast of the weather conditions prevailing in the area around the time of the accident, and preceding the event. The conditions were reported as follows:

The synoptic situation showed at midnight on 10 June a weak cold front was moving south-east over the country ahead of a depression some 600 km west of New Plymouth. A hook-shaped area of more active cloud, associated with an area of enhanced vorticity, appeared on the front over Auckland at about 1700 hours. This area moved rapidly south and at midnight was in the area around Levin, and by 0300 hours on 11 June was abeam Kaikoura. A band of rain moved south with the cloud.

A radiosonde balloon was released at Paraparaumu after 1100 hours on 10 June and recorded northerly winds of 25 knots at 10 000 feet. The winds backed about 50° to the north-west with the passage of the front with a slight increase in wind strength.

The freezing level was about 6000 feet. The temperature at 10 000 feet was minus 6.7° C and estimated to be minus 3.2° C at 8000 feet.

Relative humidity values, recorded by the radiosonde, were high, indicating the presence of cloud or rain. The high moisture levels indicated that an aircraft flying above about 8000 feet would probably have experienced a significant build up of ice within a few minutes.

A satellite picture taken between 0112 hours and 0119 hours on 11 June showed a band of cloud just to the south of North Island, with an associated hook of cloud lying over Marlborough and Cook Strait and extending onto the North Island to around Levin. It was not possible to get an indication of the height of the tops of the clouds from the satellite picture, but a tephigram suggests they were in excess of 25 000 feet. There was also lower cloud to the north extending beyond Palmerston North.

A radar sweep of the area was completed at 0147 hours on 11 June, from the MetService weather radar on Outlook Hill. A colour picture showed a cloud mass, with areas of rain or large cloud droplets, extending along the route of the aircraft. The radar echoes were weak (yellow) to moderate (blue), and generally moderate in the area of the accident. However, several red spots close to the accident area gave the strongest echoes and indicated the possibility of areas of greater moisture content within the cloud mass.

- 1.5.2 The Wellington METAR at 0100 hours on 11 June reported a visibility of 10 km in rain with few clouds at 1500 feet, scattered cloud at 3000 feet and broken cloud at 5500 feet. A TEMPO (temporary change) reported reduced visibility to 6000 m with broken cloud at 1400 feet. A wind of 350° magnetic at 21 knots was recorded at Mount Kaukau. The 0200 METAR was the same, except the wind at Mount Kaukau was 340° magnetic at 19 knots.
- 1.5.3 A pilot flying to Blenheim took off from Palmerston North Aerodrome a short time after ZK-KVL departed. He reported entering cloud between 3000 and 4000 feet. He was enroute to Paraparaumu at the time of the accident, and was flying in stratiform cloud in IMC at 6000 feet. He said he was cruising near the freezing level in wet air and that icing conditions existed. He had not planned to fly at a higher level due to icing conditions being forecast.
- 1.5.4 Another pilot flying to Palmerston North from Christchurch, via overhead Paraparaumu, at the time of the accident, reported similar conditions. He encountered some glaze icing at 9000 feet prior to his descent at Paraparaumu, and reported that there was rain in the area.
- 1.5.5 Another aircraft was flying from Christchurch to Palmerston North at flight level 210² (FL210), and was abeam Kaikoura, when the accident occurred. The Captain reported he entered IMC 40 nm from Christchurch and remained in cloud until Foxton, when the aircraft was on descent. He reported no significant weather returns on his radar. Icing conditions at FL210 were light and on descent airframe de-icing was used, in accordance with their company standard procedures for descent in IMC.
- 1.5.6 The United Aviation pilot who landed at Palmerston North Aerodrome, some 30 minutes before ZK-KVL departed, said that conditions were clear to about Wellington, then patchy rain existed to Paraparaumu and Palmerston North. He was cruising at 9000 feet until descent from Paraparaumu.
- 1.5.7 An experienced senior flying instructor and IFR pilot living in the Paraparaumu area, reported that the weather at Paraparaumu on the night of the accident was “very nasty” with heavy rain. He said he would not have flown in the vicinity of the Tararua Ranges that night because of the weather.
- 1.5.8 Residents in the northern suburbs of Wellington, and Wellington City, reported being woken after midnight the night of the accident by heavy rain falling.

Icing

- 1.5.9 The MetService advised that in the past they had received reports of pilots encountering hazardous icing in the vicinity of the Tararua Ranges. Pilots who were familiar with the area tended to avoid flying over the Tararua Ranges in conditions that could lead to icing, and some referred to the area as the “Otaki Iceblock”.

² 21 000 feet approximately.

1.5.10 An article in the October 1995 FAA Aviation News contained the following information.

Icing is more likely and more hazardous over mountainous terrain. The vertical cloud formations support large water droplets. Frontal movement over mountainous terrain combined with normal upslope airflow create extremely hazardous ice zones - most dangerous above the crests and windward of the ridges. The zone can extend up to 5000 feet above the mountain tops but can go much higher if cumuliform clouds are present.

The optimum temperature range for ice to form on aircraft is from 0°C to about minus 10°C. There must be visible moisture present, and clouds are the greatest source of that visible moisture. At temperatures colder than minus 20°C ice is rare. Severe icing conditions can be found in stratiform cloud over or downwind of large bodies of water, and when the clouds are lifted by convection over water or mountains, they become stratocumulus. That can mean thick layers of mixed clear and rime icing.

Flight planning

1.5.11 No route forecast or General Aviation Area Weather information was supplied to the pilot by either the Airways Corporation or MetService (see 1.1.8). Valid weather information for the period, supplied to another operator by the MetService, forecast moderate³ icing conditions over the route from 8000 feet to FL180⁴. The passage of the cold front through the area was forecast, along with isolated embedded cumulonimbus clouds at 2000 feet with tops to FL350⁵. The temperature at 8000 feet was forecast as minus 4°C and at 10 000 feet as minus 8°C.

1.5.12 There is no evidence that the pilot of ZK-KVL received any CAA approved aviation route forecast weather information by other means. The only information reportedly sent to the pilot by the National Briefing Office were TAFs and METARs. No pilot weather information was recovered from the wreckage. The local flight the pilot conducted during the preceding afternoon did not require him to obtain weather information, and United Aviation did not post any weather information for general reference. There was a brief discussion with the Chieftain pilot who returned from Christchurch along a coastal route 30 minutes before ZK-KVL departed, however, that discussion did not contain weather information of any substance or relevance to the pilot.

1.5.13 The earlier General Aviation Area Weather, valid until midnight, forecast the front to lie along a line from Gisborne to Waiarapa during the evening of 10 June 1997. The freezing level was forecast as 7000 feet, with moderate icing over the route above 8000 feet. Isolated embedded cumulonimbus clouds at 3000 feet with tops to FL350 were also forecast, as was rain and scattered to broken clouds from 3000 feet to above 10 000 feet.

1.5.14 The United Aviation operations manual stated that the “Meteorological conditions specified in the CAA legislation will be complied with. No PIC [pilot-in-command] will fly a company aircraft unless he considers, having studied all available weather forecasts, that the weather is suitable, with an adequate margin of safety for the proposed flight and there is reasonable assurance that the flight can be completed.” The United Aviation Route Guide to Christchurch stated, “Obtain weather for Christchurch and route.”

³ The rate of ice accumulation is such that even short encounters become potentially hazardous, and use of de-icing or anti-icing equipment or diversion is necessary.

⁴ 18 000 feet approximately.

⁵ 35 000 feet approximately.

- 1.5.15 The United Aviation procedure for obtaining meteorological information for flight planning purposes was to request the relevant material from the Airways Corporation National Briefing Office in Christchurch. General Aviation Area Weather for North and South Islands, along with TAFs, METARs and any other pertinent information, was supplied and used by United Aviation pilots for planning IFR flights. This information was supplied to the Airways Corporation by the MetService. No valid General Aviation Area Weather was available for flights between midnight and 0500 hours.
- 1.5.16 The Aeronautical Information Publication Planning Manual, Meteorological section, stated that General Aviation Area Weather was a forecast for domestic visual flight rules (VFR) operations below 10 000 feet, and was intended for planning and use by VFR operators. However, many non-commercial operators commonly used this information for planning IFR flights up to 10 000 feet.
- 1.5.17 CAA approved detailed route forecast weather information was only available from the MetService, providing textual wind, temperature and significant weather information covering selected routes and levels. Commercial Operators usually had a contract with the MetService to provide route and all other necessary meteorological information. In some cases a Personal Identification Number (PIN) was used to obtain information on an as required basis.
- 1.5.18 United Aviation did not have a contract with the MetService. A PIN was available for use but this was not generally known amongst the pilots. The PIN was not listed in the United Aviation manuals, and there were no United Aviation instructions explaining how to obtain weather information or use the PIN. The United Aviation Chief Pilot could not be certain if the pilot of ZK-KVL knew the PIN or how to use it.

1.6 Aids to navigation

- 1.6.1 The route from Palmerston North to Wellington was a charted IFR route utilising VORs. The minimum safe altitude (MSA) was 7300 feet and there were no route operating limitations.
- 1.6.2 Palmerston North Aerodrome was equipped with a non-directional beacon (NDB), and a VOR with co-sited distance measuring equipment (DME). Paraparaumu Aerodrome was equipped with an NDB and DME. Wellington Aerodrome was equipped with an NDB, VOR and DME. The aircraft reportedly was fitted with an avionics suite enabling these aids to be used. No weather radar equipment was installed in the aircraft.
- 1.6.3 The aircraft was continuously within radar coverage. Recorded radar information was retrieved for the accident flight, and included position information, altitude, time and groundspeed.

1.7 Communications

- 1.7.1 Routine taxi, departure and in-flight communications took place via very high frequency (VHF) transceivers.
- 1.7.2 All the communications appeared to be normal. The last communication was the correct reading back of a clearance to 10 000 feet, by the pilot.

1.8 Flight recorders

- 1.8.1 The aircraft was not equipped with either a cockpit voice recorder or a flight data recorder. Under the terms of the current legislation, such recorders were not required to be fitted to the aircraft.

1.9 Medical and pathological information

- 1.9.1 The nature of the pilot's injuries limited the information that could be obtained from a post-mortem examination. However, no physical abnormalities likely to have caused in-flight incapacitation were found. Evidence suggested the pilot might have been gripping the aircraft control yoke at the time of impact. Medical records and witness accounts suggest the pilot was in good health prior to the accident flight.
- 1.9.2 Toxicology testing excluded any pilot impairment due to drugs or alcohol. However, an unexpected level of a carboxy haemoglobin (carbon monoxide) of 14% in blood leached from muscle was found during the post-mortem. The expected level for a person not exposed to carbon monoxide is significantly less than 1%.
- 1.9.3 The pilot was a non-smoker, and no evidence of exposure to carbon monoxide prior to the flight could be established, such as fumes from the exhaust system of his car. A blood carboxy haemoglobin level of 14% is consistent with an inspired air carbon monoxide concentration of at least 3000 parts per million, whereas under normal circumstances the carbon monoxide concentration in inspired air is infinitesimal.
- 1.9.4 Independent expert medical opinion suggests a rapidly rising inspired carbon monoxide level with concomitant hypobaric hypoxia, due to the cabin altitude of 10 000 feet, would have caused significant pilot mental impairment, but may not at the early stages have caused total incapacitation or loss of consciousness. The intensity of impairment could not be accurately evaluated due to the limited availability of pathological test material.

Fatigue

- 1.9.5 The United Aviation records provided only covered the pilot's duty times for the week prior to the accident. A review of the pilot's logbook showed that during the 30 day period prior to the accident he had flown some 42 hours, including 14 hours at night. The last time the pilot was on duty at night was 4 June, when he had flown a return trip from Palmerston North to Christchurch, logging just over three hours flight time and finishing about 2300 hours. The hours and number of sorties flown on any given day during the 30 day period were unremarkable with the longest period being 5.6 hours of total flying.
- 1.9.6 During the week before the accident, the pilot's records indicated he had been on duty 40 hours over a six day period. The records also indicated he had worked for continuous periods of ten hours on 3 June from 1030 hours to 2030 hours, eleven hours on 4 June from 1200 hours to 2300 hours, two hours on 5 June from 1500 hours to 1700 hours and nine hours on 6 June from 0800 hours to 1700 hours. On Saturday 7 June the pilot attended a United Aviation team building training seminar, and recorded eight hours on duty. He was off duty on Sunday 8 June. On 9 June he was on duty from 0800 hours until 1700 hours and completed two local training flights amounting to less than one hour total flight time.

- 1.9.7 On 10 June, the day before the accident, the pilot was rostered off duty, but he attended an engineering meeting that afternoon followed by a local instrument training flight at 1530 hours involving limited panel operations, for one hour. He left work at about 1700 hours and returned later to attend a scholarship prize giving function. He was reported to have “dozed” at home before attending the function. The pilot was not seen to drink any alcohol during the function or prior to the flight. He left the function and returned home shortly after 2030 hours.
- 1.9.8 The pilot’s flat mate said he believed the pilot retired around 2100 hours and thought he may have slept for some two hours before he left for the aerodrome after 2330 hours. The pilot however was reported to have had two separate telephone conversations between 2145 hours and 2215 hours. During the last conversation he reportedly advised he felt tired and wished to retire and indicated he may have to fly after midnight.
- 1.9.9 During the evening of 10 June the United Aviation Operations Manager had been aware of the need for a night freight flight to Christchurch, with the possibility of a second flight. He had telephoned the pilot to see if he would be available to take the second flight if necessary, and the pilot reportedly agreed to take the flight if it came about. Later that night, around 2300 hours, the flight was confirmed and the Operations Manager contacted the pilot sometime afterwards to advise him.
- 1.9.10 Personnel who spoke to the pilot at the aerodrome prior to his departure reported him as being his normal self and in good spirits. They did not notice anything untoward. The pilot did not complain of being ill or unfit for the flight. The radio calls made by the pilot during the accident flight including his last call at 0119 hours were unremarkable, and did not suggest he was fatigued or significantly impaired up to that time.
- 1.9.11 United Aviation pilots interviewed advised that they were not under undue pressure to take or continue a flight if they were unwell or fatigued, and were free to turn down a flight in such circumstances.

1.10 Organisational and management information

General

- 1.10.1 United Aviation carried out flight training, charter, freight and passenger carrying air transport services, and maintenance. The Managing Director and owner was also the maintenance controller. The Chief Pilot and Chief Engineer reported to the Managing Director, and the Chief Pilot was also the Operations Manager.
- 1.10.2 A CAA audit of the airline maintenance activities was completed in May 1997, and further special purpose audits were scheduled following that audit. These audits were carried out after the accident.
- 1.10.3 On 14 July 1997 the Director of Civil Aviation suspended the Air Service Certificate for United Aviation. This action followed concerns about the airworthiness of some aircraft and operational procedures. The suspension was extended, and on 8 August the Director of Civil Aviation moved to permanently revoke the Air Service Certificate. The action resulted from the detection by CAA of critical safety deficiencies including poor maintenance practices, operation of aircraft with serious defects, and operational concerns.
- 1.10.4 On 14 August 1997 United Aviation went into receivership, at the request of its directors. On 9 September 1997 the Director of Civil Aviation permanently revoked the United Aviation operating certificates.

United Aviation operating procedures

- 1.10.5 The United Aviation Operations Manual stated that all flying staff would be made aware of the United Aviation policy regarding flight in icing conditions. The process of compliance included a statement that all limitations and requirements in the approved Flight Manuals for the aircraft, regarding operation in icing conditions, or the avoidance of icing conditions, were to be complied with by the pilot-in-command.
- 1.10.6 The Operations Manual required the selection of appropriate cruising altitudes to avoid those altitudes which might result in icing problems or passenger discomfort. No United Aviation aircraft were to operate in meteorological conditions which could affect safety. No pilot-in-command was to fly a United Aviation aircraft unless he considered, having studied all available weather forecasts, that the weather was suitable, with an adequate margin of safety for the proposed flight, and there was reasonable assurance that the flight could be completed. The United Aviation Route Guide to Christchurch required the pilot to obtain weather information for Christchurch and the Palmerston North - Christchurch route.
- 1.10.7 The Palmerston North - Otaki - Wellington sector was the most direct route to Christchurch. Other standard lower level coastal routes to Christchurch were available. The Route Guide stated the flight plan height on the Otaki route was 8000 feet or 10 000 feet, and could only be selected if the temperature at 8000 feet was above 2°C. The pilot was able to use discretion if the weather indicated the route was clear of cloud and the formation of ice unlikely. If cloud was encountered when exercising the discretion, a pilot was required to request a right turn and descent to 6000 feet under radar control, to intercept the Palmerston North to Paraparaumu route.
- 1.10.8 There was no documented United Aviation method for ensuring pilots had routinely read and understood the requirements of the Operations Manual, such as a signature sheet. The Chief Pilot advised he ensured pilots were familiar with United Aviation policy, from discussions with them and when he conducted routine flight checks. The Chief Pilot advised that pilot meetings were normally held fortnightly to discuss problem areas. The pilot of ZK-KVL had reportedly helped to develop the latest Operations Manual.
- 1.10.9 Apart from recurring checks and discussion, no other method was used to ensure pilots complied with United Aviation operating procedures. Recent audits by CAA reported pilots were not familiar with the contents of the Operations Manual.
- 1.10.10 As a result of questions put to senior United Aviation managers and staff by an organisational psychologist, on evidence available he observed that:
- United Aviation supervisory and operational procedures were not clearly defined.
 - There was insufficient supervision of staff by management.
 - There was no “coherent safety culture”⁶ set by management within United Aviation.
 - The flight operations procedures were not adequately promulgated and enforced.
 - United Aviation supervisory practices were inconsistent and arbitrary.

⁶ An organisational environment in which corporate behaviours and strategies are pro-actively designed and conducted to maximise safe working practices and conditions, and where all members of the organisation take personal responsibility to ensure that safety takes precedence over all other organisational demands.

- There was a vagueness regarding management's implementation and maintenance of error⁷ or violation⁸ prevention mechanisms, which had been abdicated to other agencies such as CAA or United Aviation pilots.
- United Aviation management produced no clear evidence that it had carried out any systemic analysis of the foreseeable risks associated with night freight IFR operations, or put in place effective defences to minimise the likely risks.
- The level of understanding of critical issues by management and pilots, such as icing, was confused and inadequate.
- United Aviation management had not pro-actively researched and promulgated the known facts about the effects of icing on the Beechcraft Baron.
- The Managing Director showed no evidence of having effectively followed up on the delegation of his responsibility to ensure the safe operation of the airline.
- There was no evidence that management had a planned programme of training and development for the managers or staff.

- 1.10.11 The United Aviation procedure for obtaining weather information for flight planning purposes was to request the necessary information from the National Briefing Office. General Aviation Area Weather forecasts were used for route planning information. There were no documented United Aviation instructions explaining how to obtain the necessary meteorological information, nor was there any information describing how to obtain appropriate meteorological data for flights after midnight (see section 1.5, flight planning).
- 1.10.12 The Chief Pilot advised that flights commencing between midnight and 0500 hours were uncommon, and for flights during this period the General Aviation Area Weather that was valid until midnight would be used for route planning purposes.
- 1.10.13 The most recent check on the pilot of ZK-KVL was a IFR Regulation 76 check, recorded as having been carried out on 27 May 1997 by the Chief Pilot in a BE58. No abnormal or emergency procedures were listed as having been completed. Two boxes indicating knowledge of United Aviation procedures had been ticked.
- 1.10.14 One month earlier, on 28 April, an IFR Regulation 76 check was recorded as having been carried out by the Chief Pilot in a PA31. However, the Chief Pilot's logbook did not show an entry for that date. The records did not show that any abnormal or emergency procedures had been checked. A check recorded on 30 October 1996 showed similar entries. The Chief Pilot stated that abnormal and emergency procedures were checked but "They were perhaps not placed on the form due to lack of paperwork standard."
- 1.10.15 Regulation 76 checks required pilots to be tested for competency during normal, abnormal and emergency procedures. For pilots carrying out air transport IFR operations these checks had to be completed every six months.
- 1.10.16 The Regulation 76 competency check sheets signed by the Chief Pilot consisted of simple ticks in boxes. No written comments were included. Details on several of the check sheets had been altered, including dates and aircraft registration, and did not equate with other details. The date on the most recent competency check sheet for the pilot had been altered. The check sheets had not been signed by the pilot. This was not a requirement although there was provision on the sheets for the pilot's signature. The Chief Pilot advised this state of affairs was "a reflection of [his] work load in recent years which had built to a point where the deferrable jobs such as paper work became unfortunately last priority."

⁷ Information processing problems.

⁸ Deliberate deviations from some regulated code of practice or procedure.

- 1.10.17 A CAA special audit report on the United Aviation flight operations, 17 July 1997, stated, “The recording of Reg. 76 checks was inaccurate, with check forms not reflecting the actual check content or, in two instances, reflecting a flight which did not take place. This is despite the form being certified, by the Chief Pilot, as an accurate record of the flight carried out.”
- 1.10.18 Regulation 77 required the pilot to have been checked on the Palmerston North to Christchurch route. There was no requirement for a physical route check if a thorough route briefing had been given to the pilot. This included the necessity for the pilot to have demonstrated to United Aviation an adequate knowledge of the seasonal meteorological conditions and the meteorological procedures.
- 1.10.19 There was no record of the Chief Pilot or other United Aviation staff having flown with, briefed or checked the pilot on the route. The Chief Pilot however said he had briefed the pilot and had flown with him to Christchurch. The Chief Pilot believed the pilot had demonstrated to him an adequate knowledge of the meteorological conditions likely to exist over the route. He advised that the pilot had also passed his Air Transport Pilot Licence meteorological examination a month or so before the accident.
- 1.10.20 In accordance with CAA legislation United Aviation was required to maintain records of the qualifications of all its pilots, including the manner in which the qualifications were achieved. The Chief Pilot advised that a whiteboard was the method used to record the main licence qualifications, with expiry dates, for United Aviation pilots.
- 1.10.21 The CAA had concerns over the adequacy of the pilot recurrency training and checks, and whether some had been carried out as recorded. CAA advised that a practice identified during auditing was that some checks, as they became due, would simply be signed off as having been completed. As the opportunity presented itself, usually about a month later, a check might be performed and signed off. Many of the checks were carried out on regular passenger carrying services, which would not allow emergency procedures to be checked unless no passengers showed for the service. The Chief Pilot said that emergency procedures were not checked with passengers on board.
- 1.10.22 No evidence was provided that United Aviation management had carried out any systemic analysis of the foreseeable risks associated with night freight flights to Christchurch or elsewhere, or put in place effective defences to minimise the likely risks. Apart from some discussion during checks about icing and how to avoid it, and in general conversation, plus material contained in the operations manual, pilots were not briefed specifically about the likely effects of an icing encounter.
- 1.10.23 United Aviation managers had not actively researched the effects of icing on the Beechcraft Baron and ensured that all pilots were fully briefed. On the contrary United Aviation’s response to a report of an earlier incident involving the effect of icing on the BE58 indicated they discounted or discredited that information.
- 1.10.24 A Beechcraft Baron Safety Review book had been purchased by the pilot which contained some briefs about Barons encountering icing conditions. The Managing Director advised that this book was copied and circulated for pilots to read.
- 1.10.25 Several United Aviation pilots were asked what they would expect if they encountered icing conditions in the Baron. Most did not believe it would have a serious effect on performance or pose any significant safety hazard. They did indicate they would keep their speed up and descend to a lower altitude, if necessary, to escape icing conditions. They indicated a knowledge of the escape route to the west, under radar control, when on the Otaki route.

- 1.10.26 Discussion with United Aviation managers showed the only formal training courses during the year for staff were: dangerous goods, a course for supervisors, a management course for the Managing Director, and a team building seminar for all staff.

CAA operator surveillance

(See Appendix A for a brief chronology of key events related to CAA Audits and United Aviation operations)

- 1.10.27 The audit process is the prime method used by the CAA to monitor safety and measure compliance of the operators it has approved with relevant legislation. The object of the audit is to assess an operation by a systemic sampling of activities. To supplement the audits the CAA investigates some accidents and incidents and alleged breaches of legislation, and uses statistical analysis of the auditing and monitoring process findings to indicate trends in safety.
- 1.10.28 The CAA advised that for each aviation operator a full list of audit modules is identified to match the company activity. The full list is not a stated programme that needs to be carried out in a certain timeframe, but is the field from which appropriate audits are selected and programmed. The programming of audits reflects a judgement call by CAA. Factors in selecting and timing of audits include the confidence in the particular operator, the availability of staff and other work priorities.
- 1.10.29 After March 1994, the CAA audit report form was amended to state that an operator was required to ensure all non-compliances found during audits were rectified before further operations and that an auditor could not grant dispensations against regulatory requirements. A non-compliance is where an operator is not complying with the Civil Aviation legislation.
- 1.10.30 From 1990 the report required any non-conformances to be rectified by a date mutually agreed between the operator and auditor. A non-conformance is where an operator is not complying with its own documented procedures.
- 1.10.31 A review of the audit reports for United Aviation was carried out for the period January 1994 to July 1997.
- 1.10.32 The audit report for January 1994 covered maintenance and operational practices and stated the objectives were “To conduct an analysis of United Aviation Ltd policies, standards, and facilities, in order to ensure compliance with documented procedures and civil aviation legislative requirements.” The audit report identified five non-compliances, including the use of two aircraft not approved to conduct air transport operations, and one non-conformance. The report stated that “Research prior to the audit revealed a large number of overdue actions accumulated from the previous two audits. These outstanding actions were reviewed at the entry meeting. It was pleasing to discover that the majority of the actions had been taken care of. Since the causes of these findings were a lack of procedures (especially documented procedures), it was good to see that a new OMM [Operators Maintenance Manual] / EPM [Engineering Procedures Manual] has been drafted.” The report also stated that “The findings relating to operational aspects give cause for concern as they appear to indicate a lack of awareness of basic CAA requirements.”
- 1.10.33 Following the January 1994 audit the auditor recommended “the old style Certificate of Approval” issued to United Aviation and due to expire in June, should be replaced with a “new style” and that “the expiry be set for six months since we are waiting for rectification of two years worth of audit findings.”

- 1.10.34 A special purpose audit of United Aviation aircraft cargo systems was carried out in March 1994, following an accident involving an aircraft operated by United Aviation in which the undercarriage was unable to be lowered. The accident was investigated by the Transport Accident Investigation Commission (Report 94-007) and the report findings included: the PIC's (the United Aviation Chief Pilot) class one medical certificate had expired; the all-up-weight of the aircraft probably exceeded its maximum allowable all-up-weight; the normal and emergency exits were obstructed by freight; the aircraft was not suitably equipped for freight operations; the freight on board was not secured and the portable oxygen equipment carried on board the aircraft was not of an approved type.
- 1.10.35 The stated objectives of the March 1994 audit were "To determine the level of risk being taken by not securing loads, nor ensuring that normal and emergency exits can be accessed during normal operations; and to determine load sheet and weight and balance compliance." The audit report identified two non-compliances and one non-conformance. An observation in the report identified a lack of documented United Aviation procedures, particularly those specific to short notice charters and freight operations, with a tendency for too much reliance on operating crews to action all regulatory and United Aviation requirements. The report stated "During this audit, the team perceived a desire on the part of the management to maintain a safe operation. The findings at Section 6 [list of findings] however reflect an absence of substance in this expressed desire." The report noted, "Discussions during the audit centred on the need for the Chief Executive and Chief Pilot to establish a documented system that has complete and practical relevance to the operations being undertaken by the company, and to continuously monitor that system to ensure conformance with the company's procedures. A monitoring system is also essential to ensure that the system is being used by all staff." The report identified a "lack of procedures" as one contributor that can lead to inconsistencies in standards and a high probability of system compliance failure. The report also noted "The Chief Pilot advised that a revised operations manual had been prepared, with further amendments being produced."
- 1.10.36 On 16 May 1994 CAA advised United Aviation "that the findings of the CAA audits dated 26 January 1994 and 15 March 1994 [were] not favourable." CAA advised United Aviation that it would therefore only renew its Air Service Certificate for six months from June until December 1994, rather than the usual two year period, and that an audit would be carried out prior to the expiry of the certificate. Any further renewals were to be dependent on the findings and recommendations of that audit. The CAA Controller Operator Certification explained this was a procedure he adopted to put pressure on United Aviation to rectify its non-compliances and non-conformances.
- 1.10.37 The next audit occurred in November 1994 and took samples across a range of United Aviation activities. The audit report stated that the audit was scheduled earlier than the usual cycle "because of the number and type of findings arising from the previous audit." The report identified seven non-compliances and three non-conformances. Three non-compliances and one non-conformance were the same as those from the previous audits. The audit report findings included the use of two aircraft for air transport operations when they were still unapproved for that purpose, and that an AD carried out had not been recorded appropriately. The audit report stated, "Company management MUST reduce the level of non-compliance with the legislative requirements, as indicated by this report and the preceding Civil Aviation Authority audit report". The report noted, "Accordingly whilst the company has responded to some things it was disappointing to see other findings had not been addressed." The report also noted that, "On the positive side the company had spent some considerable time rewriting manuals which have been submitted for acceptance. However, as Quality Manuals they still

require further revision. For document control it is essential that copies of all forms used in air transport operations be included in the Operations Manual. A cursory look through the new manual appears to indicate that there is still insufficient detail about specialist activities of the company e.g.: night freight and ambulance operations. The various audit findings may be attributed partly to the expansion of activities over the years but it is imperative that they all be put in order as quickly as possible The challenge for the company is clearly highlighted in the finding notices and conclusions in the various reports. The response from the company will determine the level of Civil Aviation involvement and monitoring to maintain the conditions of their Air Service Certificate.”

- 1.10.38 Following the November 1994 audit the auditors’ recommended the United Aviation Air Service Certificate be renewed for twelve months only. The Air Service Certificate was renewed on 2 December 1994 for one year, effective to 7 December 1995.
- 1.10.39 The next audit was carried out in March 1995 and sampled the maintenance activities performed by United Aviation under its Regulation 176 (Grant of certificates of approval and delegation of responsibility) certificate. One aircraft logbook was checked during the audit. The audit report identified two non-compliances and one non-conformance which had been identified during the previous audit. The report stated “The only areas where problems were found, relate to the lack of airworthiness certification noted during the documentation inspection for Piper Tomahawk ZK-KVA. The company must endeavour to educate all certifying staff [on] the importance of correct workshop and log book entries. As these items were found with KVA’s documentation, and this being the only aircraft checked, make your own check on the other aircraft you maintain to ascertain that all the documentation is correct.”
- 1.10.40 Following his review, during May 1995, of the November 1994 audit report and the previous United Aviation history a CAA Safety Analyst, stated “This audit report again shows a large number of deficiencies with their operation and indicates some of the findings from the previous audit report were still not rectified.” As a result of the review he recommended that, “a full audit be carried out 6 months from the date of the last audit this being May 1995 and the audit frequency be reduced to 6 months until this operator can show continued compliance with applicable CAA Regulations, Requirements and Procedures detailed in his own manuals.” There was no record of the audit cycle being amended and CAA advised that “an assessment of the priorities at the time meant the appropriate [CAA] staff could not be released as suggested.”
- 1.10.41 Another audit was conducted on 7 December 1995 and sampled a range of maintenance and operational activities. Seven non-compliances and three non-conformances were identified during the audit. Four non-compliances and two non-conformances had been identified during previous audits. Two non-compliances referred to five ADs that could not be verified as having been carried out. The audit report stated that while “Some findings had been addressed, others were still open and old problems are still occurring.” The report identified, amongst other issues, a lack of follow-up with defects, a lack of knowledge of many legislative requirements, insufficient attention to maintenance issues by management, inadequate manuals, and scheduled passenger services being conducted without an application for amendment to the Operations Specifications. The report also noted, “For an efficient safe operation the various systems and procedures must be clearly documented and followed. The lack of follow-up with the defects is a good example of the importance of procedures.” The United Aviation Air Service Certificate was renewed on 7 December 1995 for two years, effective until 7 December 1997.

- 1.10.42 In December 1996 an audit of the United Aviation flight operations was carried out which was restricted to observing the operation of a scheduled service. The audit report identified one safety related concern, and eight non-compliances. Three of the non-compliances had previously been identified during earlier audits. The report stated, “The overall impression gained is that there is a lack of control and monitoring of recurring items and a need for staff to raise their professional standards”. The report noted that, “Given the limited scope of the audit the number of findings is cause for concern. Of further concern is the fact that some of the findings are repeats of findings made at previous audits. At the end of the day only management and staff involved can identify the true underlying causes and implement corrective action.” The report further stated, “On the positive side it is good to see the company has gone to some length in commissioning new manuals. While it has not been in place long, the QA [Quality Assurance] manual has resulted in a finding form [document] which staff are using to some effect. The long term effect of the new manuals is dependent on the determination of staff and management to implement the manual procedures and to develop and use them to raise the operational standards of the organisation.” The report further stated, “Looking back over previous audit reports it is frustrating to see auditors making the same comments over and over. I hope the introduction of the new manuals and the move to employing more mature staff will be the start of a turn around in the company culture. To help promote this we will be ensuring that regular monitoring of company flights takes place so that we can observe the effect of the introduction of the new manuals.” The auditor also noted in the report, “I accept from our discussion during the audit that [the Chief Pilot] is making a big effort to put effective Quality Assurance in place and I hope that the audit went some way towards helping him decide what is needed.”
- 1.10.43 A CAA spot check at Gisborne during March 1997 on a United Aviation aircraft and its operation revealed three non-compliances.
- 1.10.44 On 27 May 1997 an audit of the maintenance activities was carried out. Four United Aviation aircraft were inspected including ZK-KVL. The inspection of ZK-KVL and its records did not reveal any outstanding ADs. Fourteen non-compliances and one non-conformance were identified during the audit. One of the non-compliances was that ZK-KVL was not approved for air transport operations. Four of the non-compliances were identified as being repeats of findings made during previous audits. The report stated that “It is extremely disappointing to note that a number of the non-compliances raised during this audit are repeats of previous findings.” The report also said the “disregard for the amendments to Civil Aviation legislation and the necessity to develop the changes to their management systems indicates a serious cultural problem has developed within the management of United Aviation Limited. This culture has now transcended through all levels of the maintenance organisation being reflected as an attitude deficiency which is apparent in the manner in which maintenance is planned, accomplished and recorded.” The report also stated that the auditors were misled by the Managing Director, over a purported contract for the development of the required management systems necessary to support an application for an Air Operator Certificate.
- 1.10.45 According to CAA records the completed audit report was sent to United Aviation on 13 June 1997, two days after the accident, and United Aviation was advised that the findings were to be addressed immediately, and that auditors would return to United Aviation by 20 June 1997 to confirm appropriate action had been taken and procedures put in place to correct the non-compliances. The accident to ZK-KVL occurred before the proposed date for the auditors’ return.

- 1.10.46 The non-compliances identified during the May 1997 audit, the month before the accident, were required to be corrected within two days as indicated on the audit report. CAA however did not schedule a meeting to confirm this had been accomplished until three weeks after the required date for compliance. Although the audit report requiring compliance was not sent to United Aviation until 13 June the requirement for compliance by 29 May would have been discussed at the audit exit meeting with the Managing Director of United Aviation on 27 May. The accident occurred 13 days after the corrective action by United Aviation was required.
- 1.10.47 A meeting was held between the CAA and Managing Director of United Aviation on 19 June 1997. The stated objective of the meeting was to ensure the Managing Director was clear as to what was required of him and the action the CAA would take if compliance was not achieved. The next day CAA staff visited United Aviation to ensure the outcomes of the meeting were being addressed.
- 1.10.48 On 14 July 1997 the Director of Civil Aviation suspended the Air Service Certificate of United Aviation for 14 days.
- 1.10.49 CAA records showed a special audit of United Aviation flight operations activities was carried out on 17 July 1997. The objective of the audit was to sample policies, standards, and facilities, and the procedures and performance of United Aviation in order to establish the level of conformance with its documented procedures and compliance with Civil Aviation legislation. Seven non-compliances were discovered during the audit. The audit report identified a lack of adequate leadership and a large number of deficiencies including: duty time limits exceeded; content and standard of competency checking inadequate; non-compliance with good aviation practice, legislative requirements and the United Aviation Operations Manual; a low standard of knowledge and recent practice in relation to operating requirements and emergency procedures by flight crew; and inaccurate and false recording of competency checks.
- 1.10.50 CAA records of the interviews of pilots conducted during the 17 July audit stated that emergency procedures were not demonstrated or tested during checks. They expressed other concerns including safety issues, such as being under pressure to fly with unserviceabilities on aircraft, not being familiar with the Operations Manual, and being fearful of losing their jobs if they spoke out or refused to take flights.
- 1.10.51 CAA records showed that the auditors returned to United Aviation on 21 July 1997 and carried out a special audit of United Aviation's maintenance activities. This was to determine if the maintenance activities were in compliance with relevant Civil Aviation legislation, and to sample United Aviation aircraft for structural integrity and airworthiness. United Aviation policies, standards, facilities, procedures and performance were also to be examined in order to establish the level of compliance with Civil Aviation legislation. An inspection of five United Aviation aircraft and the relevant maintenance records was carried out. Although the audit report did not specifically tabulate non-compliances and non-conformances, between six and nine "discrepancies" were noted for each aircraft. Serious safety concerns were raised by the auditors and the audit report concluded: "The document holders were found not to be in compliance with the relevant legislation. Although those aircraft inspected were found to be structurally sound and generally routinely inspected when required, there are numerous examples of lack of sound maintenance practices, lack of post-maintenance inspection, lack of correct documentation, unauthorised modifications, lack of placarding and a general lack of knowledge regarding legislation. All showing that the maintenance is not under control."

- 1.10.52 The 17 and 21 July audits on United Aviation's activities led CAA to conclude United Aviation was not in compliance, and on 28 July 1997 the Director of Civil Aviation suspended the Air Service Certificate for a further 14 days. On 8 August 1997 the Director of Civil Aviation took action to revoke the Air Service Certificate and permanently revoked it on 9 September 1997.
- 1.10.53 The CAA advised that before 1997 its strategy for following up on audit findings did not ensure that operators had implemented the necessary action to correct the non-compliances and non-conformances identified during audits. Instead CAA received written or oral assurances from United Aviation's senior management that the audit findings had been addressed. Until June 1997 there was no record of the CAA ensuring United Aviation carried out the necessary action to correct the non-compliances and non-conformances identified in the audit findings.
- 1.10.54 The CAA advised that individual auditors are now responsible to follow up on findings made during audits and to ensure that corrective action is carried out. If an auditor discovers that corrective action has not been carried out by the due date the auditor will send a reminder notice to the operator. If correction action is still not carried out a second notice will be sent. If a third notice is necessary the Controller Safety Audit will issue the notice and advise the operator that unless corrective action is carried out a recommendation will be made calling for a suspension of the operating certificates.
- 1.10.55 The CAA advised that under Section 12 of the Civil Aviation Act 1990 operators have the responsibility to respond to audit findings and rectify any deficiencies in their operations, and claim that the obligation is always on the operator to become compliant, and that United Aviation should have responded to the CAA's findings as it was required by law to do so without prompting.
- 1.10.56 The Civil Aviation Act requires the Director of Civil Aviation to control entry into and exit from the civil aviation system and to take the necessary action to enforce provisions of the Act. Section 15 of the Act states in part the "Director may require or carry out safety and security inspections and monitoring . . . (2) The Director may, . . . , carry out such inspections and monitoring as the Director considers necessary in the interests of civil aviation safety and security." The audit process was the prime method used by CAA to fulfil this requirement (see 1.10.27).

1.11 Additional information

- 1.11.1 In-flight icing of aircraft is not a new phenomenon. The hazards associated with ice accretion on aircraft during flight are well documented. Ice accumulation compromises the function of aerofoils and reduces their efficiency, so that their ability to produce lift is decreased and the stalling speed is increased.
- 1.11.2 Many aeroplanes are susceptible to icing on the empennage. Accidents and incidents have occurred involving uncommanded nose down pitch shortly after flight into icing conditions, due to loss of elevator effectiveness. The empennage can accumulate significant amounts of ice before the main wings, and propwash over the horizontal stabiliser can assist in ice formation by lowering the ambient temperature over the stabiliser. Ice on the empennage is usually not able to be detected visually.

- 1.11.3 Several overseas accidents have been recorded involving the Beechcraft BE58 Baron encountering icing conditions in flight. In one instance an aircraft descended into icing conditions and the pilot reported the aircraft had picked up about a half an inch of rime ice. Shortly afterwards radar contact was lost as the aircraft spiralled to the ground. The aircraft impacted the ground in a steep vertically banked dive at high speed. Rime ice was found in snow next to the elevator counterweight. The elevator trim was trimmed to a nose-up position.
- 1.11.4 In an another instance a BE58 departed from normal cruise flight, within three minutes of the pilot requesting a left turn due to adverse weather conditions. Radar contact was lost a short time later. Witnesses observed the aircraft come out of cloud in a steep right wing low, nose down attitude. The aircraft impacted the ground at high speed and disintegrated. No evidence of pre-impact failure of the aircraft was found.
- 1.11.5 A recent incident in New Zealand involving a light twin engine aircraft encountering icing conditions was documented in volume two, issue two, of the ICARUS magazine. The pilot had less than 1000 hours flying experience. The pilot reported: "Unpressurised, we had to fly at altitudes above MSA but below 10 000 feet. This meant we were particularly vulnerable to icing conditions. Icing was just simply something I may have read about a couple of times in the past. I certainly was not scared of it - I did not respect it, or fully appreciate what it could do to an aircraft. We were on our final leg when about half an hour into the flight we experienced subtle turbulence which we naturally believed to be a small taste of the turbulence from the mountains. This was a major mistake. We were currently IMC but because we were a good 50 KIAS [knots indicated airspeed] above the clean stall, the stall buffet never entered my mind. As it happened we entered a wing drop stall to the left. We lost 60% of our altitude before passing the freezing level and regaining control. Just prior to the stall we noticed massive amounts of ice on the leading edges and props."
- 1.11.6 According to the pilot involved in a separate incident in New Zealand involving a BE58 several years ago his aircraft was cruising at night at 9000 feet and entered the top of cumuliform cloud when he felt the controls become sluggish. The co-pilot, shining a torch on the wings, noticed a block of ice on the leading edge of the wing, inboard of the engine. Around fifteen seconds later the aircraft stalled rapidly, dropped a wing and entered a high speed spiral dive. Recovery was achieved after losing several thousand feet. The operator of the aircraft said he could not establish if the crew had switched on the pitot heat.
- 1.11.7 During November 1987 a Cessna 208 Caravan was on a scheduled night freight flight from Christchurch to Wellington when it encountered icing conditions at 11 000 feet, off the Kaikoura coast. The flight was assumed to have continued in icing conditions until the aircraft stalled and spun into the sea.

2. Analysis

- 2.1 The accident flight began as a normal event and the pilot was familiar with the route and operation. An appropriate quantity of fuel was placed on board the aircraft, and it was recorded and reported as being loaded correctly with freight.
- 2.2 The pilot planned to fly the most direct route to his destination, and activated a standard flight plan for that route. The direct route had a high initial MSA, and required the Palmerston North to Wellington leg to be flown at an altitude of at least 8000 feet, over mountainous terrain. Standard lower level coastal routes were available to the pilot.
- 2.3 The pilot activated the flight plan before receiving his CAA approved weather information, and a second request for the information was made from the freight company. The pilot probably did not receive the information before he taxied to load the aircraft. The short time between the second request and the pilot's taxi call, would have allowed little opportunity for the pilot to study the information and to select and plan a different route.
- 2.4 The meteorological information (TAFs and METARs) reportedly sent to the pilot would not have enabled him to assess accurately the forecast weather conditions for the flight planned route. The pilot did not request additional information or query why the General Aviation Area Weather was not sent to him. The chosen route was unsuitable in the prevailing weather conditions, and its use in such conditions contravened documented United Aviation policy.
- 2.5 Had the pilot received the earlier General Aviation Area Weather, appropriate route weather information from the MetService, or a detailed weather briefing, he should have been aware of the icing conditions existing along the route, and it is likely he would have chosen a lower level coastal route. The pilot may not have known how to request information from the MetService, as it was not United Aviation practice to do so. Flights were rarely commenced between midnight and 0500 hours, so the pilot would have been unfamiliar with the required procedure or unaware of the need to contact the MetService. In the absence of any route weather information, however, it would have been prudent for him to have flown a coastal route.
- 2.6 The pilot may have allowed the comment by the Chieftain pilot, that the weather was "Sweet", to influence his decision regarding his flight route. However, the Chieftain pilot had flown that route some four hours earlier, ahead of the cold front. He had returned some 30 minutes before the pilot departed, via a coastal route. Weather conditions can vary greatly, even over short distances, between mountainous and coastal areas, so the pilot should not have placed undue reliance on the Chieftain pilot's report.
- 2.7 A pilot who departed from Palmerston North for Blenheim shortly after ZK-KVL, flew at an appropriate lower level due to forecast icing conditions.
- 2.8 In the prevailing conditions ZK-KVL would have entered IMC soon after departure. The pilot was likely to have selected the heater on to keep the cabin warm and, in accordance with standard practice, turned the pitot heat on. The pilot's request to climb to 10 000 feet could have been prompted by a desire to get on top of the cloud. The request to climb was made as he approached his flight planned altitude, suggesting he wished to climb out of weather conditions likely to have existed at his planned altitude. He may have wanted to take advantage of any stronger tail winds at higher altitude, but this was considered a lesser likelihood as any gain over 2000 feet would not be significant. In addition, the normally aspirated engines fitted to the aircraft would have produced less power at the higher altitude.

- 2.9 At 10 000 feet ZK-KVL was probably still flying in IMC, with optimum conditions for ice formation existing. Favourable conditions for ice formation would have prevailed above about 6000 feet, and ice may have been accumulating on the aircraft from the time the aircraft climbed above that altitude. At any stage of the flight, had the pilot been aware of or concerned about ice accretion, he could have asked for a descent under radar control to the west, to intercept a lower level route.
- 2.10 If an unserviceability had occurred prior to departure, the pilot had the opportunity of returning the aircraft to the hangar for the Chief Engineer to assess. During flight, up until the accident, the pilot could have returned to the aerodrome.
- 2.11 From the radar records the flight appeared uneventful, until just south of Otaki Reporting Point. If ice had been forming on the aircraft up to this point, the pilot may not have been aware of it. If he was aware then he apparently was not concerned enough to ask for a descent. The aircraft however was not equipped for flight in icing conditions and had no ice detection lights. Usually ice is first detected on the windshield and then a torch beam is shone on the wings to confirm any ice formation. At night, if cabin lights are not on bright, it can be difficult to detect ice on the windshield. Had the pilot been relying on seeing ice building up on the windshield, as a first means of detection, it is possible any formation went unnoticed.
- 2.12 At 10 000 feet the aircraft would have had little or no surplus power available to counter the increased drag due to any significant ice formation, and would probably have had to sacrifice speed to maintain altitude. The radar record indicated, however, that the groundspeed and altitude remained essentially constant, and the groundspeed was normal until past Otaki, suggesting ice accretion was not significant up to that point.
- 2.13 Past Otaki the aircraft veered to the left of track. The groundspeed increased and the aircraft altitude fluctuated before the sharp right turn occurred. A logical explanation for the increase in airspeed, at essentially a constant altitude, was the aircraft encountering updraughting air associated with convective activity within a convective cell⁹, in the region of the front. Meteorological radar data showed the presence of several areas of large water droplets or rain, probably associated with a cell, in the area of the accident. With the frontal passage over the Tararua Ranges the rising terrain would promote convective activity, increasing the likelihood of cells and locally increased moisture content of the air.
- 2.14 The pilot may not have been aware of the presence of a cell, especially if it was embedded in cloud and he was flying in IMC. The aircraft was not equipped with weather radar for locating cells, and at night it can be difficult to visually detect cloud formations. The potential to inadvertently enter cloud at night, with the attendant risk of encountering an active cell, is high.
- 2.15 Whether the pilot was utilising the automatic pilot or hand flying the aircraft could not be established, although the reasonably steady altitude being maintained by the aircraft could suggest that the altitude hold function of the automatic pilot was engaged. There was no obvious operational reason for the aircraft to veer to the left of track, as observed on radar. Had the pilot wanted to escape the weather conditions he probably would have asked for a descent to the right of track. A possibility does exist, however, that ice formation on or ahead of the control surfaces could have affected their normal functioning.

⁹ Cumuliform cloud with updraughts and possible downdraughts.

Pilot impairment

- 2.16 Another explanation for the aircraft drifting off track, considered likely given the results of the post-mortem toxicological tests, was the impaired cognitive functioning of the pilot due to the presence and narcotic effects of carbon monoxide. The pilot probably experienced significant mental impairment in the last five to ten minutes of the flight, due to inhalation of carbon monoxide which had entered the cabin of the aircraft and caused a significant rise in the carbon monoxide concentration. This may have caused drowsiness, confusion and loss of situational awareness, of variable but progressive intensity. The pilot was unlikely to have suffered total incapacitation or been rendered unconscious by the carbon monoxide, during the early stages of its onset, and it is probable that he remained conscious at least until the aircraft departed from normal flight. The presence of carbon monoxide, and its symptoms, would probably have been unrecognised by the pilot.
- 2.17 Having eliminated other possible causes it was most likely that the source of inspired carbon monoxide was cabin air contaminated by fumes from a defective combustion type cabin heater. Such a defect could have included combustion tube failure (of the type covered by the AD) or exhaust erosion.

Icing

- 2.18 In any cell in the area moderate to severe icing conditions probably existed at 10 000 feet, where the temperature was around minus 8°C. Shortly before, or during, the right turn by the aircraft, ice may have built up on the aerofoils to a level sufficient to cause the aircraft to stall and to depart from controlled flight. Any ice build-up is likely to have been rapid, with an equally rapid loss of control. The right turn of the aircraft may have been initiated by the pilot, or occurred as a result of the ice. The nose up trim of the aircraft suggested airspeed may have been sacrificed, probably just before the event, by either the pilot or automatic pilot, to maintain altitude. As a result the airspeed could readily have decayed to a point where the aircraft stalled, dropped a wing and entered a spiral dive.
- 2.19 The high rate of descent of the aircraft allowed the pilot less than 60 seconds to analyse the situation and take necessary recovery action. The artificial horizon probably toppled due to the extreme attitude of the aircraft, and spatial disorientation of the pilot was likely. Spatial disorientation would have been more acute if the pilot was affected by carbon monoxide. At night, in IMC, if the aircraft was heavily contaminated by ice, the pilot had at best a minimal chance of recovery. Any impairment due to carbon monoxide would further reduce this chance. Evidence that both engines were delivering power at impact is somewhat of an anomaly, had the pilot been attempting normal recovery. This suggests that either disorientation or mental impairment was such that no proper recovery was attempted or, as a last resort, power was applied to attempt some sort of recovery.
- 2.20 The absence of any distress or advisory call by the pilot during climb or while at altitude, implies he was not conscious of any abnormality or immediate danger, and suggests that the eventual loss of control occurred rapidly and without warning. During descent the effects of disorientation and likely impairment would have afforded the pilot little time to gain control of his faculties, attempt recovery and transmit a distress call.

Other considerations

- 2.21 The moderate nose up trim position discounted the possibility of the automatic pilot malfunctioning and trimming the aircraft to a severe nose attitude. Whether the pitot heat was turned on or functioning correctly could not be established. The pilot would normally have checked that the pitot heat was functioning as part of his pre-flight checks, and selected heat on before entering cloud.
- 2.22 A sudden total electrical failure or flight reference instrument failure was not considered likely in the circumstances. Had the flight reference instrument lighting failed cabin flood lights were available to help illuminate the instruments. A standby torch was also available. The pilot was familiar with limited panel operations, having conducted a limited panel instrument training flight the day before the accident. No radio or cellular telephone calls were made to Christchurch Control advising of any malfunction, or requesting assistance.
- 2.23 Although the co-pilot's artificial horizon had been removed and the pressure line blanked off in accordance with normal practice, the possibility could not be discounted of that or another blanking plug dislodging during the flight thus causing a reduction of gyroscopic instrument air pressure. Alternatively a pressure line in the system could have ruptured causing a pressure reduction. These are however unlikely events to which the pilot should have been alerted. If such an event had occurred this should not have led to the pilot losing control of the aircraft.

Fatigue

- 2.24 At the aerodrome prior to departure the pilot did not appear to be unduly tired or unfit for the flight.
- 2.25 Expert medical opinion stated that the pilot's tendency to drowsiness and fatigue related impairment can be assessed on the basis of three possible factors.

Chronic fatigue. His flying hours for the previous 30 days were relatively low. While the records of total duty were not sufficiently accurate to be assessed they did not show excessively long duty periods, unusual periods of commencement and termination of duty, or inadequate rest periods between duties or patterns of sleep wake activity likely to cause fatigue.

Acute fatigue. The pilot had worked a relatively low number of flight and total duty hours during the week prior to the accident. He had been rostered off duty on 8 June and 10 June, although he had worked for a few hours during the afternoon of 10 June including one hour of flying duty. His work on 9 June was a total of nine hours, including meals and other breaks and 0.9 hours of flying duty. On the evening before the accident he probably slept for approximately 30 minutes and had apparently napped earlier in the evening which would have provided some reduction in fatigue from the day. There was no indicator that he had been engaged in arduous non-work activity during the week prior to the accident. The brief naps would have reduced sleepiness without adverse effects from sleep inertia.

Circadian rhythms. While circadian rhythm related performance would have been tending to decline at this time of day in areas such as vigilance, the effects of circadian dysrhythmia would have been relatively small and no worse than an early start, in the absence of fatigue.

Given the stage of flight and the demanding weather conditions at the time it is unlikely that fatigue and circadian dysrhythmia were severe enough to have caused irresistible sleepiness or loss of consciousness.

Mistakes¹⁰

- 2.26 A number of mistakes were made by the pilot during the planning stage of the flight, and during the flight itself. Some of these took place before any appreciable onset of any debilitating narcotic affects of carbon monoxide were likely to have occurred. This suggested some mistakes included either a failure of expertise in which either the plan was poorly constructed, or an inappropriate solution was applied to it, or a lack of expertise where the pilot simply did not know what to do in the particular situation.
- 2.27 The mistakes prior to carbon monoxide poisoning included: poor flight planning; failure to obtain necessary meteorological information; the choice of an inappropriate route. The potential carbon monoxide affects may have contributed to mistakes of: flying outside the design requirements of the aircraft; continuing in conditions conducive to icing; electing not to use escape options available.

United Aviation

- 2.28 The ultimate accountability for the establishment and maintenance of a safe working environment rested with United Aviation's senior managers. These individuals had the greatest capacity to influence the organisational culture of United Aviation.
- 2.29 The Civil Aviation Act established a clear precedence of organisational responsibility. Section 12 of the Act required each operator who held an aviation document to:
- establish and follow a management system that would ensure compliance with the prescribed safety standards and conditions, and to promote safety;
 - provide training and supervision to all employees so as to maintain compliance;
 - provide sufficient resources to ensure compliance.
- 2.30 During the investigation process United Aviation senior managers were unable to provide clear evidence that they had taken responsibility for pro-actively developing a coherent safety culture, or that they had adequate measures in place to ensure safe operation of their aircraft. Supervision practices appear to have been inconsistent and arbitrary. Procedures did not appear to be well established by managers, and proper leadership and supervision of staff seemed inadequate. Discussion with United Aviation personnel indicated that some important safety and operating policies and procedures were not followed because staff were either unaware of them or they were not clearly defined.
- 2.31 United Aviation appeared to have adopted an inconsistent approach to the maintenance of safe flight operations, and the non-compliances with relevant legislation demonstrated an unacceptable approach to safety, which may have placed the pilots unknowingly in a situation of elevated risk. United Aviation pilot competency checking and training was of a poor standard.
- 2.32 United Aviation presented no convincing evidence that it had researched and identified the likely risks of operating single pilot night IFR freight operations, and as a consequence appeared to have had minimal defences in place to counter the risks. Even though the pilot was instrument rated he was not an experienced IFR pilot, and may not have encountered icing conditions of any significance previously.

¹⁰ This word is used in its human factors context to mean: deficiencies or failures in the judgmental or inferential processes involved in the selection of an objective, or in the specification of the means to achieve it, irrespective of whether or not the actions run according to plan.

- 2.33 United Aviation did not ensure its pilots were able to obtain pertinent meteorological information for planning IFR flights. In practice United Aviation did not actively discourage the use of invalid or inappropriate information and, by implication, permitted its use.
- 2.34 Although there were restrictions in the United Aviation Operations Manual and Flight Manual regarding flight in icing conditions, there was no adequate means of ensuring pilots were aware of the contents of the manuals, or complied with the manuals and United Aviation policy. The United Aviation approach to safety may not have encouraged pilots to comply with some restrictions in the manuals.
- 2.35 Although the maintenance of United Aviation aircraft was less than adequate there was no evidence that any aircraft failure or defect, other than that involving the heater, caused or contributed to the accident. Carbon monoxide poisoning of the pilot was suspected as a significant causal factor in this accident.
- 2.36 It was impossible to confirm from the aircraft records and the wreckage whether the heater AD applied to ZK-KVL. The probability exists however that the AD did apply. Had the inspection of the heater been required by the AD, and been carried out, this would have minimised the potential for carbon monoxide to leak from the heater into the cabin.
- 2.37 Although ZK-KVL was not approved for air transport operations, United Aviation authorised its use on those flights.
- 2.38 The United Aviation senior managers had not taken all reasonable steps to ensure that foreseeable risks associated with the operation had been identified and quantified, and adequately guarded against. Therefore management increased the likelihood that a juxtaposition of error-producing local conditions, such as those that occurred with ZK-KVL, would result in an accident.

CAA auditing

- 2.39 The CAA auditing programme, over at least three years, was effective in identifying a number of non-compliances, non-conformances and other shortcomings with United Aviation's operations. During subsequent audits some non-compliances and non-conformances which should have been remedied by United Aviation were discovered to be outstanding.
- 2.40 Apart from obtaining assurances from United Aviation that non-compliances and non-conformances identified during audits were rectified, there was no record that CAA confirmed United Aviation had carried out the rectification. Because CAA accepted United Aviation's assurances in good faith some problem areas which were not corrected remained outstanding, and were rediscovered during subsequent audits. The lack of firm action by CAA when it discovered that some rectifications promised by United Aviation had in fact not been completed in a timely manner, may have encouraged United Aviation to disregard the audit findings and continue with some unsafe practices.
- 2.41 Since audits only sampled the range of United Aviation activities rather than inspected every aspect of the United Aviation procedures and operations, some non-compliances and non-conformances probably went undetected. United Aviation's shortcomings were therefore likely to have been more widespread than those identified by the series of audits. Some undetected shortcomings which contributed to the accident included: United Aviation not identifying the particular risks of single pilot night freight operations; inadequate defences in place to counter the risks; United Aviation not ensuring pilots obtained relevant meteorological information to plan all flights; and United Aviation allowing the use of invalid and

inappropriate meteorological information. However, a shortcoming relevant to the accident flight was detected during the November 1994 audit. In his report on this audit the lead auditor observed that “a cursory look through the new [operations] manual appears to indicate that there is still insufficient detail about specialist activities of the company e.g. night freight operations”. The detail about which he was concerned was not specified. The more comprehensive audit programme indicated as prudent by those audits which were completed should have detected these problems.

- 2.42 Nevertheless the audits in November 1994 and December 1995 had identified that United Aviation was not recording and complying with some ADs correctly. Compliance with ADs is an essential requirement of aircraft maintenance and any omissions should have been followed up to ensure compliance. As the CAA did not ensure United Aviation had a procedure to identify and comply with all relevant ADs there was significant potential for non-compliance with ADs such as that probably relating to ZK-KVL’s cabin heater.
- 2.43 The January and November 1994 CAA audits identified aircraft which were being used on air transport operations when they were not approved for those operations. On 27 May 1997 the CAA audit found that ZK-KVL was being used for air transport operations when it was not approved for that purpose. The audit report required all non-compliances to be corrected before further operation and 29 May was specified in the audit report for this purpose. United Aviation however had not obtained approval for ZK-KVL to be operated on air transport operations before it tasked the aircraft for the flight on 11 June 1997 on which the accident occurred. CAA advised that had such approval been sought it was unlikely to have been declined because United Aviation already had similar aircraft approved for air transport operations.
- 2.44 In May 1995 a CAA Safety Analyst had called for more frequent audit checks to be carried out on United Aviation and that measures be put in place to ensure United Aviation’s compliance with relevant legislation. However, CAA took no additional action following the Analyst’s recommendation and the audit frequency was not increased, as CAA decided appropriate staff could not be released from other work priorities. The next audit was carried out seven months after the recommendation.
- 2.45 From the results of the years of audits, the repeated examples of non-compliances and non-conformances, the CAA safety analyst’s and auditors’ comments, and the reduction in the normal period of validity for the Air Service Certificate, it was evident that United Aviation had a deficient safety culture and had forfeited the right to participate in the aviation industry. The CAA’s apparent failure to take appropriate action, from January 1994, when it first became clear that United Aviation was not rectifying the non-compliances, and on each of the subsequent audits until May 1997, contributed to the accident.
- 2.46 For an audit process to be complete and effective, it was necessary for CAA to take suitable follow up action to ensure non-compliances and non-conformances were rectified, and strategies put in place to ensure ongoing compliance with appropriate legislation. While it is incumbent on operators to comply with the legislation, if they do not comply the Director of Civil Aviation “shall take such action as may be appropriate in the public interest to enforce the provisions of this Act” (Civil Aviation Act, Section 72I).
- 2.47 The action by CAA following the audit in May 1997 led to the eventual suspension and revoking of United Aviation’s operating certificates, in accordance with the Civil Aviation Act Sections 17 and 18, on 14 July and 9 September 1997 respectively. This action however occurred after the accident, which itself occurred 13 days after the deadline for corrective action by United Aviation had passed.

2.48 The overriding theme in respect of CAA auditing of United Aviation is that successive audit reports indicated that unsatisfactory practices were evident and had been increasing within United Aviation for some time. More effective strategies could therefore have been put in place sooner by CAA to ensure firm action was taken, when the non-compliances and non-conformances and other United Aviation shortcomings which CAA identified were not rectified. Had this occurred United Aviation's safety culture should have improved, and the potential for this accident to occur would have been significantly reduced.

3. Findings

Findings and any safety recommendations are listed in order of development and not in order of priority

- 3.1 The pilot was appropriately licensed and fit to conduct the flight.
- 3.2 The pilot had limited experience in IFR operations.
- 3.3 The pilot did not obtain sufficient meteorological information to plan the flight adequately.
- 3.4 The means to obtain all the necessary meteorological information for flights after midnight had not been made available to the pilot by United Aviation.
- 3.5 Icing conditions were forecast, and optimum icing conditions existed along the route at the altitudes planned and flown by the pilot.
- 3.6 The pilot was probably unaware of any forecast or reported icing conditions along the planned route.
- 3.7 An appropriate lower level coastal route was available for the flight, and should have been planned by the pilot .
- 3.8 Icing conditions probably were encountered during the flight, and the flight continued in those conditions.
- 3.9 Documented Flight Manual and United Aviation requirements prohibited flight in icing conditions.
- 3.10 The option of diverting from his planned route to avoid icing conditions was available to the pilot, but he did not exercise this option.
- 3.11 The pilot may not have been aware of ice forming on his aircraft.
- 3.12 Ice probably formed rapidly to a critical level on the aircraft, causing it to stall and enter a spiral dive.
- 3.13 A defect in the combustion heater was likely to have lead to an unacceptable level of carbon monoxide in the aircraft cabin.
- 3.14 A progressively increasing level of carbon monoxide probably caused significant pilot mental confusion and impairment, and may have led to a subsequent loss of situational awareness.
- 3.15 The pilot was unlikely to have been rendered unconscious or suffered total incapacitation by the carbon monoxide contamination during the early stages of its onset.
- 3.16 Spatial disorientation, likely during the descent, would have reduced the pilot's chance of successfully regaining control of the aircraft in the short time available.

The aircraft

- 3.17 ZK-KVL had not been approved for the type of operation being conducted.
- 3.18 The aircraft had a valid Certificate of Airworthiness, and its records indicated it was airworthy and operating within the required maintenance period.
- 3.19 The aircraft weight and balance were within limits.
- 3.20 The combustion heater in ZK-KVL had not been maintained adequately.
- 3.21 The other recorded outstanding defects on the aircraft were unlikely to have contributed to the accident.
- 3.22 No evidence was found to suggest any systems or structural failure occurred during the flight.

United Aviation

- 3.23 A coherent safety culture did not exist within United Aviation.
- 3.24 No effective means were used to ensure pilots understood or complied with documented United Aviation operating procedures.
- 3.25 United Aviation safety related procedures and supervisory practices were inadequate.
- 3.26 United Aviation's competency checking and training of its pilot was inadequate.
- 3.27 United Aviation did not ensure the pilot had access to necessary meteorological information.
- 3.28 United Aviation did not actively discourage the use of invalid and inappropriate meteorological information.
- 3.29 United Aviation had not analysed the particular risks associated with the accident flight or put in place suitable defences to counter the risks.
- 3.30 United Aviation did not ensure its pilots had sufficient knowledge of the dangers associated with in-flight icing conditions to plan their flights to avoid these hazards.
- 3.31 As United Aviation was responsible for compliance with CAA legislation and the safe operation of its aircraft, it was incumbent on it to respond in a timely and appropriate manner to CAA audit findings to ensure the safe operation of its aircraft.
- 3.32 United Aviation did not respond in a timely and appropriate manner to CAA audit findings.

CAA

- 3.33 The Civil Aviation Act requires the Director of Civil Aviation to control entry into and exit from the Civil Aviation system and to take the necessary action to enforce provisions of the Act, including if necessary suspension or revocation of an operator's aviation documents.
- 3.34 The CAA auditing process detected some uncorrected deficiencies in the United Aviation operating and maintenance procedures over a period of at least three years before the accident.

- 3.35 Safety concerns raised in CAA audits of United Aviation did not result in an appropriate response such as the imposition of sanctions by CAA to ensure United Aviation rectified its non-compliances and non-conformances.
- 3.36 Given the number of new and repeat non-compliances and non-conformances detected during each audit, the CAA should have taken firmer action, if necessary suspending United Aviation's Air Service Certificate, well before it did.

Factors relating to the accident

- 3.37 A number of active and environmental factors combined to bring about the accident. These included:

3.38 Active failures

- The pilot not obtaining adequate meteorological information, and the consequent choice of an inappropriate route.
- The contravention of documented requirements to avoid flight in forecast or known icing conditions.
- The pilot not making use of escape options and instead continuing in icing conditions.

3.39 Environmental factors

- A loss of control due to a probable rapid build up of ice on the aircraft.
- The existence of meteorological conditions along the flight route conducive to moderate or severe icing.
- Carbon monoxide contamination of the cabin, probably causing pilot mental impairment and a loss of situational awareness.

3.40 Latent failures

A number of latent failures were identified which indirectly contributed to the accident. These included:

United Aviation

- The absence of a suitable safety culture within United Aviation.
- Inadequate United Aviation safety related procedures, which were also identified by CAA audits.
- Inadequate supervision of pilots.
- Adequate analysis of the operational risks for the accident flight had not been conducted.
- The existing defences were inadequate to counter the key operational risks associated with the accident flight.
- Not ensuring pilots were suitably briefed about the specific dangers of encountering in-flight icing in a Beechcraft Baron.

- Inadequate procedures for obtaining meteorological information.
- Not ensuring pilots obtained, or were able to obtain, necessary meteorological information.
- Allowing the use of invalid or inappropriate meteorological information.

The CAA

- The Authority's lack of appropriate action to ensure United Aviation rectified the non-compliances and non-conformances which the CAA knew to exist.

4. Safety Actions

- 4.1 No safety recommendations could be made to United Aviation, as a result of the Director of Civil Aviation revoking United Aviation's operating certificates, and United Aviation entering receivership.
- 4.2 As a result of recognising deficiencies within its audit process, including audit findings not being followed up effectively, the CAA began restructuring its auditing operations from November 1996. The CAA advised it has put in place procedures intended to follow up on audit findings effectively. These procedures require individual auditors to ensure operators carry out any corrective action necessary to rectify deficiencies and shortcomings identified during CAA surveillance. If an auditor discovers that corrective action has not been carried out by the due date the auditor will send a reminder notice to the operator. The auditor will send a second notice if corrective action is still not carried out. If a third notice is necessary the Controller Safety Audit will issue the notice and advise the operator that unless corrective action is carried out a recommendation will be made calling for a suspension of the operating certificates.

5. Safety Recommendations

5.1 The Commission recommended to the Director of Civil Aviation that he:

5.1.1 Review the likely safety benefits of the installation of suitable carbon monoxide detection devices in the cabins of aircraft which have potential for an ingress of carbon monoxide, with a view to making the installation of such devices mandatory in appropriate circumstances. (009/98)

5.2 The CAA responded as follows:

5.2.1 The CAA is prepared to adopt the recommendation as proposed. The recommendation will be included in the rule making process for the next amendment of the relevant rule. This process is expected to be initiated by the end of June 1998, with finalisation hopefully this year.

5.3 During the investigation into the DHC-8 accident near Palmerston North in June 1995 serious shortcomings in the CAA safety audit system were discovered. At the time the Director of Civil Aviation advised the Investigator-in-Charge these inadequacies were being addressed.

While a significant improvement was made in the detection of non-compliances and non-conformances, a lack of effective action in the case of United Aviation to ensure compliance and conformance continued at least until the fatal accident involving United Aviation's Baron aircraft in 1997.

The CAA must have a system which ensures it takes appropriate action, in the public interest, to enforce the provisions of the legislation with sufficient expedition to prevent approved operators from lapsing into unsafe practices.

The Commission therefore recommended to the Minister of Transport that he:

5.3.1 Require the CAA to implement, as soon as practicable, a system which will ensure any instances of operator non-compliance and non-conformance which are identified by, or to, the Authority are corrected promptly or sanctions automatically follow. (010/98)

5.4 The Minister of Transport responded as follows:

5.4.1 The Civil Aviation Act requires the Civil Aviation Authority to monitor adherence to safety standards and places specific responsibility on the Director of Civil Aviation to enforce compliance with the provisions of the Act and the rules made under the Act. The Director has statutory discretion with respect to the exercise of this function and is not subject to the requirements or directions of the Minister.

The Director has a range of options for responding when non-compliance is identified by, or to, the Authority. These options include safety education and voluntary compliance measures, varying the conditions or scope of privileges of an aviation document and ultimately revocation of the document and/or prosecution through the courts.

The legislation envisages judgements being made as to the appropriateness of the response having regard to the seriousness of the non-compliance and other information available to the Director, rather than a system of automatic sanctions.

I am advised by the Director of Civil Aviation that he has recently established a coordination committee under the control of the Deputy Director which is aimed at improving the appropriateness and consistency of CAA actions, and ensuring a timely response to incidents of non-compliance.

This committee will review the TAIC report and consider the scope for earlier and firmer "sanctions" for consideration in the future exercise of the Director's enforcement and safety discretion.

14 May 1998

Hon. W P Jeffries
Chief Commissioner

Appendix A

Brief chronology of key events related to CAA Audits and United Aviation operations

* denotes those areas not discussed in the body of the report but included to provide context

From 1982 - 1983	<p>* United Aviation Ltd (United Aviation) formed and issued an Air Service Certificate (ASC). Operated under Civil Aviation Division (CAD) of the Ministry of Transport (MoT), Civil Aviation Regulations 1953. The Palmerston North CAD office inspected and monitored United Aviation.</p>
1988	<p>* CAD restructured and became the Air Transport Division (ATD).</p>
March 1991	<p>* First ATD audit report on United Aviation. Five non-compliances and two non-conformances found.</p>
August 1992	<p>* Civil Aviation Authority (CAA) formed.</p>
1992 - 1993	<p>* Reference to a CAA audit during this period but the report is not on CAA files.</p>
January 1994	<p>CAA audits United Aviation's range of activities. Five non-compliances and one non-conformance identified. A "large number" of overdue actions outstanding from the previous two audits. Audit identified two aircraft being used for air transport operations when not approved for that purpose.</p> <p>CAA Auditor recommends United Aviation's ASC be renewed for six months only, rather than the usual two year period, as CAA was waiting for rectification of two years of audit findings.</p>
March 1994	<p>Transport Accident Investigation Commission (TAIC) investigates United Aviation accident (Report 94-007) involving their PA31 ZK-PKC, flown by their Chief Pilot. CAA also investigated.</p> <p>CAA conducts a special audit of United Aviation's cargo systems following the accident. Two non-compliances and one non-conformance found.</p>
May 1994	<p>CAA advises United Aviation that its ASC will be renewed for six months only, rather than the usual two year period, due to the unfavourable findings of the previous audits.</p>
July 1994	<p>*CAA gives United Aviation Chief Pilot a warning as a result of the March 1994 accident for failure to comply with Civil Aviation Rules and Regulations.</p>
August 1994	<p>TAIC publishes final Report 94-007 identifying six safety deficiencies in United Aviation's operation.</p>
November 1994	<p>CAA audits a range of United Aviation's activities. Seven non-compliances and three non-conformances identified. Three of the non-compliances and one non-conformance were identified in previous audits. Non-compliances include one airworthiness directive (AD) identified as not</p>

	<p>being correctly recorded after it was carried out, and aircraft identified in the January audit still being flown on air transport operations when not approved to do so.</p> <p>Auditor comments on insufficient detail in Operations Manual.</p> <p>CAA auditors' recommend renewal of United Aviation's ASC for 12 months only.</p>
December 1994	United Aviation's ASC renewed for 12 months.
March 1995	<p>CAA audits United Aviation's maintenance activities.</p> <p>One aircraft logbook checked.</p> <p>Two non-compliances and one non-conformance found.</p> <p>The non-conformance was outstanding from the previous audit.</p>
May 1995	<p>CAA Safety Analyst reviews United Aviation's history and makes unfavourable comment relating to United Aviation.</p> <p>He recommends audits be carried out six monthly until United Aviation can demonstrate compliance with Civil Aviation legislation.</p> <p>CAA audit cycle not amended as recommended by the Safety Analyst.</p>
7 December 1995	<p>CAA audits a range of United Aviation's activities.</p> <p>Seven non-compliances and three non-conformances found.</p> <p>Four of the non-compliances and two non-conformances were outstanding from previous audits.</p> <p>The non-compliances included not carrying out five ADs.</p> <p>United Aviation's ASC renewed for two years.</p>
November 1996	CAA issues AD on specified models of Janitrol heater.
December 1996	<p>CAA audits the operation of a United Aviation scheduled service.</p> <p>Eight non-compliances and one safety related concern found.</p> <p>Three of the non-compliances were outstanding from previous audits.</p> <p>ZK-KVL registered to United Aviation and issued a Certificate of Airworthiness by CAA.</p>
March 1997	<p>CAA conducts spot check of a United Aviation aircraft.</p> <p>Three non-compliances found.</p>
From 1 April 1997	<p>*Under the new Civil Aviation Rules (Part 119 Air Transport Operator - Certification) all air transport operators need to be re-certified under the Rule. Transition period allowed - all existing operators should become re-certified no later than December 1999.</p> <p>Civil Aviation Regulations 1953 no longer in force.</p>

6 April 1997	Final compliance date for AD applicable to Janitrol model heater probably fitted to ZK-KVL. No record of United Aviation complying with the AD or of the AD being not applicable.
27 May 1997	CAA audits United Aviation's maintenance activities. Fourteen non-compliances and one non-conformance found. Four of the non-compliances outstanding from previous audits. ZK-KVL inspected - discovered not approved to conduct air transport operations. United Aviation required to rectify the non-compliances by 29 May.
29 May 1997	No apparent follow-up action by CAA to the 27 May audit.
11 June 1997	Accident with ZK-KVL.
13 June 1997	United Aviation was advised that CAA auditors would return to United Aviation by 20 June to confirm rectification of non-compliances. First time any evidence of positive follow-up action by CAA to ensure non-compliances rectified.
19 June 1997	CAA meets the Managing Director of United Aviation.
20 June 1997	CAA auditors return to United Aviation.
14 July 1997	Director of Civil Aviation (DCA) suspends United Aviation's ASC for 14 days.
17 July 1997	CAA audits United Aviation's flight operations. Seven non-compliances found.
21 July 1997	CAA audits United Aviation's maintenance activities. Serious safety concerns raised by the audit.
28 July 1997	DCA suspends United Aviation's ASC for a further 14 days.
8 August 1997	DCA takes action to revoke United Aviation's ASC.
14 August 1997	United Aviation enters receivership.
9 September 1997	DCA permanently revokes United Aviation's ASC.

Glossary of abbreviations in the appendix

AD	Airworthiness Directive	CAD	Civil Aviation Division
ASC	Air Service Certificate	DCA	Director of Civil Aviation
ATD	Air Transport Division	MoT	Ministry of Transport
CAA	Civil Aviation Authority	TAIC	Transport Accident Investigation Commission