BUREAU OF AIR SAFETY INVESTIGATION REPORT

BASI Report B/926/1005

Beechcraft Baron 95-B55

Tarago, New South Wales

19 June 1992

COMMONWEALTH DEPARTMENT OF TRANSPORT AND REGIONAL DEVELOPMENT

BASI
Bureau of Air Safety Investigation

Department of Transport and Communications

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INVESTIGATION REPORT

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CONTENTS

ABBREVIATIONS

ADF	Automatic Direction Finding
AMSL	Above Mean Sea Level
APP	Approach Control
ATC	Air Traffic Control
AVR	Automatic Voice Recording
CAA	Civil Aviation Authority
CAO	Civil Aviation Orders
c.g.	Centre of Gravity
CIR	Command Instrument Rating
DME	Distance-measuring Equipment
IFR	Instrument Flight Rules
ILS	Instrument Landing System
MTOW	Maximum allowable Take-off Weight
NM	Nautical Miles
NVFR	Night Visual Flight Rules
NDB	Non-directional Beacon
POH	Pilots Operating Handbook
TTIS	Total Time In Service
VHF	Very High Frequency
VOR	VHF Omnidirectional Radio Range

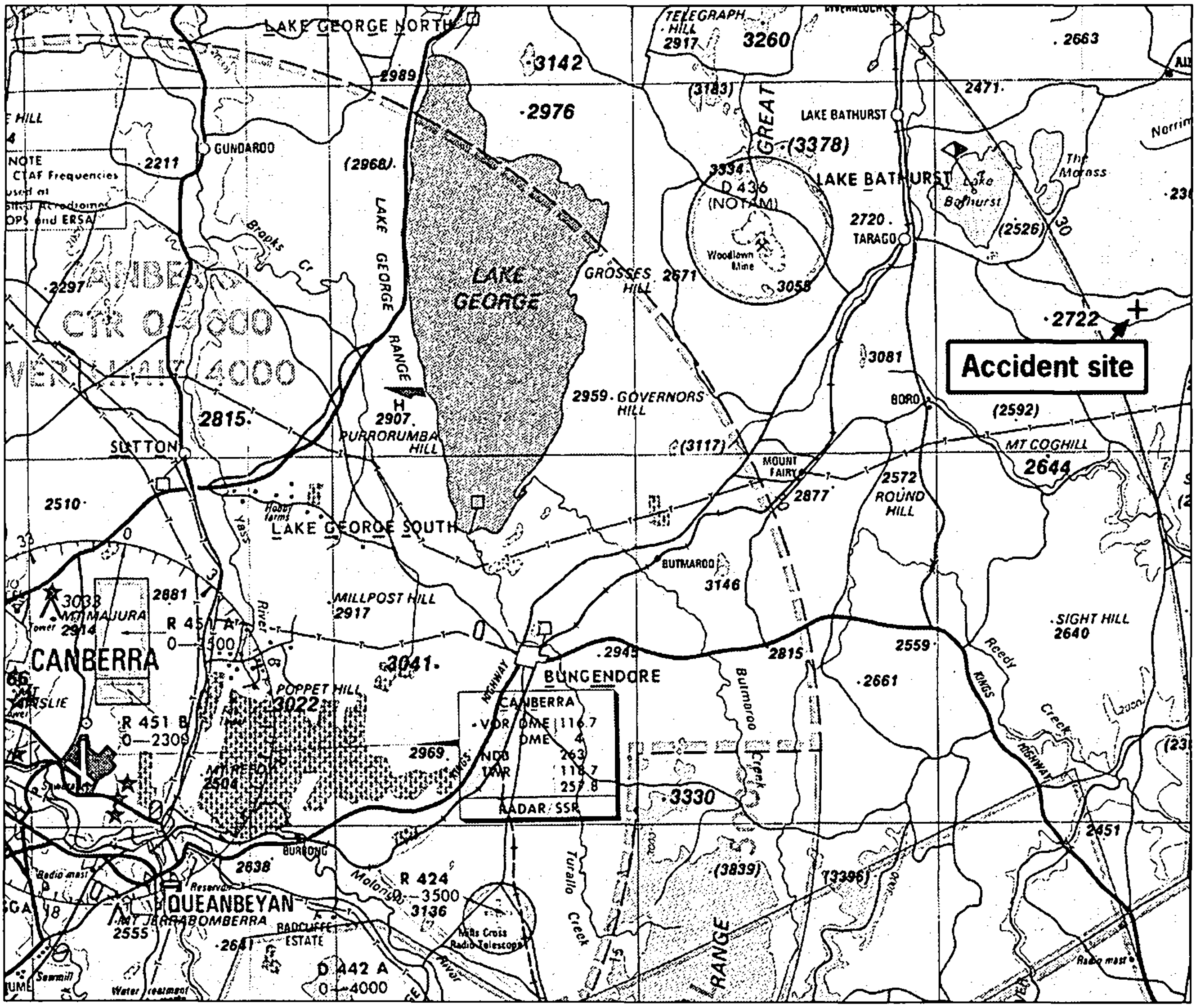
Unless otherwise indicated, all times are Australian Eastern Standard Time (Co-ordinated Universal Time + 10 hours).

SYNOPSIS

On 19 June 1992, at approximately 1853 hours, a Beechcraft Baron 95-B55, registration VH-JDL, disappeared from Air Traffic Control radar display, without prior indication of difficulty. The aircraft wreckage was located the following morning on a moderately timbered slope, 700 metres above mean sea level and 45 kilometres north-east of Canberra, Australian Capital Territory. The pilot and all five passengers were killed and the aircraft was destroyed by impact forces.

The investigation determined that the aircraft departed Bankstown Airport loaded in excess of the maximum allowable take-off weight, and that the pilot did not comply with either Instrument Flight Rules or Night Visual Flight Rules rating recency standards required for the conduct of the flight. While cruising at 8,000 feet, the aircraft entered a rapid descent, during which it reversed direction in a left turn. The descent was briefly arrested at a low altitude; however, the aircraft again turned left and descended rapidly.

The aircraft exhibited flight characteristics consistent with those of an aircraft loaded to an aft centre of gravity position. There are indications that the centre of gravity moved further aft during the flight, until reaching a point at which the pilot was unable to prevent significant diversions in both climb and descent from the reference altitude, culminating in the rapid descent.



Accident location

1. FACTUAL INFORMATION

1.1 History of the flight

The pilot submitted a flight plan nominating a private category Instrument Flight Rules (IFR) flight, from Bankstown to Cooma NSW, tracking over the Shellys non-directional beacon (NDB). Cruise altitude was shown as 6,000 feet (ft) to Shellys, and then 8,000 ft to Cooma. The flight plan indicated a fuel endurance of 189 minutes.

VH-JDL, with five passengers on board, departed Bankstown at 1811 hours, after a delay while waiting for an airways clearance. Shortly after takeoff, Sydney Air Traffic Control (ATC) issued the aircraft a clearance to climb to and cruise at 6,000 ft. After passing over Shellys at 1840 hours, the pilot advised that the aircraft was on climb to 8,000 ft. At 1848 hours he reported to Canberra Approach Control (APP), requesting clearance to enter controlled airspace at 8,000 ft. The pilot was issued the clearance, which he correctly acknowledged, and was advised that the aircraft was positioned about three nautical miles (3 NM) left of the direct Shellys-to-Cooma track.

APP reported that at 1853 hours, radar contact with the aircraft was lost, and that attempted radio communication was unsuccessful.

The next morning, the aircraft wreckage was located at latitude 35°6'30" south and longitude 149°46'33" east, on a moderately timbered ridge 700 metres (m) above mean sea level (AMSL) and 45 kilometres (km) north-east of Canberra. The aircraft had impacted the ground heavily, apparently at high speed, and had then collided with several trees, resulting in the disintegration of the structure. There were no survivors.

1.2 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	1	5	–
Serious	–	–	–
Minor/None	–	–	–

1.3 Damage to aircraft

The aircraft was destroyed by impact forces.

1.4 Other damage

Other damage was confined to a section of fence and a number of destroyed trees.

1.5 Personnel information

The pilot in command was aged 23 years. He held a current Commercial Pilot Licence which was appropriately endorsed for the Beechcraft 95-B55 (B55) Baron aircraft. He also held a Command Instrument Rating (CIR) for multi-engine aircraft. However, at the time of the accident, he did not meet the recency standards required by Civil Aviation Orders (CAO) 40.2.1 for the use of the rating.

The pilot had a total flying experience of 920 hours, of which 730 were as pilot in command. He had recorded about 60 hours in multi-engine aircraft, including 32 in command. He had flown about 3 hours on Beechcraft Baron series aircraft, primarily on the larger Baron 58 model, when he gained the type endorsement about 20 months prior to the accident. There were no further logbook entries relating to Baron aircraft prior to a check flight on 18 June 1992. The pilot held a Grade 2 Instructor rating, and the majority of his flying experience was derived from instructing on small, single engine aircraft.

To satisfy the recency requirements for single-pilot IFR flight, as contained in CAO 40.2.1, the pilot was required, during the preceding 90 days, to have completed at least 1 hour of instrument time including one instrument approach, whilst acting in command under supervision. The pilot was also required to meet recency standards for the navigation aids he intended to use. The flight plan indicated that the pilot was qualified to use instrument landing system (ILS), VHF omnidirectional radio range (VOR) and automatic direction finding (ADF) equipment, and also distance-measuring equipment (DME). An ILS approach had to be flown—either in flight or in an approved simulator—within the preceding 35 days. The VOR and the ADF require 90-day recency.

In July 1991 the pilot completed a flight test for the initial issue of the CIR and in December 1991 he conducted 2.5 hours of simulated navigation aid practice on the NDB, VOR and ILS. Since that date the pilot had not recorded any further in-flight or simulated instrument time.

To comply with the night flight recent experience requirements of Civil Aviation Regulation 5. 109 (b), the pilot should have completed three takeoffs and landings by night within the preceding 90 days.

The pilot's logbook contained no entry for Night Visual Flight Rules (NVFR) flight since May 1991.

During the previous 90 days, the pilot had flown about 3 hours, with less than 1 hour on the aircraft type. His most recent proficiency check was on 18 June 1992, when he completed a daylight check flight in VH-JDL. This was his only flight during the preceding seven days. The pilot was adequately rested prior to the flight, had no known medical problems, and held a current Class 1 medical certificate with an expiry date of 8 March 1993.

1.6 Aircraft information

The aircraft, Serial No. TC-1382, was manufactured by Beech Aircraft Corporation in the USA, in 1971. It was a low-wing, twin-engine, propeller-driven aircraft with a maximum allowable take-off weight (MTOW) of 2,313 kg. It was imported to Australia from South Africa in 1986. When registered as VH-JDL on 6 June 1986, it was issued with Certificate of Airworthiness No. BK1287. Maintenance Release Certificate No. 185158, issued on 20 December 1991, was valid until 9 July 1992, or 3,283.9 hours total time in service (TTIS). The aircraft TTIS prior to the accident flight was about 3,250 hours. There were no identified outstanding maintenance requirements.

At the time of the accident, the aircraft was fitted with six forward-facing seats.

The aircraft was powered by two Continental I0-470-L engines driving Hartzell fully feathering propellers. These components were within their mandatory service lives. The design of the propellers provides counterweights and a feathering spring to drive the blades into the feather position when the control is selected to feather, or when engine oil pressure has been lost.

The aircraft was equipped and approved to IFR standard, and fitted with a three-axis Edo-Aire Mitchell 'Century 3' automatic pilot system. In the event of an autopilot malfunction, the pilot is able to disconnect the system by use of the appropriate switch on the autopilot control panel or a switch button on the control wheel. The autopilot is also designed to enable a pilot to override it by the application of sufficient force to the elevator control to overpower the autopilot-applied control forces.

The elevator trim control system fitted to the aircraft was available only in manual mode at the time of the accident, due to the prior removal of the control-wheel mounted electric system switch. An additional attitude indicator and altimeter were fitted to the right-hand instrument panel. The right-hand crew position was fitted with stowable rudder pedals, but not with an individual control wheel. The control wheel fitted to the aircraft could be placed in front of either front-seat position by being unlocked and rotated over to the other position. An optional dual-control column is required for flight-instructional purposes.

The pilot control levers for engine throttle and propeller pitch are fitted to Beechcraft Baron series aircraft in the reverse order when compared to other aircraft types flown by the pilot.

The B55 aircraft has a nose locker of 0.34 m^3 capacity and an area of similar volume behind the rear seats.

No defects were reported when the aircraft was flown the previous day.

1.6.1 Fuel system

Fuel was contained in four individual wing tanks. The main tanks are located forward of the wing main spar, and the auxiliary tanks are located aft of the spar. The two main tanks have a total capacity of 199 kg, and the two auxiliary tanks 166 kg. The fuel tank selector valves provide for selection of: OFF, AUXILIARY, MAIN, and CROSSFEED. The Pilots Operating Handbook (POH) recommends that the main tanks only should be selected for takeoff and landing. The auxiliary tanks should be used only during cruise flight. Examination of the fuel selectors determined that at the time of impact, each was selected to its respective main tank. Of the multi-engine aircraft on which the pilot was endorsed, only the B55 required the management of main and auxiliary fuel tanks.

The aircraft was refuelled to capacity (516 litres (L) useable) prior to the check flight on the previous day, and was not subsequently topped up. The check flight required about 65–75 L of fuel.

1.6.2 Weight and balance

The aircraft Flight Manual provided the loading calculation system chart BC-48, which clearly indicated that weight positioned aft of the pilot seat would provide a rearward movement of the centre of gravity (c.g.). The reference aircraft weight and balance data contained in the Flight Manual did not reflect the latest amendment status. This data was derived from the initial weighing conducted on 23 May 1986 and since that date the aircraft had been reweighed twice—on 1 July 1989 and 24 July 1990. The aircraft basic weight was 1,574.9 kg and the MTOW 2,313.3 kg.

At some time during flight planning, the pilot calculated weight and balance figures using the BC-48 chart. Entries on the chart were adjusted to comply with the MTOW and c.g. requirements, indicating that fuel would be carried in the main tanks only and that all baggage would be placed in the nose compartment.

Fuel system management can influence the positioning of the c.g. Using fuel from the main tank will cause the c.g. to move rearwards and auxiliary tank fuel usage will cause the c.g. to move forward. Fuel tank selection during the flight could not be determined.

The following table shows the data entered on the BC-48 chart compared with figures obtained during the investigation:

	Pilot-calculated weights (kg)	Investigation-derived weights (kg)
Pilot and five passengers	500	480
Baggage	80	137 (includes spare oil)
Fuel at takeoff	163	303
Total	743	920

The flight plan indicated that the fuel at takeoff was 350 L (252 kg).

The aircraft weight at takeoff was calculated to have been about 2,495 kg, which exceeded the MTOW by 182 kg. Due to the degree of break-up of the aircraft, it was not possible to determine the disposition of the baggage and personal effects, which were found to weigh 134 kg, plus oil containers which added about 3 kg. The seating arrangements for the passengers could not be confirmed, although it was suggested that the heaviest passenger would have been seated next to the pilot.

Several snow skis were in the aircraft. Their length (205 cm) would have necessitated their carriage within the passenger compartment, aligned with the aircraft longitudinal axis and placed between the passenger seats.

The aircraft manufacturer provided the following advice in the POH, section 10-26:

> If an aircraft is loaded aft of the aft c.g. limitation, the pilot will experience a lower level of stability. Airplane characteristics that indicate a lower stability level are: lower control forces, difficulty in trimming the airplane, lower control forces for maneuvering with attendant danger of structural overload, decayed stall characteristics, and a lower level of lateral-directional damping.

The regulations under which this aircraft type was certificated, US Civil Air Regulations Part 3, did not require that the manufacturer demonstrate aircraft handling characteristics with the aircraft loaded beyond the design weight and balance parameters.

1.7 Meteorological information

The Bureau of Meteorology prepared a 'post analysis' report of the meteorological conditions between Bankstown and Tarago. This report concluded that the weather conditions en route would have been clear, with the possibility of some scattered low-level cumulus cloud, and high-level cirrus cloud. The wind at 7,000 ft was from 240°T at 10 kts. At Tarago the surface wind was light and variable, and visibility was about 30 km.

Although the forecasts that the pilot received indicated that there could be showers and some thunderstorm activity en route, pilots who had flown in the area near the time of the accident reported actual conditions very similar to those described in the 'post analysis'. The night was dark, with the moon rising after the time of the accident.

There is no indication that weather conditions contributed to the accident.

1.8 Aids To navigation

The flight plan indicated that the aircraft was equipped with, and the pilot was qualified to use, VOR, ADF and DME navigation aids. The flight-planned route was serviced by VOR, NDB and DME when within range of Sydney and Canberra, and with an NDB transmitter at Shellys.

Although there are indications that electrical power was available to the aircraft avionics, and that the pilot had earlier tracked with reference to the Sydney VOR and the Shellys NDB, no determination could be made as to the serviceability or use of the aircraft navigational equipment immediately prior to the descent from 8,000 ft. The pilot reported over Shellys

NDB at 1840 hours. Within 8 minutes of passing the NDB, he was advised by APP that the aircraft was 3 NM left of the direct Shellys-to-Cooma track. Radar data indicates that the aircraft was regaining the direct track at the time of the descent from 8,000 ft.

A secondary surveillance radar transponder was fitted to the aircraft, and was responding normally to interrogations by Canberra ATC radar.

1. 9 Communications

The aircraft was fitted with VHF radio communication equipment appropriate to the planned flight. The pilot had communicated, apparently without difficulty, with Bankstown Tower, Sydney Flight Service, Sydney ATC, and with Canberra ATC. Review of the automatic voice recording (AVR) tapes did not reveal any indication—either expressed, or implied by the pilot's tone of voice—that the flight was other than normal. The last radio transmission between the aircraft and APP was at 0848 hours, about 4 minutes before the descent from 8,000 ft. The control wheel was not fitted with a 'press-to-transmit' button, but a hand-held microphone and a headset were available to the pilot.

1. 10 Aerodrome information

Not relevant

1. 11 Flight recorders

The aircraft was not equipped with a flight data recorder or a cockpit voice recorder, nor was any required by regulation.

1. 12 Wreckage and impact information

Both wings were damaged as the aircraft descended through trees, while in a right-wing low, nose-down attitude, heading in a westerly direction. Seventeen metres beyond the first tree contact, the aircraft struck the ground heavily, right engine first, followed immediately by the fuselage and then the left engine. The force of this initial ground contact caused substantial

Impact trail (looking in direction of flight). Initial ground impact point indicated.

deformation of the primary structure, rupturing of the fuel tanks, and the separation of some components. The aircraft then bounced about 20 m before colliding with a large log which ruptured the fuselage.

Continuing with little directional deviation, the aircraft encountered numerous trees of 8–12 m in height, which caused the disintegration of almost the entire structure. The engines were torn from the wings and the wings and horizontal stabilisers separated from the fuselage. The fuselage had broken near the wing trailing edge, and the cabin roof was torn away. Both propellers had separated from the engines. The left propeller remained attached to the crankshaft mounting flange, which was sheared from the crankshaft. Two blades had separated from the left propeller, while all three blades separated from the right propeller. The landing gear was found to be in the retracted position and wing-flap actuator settings indicated that the flaps were also retracted at impact.

The main wreckage area was located between 40 m and 60 m from the initial ground contact point, and the engines were displaced up to 40 m further along the wreckage trail (see figure 1).

The main wreckage area

Attempts to identify propeller blade ground contact marks for the purpose of speed determination were unsuccessful.

1. 12. 1 Final flight path and aircraft attitude calculations

The final descent angle relative to the horizontal was determined to have been about 35° and the aircraft nose attitude was about 7° down, resulting in a relative angle of attack of about 28°. The ground slope at the impact point was 7° up. The aircraft was banked about 23° to the right at the initial tree contact and this angle increased as the aircraft descended to ground impact. The speed of the aircraft was estimated to have been 150–180 kts immediately before contact with the trees.

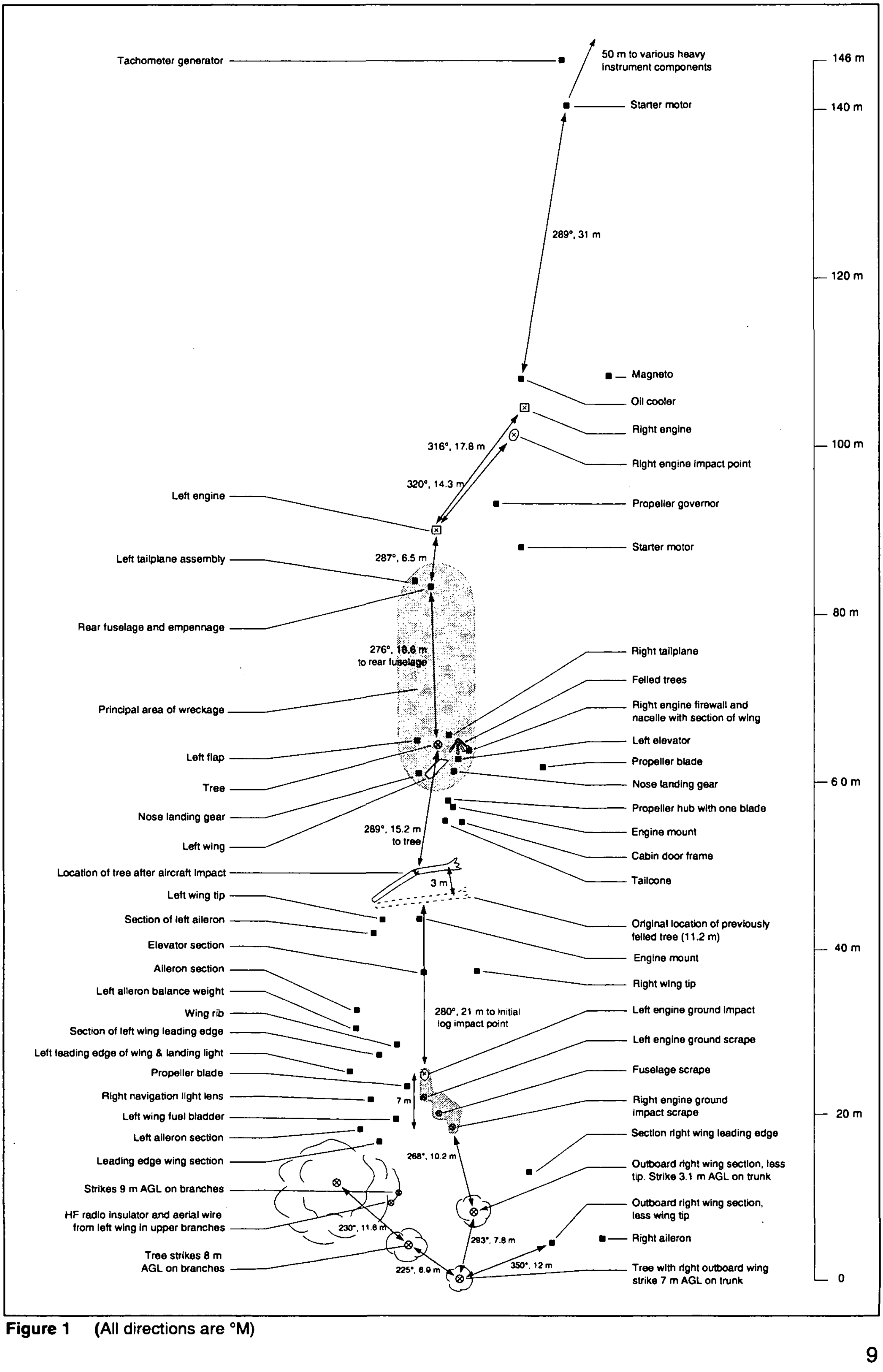


Figure 1 (All directions are °M)

1. 12. 2 Aircraft systems examination

All passenger restraint harnesses and their attachment points had sustained damage consistent with having been subjected to a significant overload.

The only fuel samples available from the wreckage were small quantities found in the engine fuel injection systems. Conclusive evidence of fuel spill on the ground or on vegetation throughout the accident site was not found, despite the known substantial quantity of fuel carried by the aircraft. All fuel tank caps were located and assessed as having been correctly fitted.

The engines and propellers were dismantled and examined. The investigation gave considerable attention to engine oil leaks and rough engine operation allegedly reported during the flight (see para. 1.17.2). No indication of pre-existing defects which may have led to the reports was found. The wreckage was inspected for evidence of in-flight engine oil loss, but no indication beyond normal in-service oil staining was found. There was also no evidence of oil having been thrown against the fuselage from either engine during flight.

The condition of each engine was consistent with it having operated under power immediately prior to impact, and the propeller component impact indications suggested that the pitch settings were about 46°, which is also consistent with having been under power. The fuel injector nozzles fitted to the left engine were of a higher fuel-flow rate than those fitted to the right-hand engine. The bore size of the cylinder assemblies fitted to the right engine had been machined to 0.015 inch oversize, while the left engine was fitted with standard diameter cylinder bores. The mode of failure of the left engine crankshaft flange was determined to be due to a combination of bending and torsional overload, with no pre-existing defect found on the fracture surface. One engine cowl flap actuator was identified, but due to its severely damaged condition, no reliable information as to its position at impact could be ascertained.

The airframe, avionics and instrumentation were examined, but no pre-existing defects were found. All identified damage was consistent with impact overload. Examination of light-bulb elements showed evidence of power to two navigation lights and a number of globes from the radios and the instrument panels. The autopilot and its associated systems were subjected to extensive analysis. A determination concerning both the serviceability and the operation of the autopilot at or shortly prior to impact could not be made, although specialist opinion is that the autopilot may not have been switched on.

Examination of the fuel selector valves determined that at the time of impact, each valve was selected to its respective main tank. It was not possible to establish if the auxiliary tanks were used at any time during the flight. Examination of the flight control system trim jacks for indications of pre-impact settings was generally inconclusive due to the degree of disruption to the airframe.

The stowable rudder pedals fitted to the right-hand crew position were found to have sustained damage which indicated that the pedals were stowed at the time of impact.

No defects which may have influenced the circumstances of the accident were identified.

1. 13 Medical and pathological information

There was no evidence that the pilot had any prior medical or psychological condition which might have contributed to the accident. Pathological examination was unable to determine if the pilot had suffered a sudden illness or incapacitation which could have influenced his ability to control the aircraft.

1. 14 Fire

There was no evidence of pre- or post-impact fire.

1.15 Survival aspects

This accident was not survivable.

1.16 Tests and research

1.16.1 Exhaust pipe temperature data

To assist in the determination of engine operating status, laboratory tests were conducted on parts of the engine exhaust systems to gauge pipe surface temperature at impact. These tests indicated that the right engine exhaust pipe temperature was about 400°C and that the left engine pipe temperature was probably not above 350°C. The accuracy of the temperature determinations was constrained by the physical properties of the pipe material, which may not produce discernible change in the micro-hardness at temperatures below 400°C.

The investigation sought to establish normal operational temperature data specific to this aircraft model, as a baseline against which the laboratory information could be compared. The exhaust system for each engine of this aircraft consists of two separate branches, each having three pipes feeding into one. A similar aircraft was equipped with eight temperature-sensing probes fitted to the exhaust pipes at locations on the individual cylinder pipes and in the areas of the junctions of these pipes to replicate the exhaust pipe positions from which the laboratory test samples were taken. The aircraft was then operated in a sequence of normal flight profiles, with no attempt being made to obtain probe readings from non-standard aircraft systems configurations, or operations outside recommended profiles. The engine fuel mixture control levers were maintained at settings appropriate to achieving recommended fuel-flow rates for the various power settings. The probes provided readings of between 453.6°C and 325°C. During climb with the cowl flaps open, the recorded temperatures were 40–50° cooler than those recorded during cruise.

The cooling rate of the exhaust pipes due to power reductions was measured. Power was reduced from the cruise setting of 22 inches Hg and 2,300 RPM, to 10 inches Hg and 2,100 RPM. The following table shows the recorded rates of cooling for a representative selection of the probes. Probe 4 recorded the maximum cooling rate and probe 6 recorded the approximate average rate for the remaining seven probes.

Time (seconds)	Temperature (°C)			
	Probe 1	Probe 4	Probe 6	Probe 7
00	408	447	351	362
20	400	437	342	352
40	376	408	320	333
60	363	382	303	318
80	360	372	295	310

1.17 Additional information

1.17.1 Flight preparation

The flying instructor who performed the check flight with the pilot on 18 June was on duty when the pilot prepared the aircraft for the flight to Cooma. He advised that the check flight involved a number of takeoffs and landings, a short cruise, and some asymmetric operation. Weight and balance computations for the flight to Cooma were discussed, as were flight planning, recommended airspeeds and emergency operation. There were no aircraft unserviceabilities reported following the check flight. The instructor was aware that the pilot held a Commercial Pilot Licence with CIR and Instructor rating, but did not require the pilot to verify compliance with recency requirements for either NVFR or IFR flight.

The instructor reported that the pilot left the office to load the passengers for Cooma at between 1700 hours and the end of daylight (about 1730 hours). Consequently, he gained the impression that the flight would be unlikely to depart before 1800 hours. He had not seen the loading of the aircraft prior to its departure. The pilot had entered details in the authorisation sheet, including fuel quantity, which was listed as full main tanks. Aircraft refuelling records indicated that the fuel tanks were filled after flight on 13 June 1992. The aircraft was then not flown until the check flight on 18 June. The instructor reported that the fuel tanks were full prior to the check flight and that they were not topped up after the 0.7-hour flight.

The pilot would have been aware of the fuel quantity, and had not required that a change be made. Several different take-off fuel quantities were documented by the pilot. The flight plan showed 350 L, the flight authorisation indicated full mains (280 L) and the pre-flight load chart BC-48 recorded the figure of 163 kg (226 L). Evidence obtained during the investigation indicated that the aircraft contained a total of about 425 L, representing full tank capacity reduced by about 90 L for the check flight and for taxiing at Bankstown prior to departure for Cooma.

The departure delay at Bankstown was due to heavy traffic inbound to Bankstown from controlled airspace.

1.17.2 Information from witnesses

A friend of the pilot reported that during planning for the flight, the pilot had expressed concern that he may have to reduce the fuel load due to the passenger loading. The pilot had also discussed the possibility of a diversion if he found unfavourable weather at Cooma. He indicated he would consider landing at Merimbula.

A flying instructor who conducted a training flight from Canberra to Goulburn shortly before the time of the accident, and then to Moruya about 30 minutes after the occurrence, advised that there had been no weather-related difficulties. Cruise at 7,000 ft was in clear, non-icing conditions, with only scattered low-level cloud and cloud above 10,000 ft.

Residents near the accident site reported hearing and seeing an aircraft, or seeing aircraft lights, between 1825 hours and 1930 hours. It became apparent that some reports to police were based on the assumption that the same aircraft had been operating in the area from 1825 up to the time of the accident. The reported sightings of the subject aircraft after 1900 hours were the result of a miscalculation of time by the witnesses.

A resident located about 4 km south-west of the accident site heard an aircraft approaching from the east at about 1850 hours. She observed the aircraft descend below a ridge to the east of the house, noticed an increase in engine noise, and inferred from its sound that the aircraft turned and continued behind the ridge. Another resident, located about 5 km south-west of the accident site reported hearing a 'screaming sound' above his house, and then saw lights at a low height, causing him to be concerned for the safety of the aircraft as it approached a timbered ridge. Two people camping in a paddock about 1 km north of the accident site were alerted to an aircraft by a 'screaming noise'. The couple reported that the aircraft appeared to briefly fly level before pitching up and then turning down to the left. The aircraft disappeared below the level of the trees and they then heard a noise like the cracking of trees.

The police were provided with a statement from a friend of the passengers, who was to meet the aircraft at Cooma. According to the statement, a passenger had telephoned the friend prior to departure from Bankstown to advise of a delay caused by an engine oil leak. About 27 minutes after departure, he again called and complained of rough engine operation and engine oil leaks which caused oil to be thrown onto the fuselage.

1. 17. 3 Recorded radar data

Radar data of the flight recorded at Sydney and Melbourne was examined. Due to radar-range limitations at the altitudes flown by VH-JDL, data was not available for the flight from 1826 hours to 1845 hours.

Examination of the recorded aircraft profile during cruise at 6,000 ft showed fluctuations in altitude at rates of up to 500 ft/min. At the later cruise level of 8,000 ft, the aircraft deviated up to 400 ft from the reference altitude at relatively high rates of climb and descent. During a 4-minute period from 1848 hours, the aircraft was shown to have made 10 altitude diversions at rates of 500 ft/min or greater. Two departures from the reference altitude exceeded 1,000 ft/min and one recorded 2,000 ft/min, which immediately preceded the rapid descent to possibly less than 4,800 ft.

Radar analysis did not give a reliable indication of the circumstances of the descent from 8,000 ft, other than to display a relatively constant track representation down to about 7,600 ft AMSL. The data was incomplete from the 7,600-ft position, due to terrain shielding and manoeuvring of the aircraft. The available data indicated that the aircraft entered a manoeuvre which resulted in a track reversal, turning from the south-west to the north-east. A radar return 40 seconds after the 7,600-ft position placed the aircraft at about 740 m south-east from the accident site, at 4,800 ft AMSL (representing an average descent rate of about 4,200 ft/min).

The radar data indicated that the aircraft average ground speed during cruise flight was maintained at a speed consistent with normal cruise.

Information derived from the radar recordings was also assessed for indications of aircraft stability and handling. The fluctuations evident in rate of climb, airspeed, and altitude data were examined for characteristics consistent with those of an aircraft loaded to a rear c.g. position.

The radar altitude trace for VH-JDL was compared with those of similar aircraft conducting normal operations and although the circumstances of the aircraft vary, VH-JDL exhibited indications of more frequent altitude fluctuations which were also significantly more divergent.

The radar data was also assessed to confirm the existence of other aircraft in the area during the time leading up to the accident. A military Caribou aircraft was in the general area from 1805 hours to 1818 hours. A light aircraft was seen conducting navigation aid practice at Goulburn, and tracking to within 10 NM north of the accident site, between 1828 hours and 1835 hours.

1. 17. 4 In-flight use of portable cellular telephones

Portable cellular telephones were found in the aircraft wreckage. The only verified telephone use during the flight was at 1838 hours, about 15 minutes before the estimated time of the accident.

The Department of Transport had issued advice during 1988 regarding potential problems associated with in-flight use of cellular telephones, but had not banned their use. Telecom had banned the use of these devices in aircraft while airborne, citing concern for interference with the MobileNet and with the aircraft electronic equipment. However, this concern was not formally conveyed to its clients.

There has been at least one occurrence reported in Australia of a hand-held cellular telephone interfering with VHF communication during flight. However, there is no record of navigational difficulty resulting from cellular telephone interference to airborne navigation equipment. The Bureau of Air Safety Investigation's database has no record of aircraft electronic systems interference attributable to the use of cellular telephones.

Further Department of Transport/Civil Aviation Authority (CAA) advice on the use of airborne cellular telephones was not promulgated until after the accident. The later information advised pilots of the possibility of interference to aircraft electronic equipment. Pilots in command were required to satisfy themselves that no risk would result should in-flight use of a cellular telephone be permitted.

The opinion of representatives of the General Aviation electronics sector was that interference by these transmissions sufficient to cause the electronic equipment as fitted to this aircraft to malfunction was possible but unlikely.

1. 17. 5 Aircraft manufacturer involvement

The investigation was offered support by the manufacturer. At an early stage in the investigation, aspects of the aircraft operation relating to weight and balance were seen as crucial to the determination of the circumstances of the accident. The manufacturer was requested to conduct simulator analysis of B55 aircraft control system response characteristics when loaded similarly to VH-JDL. Despite repeated requests, at the time of printing of this report, no information relating to the circumstances of this accident has been received from the manufacturer.

2. ANALYSIS

2.1 Introduction

In the absence of weather implications or any indication from the pilot that he was experiencing difficulty with the operation of the aircraft, the analysis has relied to a significant degree upon information relating to the aircraft loading and the examination of recorded ATC radar data.

2.2 The pilot

The pilot was a qualified flying instructor and as such could be expected to be not only aware of the requirements regarding aircraft weight and balance, but also to be familiar with the implications of incorrect weight and balance procedures. Although he had accumulated over 900 flying hours, the pilot had conducted very few commercial flights other than instructional sequences. Available evidence indicates that the accident flight was one of only a few flights he had conducted which involved real operational pressures due to critical aspects of passenger, baggage and fuel weights. During the check flight on 18 June 1992, the pilot would have been aware of the aircraft fuel status and with the aircraft loading requirements. He should have recognised that the proposed flight to Cooma would involve overloading the aircraft, unless reductions in the fuel and/or baggage weights were made. Despite this, the pilot commenced the flight with a significant overload, for which no explanation has been found.

Although aware during planning that the flight would be conducted at least in part at night and that there was a possibility of IFR conditions, the pilot apparently made no attempt to meet the recency requirements for either NVFR or IFR operations.

During takeoff, the pilot should have been aware of the effects on the aircraft of the overweight and rear c.g. condition. It has not been possible to determine whether he would have been aware of the influence of fuel management on the c.g. movement. He may have assumed that as the flight progressed and the fuel weight reduced, the aircraft handling would improve.

The dark-night conditions and the aircraft-handling difficulty could be expected to increase the workload to a significant level for a pilot with limited aircraft-type experience, and who during the previous 11 months had flown only in daylight Visual Flight Rules operations.

Consideration was given to the possibility that the pilot, due to his experience as a flight instructor, may have permitted the front passenger to handle the aircraft controls. Available evidence indicates that this was most unlikely. The right-hand rudder pedals were in the stowed position at impact, the aircraft was not fitted with dual-control wheels and the pilot was not experienced on the aircraft type or in night flight. The CAA flight crew database contains no record of the front passenger having held any category of pilot licence.

The pilot had received instruction in the use of 'Century 3' autopilot systems during training sequences for the CIR. He could therefore be expected to have been sufficiently familiar with the device to use it, subject to serviceability, during the flight.

Prior to the descent from 8,000 ft, the lights of Canberra and Queanbeyan would have provided the pilot with a visual reference. During the descent, as the aircraft turned into the north, this visual reference would have been lost, and the pilot would then have been dependent upon his ability to maintain orientation primarily by reference to the aircraft flight instruments. However, his lack of recent experience in instrument flight procedures may have made this task more difficult.

2. 3 The aircraft

There has been no confirmation that the aircraft was delayed at Bankstown due to an engine oil leak. The only verified delay was one of about 25 minutes, from taxi to takeoff, which was partially due to difficulty the pilot experienced in obtaining an airways clearance.

No evidence of in-flight engine oil leaks was found. The reported passenger concern relating to rough engine operation may have been the result of the pilot experiencing difficulty in operating the aircraft and its systems smoothly, such as maintaining the engines synchronised, or in adjusting the fuel-mixture settings. The pilot may have caused erratic engine operation at times if he operated the propeller control rather than the throttle control, or vice-versa, due to the reversed positions of the controls on this aircraft as compared with other aircraft with which the pilot was more familiar.

Examination of the aircraft flight-control trim systems to determine pre-impact settings was generally inconclusive, although there were indications that the elevator trim control had been set in the nose-down range, and that the rudder trim was set at or near the neutral position. The pre-impact functional status of the automatic pilot system could not be established.

The apparent lack of fuel spill at the impact site, despite the significant quantity of fuel carried by the aircraft on departure from Bankstown, could be consistent with the severity of the high speed impact. It is likely that as the fuel tanks ruptured at the initial ground impact, much of the fuel was dispersed in an atomised state.

2. 3. 1 Exhaust pipe temperature data

The results of the flight test exhaust pipe temperature readings indicated that the laboratory-derived temperatures for the right-engine pipes were consistent with normal operation. The laboratory finding that the left-engine pipes were at 350°C or less, may be attributable to environmental and/or operational factors. Cowl-flap position, fuel-flow settings, engine condition and cowling efficiency, etc., may have varied between the two engines, resulting in the apparent disparity. It is known from the engine examination that the fuel injector nozzles and the cylinder bore diameters differed between the two engines, suggesting that the right-hand engine would operate at a temperature higher than that of the left engine.

When these findings are related to engine and propeller-impact indications of power being delivered, the radar data ground-speed indications and the lack of any concern expressed by the pilot, it is considered that both engines were capable of normal operation prior to impact.

2. 4 Weight and balance

The pilot had addressed various aspects of flight planning, including MTOW and c.g. considerations, but his management of the actual aircraft loading did not reflect an appreciation of these aspects. Rather, he appears to have simply accepted the situation as presented to him. Calculations made by the pilot on the BC-48 chart during flight planning indicated he was aware that to carry the intended passengers and load the aircraft to within the required limits, baggage and fuel weight would have to be restricted, and the baggage weight placed as far forward as possible. The chart entries did not reflect the actual loading of the aircraft, as the figures were adjusted to comply with MTOW and c.g. limitations.

It has not been possible to define the position of the aircraft c.g. at takeoff, or its movement during the flight. However the c.g. at takeoff was most likely at, or beyond, the rear limit. This assessment is based on:

(a) The physical limitations of the aircraft when required to carry six adults and a substantial quantity of baggage. The limited forward baggage compartment volume would necessitate the placement of a considerable amount of baggage in the cabin and rear compartment. Of the 137 kg baggage and other items, it is considered unlikely that the pilot could have located more than about 50 kg in the nose compartment. The remainder would have had to be carried in the cabin and the rear baggage area.

(b) The main fuel tanks being partially depleted, and the auxiliary fuel tanks being full.

(c) The flight profiles produced by the recorded ATC radar data.

(d) Indications that, during the descent, the pilot briefly regained a measure of control, but could not prevent a further descent.

The reason for the apparent deterioration in aircraft-handling characteristics during the flight could be the result of fuel burn-off from the main tanks producing a rearward movement of the c.g., and/or the movement during flight of baggage to a position further to the rear of the cabin.

Although the aircraft Flight Manual did not contain the latest weight and balance information, the changes were not considered significant to this occurrence.

2. 5 In-flight use of cellular telephones

The circumstances of the rapid descent from cruise altitude are not consistent with a loss of control induced by interference to the autopilot or navigational equipment by passenger use of portable cellular telephones.

Specialist examination of the altitude fluctuations shown on the ATC radar tapes for the flight concluded that they were not characteristic of a pattern produced by autopilot-induced oscillations.

There was no indication of interference to radio transmissions at any time during the flight.

2. 6 Recorded radar data

The fluctuations in rate of climb and descent, in airspeed and in altitude, evident from the radar data, are considered to be indications that the aircraft was exhibiting insensitivity to control inputs and a sensitivity to external disturbances—a condition consistent with a rear c.g. position. This finding is supported by the comparison of the radar-tape display of VH-JDL with those of similar aircraft.

The apparent difficulty with which the pilot was controlling the aircraft could be an indication that he was actually 'out of phase' with the required control system response. This is a situation typified by the inability of a pilot to apply a timely and appropriate control response to the increasing divergence of the aircraft from the reference altitude.

The rate of descent after leaving the 8,000 ft cruise level may have exceeded the 4,200 ft/min value calculated from the radar data, due to incomplete information in the area of the manoeuvre from a south-westerly heading to a north-easterly heading. Witness statements concerning the manoeuvring of the aircraft suggest that it may have manoeuvred beyond radar-data indications. The time available during the loss of radar data precludes any significant differences in the aircraft radius of operation; however, the altitude to which the aircraft descended prior to the brief recovery may have been lower than the recorded 4,800 ft.

Radar-recorded average ground speeds gave no indication of a loss of performance which would have been expected if engine operational problems had occurred. Although significant speed fluctuations occurred during the cruise at 8,000 ft, these were consistent with the altitude deviations.

2. 7 Witness reports

Although some witness reports confused the time at which VH-JDL was heard and seen in the area (possibly because of other aircraft activities), the aircraft was heard during descent, with indications of high speed. It was also observed at a low altitude, apparently after the pilot had regained some degree of control, shortly before the final descent. Aircraft lighting was observed, and engine power was heard.

2. 8 Summary

The pilot had maintained control of the aircraft, albeit with indications of significant altitude inaccuracy, to a stage of the flight at which his lack of NVFR and IFR recency should not have been crucial. He would have been able to maintain orientation by the lighting panorama afforded by the cities of Canberra and Queanbeyan.

The circumstances of the rapid descent and the lack of communication from the pilot are not consistent with circumstances which could be expected to result from the failure of an engine. The pilot was apparently occupied throughout the descent in attempting to restore control of the aircraft, to the extent that he was unable to broadcast an emergency call. No indication was found to suggest that the control difficulties experienced by the pilot were the result of a failure of the aircraft structure or systems.

The circumstances of the loss of control can, however, be seen as consistent with the deterioration in aircraft longitudinal control and possibly also lateral control, resulting from the further rearward movement of an aft c.g. position. The degree to which the lack of recency and specific aircraft type experience diminished the pilot's ability to respond appropriately to the handling difficulties, could not be determined.

It was not possible to determine if the snow skis or other articles which were carried in the cabin area had caused interference to the pilot and/or the flight controls, particularly during possible abrupt manoeuvres associated with the altitude deviations.

3. CONCLUSIONS

3.1 Findings

1. The pilot held a valid Commercial Pilot Licence, with a current medical certificate.
2. The pilot was appropriately endorsed; however, he was not experienced on the aircraft type.
3. The pilot did not meet required NVFR and IFR recency standards.
4. The company from whom the aircraft was hired did not fully establish the operational intentions of the pilot when assessing his competence to conduct the flight to Cooma.
5. Current Civil Aviation Regulations and Orders make the pilot responsible for ensuring that he has the required qualifications and recency to undertake the intended flight.
6. The Aircraft Maintenance Release Certificate was valid, and there were no identified outstanding maintenance requirements.
7. During flight planning, the pilot was aware of a potential overload and c.g. location beyond the rear limit.
8. The aircraft departed Bankstown airport at a weight which exceeded the permissible MTOW by about 180 kg.
9. The aircraft exhibited flight characteristics consistent with an aircraft loaded to a c.g. position at or beyond the rear limit. Fuel burn and/or the rearward movement of baggage during the flight may have caused the c.g. to move further aft.
10. The distribution of the passengers and baggage prior to impact could not be determined.
11. There was no indication that either engine suffered any form of malfunction.
12. The aircraft impacted the ground at a high speed.
13. The fuel tank valves were found to be selected to their respective main tanks; however, in-flight fuel management could not be determined.
14. No evidence was found to indicate that the aircraft had suffered pre-impact mechanical or structural failure.
15. No indication of any interference to the aircraft electronic systems was found.
16. Review of the tape recording of the pilot's communications did not reveal any indication—either expressed or implied—to suggest that the flight was other than normal.

3.2 Significant factors

1. The aircraft departed Bankstown Airport loaded in excess of the maximum permissible take-off weight.
2. The pilot had limited experience on the aircraft type and a lack of recent experience with IFR and NVFR flight.
3. The aircraft probably was loaded to a c.g. position at or beyond the rear limit. Fuel burn and/or rearward movement of baggage during flight may have caused the c.g. to move further aft.
4. During cruise, the aircraft diverted from the nominated 8,000-ft altitude in both climb and descent. These diversions culminated in a rapid descent from which the pilot was unable to fully recover the aircraft.

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