ATSB Australian Transport Safety Bureau

AUSTRALIAN TRANSPORT SAFETY BUREAU

AIR SAFETY INVESTIGATION

200100348

Cessna C310R, VH-HCP 3 km E Newman Aerodrome

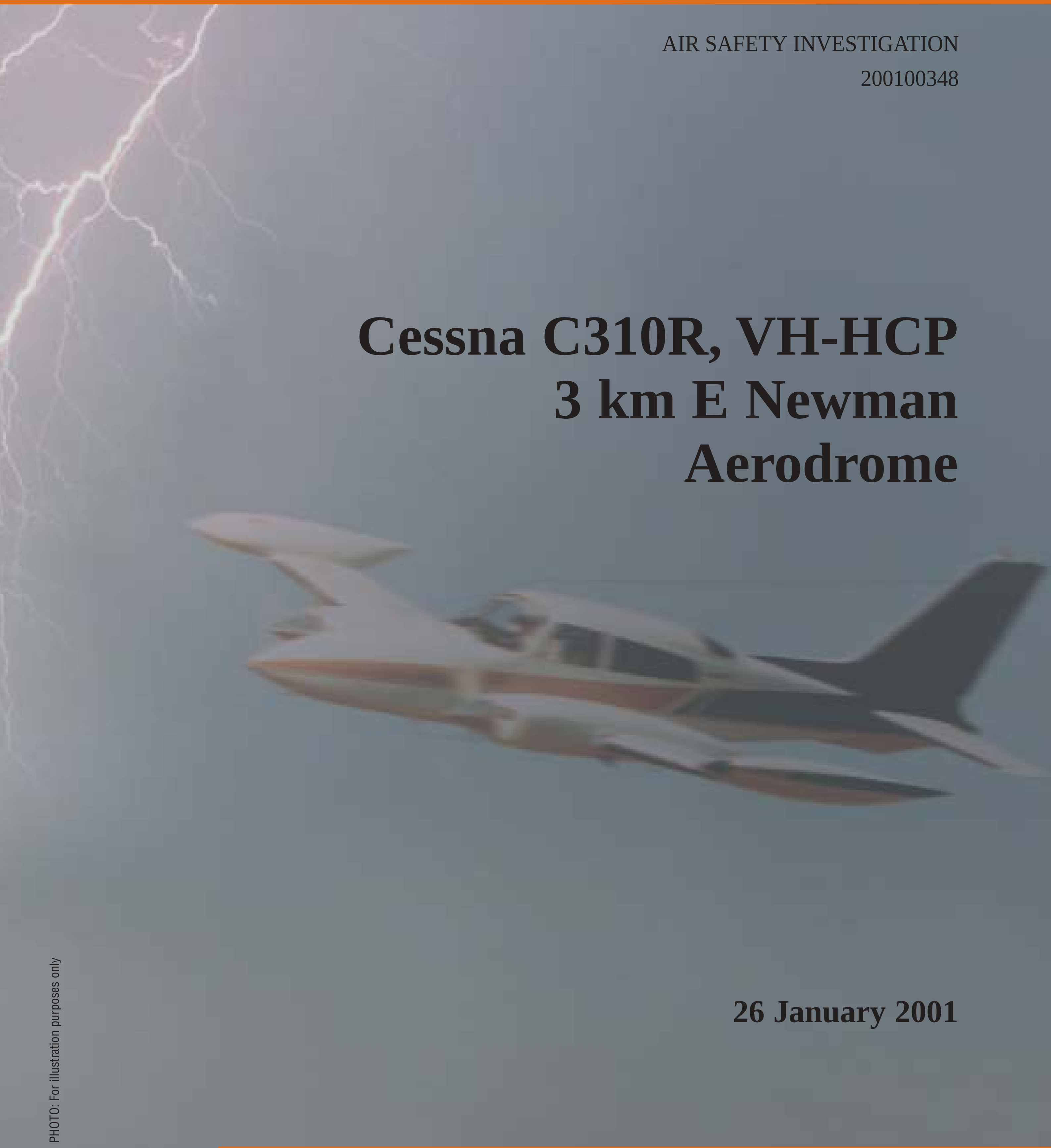


PHOTO: For illustration purposes only

26 January 2001

COMMONWEALTH DEPARTMENT OF TRANSPORT AND REGIONAL SERVICES

Department of Transport and Regional Services

Australian Transport Safety Bureau

INVESTIGATION REPORT
BO/200100348

Cessna C310R, VH-HCP
3 km E Newman Aerodrome
26 January 2001

Released under the provisions of Section 19CU of Part 2A of the *Air Navigation Act 1920*.

The Australian Transport Safety Bureau (ATSB) is an operationally independent multi-modal Bureau within the Commonwealth Department of Transport and Regional Services. Safety investigations conducted by ATSB are independent of regulatory, operator or other external bodies.

In terms of aviation, ATSB is responsible for investigating accidents, serious incidents, incidents and safety deficiencies involving civil aircraft operations in Australia, as well as participating in overseas investigations of accidents and serious incidents involving Australian registered aircraft. ATSB also conducts investigations and studies of the aviation system to identify underlying factors and trends that have the potential to adversely affect safety. A primary concern is the safety of commercial air transport, with particular regard to fare-paying passenger operations.

ATSB investigates occurrences in accordance with Australia's international obligations as a signatory to the Chicago Convention (1944), and the subsequent establishment of the International Civil Aviation Organisation (ICAO). ICAO Annex 13 specifically addresses accident and incident investigation amongst contracting states.

ATSB performs its aviation investigation functions in accordance with the provisions of the *Air Navigation Act 1920*, Part 2A. Section 19CA of the Act states that the object of an investigation is to determine the circumstances surrounding any accident, serious incident, incident or safety deficiency to prevent the occurrence of other similar events. The results of those determinations form the basis for safety recommendations and advisory notices and ultimately accident prevention programs. As with equivalent overseas organisations, ATSB has no power to implement its recommendations.

Consistent with the standards and recommended practices of ICAO, it is not the object of an investigation to determine blame or liability. However, it should be recognised that an investigation report must include factual material of sufficient weight to support the analysis and conclusions reached. That material will at times contain information reflecting on the performance of individuals and organisations, and how their actions may have contributed to the outcomes of the matter under investigation. At all times ATSB endeavours to balance the use of material that could imply adverse comment, with the need to properly explain what happened, and why, in a fair and unbiased manner.

ISBN 1 877071 15 3 October 2002

This report was produced by the Australian Transport Safety Bureau (ATSB), PO Box 967, Civic Square ACT 2608.

Readers are advised that the ATSB investigates for the sole purpose of enhancing safety. Consequently, reports are confined to matters of safety significance and may be misleading if used for any other purpose.

CONTENTS

GLOSSARY OF TERMS

AFM	Aircraft Flight Manual
AGL	Above Ground Level
AIP	Aeronautical Information Publication
AMSL	Above Mean Sea Level
AOC	Air Operator’s Certificate
AOCM	Air Operator Certification Manual
ASSP	Aviation Safety Surveillance Program
ASU	Air Support Unit
ATC	Air Traffic Control
ATO	Authorised Testing Officer
ATS	Air Traffic Services
ATSB	Australian Transport Safety Bureau
BASI	Bureau of Air Safety Investigation
BOM	Bureau of Meteorology
CAA	Civil Aviation Authority
CAAP	Civil Aviation Advisory Publication
CAO	Civil Aviation Order
CAR	Civil Aviation Regulation
CASA	Civil Aviation Safety Authority
CASR	Civil Aviation Safety Regulation
CPL	Commercial Pilot Licence
CIR	Command Instrument Rating
DFOM	District Flying Operations Manager
DME	Distance Measuring Equipment
DP	Discussion Paper
ENR	En Route
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FOI	Flying Operations Inspector
GPS	Global Positioning System
hPa	Hectopascal
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
MBZ	Mandatory Broadcast Zone
NDB	Non-Directional Beacon
NOTAM	Notice to Airmen
NPRM	Notice of Proposed Rule Making
NM	Nautical Miles
OIC	Officer in Charge
RPM	Revolutions Per Minute
RPT	Regular Public Transport
SAR	Search and Rescue
SARTIME	Search and Rescue Alerting Time
STI	Safety Trend Indicator
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omnidirectional Radio Range

EXECUTIVE SUMMARY

At about 1930 Western Standard Time[1] on 26 January 2001, a Cessna 310R aircraft, VH-HCP, departed Kiwirrkurra, Western Australia (WA), for Newman. The flight was conducted at night under the visual flight rules (VFR), with one pilot and three passengers on board. The aircraft was operated by the Air Support Unit (ASU) of the WA Police Service and had been used to transport police officers from Newman to Kiwirrkurra earlier that day.

The aircraft arrived in the circuit area at Newman at about 2150 for a landing on runway 23. Witnesses at the aerodrome heard the engines start to 'cough and splutter'. Soon after, the aircraft collided with the ground about 3 km to the east of Newman aerodrome. The four occupants sustained fatal injuries. Impact forces destroyed the aircraft.

The investigation determined that both of the aircraft's engines failed due to fuel starvation,[2] prior to impact with the ground. There was no evidence of a technical malfunction or of an in-flight fuel leak. From the information available, the investigation calculated that the aircraft probably had about 165 L of useable fuel at impact. Approximately 30 L of fuel was recovered from the aircraft's auxiliary fuel tanks and it was probable that fuel had leaked from these tanks post-impact.

The investigation identified a number of factors that had contributed to the circumstances of the accident. These factors included operational events on the night of the accident, local conditions associated with the circumstances of the operational events, the defences that were used to manage risk, and organisational conditions that influenced the effectiveness of the defences.

Operational events and local conditions

The investigation identified a number of deficiencies associated with the pilot's pre-flight preparation and conduct of the flight. There was no evidence that he had obtained a weather forecast, considered the need for extra fuel, or submitted the appropriate flight notification and he had exceeded the maximum duty period permitted by the Civil Aviation Safety Authority (CASA) under Civil Aviation Order 48. Also, the flight was not operated in accordance with required procedures for VFR flights conducted at night, with respect to contingencies for runway lighting and provision for flight to an alternate aerodrome. The investigation concluded that these factors suggested that the pilot had probably not identified, or fully considered, the hazards associated with the flight. A number of physiological factors such as fatigue, dehydration, and a lack of recent nutrition could also have affected his performance. The pilot was probably experiencing self-imposed pressure to conduct the flight.

The fuel starvation of the engines was probably the result of inadequate techniques used by the pilot to monitor and manage the consumption of fuel from the aircraft's fuel tanks. This had resulted in a low quantity of fuel in the main fuel tanks at the time the engines failed. The investigation could not determine the sequence of events that led to the low quantity of fuel in the main tanks. It was possible that the pilot had

1 Australian Western Standard Time is UTC +8 hours.

2 Fuel starvation refers to an event where fuel is not being supplied to the engines, but useable fuel is available in at least one of the aircraft's fuel tanks.

inadvertently omitted to use the auxiliary tanks, had used the auxiliary tanks for an unusually short period of time, or made some other type of error with the tank selections during the flight. Regardless of what fuel tank selections were made during the flight, the pilot had probably not detected the critically low quantity of fuel in the main tanks towards the end of the flight. The investigation could not find any evidence that the pilot had used structured techniques to monitor the quantity of fuel consumed from the aircraft's tanks during the flight. This could have affected his ability to successfully detect and resolve abnormal indications from the aircraft's fuel gauges.

The pilot experienced a difficult set of circumstances in which to respond to the initial and subsequent engine failure. Those circumstances included a lack of significant external visual reference due to the dark night conditions, the limited height available at circuit altitude and the pilot's skill level in handling emergency situations in multi-engine aircraft. He did not maintain control of the aircraft following the engine failures.

The pilot held a commercial pilot (aeroplane) licence and was rated to fly single-engine aircraft at night under the VFR. He did not hold a valid rating to fly multi-engine aircraft at night, although he probably thought that he had been issued with such a rating following a flight test conducted by the ASU chief pilot. However, the chief pilot was not authorised by CASA to conduct flight tests to issue night VFR ratings. The investigation could not find any objective evidence to indicate that the occurrence pilot had received recent training to control a multi-engine aircraft solely by reference to the aircraft flight instruments following a simulated engine failure, or that this ability had been tested prior to, or after the issue of, the (invalid) multi-engine night VFR rating.

Defences and organisational conditions

The investigation concluded that the processes used by the ASU for training in, and supervision of, fuel planning and fuel management were deficient. This probably contributed to the occurrence pilot not using structured procedures and techniques that could have provided him with a greater level of awareness of his fuel situation during the flight.

Deficiencies were also found with the ASU training and checking of night operations. Pilots did not receive recurrent checking of their performance during night operations. The ASU had not fully recognised the risks of remote area night operations and did not have effective defences to manage those risks.

The ASU chief pilot had been provided with minimal training, guidance and professional development to effectively perform his duties. His performance in several safety critical areas was not monitored and resulted in a series of failures in the overall system of safety management at the ASU. Senior management of the WA Police Service assumed that the regulatory relationship between the ASU and CASA provided adequate assurance that the ASU's operations were conducted to an appropriate standard. However, CASA prioritised its surveillance activities, utilising available resources to achieve surveillance targets for operations carrying fare-paying passengers. Organisations holding an aerial work Air Operator's Certificate (AOC), such as the ASU, were allocated a lower priority when planning surveillance tasks and therefore CASA had not performed any significant assessment of the ASU's fixed-wing operation during recent years.

A number of the ASU's safety defences exceeded minimum regulatory requirements. However, the overall safety management system did not have the capacity to ensure the safety of operations in the wide range of circumstances that could reasonably be anticipated. Insufficient management processes existed to ensure that adequate defences were in place at the operational level to provide an assurance of flight safety.

The WA Police Service provided limited guidance for the ASU to develop safety management processes. The ASU management was expected to develop such processes, and a heavy emphasis was placed on the ASU chief pilot to ensure the safety of flight operations. Although he was a key person within the organisation with defined legal responsibilities, he had not been adequately prepared for this role, and the WA Police Service had no procedures to ensure that the chief pilot was supervising operations to an appropriate safety standard. Many of the deficiencies detected with the ASU's system of safety management had existed for many years, but the WA Police Service did not have a system to identify safety deficiencies in operational areas.

As a result of this accident, the ASU implemented a number of changes to the conduct of its operations. These included: the introduction of a new operations manual; a new training and checking manual; revised procedures for management of fuel by the ASU's pilots; appointment of a safety manager within the ASU; implementation of a hazard identification and communication program; and introduction of procedures to supervise remotely-based pilots. The WA Police Service also formally recognised the chief pilot position in the organisational structure of the service and implemented a reform process to improve pilot and crew selections, training, flight risk management, fatigue management, professionalism, external crosschecking and validation of the ASU systems against industry best practice.

Other issues

At the time of the accident, the relevant aviation regulations permitted flight at night under the VFR at times when pilots may have had insufficient external visual reference to control the aircraft using external visual cues. Under such conditions, the pilot would have been required to control the aircraft using the flight instruments. However, the training and currency requirements for VFR operations at night placed minimal emphasis on flight under such conditions. There was no formal advisory material linked to these requirements to help pilots identify higher risk situations or otherwise encouraging the use of various risk mitigation strategies.

The process used by CASA to approve the appointment of the ASU chief pilot did not detect his (or the operator's) limited knowledge of system safety concepts, nor did it provide any assurance that he understood the extent of his role and responsibilities as chief pilot. That also extended to the manner by which the chief pilot received his CASA approval as a training and checking pilot.

Some of the deficiencies associated with the ASU's procedures and management processes may have been able to be detected during the completion of a CASA periodic inspection. The investigation could not determine why those deficiencies were not detected during earlier periodic inspections, during reviews of documentation associated with checklist completion for the reissue of an AOC, and at other times CASA staff had contact with the ASU.

CASA has recently modified its surveillance planning to ensure that all operators are subject to a recertification audit prior to the reissue of an AOC. CASA is also progressively working on its capacity to identify organisations requiring additional surveillance activity on the basis of risk.

CASA has proposed a number of regulatory changes in the area of General Operating and Flight Rules that relate to fuel planning and fuel management.

While acknowledging the significant safety action underway, the ATSB has issued three additional recommendations concurrently with the release of this report. The recommendations cover: the provisions for the disposition of fuel reserves in fuel tanks to be used during the approach and landing; operational requirements and guidance material for pilots conducting VFR flight in dark night conditions; and required qualifications and/or competencies for chief pilots, with particular reference to management and system safety issues.

1 FACTUAL INFORMATION

1.1 History of the flight

At about 1930 Western Standard Time[1] on 26 January 2001, VH-HCP, a Cessna 310R (C310R) aircraft departed Kiwirrkurra[2] for Newman, Western Australia, about 440 NM (815 km) to the west. The aircraft was being operated by the Air Support Unit (ASU) of the WA Police Service. One pilot and three passengers were on board. The aircraft arrived at Kiwirrkurra earlier that afternoon, and was being used to transport police officers who had been required to attend a serious incident. The aircraft departed Kiwirrkurra after last light,[3] and was operated at night under the visual flight rules (VFR).

The aircraft arrived in the Newman circuit area at about 2150. Three police officers who were at the aerodrome to meet the aircraft, observed it approach from the east and make a left turn after it had passed overhead. The description of the flight path was consistent with the aircraft joining for a left circuit to land on runway 23.

The officers recalled that the runway lights were already illuminated when they arrived at the aerodrome. They also recalled that it was a very dark night, and they could only see the aircraft's external position and anti-collision lights.

The aircraft appeared to be flying at a constant height on the downwind leg of the circuit and the officers reported that the engines sounded normal. When the aircraft was on late downwind they heard an engine or engines start to 'cough and splutter'. At about that time, they noticed that the aircraft had begun to descend.[4]

The officers reported that, during the descent, the aircraft did not travel to their left or right, but remained in a constant direction from where they were standing. They recalled that the red and green wingtip position lights appeared to 'intertwine', maintaining a similar height relative to each other. One of the witnesses reported that the aircraft appeared to be 'spiralling', while another reported that the aircraft seemed to fall to the ground 'like a fluttering leaf' (see also observation 1.12.2). All of the witnesses reported that the sound from the engines stopped while the aircraft was still clearly in view and descending towards the ground. The witnesses heard the sound of an impact shortly after the aircraft had disappeared from view.

The aircraft impacted the ground about 3 km to the east of Newman aerodrome and was destroyed by impact forces. The four occupants sustained fatal injuries.

Fig. 1 shows a map of Newman aerodrome, including the location of the accident site, and the location of the witnesses. Fig. 2 shows the location of Newman aerodrome relative to the township and the approximate track from Kiwirrkurra.

---

1 Australian Western Standard Time (WST) is UTC +8 hours.

2 Kiwirrkurra is a remote community in the Gibson Desert, with an aircraft landing area about 4 km to the west.

3 Last light at Kiwirrkurra on 26 January 2001 was 1842 WST.

4 Due to the speed at which sound waves travel through air, there was a significant delay between events that the witnesses were hearing and what they were seeing. The investigation calculated that this delay could have been as long as 10 seconds.

FIGURE 1:
Newman aerodrome and accident site

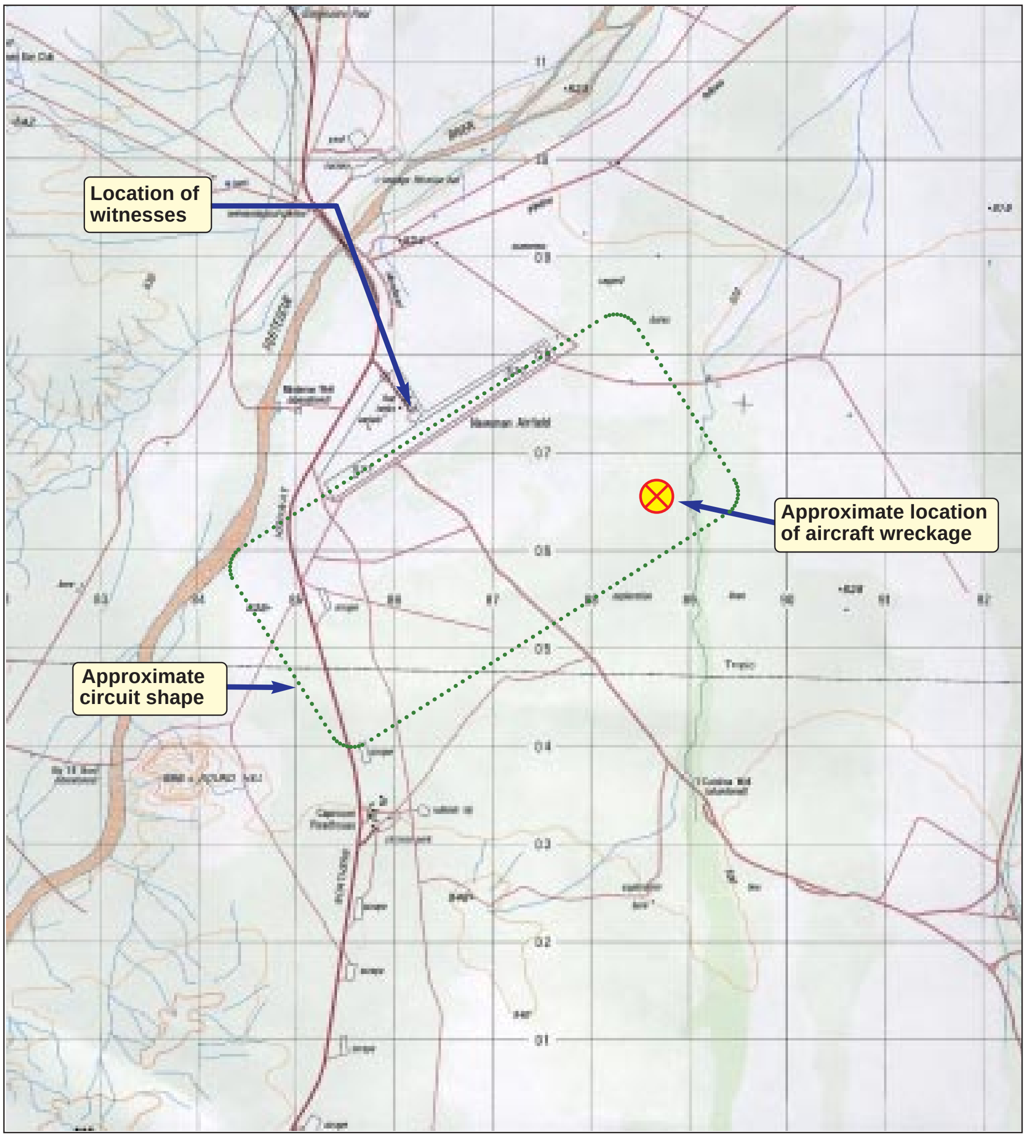
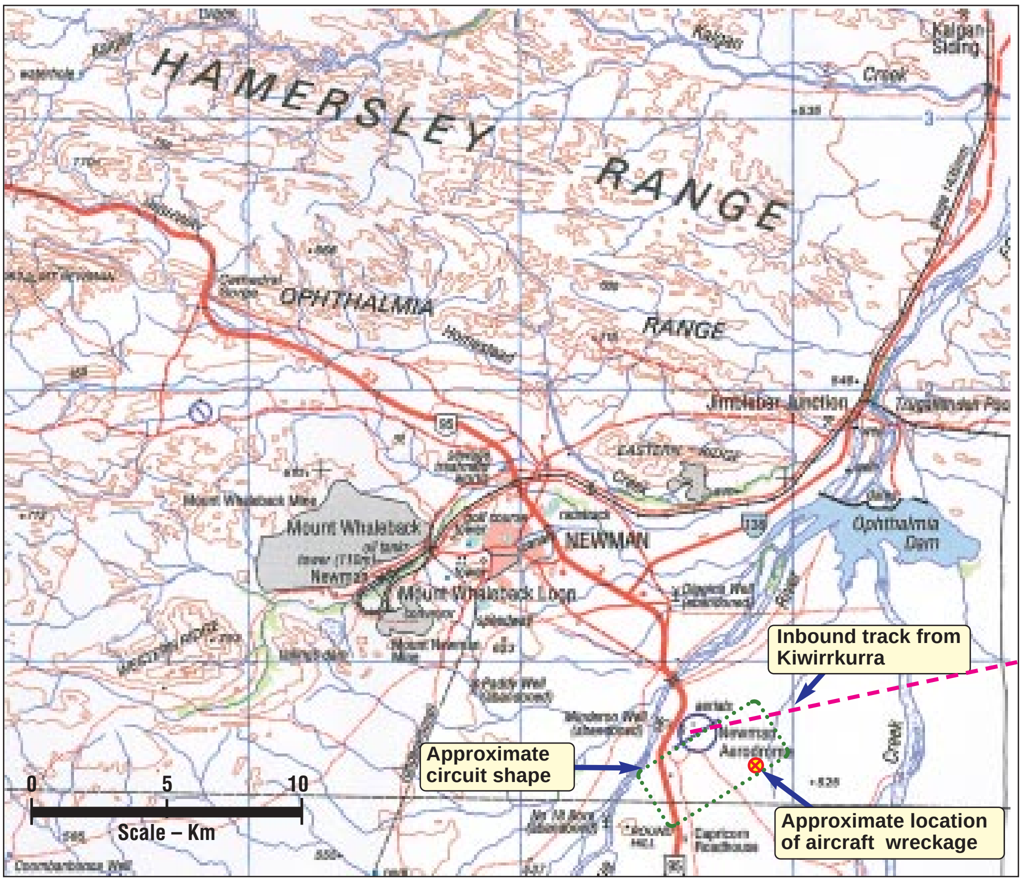


FIGURE 2:
Newman aerodrome and location of Newman township



1.2 Injuries to persons

Degree of injury	*Crew*	*Passengers*	*Others*	*Total*
Fatal	1	3	0	4
Serious	-	-	-	-
Minor	-	-	-	-
None	-	-	-	-

1.3 Damage to aircraft

The aircraft was destroyed by impact forces.

1.4 Other damage

No other property damage was reported.

1.5 Personnel information – pilot

Licence category:	Commercial Pilot (Aeroplane) Licence
Medical:	Class 1, vision correction required[5]
Total hours:	2,423 hours (including 189 night)
Total in command:	2,256 hours (including 176 night)
Total multi-engine:	252 hours (5 night)
Total multi-engine command:	199 hours (4 night)
Flight time C310:	104 hours (4 night)
Flight time last 90 days:	84 hours (4 night)
Flight time last 30 days:	45 hours (4 night)
Last recurrent check:	12 January 2001 (base check, ½ hour)

The pilot had been a serving police officer since 1972 and obtained a commercial pilot licence (CPL) in June 1992. He joined the ASU as a pilot in October 1994, with a total of 242 hours flying experience, and was based at Jandakot until the beginning of January 2001. During July 2000, he had conducted operations from Karratha for a four-week period.[6] The ASU had transferred the pilot on a regional posting to Karratha about 3½ weeks before the accident.

ASU pilots and external flying instructors who had flown with the pilot since he joined the ASU reported that he took longer than most pilots to assimilate training, and needed to work hard to retain his skill levels. Most of the pilot’s ASU flying was done in the operator’s single-engine Cessna 182 (C182).[7]

The pilot undertook ASU training during June 1998 for the initial issue of a multi-engine endorsement but experienced difficulty handling simulated engine failures and with overall cockpit organisation. The ASU discontinued his training and the supervising instructor also identified that the pilot required ‘more guidance on flight planning particularly with regard to cruise altitudes and fuel planning’. The pilot subsequently undertook additional training at his own expense, external to the ASU, and obtained his initial multi-engine endorsement in August 1998.

The pilot also experienced difficulties, during two attempts, to obtain a C310 type endorsement with the ASU during the period July to September 1999. During June 2000, the pilot undertook additional training at his own expense, external to the ASU, and obtained a C310 type endorsement.

Between June 2000 and the date of the accident, the ASU chief pilot had completed seven multi-engine flights with the pilot. The chief pilot stated that he did not detect any significant problems with the pilot’s performance during any of these flights. Some of these flights included assessment of the pilot’s performance during simulated engine failures. The occurrence pilot’s logbook did not include any entries to indicate that instrument flying practice was performed during these flights.

5 The pilot was wearing glasses at the time of the accident.

6 This was relief duty to cover a scheduled period of leave.

7 The C182 operated by the ASU had a simple two-tank fuel system, with possible cockpit fuel tank selections of ‘both’, ‘left’, ‘right’ and ‘off’.

The pilot obtained a single-engine night VFR rating in March 1996. This training was provided by a CASA-approved Authorised Testing Officer (ATO), who had been contracted by the ASU to provide flight instruction and testing for the issue of the pilot's single-engine night VFR rating.

The pilot's logbook indicated that since March 1996 he had accumulated about 184 hours night flying experience in single-engine aircraft. Only a small proportion of these hours related to flights performed in dark night environments and at aerodromes remote from extensive ground lighting.

The ASU did not provide the pilot with any training towards the issue of a command instrument rating (CIR). The pilot had privately self-sponsored some training towards the issue of a CIR, from organisations external to the ASU. Most of this training was conducted between November 1999 and February 2000.

The pilot experienced difficulty completing his CIR training. His initial multi-engine CIR training period with one organisation was discontinued in December 1999 due to limited progress being achieved during 30 hours of instruction. The pilot then commenced single-engine CIR training with another organisation in January 2000, completing an additional 13 hours training but not attaining the required standard to attempt the CIR flight test.

The investigation found no evidence that the pilot had recently received training to control a multi-engine aircraft solely by reference to the flight instruments following an engine failure. The pilot had probably received some basic training for this task during his initial period of CIR training, but as previously noted, he had also experienced difficulty completing this training. The WA Police Service reported that they considered that the relevant standards and drills used by the ASU pilots for controlling an aircraft following an engine failure required primary regard to instrumentation, irrespective of the lighting conditions.

The pilot was issued with a multi-engine night VFR rating on 2 November 2000. The investigation concluded that there were several reasons to consider the issue of the pilot's multi-engine night VFR rating was invalid, and therefore, that the pilot was not legally qualified to conduct the occurrence flight (see Attachment A). Prior to the occurrence flight, the pilot had logged 1.5 hours night flying as pilot in command of multi-engine aircraft.

Before the day of the accident, the pilot had last flown on Saturday 20 January 2001. According to his flight and duty sheets, he did not work on the Sunday and worked Monday to Wednesday, 0800 to 1600 on non-flying tasks. The duty sheets for Thursday 25 January and Friday 26 January were incomplete, but it was reported that he worked normal non-flying duty hours on the Thursday and had gone to work as normal on the day of the accident. Non-flying tasks performed in the week prior to the accident included office duties and other tasks at the Karratha ASU hangar.

The evening before the accident, the pilot was reported to have spent some time attending to paperwork associated with his Karratha relocation. He went to bed at his usual time (2230) and slept normally. He usually woke around 0530 in the morning. It was reported that there was nothing unusual or significant about his sleep patterns in the days prior to the accident.

The pilot was contacted at about 1125 on the morning of the accident and advised of the requirement to transport police officers from Newman to Kiwirrkurra. At the time of the accident (2150), he had been on work-related duty for about 14 hours.

The pilot was reported to be a physically active person who was in a good state of health. He was described as a regular smoker. Witnesses reported that, when the passengers boarded the aircraft at Newman, they carried a small quantity of food with them. The pilot was given a bottle of water at Kiwirrkurra, but did not request any other food or drink. He did not have access to any rest facilities during the time he was on the ground at Kiwirrkurra.

Additional information about medical and pathological issues is contained in section 1.13.

1.6 Aircraft information

1.6.1 Aircraft data

Registration:	VH-HCP
Manufacturer:	Cessna Aircraft Company
Model:	310R
Serial number:	310R0849
Country of manufacture:	United States of America
Year of manufacture:	1977
Certificate of Airworthiness:	JT 205 (1988), Category Normal
Certificate of Registration	
Number:	JT/00205/02
Issued:	02 August 1993
Holder:	Commissioner of Police, Western Australia Police Service
Maintenance release	
Number:	321938
Issued:	11 January 2001
Valid to:	10 January 2002 or 8885.8 hours
Total airframe hours at accident:	8816.8 hours

The last scheduled maintenance was completed on 11 January 2001, and a maintenance release was issued in the aerial work category to an instrument flight rules (IFR) standard. No defects had been recorded on the maintenance release since the time of issue.

The aircraft was equipped with the flight instruments required for flight under the IFR. They included two vacuum-operated attitude indicators, a vacuum-operated directional indicator, two altimeters, an electric turn coordinator, a vertical speed indicator, and an airspeed indicator. The aircraft was also equipped with a two-axis autopilot, a colour weather radar, and a digital fuel management system. This equipment exceeded the minimum requirements stipulated by CASA for flight at night under the VFR.

The aircraft weight and balance was estimated to be within limits at the time of impact.

1.6.2 Fuel system

The aircraft fuel storage system consisted of the main fuel tanks located on the tip of each wing, augmented by two auxiliary fuel tanks, one located within each wing. The Aircraft Flight Manual (AFM) stated that the combined capacity of the two main fuel tanks was 386 L, of which 379 L was useable fuel. The combined fuel capacity of the two auxiliary tanks was 242 L, of which 238 L was useable fuel.

A fairing at the rear of each main fuel tank housed an electrically-powered lateral transfer fuel pump. These pumps operated continuously whenever the battery master switch was on, and transferred fuel from the front part of the main tank into the tank's collection sump.

An electric auxiliary fuel pump was housed inside each main fuel tank and provided fuel pressure for priming during engine start, purging fuel vapour from the fuel lines, and supplied fuel to the engine in the event of failure of the engine-driven fuel pump.

Each auxiliary fuel tank consisted of two interconnected bladder-type fuel cells, that were located between the wing spars in the outboard section of each wing.

Fuel supplied by each engine-driven fuel pump, and not used by the engines was returned to each main tank via a vapour return line. The AFM stipulated a requirement to select main tanks for the first 90 minutes of flight, before switching to the auxiliary tanks. This was to ensure that the main tanks did not overflow due to the return of surplus fuel during auxiliary tank selection.[8] Information obtained from other C310R operators indicated that the combined outflow from both auxiliary tanks was between 190 and 250 L per hour. The actual auxiliary tank outflow rate for VH-HCP could not be determined.[9]

Each fuel tank was equipped with a capacitance-type fuel quantity sensing system that provided information to the cockpit-mounted fuel gauges (see fig. 3), installed on the right side of the instrument panel. Each gauge continuously indicated the fuel quantity of the tank from which the engine was drawing fuel. A spring-loaded toggle switch enabled the pilot to monitor the quantity of fuel contained in the non-selected tank. The main fuel tanks were not equipped with a low fuel quantity warning system.

The two indicator lights positioned below the fuel gauges illuminated whenever the wing fuel selector valve was positioned to draw fuel from the auxiliary tank. Illumination of that light enabled the pilot to verify that fuel was being consumed from the auxiliary tank and that the fuel gauge was indicating the contents of the auxiliary tank.

---

8 When selected, the auxiliary fuel tanks supplied the engine-driven fuel pumps with more fuel than was actually consumed by each engine. The surplus fuel from each engine-driven pump was returned to each main fuel tank. The actual volume of fuel returned to each main tank depended on a number of variables, including engine power setting, leaning of the fuel-air mixture and engine operating RPM. Recent in-flight trend sheets completed by the pilot indicated that he was consistently attaining fuel consumption of between 108 to 112 L per hour during cruising flight.

9 This was because the available fuel records did not accurately document the rate at which fuel was consumed from the auxiliary fuel tanks on VH-HCP and impact damage to each engine's engine-driven pump that precluded determination of the actual pump output during post-impact testing. A number of factors affect the outflow rate of the auxiliary tanks, including the mechanical condition of each pump, the setting of the pump's fuel pressure regulator and the engine operating RPM.

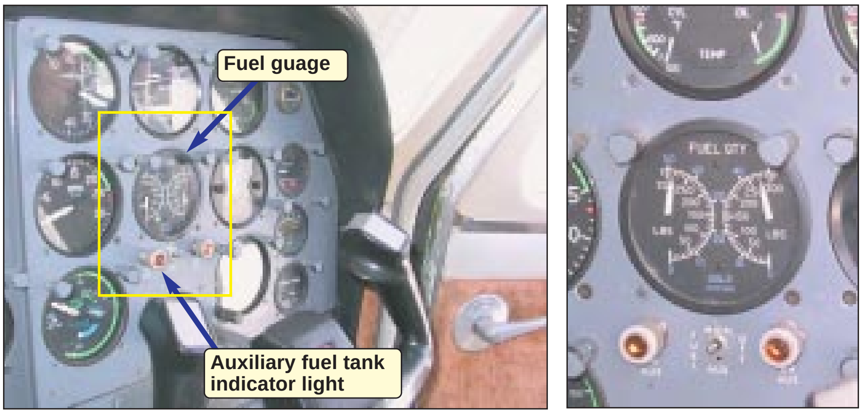
The fuel gauge was calibrated in pounds (lbs). The maximum indication was 310 lbs, and the graduations reduced at intervals of 10 lbs over an indicating arc of about 180 degrees (see fig. 3).

The fuel gauges were calibrated during routine servicing in March 2000, and the left main, left auxiliary and right main tank gauges were found to be accurate within +/- 5 per cent throughout their indicating range. The gauge for the right auxiliary tank was found to slightly under-read and a calibration card[10] was completed. That card indicated for an actual fuel quantity of 50 lbs (32 L), the gauge reading would be 40 lbs (26 L).

Controls for each wing-mounted fuel selector valve were situated on the floor of the cockpit between the pilot and copilot seats and enabled the pilot to select from which tank each engine was drawing fuel. Each selector had four positions: main tank (same side as engine); auxiliary tank (same side as engine); opposite main tank; and off. Conventional use of the fuel system required the pilot to use fuel from the tanks on the left side of the aircraft to supply fuel for the left engine and fuel from the right tanks to supply the right engine. The opposite main tank position enabled the balancing of asymmetric fuel loads.[11]

Both the C310's AFM and the ASU C310 checklist stipulated that the main tanks must be used for takeoff and landing. In addition, the ASU C310 checklist stipulated that the main tanks were to be selected at the top of descent.

FIGURE 3:
Typical C310 fuel gauge and position on right side of instrument panel



1.6.3 Digital fuel management system

The aircraft was equipped with a digital fuel management system that provided the pilot with an indication of the instantaneous fuel flow to each engine and computed the aircraft's endurance based on the current fuel flow and the system-totalised quantity of fuel remaining. The system did not derive information from the aircraft's fuel quantity indicating system but relied on information programmed into it by the pilot and the system-totalised quantity of fuel consumed. The data presented to the pilot did not provide information about the quantity of fuel contained in individual fuel tanks. The pilot could manually input the quantity of fuel added, manually update

10 The calibration card was displayed in the cockpit in proximity of the fuel gauge.

11 A significant difference between the quantity of fuel contained in each respective main tank.

the system's computation of fuel remaining, or select a 'full' fuel default. This default was set to 600 L for the system installed in VH-HCP.

1.7 Meteorological information

1.7.1 Observed conditions

On the day of the accident a broad heat trough existed over the inland Pilbara. Temperatures within the region were generally warm to hot. The Bureau of Meteorology (BOM) estimated that the maximum temperature at Kiwirrkurra was about 38 degrees Celsius. Seasonal atmospheric instability prevailed and combined with moisture in the air to produce conditions that were conducive to afternoon thunderstorms and showers.

The police officers at Newman aerodrome to meet the aircraft reported that an active thunderstorm was visible to the north, but that the area surrounding the aerodrome appeared to be clear. The BOM reported that satellite imagery[12] confirmed the existence of significant thunderstorm activity in the vicinity of Newman between 2030 and 2330 and the presence of some middle-level[13] cloud along the track from Kiwirrkurra to Newman.

Archived data from ground-based lightning sensors[14] recorded thunderstorm activity in the region on the night of the accident, which included activity proximal to the track from Kiwirrkurra to Newman. Although the hourly satellite imagery did not reveal evidence of significant thunderstorm activity along the aircraft's track during the flight, a number of lightning strikes were recorded by the lightning sensors. Some of these strikes were within 30 NM of the aircraft's probable position (see fig. 5 to 7) and could be correlated with areas of cloud depicted on the satellite imagery. It was possible that there was thunderstorm activity along the track Kiwirrkurra to Newman during the occurrence flight, and it was likely that some lightning activity was not detected by the ground-based lightning sensors.

At 2130, about 20 minutes before arriving overhead Newman, the pilot contacted air traffic services (ATS) by radio and requested the latest weather for Newman. The pilot was advised that the 2100 readout from the Newman automatic weather station indicated that the wind was 150 degrees at 3 kts, temperature was 29 degrees, dewpoint 21 degrees and QNH (sea-level altimeter sub-scale pressure setting) was 1010 hPa.

1.7.2 Forecasts

The aviation forecasts prepared by the BOM described the weather conditions for the day of the accident. The track from Kiwirrkurra to Newman passed through aviation forecast areas 66 and 83. The forecasts issued at 1013 and valid from noon to midnight, indicated that isolated thunderstorms would be present throughout the

---

12 The satellite imagery was taken at hourly intervals.

13 Middle-level clouds generally occur between heights of 8,500 to 20,000 ft.

14 The system consisted of Lightning and Position Tracking System (LPATS) sensors situated at different locations. Those sensors detected the broad-spectrum radio energy generated by a lightning discharge event and the system calculated the location of the strike by conducting a comparative analysis of the signal time-of-arrival. Not all lightning discharge events were likely to be detected by the LPATS system.

region, with bases ranging from 6,000 ft and tops to 35,000 ft. Visibility was forecast to reduce to 3,000 m in thunderstorms and 5,000 m in showers. Broken stratocumulus and scattered cumulus cloud was forecast with the thunderstorms. Broken middle-level altocumulus and altostratus cloud was forecast above 12,000 ft.

The aerodrome forecast for Newman, issued at 1412 and valid from 1600 to 0400, indicated a 40 per cent probability of intermittent thunderstorm activity between 1600 and 0200. Associated with the thunderstorms were wind gusts forecast to 40 kts and scattered low cloud.

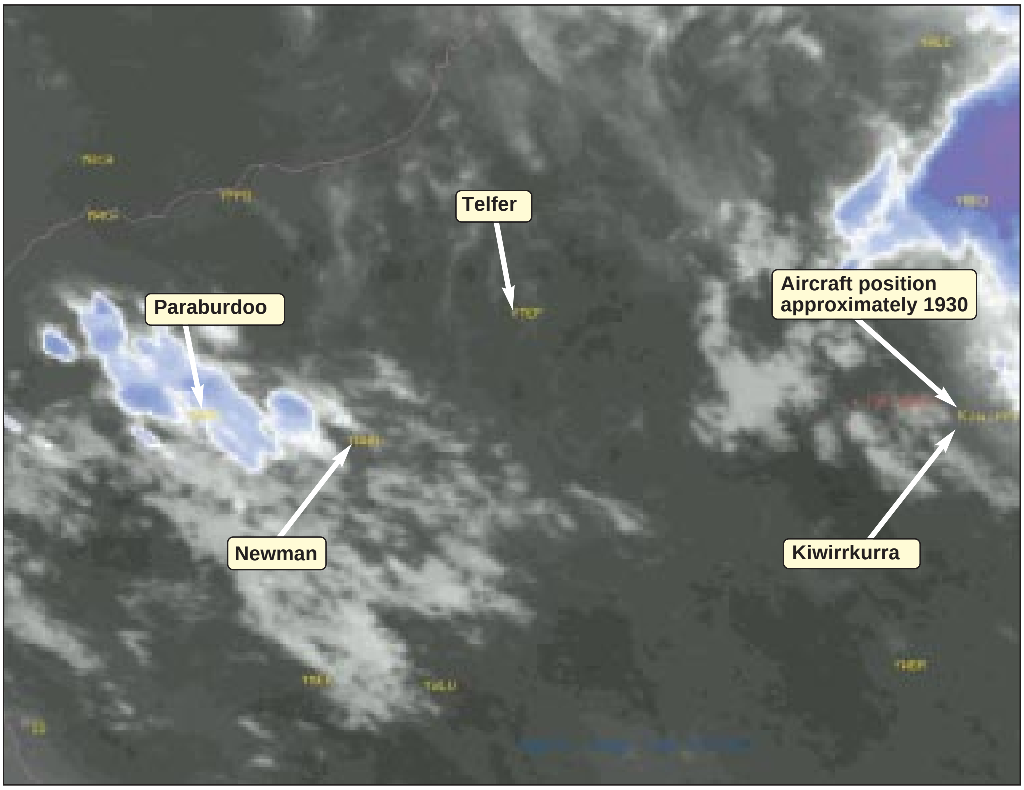
1.7.3 Environmental conditions

A pilot departed Newman about 1 hour after the accident to assist with the search for the missing aircraft. He reported that it was a very dark and hazy night, and that there was no discernible horizon. There was no celestial illumination, and it was not possible to fly the aircraft using external visual references.

The moon had set below the western horizon at 2010. It was a waxing crescent and, when visible, about 4 per cent of the disc was illuminated.

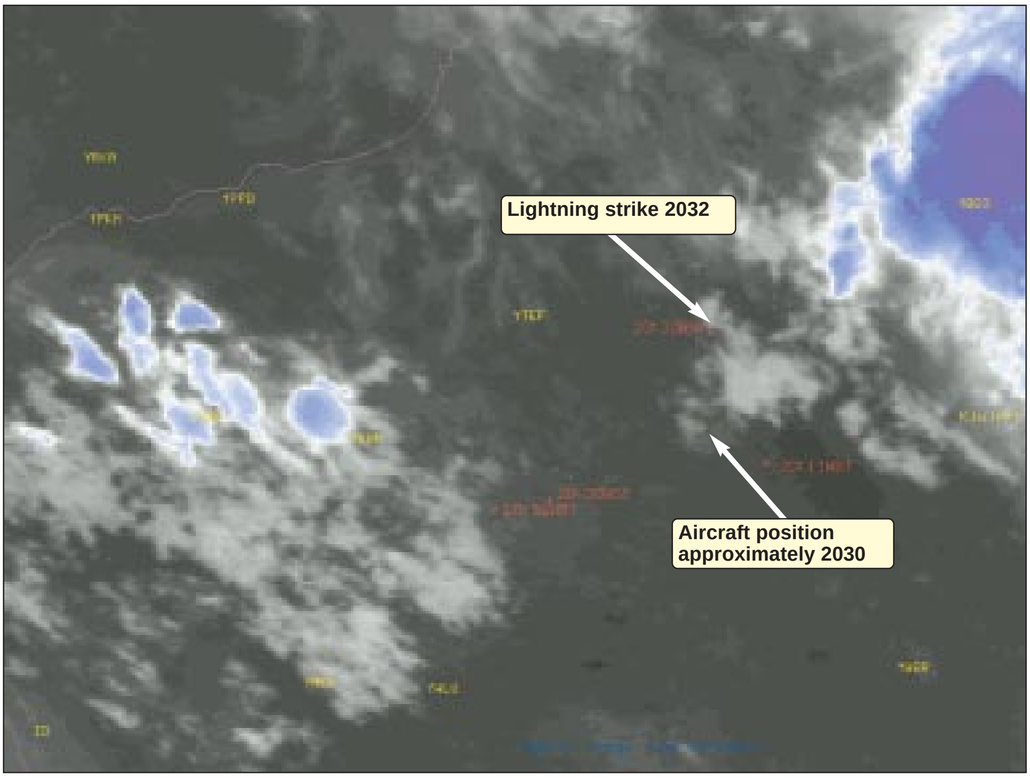
The elevation of Newman aerodrome is 1,724 ft.

FIGURE 4:
Satellite image taken approximately 1930



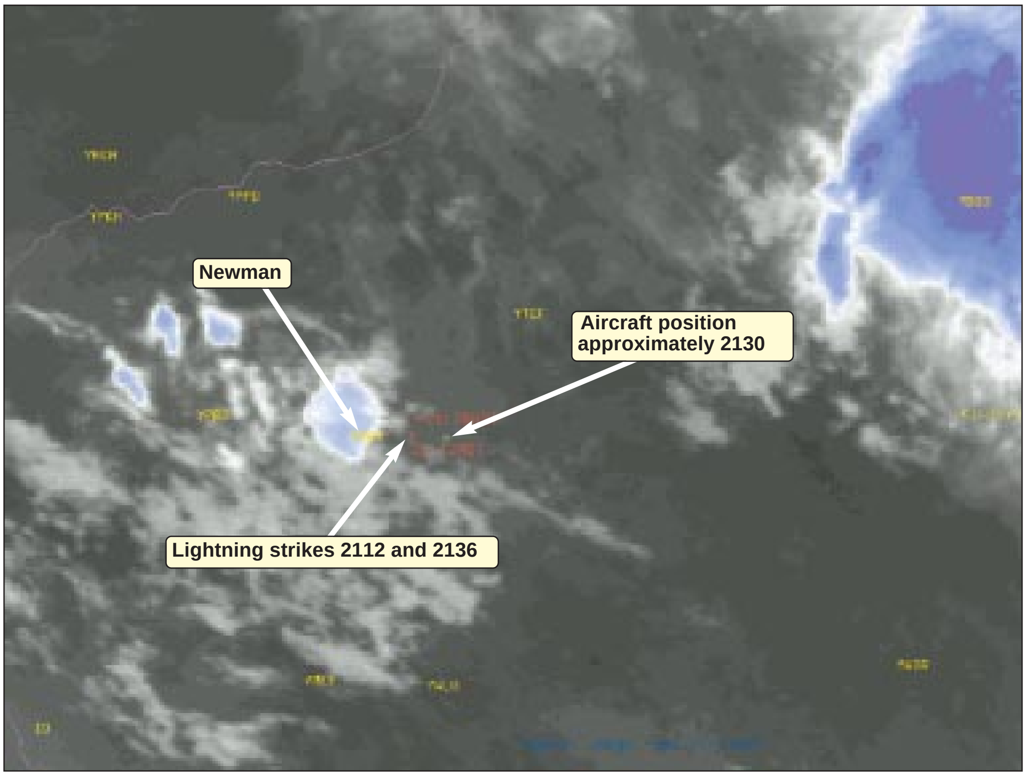
Satellite imagery from the Geostationary Meteorological Satellite (GMS-5), copyright Japan Meteorological Agency.
With acknowledgment to the Bureau of Meteorology.

FIGURE 5:
Satellite image taken approximately 2030



Satellite imagery from the Geostationary Meteorological Satellite (GMS-5), copyright Japan Meteorological Agency.
With acknowledgment to the Bureau of Meteorology.

FIGURE 6:
Satellite image taken approximately 2130



Satellite imagery from the Geostationary Meteorological Satellite (GMS-5), copyright Japan Meteorological Agency.
With acknowledgment to the Bureau of Meteorology.

1.8 Aids to navigation

The availability or functioning of the ground-based navigation aids or navigation equipment on board the aircraft were not considered to have been factors in the accident.

The flight-planned track between Kiwirrkurra and Newman was over sparsely populated and mostly featureless terrain. There was no ground-based navigation aid at Kiwirrkurra, and the direct track from Kiwirrkurra to Newman did not pass within the rated coverage of any off-track navigation aids.

Newman was equipped with non-directional beacon (rated coverage 85 NM), very high frequency omnidirectional radio range (VOR), and distance measuring equipment (DME) navigation aids. The rated VOR/DME coverage between 5,000 and 10,000 ft was 90 NM.

The aircraft was equipped with a satellite global positioning system (GPS) receiver. The GPS receiver was not equipped with a current data card, nor was it required to be when used under the VFR as a supplemental navigation aid. The pilot was not approved to use the GPS as a primary means of navigation.

1.9 Communications

There was no information to suggest that there were any problems with radio communication equipment or facilities.

Review of the ATS audio voice recording for the day of the accident found that the pilot did not indicate at any stage that he was experiencing abnormal aircraft operations.

At the time of the accident the pilot was operating inside the Newman mandatory broadcast zone (MBZ). The MBZ frequency was not monitored by ATS and was not recorded, nor was it required to be.

1.10 Aerodrome information

Newman aerodrome had a sealed runway 2,072 m long. The runway was aligned northeast to southwest and was equipped with single-stage pilot-activated lighting. One illuminated windsock was situated directly to the east of the apron. Each runway was equipped with a visual aid that provided approach slope guidance to the runway. A standby generator provided back-up electrical power for the runway lighting.

Newman township is approximately 6 NM (11 km) to the northwest of the aerodrome. There were isolated sources of ground lighting in the vicinity, mostly associated with nearby mining operations. The area immediately surrounding the aerodrome had very few sources of ground lighting.

Some pilots who had extensive night flying experience reported that Newman was an aerodrome where 'black hole'[15] conditions could be encountered. A pilot flying downwind for runway 23 would have the town lights on the left side of the aircraft. Those lights would progressively disappear from the pilot's field of view as the aircraft continued downwind.

---

15 The term 'black hole' is generally used to describe aerodromes isolated from sources of significant ground lighting. On a dark night, those aerodromes necessitate an approach to the runway over dark and generally unlit terrain and can contribute to the pilot experiencing various visual and other sensory illusions.

1.11 Flight recorders

The aircraft was not equipped with a flight data recorder or cockpit voice recorder, nor was either recorder required by the relevant aviation regulations.

1.12 Wreckage and impact information

1.12.1 Overview of wreckage

The terrain in the vicinity of the accident site was flat, with light scrub and small trees. The aircraft wreckage was substantially intact, upright and in the immediate proximity of the impact point. The nose of the aircraft was pointing towards the runway threshold. All structural components and flight control surfaces were located in the immediate vicinity of the wreckage. That was consistent with the aircraft being intact on impact with the ground. There was no evidence of fire.

The aircraft struck the ground at a moderately low forward speed, but with a high rate of descent. The aircraft nose and right wing struck the ground first, while banked slightly to the right in a nose-low attitude, estimated to have been about 25 to 35 degrees below the horizon. Distortion to the instrument panel and deformation to the rear fuselage was consistent with the aircraft sideslipping[16] to the right at the time of initial impact.

1.12.2 Wreckage examination

Examination of the aircraft and its systems did not reveal any pre-existing defect that may have contributed to the circumstances of the accident.

Damage to the blades of both propellers was consistent with neither engine producing power at the time of impact. Detailed examination of the left and right engines revealed no evidence of a defect or mechanical malfunction.

The left engine propeller blades were feathered[17] at the time of impact. Examination of the feathering latches indicated that they were capable of normal operation and were not in contact with their stops at the time of impact.

The right engine propeller blades were in the fine pitch range at the time of impact. Damage to the feathering latches indicated that they were in contact with their stops, consistent with an unfeathered propeller rotating at less than 600 RPM.

The landing gear and wing flaps were in the retracted position at the time of impact. Examination of the rudder revealed that the trim tab was marginally deflected to the right of neutral. The deflection was not consistent with the amount of trim input needed to reduce rudder control inputs following an engine failure. The elevator trim tab was positioned slightly nose-up.

Due to impact related damage, technical examination of the aircraft flight instruments and on-site examination of the cockpit controls did not provide any conclusive information about instrument indications and control positions.

---

16 The term 'sideslipping' refers to a condition of flight where the aircraft's flight path though the air is different from the direction in which the aircraft's nose is pointing.

17 The term 'feathered' refers to the blades of a variable-pitch propeller of an inoperative engine, being rotated to an angle where they produce a minimum amount of drag. Such action is normally accomplished (most piston-engine aircraft) by the pilot manually selecting the propeller pitch lever to the 'feather' position.

Observation:

Some of the witnesses stated that they thought the aircraft was 'spiralling' during its descent (see section 1.1). The investigation considered that this recollection could also be consistent with the aircraft nose yawing to one side and then the other following the failure of the engines. Examination of the wreckage revealed no conclusive evidence that the aircraft was spinning or spiralling at the time of impact with the ground.

Fig. 8 – 13 show various aspects of the aircraft wreckage.

1.12.3 Examination of aircraft fuel system

Search parties located the aircraft wreckage about 6½ hours after impact. Emergency services personnel at the site reported that a fuel smell could not be detected until they were close to the aircraft. One person reported that there was a strong smell of fuel in the vicinity of the left side of the aircraft fuselage and other personnel reported that they did not detect any strong smells of fuel. In addition, emergency services personnel at the scene prior to arrival of ATSB investigators reported that there did not appear to be any fuel in the undamaged part of the right main fuel tank and that the tip of the left main fuel tank contained about 5 L of fuel. The emergency services personnel also reported that the ground directly beneath the main tanks appeared to be dry and there was no indication that a significant quantity of fuel had spilled from the tanks. However, the soil at the accident site was of sandy consistency, and any spilt fuel could have dissipated relatively quickly.

Foam was applied by emergency services personnel into each of the four fuel tanks[18] during the initial stages of the emergency response. There had also been other police and emergency services activity in the vicinity of the aircraft wreckage. The ATSB investigation team arrived on site about 10 hours after the wreckage was located.

Each cockpit fuel selector control was positioned to the main tank associated with its respective engine. The fuel valves in each wing, that were controlled by the cockpit fuel selectors, were both found in the main tank position. Examination of the wreckage revealed no evidence of an in-flight fuel leak.

The cockpit fuel gauges were recovered from the wreckage and examined. Numerous marks had been made by the indicating needles on the face of the gauge, but they provided no conclusive evidence of the main tank fuel quantity at the time of impact.

Each fuel tank had a decal mounted adjacent to the filler neck, indicating the useable fuel capacity of each individual tank. The investigation noted that each decal for VH-HCP was incorrect, and indicated the combined capacity of both auxiliary tanks and the combined capacity of both main tanks. That is, 238 L was placarded adjacent to each auxiliary tank filler neck, and 379 L was placarded adjacent to each main tank filler neck. The investigation found no evidence to indicate that these placards had in any way influenced the pilot's consideration of fuel tank capacity or aircraft endurance. Available flight planning documentation was consistent with the pilot using the correct fuel quantities.

The right main fuel tank was significantly damaged on impact. There were some holes and compression damage to the forward part of the tank structure, although the rear part of the tank remained substantially intact.

---

18 Emergency services personnel obtained fuel samples from three of the aircraft's fuel tanks prior to the application of foam. The other tank was empty and no fuel sample could be obtained. This occurred prior to the arrival of ATSB investigators at the site.

The forward part of the left main tank was disrupted upwards, but remained attached to the tank structure by aluminium fuel lines, and was resting inverted on the rear part of the tank.

About 20 L of fuel was recovered from the right auxiliary fuel tank. To test the integrity of the tank, it was filled with water and was observed to leak from a hole in the vicinity of the fuel drain fitting. This damage was assessed as being impact related and a consequence of the initial ground contact.

About 8 L of fuel was recovered from the left auxiliary fuel tank. The underside of the wing skin in the vicinity of the inboard auxiliary fuel cell exhibited damage that was consistent with fuel contained in the inboard cell acting on the skin during impact with the ground. The inboard cell was also holed in the vicinity of the fuel drain fitting, and when filled with water was observed to leak at that point. This damage was assessed as being impact related and a consequence of the initial ground contact.

As a result of the impact, both wings were resting on the ground and had lost their normal dihedral relationship with the aircraft fuselage. Consequently there was less than the normal tank inclination between the outboard and inboard auxiliary fuel cells. There was no evidence that any of the fuel cells in the auxiliary tanks had detached or partially collapsed inside the wing prior to impact.

The distribution manifolds of the left and right engine fuel injection systems were examined. The fuel lines were dry and neither the left nor right engine's fuel distribution manifold contained any fuel. Both engine-driven fuel pumps and the fuel lines supplying those pumps contained only a trace of fuel, which was consistent with an interruption of the supply of fuel to each pump.

The lateral transfer pump from the right main fuel tank was dismantled on site. The pump chamber contained only a trace of fuel. The lateral transfer pump from the left main tank and both auxiliary electric fuel pumps were recovered and examined approximately two weeks after the accident. A small quantity of fuel was recovered from the pump chamber of the left lateral transfer pump. No fuel was recovered from either of the auxiliary fuel pumps. All of the fuel pumps functioned normally during post-accident testing.

Observation:

Examination of the aircraft's fuel system indicated that both engines stopped due to fuel starvation.[19] Useable quantities of fuel were recovered from the auxiliary fuel tanks, however that fuel was not being supplied to the engines. Each cockpit fuel selector control was positioned to the main tank associated with its respective engine. The quantity of fuel on board was unable to be determined by examination of the wreckage because of impact related damage sustained by the fuel tanks.

19 Fuel starvation refers to an event where fuel is not being supplied to the engines, but useable fuel is available in at least one of the aircraft's fuel tanks.

FIGURE 8:
Aerial view of aircraft wreckage (note lack of wreckage trail, indicating steep flight path impact angle and low relative forward speed)

FIGURE 9:
View of wreckage from front of aircraft (roof of aircraft cabin cut away by emergency services personnel, prior to arrival of ATSB investigators)

FIGURE 10:
Rear view of aircraft fuselage

FIGURE 11:
Damage to left main fuel tank

FIGURE 12:
Crush damage to forward fuselage section

FIGURE 13:
Impact damage to right main fuel tank (note fuel cap previously disturbed by emergency services personnel prior to arrival of ATSB investigators)

1.12.4 Emergency locator transmitter

The aircraft's emergency locator transmitter did not automatically activate on impact.

Inspection of the transmitter revealed a dry soldering joint, connecting the impact activated 'g' switch to the circuit board. That resulted in intermittent triggering of the unit when operated in the 'auto' mode.

1.12.5 Stall warning

The aircraft's stall warning system had been functionally tested during the aircraft's last period of scheduled maintenance on 11 January 2001 and no entry had been made on the aircraft maintenance release since that date to indicate that the stall warning system was unserviceable. During dismantling of the wreckage for disposal, the stall warning transmitter vane was found disconnected from its wiring loom at a plastic snap connector. Subsequent examination of the transmitter vane found no evidence of a pre-existing defect with the sensor. The AFM required that the stall warning system be checked prior to the first flight of the day, and there was no indication that recent checks by the pilot had detected a problem.

The investigation considered that it was unlikely that the plastic snap connector would disconnect during normal flight. However, it was possible that the connector could have disconnected due to forces sustained during the impact or during the dismantling of the wreckage.

1.12.6 Weather radar

The aircraft's weather radar was found switched on. The investigation was unable to determine if the pilot was using the radar for weather avoidance during the Kiwirrkurra to Newman flight.

1.13 Medical and pathological information

Post-mortem examination of the pilot indicated that he had probably not eaten for at least 8 to 12 hours prior to the accident.[20] The pilot's blood carbon monoxide level was 6 per cent, which was within the normal range for a regular smoker.

A review of the pilot's medical records, the results of the post-mortem examinations and toxicological testing, and investigation interviews found no evidence of pre-existing medical conditions that may have influenced his performance.

1.14 Fire

There was no evidence of fire in flight or after the impact.

1.15 Survival factors

Due to the high impact forces, the accident was not survivable.

---

20 Post-mortem examination indicated that at least two of the passengers had eaten during the period 8 to 12 hours before the accident.

1.16 Tests and research

1.16.1 Examination of digital fuel management system

Data recovered from the non-volatile memory of the digital fuel management system indicated that at the time of impact, 284 L of fuel had been consumed, and there was 108 L of fuel remaining.[21, 22] Functional testing verified that the unit was operating normally.

The fuel flow transducer from each engine was bench tested. The testing revealed a slight measurement error, resulting in an over-reading error of both the left and right transducers of 2.06 per cent and 0.87 per cent respectively. As a result, the transducer would overestimate the amount of fuel consumed. Those measurement errors were attributed to normal transducer wear. Although the errors were not significant, the calibration of the digital fuel management system could have been adjusted to compensate for the difference. The investigation did not consider the calibration error to be a factor in the accident.

1.16.2 Examination of fuel samples

The fuel samples recovered from the aircraft's fuel tanks (see section 1.12.3) were tested by an independent laboratory accredited by the National Association of Testing Authorities.

A comparative analysis of the fuel samples was performed using the techniques of nuclear magnetic resonance spectroscopy and gas chromatography. Additional samples from the hand-pump at Kiwirrkurra (which was still in the empty drum used by the pilot) and the fuel distributor's batch retention sample were also tested.

The report from the laboratory confirmed that the distributor's retention sample was 'practically identical' to the sample obtained from the hand-pump at Kiwirrkurra and was evidence that the fuel loaded at Kiwirrkurra had not been significantly weathered or otherwise contaminated by organic material.

The fuel samples obtained from the left and right auxiliary tanks were found to be very similar to the distributor's retention sample. However, testing of these samples also revealed minor traces of a contaminant which was not detected in any of the other fuel samples tested. Further analysis revealed that this contaminant was consistent with a plasticiser commonly used during the manufacture of plastic (PVC) products. The investigation concluded that this contaminant was probably introduced during the post-accident sampling of the fuel. It was considered likely that the contamination was from the equipment used by emergency services personnel to sample the fuel from the left and right auxiliary tanks. In any event, the investigation considered that the presence of these contaminant traces was not significant for the operation of the aircraft engines.

As discussed in section 1.12.3, the left main fuel tank was ruptured and the remaining fuel was exposed to the atmosphere. Testing of the sample obtained from this tank

---

21 The examination was conducted by the instrument manufacturer in conjunction with the United States' National Transportation Safety Board and under the direct supervision of an inspector from the US Federal Aviation Administration.

22 As discussed in section 1.6.3, the digital fuel management system did not derive information from the aircraft's fuel quantity indicating system, but relied upon pilot input of fuel added and the system-totalised quantity of fuel consumed.

revealed that it was significantly different in composition from the other samples tested, although there was no evidence of fuel contamination. These differences were attributed to the weathering of the fuel, which had resulted in the evaporative loss of the more volatile components into the atmosphere. This process had probably occurred between the time of the accident and the time that the fuel sample was sealed in an airtight container.

Specification testing performed on a sample of fuel from the distributor's retention sample confirmed that the fuel met the required standard and relevant specification for AVGAS.

1.17 Operational information relating to flights conducted on the day of the accident

1.17.1 Pre-departure Karratha

Newman police contacted the pilot by telephone at about 1125, and advised of a requirement to transfer police officers to Kiwirrkurra so that they could attend a serious incident. The pilot advised that he would depart immediately and arrive at Newman aerodrome about 1330. Prior to departing Karratha, the pilot went home and collected his service-issued firearm.

The aircraft was last refuelled on 23 January 2001, and the pilot recorded that the fuel on board the aircraft was 460 L. The Schedule of Operations[23] completed by the pilot on the day of the accident indicated that the aircraft's take-off weight at Karratha was 2,185 kg. This calculation comprised the zero fuel weight (recorded as 1,855 kg) and the fuel load (recorded as 230 kg). However, the investigation noted that there was an actual difference of 330 kg (approximately 460 L) between the take-off weight and the zero fuel weight recorded for Karratha. The investigation considered that the pilot had most probably intended to record the fuel load departing Karratha as 330 kg. The pilot frequently recorded 330 kg as the aircraft fuel load, even for flights where refuelling records indicated more fuel was on board the aircraft.

To ensure that aircraft were available for departure at short notice, the ASU operations manual required aircraft to be refuelled to a standard fuel load at the completion of each day's flying. For this purpose, the operations manual referred to aircraft information contained in 'Part B' of that document. However, Part B contained no specific information of this nature. Although no standard fuel load was published for the C310 (or other current fixed-wing aircraft), the previous Karratha-based pilot reported that he used a standard load of full main tanks plus 50 L added to each auxiliary tank (at least 479 L fuel on board). That fuel quantity permitted a load of about 375 kg to be carried to most locations in the region, without exceeding maximum take-off and landing weights.

Some relatively recent refuelling dockets indicated that the occurrence pilot had requested the main tanks be fully fuelled and 50 L added to each auxiliary tank (at least 479 L useable fuel). However, other fuel-related documentation indicated that the pilot

23 The ASU pilots were required to record details from each flight on a 'Schedule of Operations' form. The form contained spaces for the pilot to record the weight of passengers, baggage, freight and fuel, as well as the aircraft's take-off and landing weight. On completion of each flight, the pilot was required to record the quantity of fuel that had been used in kg. On a separate part of the form, the pilot was also required to record the quantity of fuel that had been added during the day in L.

was recording his standard fuel load as 460 L. The aircraft was also refuelled to different levels from these on other occasions.

Analysis of fuel documentation and flight records revealed inconsistencies with the pilot's recorded fuel consumption for some flights conducted prior to 26 January 2001. Consequently, it was not possible to use fuel records to verify the aircraft's actual fuel load prior to departure from Karratha on the day of the accident.

Recent entries made by the pilot on the aircraft's performance card indicated that the cruise fuel consumption was consistently within the range of 108 to 112 L per hour.

Observation:

The refueller at Newman reported that the aircraft had full fuel tanks prior to departing for Kiwirrkurra (see section 1.17.3). Based on the pilot's recorded fuel consumption from Karratha to Newman (see section 1.17.2), the investigation calculated that the fuel load departing Karratha was about 574 L.

The discrepancy between the record of fuel on board the aircraft at Karratha (460 L) and the figure derived from the Newman refuelling and fuel consumption records (574 L) was not considered unusual for the occurrence pilot, given the inconsistency between some of the pilot's previous fuel documentation and flight records.

1.17.2 Karratha to Newman

The pilot recorded his engine start at Karratha as 1209 and broadcast his departure time on the ATS area frequency as 1228. The engine shut-down time at Newman was recorded as 1355.

The pilot recorded a fuel consumption of 144 kg (200 L) for the sector. After correcting for the calibration error of the digital fuel management system, the investigation calculated that quantity to be 197 L.

1.17.3 Refuelling at Newman

The refueller at Newman recalled that the pilot had requested full fuel. He stated that fuel was added to all four tanks, and that the aircraft was filled to capacity (617 L). Refuelling documentation showed that 240 L of fuel was added to the aircraft's tanks. The refueller reported that the pilot checked the fuel level in each tank and secured the fuel caps.

The pilot recorded the starting fuel load at Newman as 370 kg (514 L) and the aircraft's take-off weight as 2,575 kg. The maximum permitted take-off weight was 2,576 kg.

Based on the weights of the passengers, 617 L of useable fuel and the various items of baggage recovered from the wreckage, the investigation calculated that the aircraft departed Newman approximately 100 kg in excess of its maximum permitted take-off weight.[24]

Prior to the aircraft's departure from Newman, the Newman police had contacted Telfer[25] to confirm that fuel was available. That was based on their experience of other flights to Kiwirrkurra, where the previous ASU pilot had refuelled at Telfer on both the outbound and inbound flights. Overnight accommodation at Telfer was arranged for four persons.

24 The aircraft was also probably 10 kg over the maximum landing weight at Kiwirrkurra.

25 Telfer was a licensed aerodrome about 169 NM northeast of Newman and approximately 93 NM north of the direct track Newman to Kiwirrkurra. It was the only licensed aerodrome between Newman and Kiwirrkurra.

1.17.4 Newman to Kiwirrkurra

The pilot recorded his engine start time at Newman as 1410 and broadcast his departure time as 1419. The engine shut-down time at Kiwirrkurra was recorded as 1700.

The pilot recorded a fuel consumption of 218 kg (303 L) for the sector. After correction for the calibration error of the digital fuel management system, that quantity was calculated to be 298 L. The amount of fuel remaining on board was therefore about 320 L. Based on the pilot's written record of airswitch[26] time intervals, the average rate of fuel consumption for the flight was 115 L/hour.[27]

During the flight from Newman to Kiwirrkurra, the pilot made a note on the flight plan that the auxiliary tanks were selected 'on' at 1510 and 'off' at 1600.

A review of the pilot's previous flight documentation revealed that he had recorded his auxiliary fuel tank selection times for some flights. Those records were more common in July 2000, when he previously operated the C310, than in the weeks prior to the accident. Based on those records, the investigation established the following:

- The pilot generally recorded 'on' and 'off' times for the auxiliary tanks rounded to the nearest '0' or '5' minutes.
- The 50-minute selection of auxiliary tanks was consistent with previous flights when the aircraft was fully fuelled.
- The pilot appeared to typically use the auxiliary tanks until approximately 20 to 40 L of useable fuel remained across both tanks.
- On this flight (and some previous flights), the pilot switched to the auxiliary tanks before 90 minutes of flight had elapsed, contrary to the AFM requirement (see section 1.6.2).
- The pilot did not seem to have standard practices for switching to the auxiliary tanks. For flights when the aircraft was not fully fuelled, the auxiliary tanks were selected 'on' 30 minutes after engine start on several occasions, and more than 60 minutes after engine start on several other occasions.

Observations:

The aircraft probably arrived in Kiwirrkurra with about 320 L of fuel on board. There was no conclusive evidence to indicate the actual fuel distribution between the tanks on arrival. The following factors could have influenced that distribution:

- The actual time that the pilot selected the auxiliary tanks (range of times between 1507.5 to 1512.5, but being recorded to the nearest 5 minutes).
- The actual time that the pilot reselected the main tanks (range of times between 1557.5 to 1602.5, but being recorded to the nearest 5 minutes).
- The outflow rate from the auxiliary tanks (190 to 250 L/hour).

The investigation used previous fuel records and manufacturer's data to establish the aircraft's likely fuel consumption. Considering the variables listed above, the

26 An airswitch is a meter in the aircraft cockpit, which records the cumulative time in flight. This meter is frequently used to record flight time for the purposes of calculating maintenance intervals.

27 The average rate of fuel consumption based on previous flight records and reports from the previous Karratha-based ASU pilot was about 120 L/hour.

investigation calculated that the fuel distribution on arrival Kiwirrkurra was between 220 L mains (100 L auxiliary) and 290 L mains (30 L auxiliary).[28]

Given the pilot's previous fuel management practices and a review of previous fuel records, it was considered more likely that the fuel quantity contained in the auxiliary tanks was closer to 30 L.

Based on the outflow rate from the auxiliary tanks and the times recorded by the pilot for switching the auxiliary tanks 'on' and 'off', the investigation considered that it was unlikely that any significant amount of fuel was vented overboard during the time that the auxiliary tanks were selected. In addition, as noted in section 1.12.3, there was no evidence of an in-flight fuel leak.

The investigation also concluded that the duration of use for the auxiliary tanks was consistent with other flights for which the auxiliary tanks had been fully fuelled and, accordingly, was also consistent with the aircraft's auxiliary fuel tanks being filled to maximum capacity at Newman.

1.17.5 Events at Kiwirrkurra

After arriving at Kiwirrkurra the four police officers were driven from the airstrip to the settlement. It was reported that there was tension between the attending officers and some members of the community during the visit, in particular as it related to the officers' initial intention to take an alleged offender into police custody. The situation was resolved and the officers decided not to make an arrest. As it was getting dark, staff at Kiwirrkurra suggested they fly back to Newman the next day, and private accommodation was offered to them. The officers indicated that they preferred to return to Newman that night and arrangements were made for their departure.

The pilot was not involved in any aspect of the police business at Kiwirrkurra. Shortly after arrival at the settlement, he was driven back to the airstrip where he refuelled the aircraft from a private stock of drum fuel. Despite other full drums of fuel being available, the pilot refuelled from a 200 L drum of AVGAS that had been opened earlier that day by the pilot of another aircraft. This pilot recorded on the stock control sheet that he had used a quantity of 235 L, and subsequently reported that of this quantity, about 75 L was from the drum that was later used by the ASU pilot.

A witness at Kiwirrkurra reported that the ASU pilot hand-pumped fuel into the aircraft's auxiliary fuel tanks, but did not pump any fuel into the main tanks. The hand pump was not equipped with a meter to indicate the quantity of fuel added.

The ASU pilot made an entry on the stock control sheet indicating that he had added 165 L of fuel to his aircraft. That figure was also entered on the Schedule of Operations. Based on the other pilot's recollection of the quantity of fuel used from the drum (75 L), it is probable that the ASU pilot had only added about 125 L into the aircraft (that is, 200 L full drum capacity less 75 L used by previous pilot).[29]

28 These calculations were consistent with no significant quantity of fuel being vented overboard due to overfilling of the main tanks (by the excess fuel returned from the engine-driven fuel pump) while the auxiliary tanks were selected.

29 The figure of 235 L on the stock control sheet may have contributed to the ASU pilot's incorrect assessment of the amount of fuel remaining in the drum from which he refuelled the aircraft. That is, he may have considered that the 235 L consisted of one full drum of fuel plus 35 L from the partly used drum.

The extent to which the pilot checked the amount of fuel contained in the fuel tanks after refuelling the aircraft could not be established. The aircraft was not equipped with calibrated dipsticks for either the main or auxiliary fuel tanks.[30] Additionally, there was no way for the pilot to accurately estimate the quantity of fuel remaining in the already opened drum. There was no calibrated dipstick for the fuel drums at Kiwirrkurra, nor was there a requirement that one be available.

Persons at the airstrip for the aircraft's departure reported that there were thunderstorms to the west of Kiwirrkurra and in the general direction of Newman. When one of the passengers asked the pilot about fuel, the pilot had offered reassurance that they had sufficient to complete the flight.

Prior to departing Kiwirrkurra, the officers used their satellite telephone to update their colleagues at Newman, advising that they had concluded their attendance, had not taken a person into custody and were returning to Newman and required overnight accommodation for the pilot.

Observations:

On the evidence available, the pilot added about 125 L of fuel at Kiwirrkurra and the fuel on departure was probably about 445 L. Other than the 125 L added to the auxiliary tanks, the investigation could not conclusively determine the distribution of fuel between the four tanks. Had the pilot used the complete contents of a previously unopened drum to refuel the aircraft, it would have given him an opportunity to add a known quantity of fuel.

It was probable that none of the aircraft's fuel tanks were filled to a known quantity at Kiwirrkurra. The pilot had no way of checking a physical (observed) fuel level against a fuel gauge reading or against any calculation that could have been obtained from a fuel log.

1.17.6 Kiwirrkurra to Newman

The pilot recorded his engine start time at Kiwirrkurra as 1919 and the aircraft departed at about 1930. Portable runway lighting was used to light the airstrip.

The pilot contacted Newman police by radio at about 2115 and advised that the aircraft would arrive at 2150. At 2134, the pilot broadcast an inbound call on the ATS area frequency, reporting that the aircraft was 50 NM east of Newman on descent, passing 8,000 ft and estimating the circuit area at 2149. That was the last recorded transmission from the pilot.

Documents recovered from the accident site revealed that the pilot had recorded some basic operational information relevant to the flight from Kiwirrkurra to Newman. That information included the engine start time at Kiwirrkurra and the Newman weather information that the pilot obtained by radio from ATS. It did not include any information on whether the auxiliary tanks had been selected during the flight or any information consistent with calculations for an in-flight fuel log.

Data recovered from the digital fuel management system indicated that 284 L of fuel had been used. After correction for the calibration error, the fuel quantity used was calculated to be about 280 L.

---

30 Many C310 operators do not use dipsticks due to the shape of the fuel tanks, nor are they required by regulation.

Accordingly, the investigation concluded that at the time of impact, there was probably about 165 L of useable fuel on board the aircraft (that is, 445 L minus 280 L). It was not possible to determine the distribution of this fuel between the aircraft's fuel tanks, due to the damage sustained on impact with the ground.

As discussed in section 1.16.1, data recovered from the digital fuel management system indicated that 108 L of fuel remained at the time of impact.

Observations:

The fuel consumption and elapsed time intervals for the flights from Newman to Kiwirrkurra and Kiwirrkurra to Newman were within the normal range for the aircraft under the prevailing conditions. The investigation could not further verify the accuracy of the fuel consumption entry made by the pilot for the Newman to Kiwirrkurra flight.

The actual flight time and fuel consumption from Kiwirrkurra to Newman was slightly less than the estimated time interval and estimated fuel required, as calculated by the investigation. It was unlikely that the pilot made significant diversions en-route, or experienced problems that had resulted in a higher than normal fuel consumption.

Data recovered from the digital fuel management system indicated 108 L of fuel remained at the time of impact. This information would have been displayed to the pilot in terms of the aircraft's endurance, in hours and minutes, and was calculated by comparing the system's computation of fuel remaining and the current rate of fuel consumption. However, on the available information, the investigation calculated that about 165 L of fuel remained at the time of impact.

The investigation could not determine the reason for the existence of such a significant discrepancy. Departing Newman, the digital fuel management system should have indicated 600 L (see section 1.6.3) and 297 L on arrival at Kiwirrkurra. If the pilot input a quantity of 165 L fuel added at Kiwirrkurra, the system should have indicated 462 L departing Kiwirrkurra and 178 L at the time of impact.

1.17.7 Other flight planning and operational issues

The investigation reviewed a range of operational documentation and other information, including an examination of the pilot's fuel planning and fuel management practices. That review identified several safety-related issues that were not considered to have had a direct influence on the circumstances of the accident. Some of those issues are discussed in sections 1.17.1 to 1.17.6. Other issues identified include the following:

- There was no indication that the pilot obtained weather or other pre-flight briefing information prior to any of the flights conducted on the day of the accident, as required by the Aeronautical Information Publication (AIP), En Route (ENR) 1.10, paragraph 1.1.
- The pilot's flight planning for the flight from Newman to Kiwirrkurra and return underestimated the distance between the two locations by 47 NM (392 NM instead of 439 NM). That underestimation of distance was partially offset by a 10-minute overestimation of the time interval to travel the distance (148 minutes instead of 138 minutes using the nominated planning speed of 170 kts). Overall the pilot had calculated that the required flight fuel was 296 L (excluding contingencies and fixed reserve).[31] The investigation calculated that 324 L of flight fuel was required (excluding contingencies and reserves).

31 These calculations did not take into account the forecast wind.

- There was no indication that the pilot considered operational requirements relating to the forecast weather conditions and the runway lighting at Newman. The relevant operational requirements included:
  - Due to the forecast possibility of thunderstorms at Newman, there was a requirement to provide 30 minutes holding fuel. That contingency required an additional 37 L of fuel.[32]
  - Provision for the possibility that the pilot-activated runway lighting system at Newman did not operate. That meant either ensuring a responsible person[33] was at the aerodrome for the aircraft's estimated time of arrival (to manually activate the runway lighting if required), or carrying additional fuel to allow for a diversion to the nearest alternate aerodrome (in that case Paraburdoo). As the pilot had not arranged for a responsible person to attend Newman aerodrome for the runway lighting contingency, the pilot was required to provide sufficient additional fuel for a diversion to Paraburdoo. That contingency required an additional 122 L of fuel.
  - The investigation calculated that 559 L of fuel was required on departure form Kiwirrkurra. If a responsible person had been in attendance at Newman to manually activate the runway lights then 437 L of fuel was required.
- The pilot completed a written fuel plan for only one of the three flights conducted on the day of the accident. That plan included a fixed fuel reserve of 45 minutes (90 L).[34] The time interval used to calculate the flight fuel required was consistent with the pilot's flight plan calculations for either a flight to or from Kiwirrkurra. The pilot also did not complete fuel plans for a number of other flights (see also section 1.19.3).
- There was no indication that, prior to departing Newman, the pilot confirmed the availability of fuel at Kiwirrkurra. The investigation considered that if fuel was not available at Kiwirrkurra, the pilot would have probably flown to Telfer as originally planned. Flight documents recovered at the accident site did not contain information to indicate that the pilot had performed calculations to verify that sufficient fuel was available to complete the flight to Telfer. The investigation could not determine the basis on which the pilot decided not to refuel at Telfer on the outbound sector.
- There was no indication that the pilot had verified that the forecast weather conditions permitted flight under the VFR. Relevant limitations included:
  - Aspects of the area and Newman terminal aerodrome forecast weather conditions were below the minima required for VFR flight.
  - Navigation requirements for VFR flight required that the pilot fix his position every 2 hours (using navigation aids) or by visual reference to features depicted on topographical charts at intervals not exceeding 30 minutes (AIP ENR 1.1 paragraph 17.1 and 17.2). The investigation considered that on the basis of the

---

32 The pilot operating handbook for the Cessna 310R published the power setting and fuel flow for holding as 74 L/hour.

33 The persons at the aerodrome at the time of the aircraft's arrival did not know how to manually activate the runway lights in the event that the pilot-activated system did not operate normally.

34 The pilot had calculated this at the block plan fuel flow of 120 L/hr. The ASU operations manual required a fixed reserve of 75 L.

pilot's flight-planned airspeed and using the correct distance Kiwirrkurra to Newman, the 2-hour position-fixing requirement would not have been met.[35] On a dark night it was unlikely that there would have been sufficient topographical features along the flight-planned track to comply with the requirement to visually fix position every 30 minutes.

- There was no indication that the pilot submitted a SARTIME flight notification, or left a flight note with a responsible person. Such a notification was required for all VFR flights conducted at night beyond 120 NM of the departure aerodrome, and also for all flights over Designated Remote Areas (AIP ENR 1.10 paragraph 2.10 and CAO 20.11 Appendix III). The track between Kiwirrkurra and Newman was within a Designated Remote Area. Although the Newman police were aware of the flight from Kiwirrkurra, they were not advised that they were responsible for SAR alerting if the aircraft failed to arrive by a nominated time and were provided no specific information about the planned track to Newman. The investigation considered that the telephone call placed by the attending officers was not for the purpose of providing a flight note and did not comply with guidance information contained in the AIP for flight note submission.

1.17.8 Events following the initial engine failure

The investigation could not positively determine which of the aircraft's engines had failed first. The following discussion is for the purpose of providing general background information into some of the issues that may have been faced by the pilot in maintaining control of the aircraft.

The aircraft nose would have commenced to yaw towards the inoperative engine after the initial engine failure. This would be accompanied by the aircraft commencing to bank in the direction of the failed engine and also possibly some change to the pitch attitude of the aircraft's nose. As discussed in section 1.12.3, the initial engine failure was due to fuel starvation. The aircraft's engine could have surged several times during the initial stages of this event.

Following the failure of the engine, the pilot was required to make specific control inputs to maintain control of the aircraft. These included application of rudder to control the yaw and use of aileron to maintain the desired angle of bank. Due to the dark night conditions and the lack of external visual reference, the pilot would have needed to interpret the aircraft's flight instruments to identify the inoperative engine and determine the correct control inputs required. The drag from the unfeathered propeller of the inoperative engine and the power being produced by the operating engine also add to the size of control inputs required. Feathering the propeller of the inoperative engine reduces the size of these control inputs and improves the controllability of the aircraft.

The use of aileron to control bank angle, without rudder input to control the yaw, would increase the angle of sideslip. This would increase the drag on the aircraft and accordingly, increase the rate at which the airspeed of the aircraft reduced. The forces acting on the aircraft during the sideslip could cause the remaining fuel in the tanks associated with the operating engine to be displaced away from the tank's fuel pick-up point. In addition, the large aileron deflections required to maintain wings-level flight

[35] Notwithstanding, the investigation concluded that the aircraft's actual in-flight performance on the night of the accident placed it within the rated coverage of the Newman VOR/DME within the 2-hour position-fixing requirement.

if rudder was not used to control the yaw would reduce the aircraft's controllability, especially if the pilot attempted to turn the aircraft in the direction of the operating engine.

The published stall speed (wings-level) for the aircraft (throttles at idle, landing gear and wing flaps retracted) was 76 kts calibrated airspeed at the aircraft's maximum take-off weight.

The aircraft's published minimum control speed (Vmca) was 71 kts indicated airspeed. This speed was demonstrated to certain criteria during certification testing, and was the minimum speed under these conditions at which, following an engine failure, aircraft control could be maintained. A number of factors affect the actual minimum control speed achieved, including pilot handling technique, aircraft altitude, engine power setting, aircraft operating weight, loading and other factors.

1.18 Organisational and management information – Air Support Unit

1.18.1 Overview of the ASU

The ASU commenced operations in 1982 with two fixed-wing aircraft. At the time of the accident, the ASU had four aircraft: the C310 based at Karratha, a Cessna 182 and Piper PA31 based at Jandakot, and a Kawasaki BK117 helicopter also based at Jandakot. The main activities conducted were transport, search and rescue and support of police operations.

The transport activities involved moving police officers and department personnel throughout the state for a variety of operational and support functions. Passengers carried on the ASU's aircraft also included juvenile prisoners and personnel from related government departments. The ASU conducted 243 passenger flights involving 615 passenger movements in the period July to December 2000.[36]

The WA Police Service provided the ASU with a budget for its activities. The ASU did not charge other business areas within the police service for flights that were conducted on their behalf, but occasionally, other business areas contributed to the costs of an activity. The ASU staff reported that organisations external to the WA Police Service did not provide any payment for flights.[37]

At the time of the accident, the ASU had five fixed-wing pilots, including the chief pilot. One of those pilots was based at Karratha, whereas the chief pilot and the remaining pilots were based at Jandakot. All the ASU fixed-wing activities were conducted as single pilot operations. With the exception of the occurrence pilot, all the ASU fixed-wing pilots held multi-engine CIRs.

Maintenance for the fixed-wing aircraft fleet was conducted by an external organisation and coordinated by the ASU staff.

---

36 The number of passenger movements was obtained by summing the number of passengers for each landing, and then totalling those figures for all landings. Only transport activity flights were included in those calculations.

37 A series of four flights conducted for another government agency during December 2000 on a basis of 'cost-recovery' was noted during the investigation. Such flights were considered substantially similar to commercial operations and would be expected to have a charter AOC. As noted in section 1.18.2, the ASU held a charter AOC between 1994 and 1996.

1.18.2 Air Operator's Certificate

Civil Aviation Regulations (CARs) specified four classifications for civil air operations: regular public transport (RPT); charter; aerial work; and private. The purpose of the different classifications was to permit the application of a range of safety standards appropriate to the operation being undertaken. For example, compared with private flights, fare-paying passenger flights (RPT and charter) had a requirement to maintain higher safety standards, mandatory insurance requirements, and greater regulatory oversight by CASA. RPT, charter and aerial work operations were commercial in nature, and required a CASA-issued Air Operator's Certificate (AOC). Operations conducted in the private category did not require an AOC.

Under legislation current at the time of the accident, an organisation could own and/or lease aircraft and use those aircraft to transport employees and related personnel. Because those flights were not considered to be commercial in nature, they could be conducted as a private operation and with the lowest level of CASA-imposed minimum safety standards. These issues are discussed further in Attachment B.

The ASU operations were conducted in accordance with an aerial work AOC issued by CASA in May 2000. The ASU had been operating aircraft in the aerial work category throughout the 1990s except between 1994 and 1996 when it operated with an AOC permitting operations in both charter and aerial work categories. Although passenger transport activities of employees of the WA Police Service could have been conducted by the ASU as a 'private' category operation, its other activities were prescribed as, or were substantially similar to, aerial work purposes (CAR 206(1)).

1.18.3 Management structure – fixed wing

The ASU's fixed-wing chief pilot had been in that position since May 1997 and had been a pilot with the ASU since 1989. CAO 82.0 Appendix 1 outlined the responsibilities and qualifications of a chief pilot. Those included ensuring that flight operations were conducted in compliance with the legislation, arranging flight crew rosters, maintaining a record of licences and qualifications, maintaining a record of flight crew flight and duty times, ensuring compliance with loading procedures, monitoring operational standards, supervising the training and checking of flight crew, and maintaining a complete and up-to-date reference library of operational documents. The ASU's fixed-wing chief pilot also became the training and checking pilot for fixed-wing operations in September 1998 (see section 1.18.7).

The fixed-wing chief pilot could not recall being given any education, training or guidance in his responsibilities as chief pilot prior to the time that he was appointed. He could only recall general discussions with a CASA flying operations inspector (FOI) on those issues at the time of his appointment (see also section 1.22.2). Since his appointment, he occasionally sought advice from the previous fixed-wing chief pilot or alternatively the ASU rotary-wing chief pilot. Despite performing the duties of chief pilot and training and checking pilot, he received the same level of pay as other senior ASU fixed-wing pilots. That is, he was not financially reimbursed for his chief pilot and training and checking duties.

The fixed-wing chief pilot was not provided with any management training by the WA Police Service or other external providers. He had received no formal training in safety management, risk management or occupational safety. He believed that, in hindsight, chief pilots should be provided with a formal training program, particularly in terms of the legal responsibilities and requirements of the position and additional training in the manner by which a chief pilot was expected to interact with the regulator.[38]

The chief pilot reported to the officer in charge (OIC) of the ASU, who was responsible to the WA Police Service for managing the ASU's activities, but was not directly involved in managing day to day operational issues such as flight crew training and standard operating procedures.[39] The OIC had undertaken several short management courses offered within the WA Police Service, and had been OIC of the ASU since March 1999.

The OIC reported to the Inspector (Response and Specialist Support) on ASU administration issues and to the Superintendent (Response and Specialist Support) on ASU operational and strategic issues. The Superintendent reported to the Assistant Commissioner (Traffic and Emergency), who reported to the Commissioner.

1.18.4 Safety and risk management processes

In terms of general policies with regard to managing safety and/or risk, section HR-8 of the Commissioner's Orders and Procedures Manual was titled 'Occupational Safety and Health'. The section included the following statement:

> The purpose of the policy is to declare the Western Australia Police Service's commitment to establishing and maintaining, so far as is practicable, the highest standards of occupational safety and health for all personnel by ensuring appropriate resources and effort are effectively utilised in areas of accident and injury prevention, hazard control and promoting a healthy work environment.

Polices and procedures in relation to some specific operational activities and hazards were included in the manual. None of those were directly relevant to the flight operations conducted by the ASU. The investigation did not identify any detailed, formal guidance or standardised processes within the WA Police Service for the identification, assessment and control of safety risks,[40] or for the overall management of safety for a particular function or area.

According to the commissioned officers responsible for oversighting ASU activities at the time of the accident, the manner in which safety and risk were managed was a responsibility of the unit's local management. The commissioned officers reported that they were not personally aware of aviation safety issues, and relied on the chief pilot to provide safety assurance on all operational matters. The officers noted that the civil aviation legislation outlined the legislative requirements of the position, and that the chief pilot was legally obliged to ensure that the ASU fully met those standards.

The commissioned officers were unaware that there was a difference in the minimum safety standard required between charter and aerial work operations, and that if another aircraft operator was contracted to transport police service personnel, that operator would be required to operate to a higher minimum standard. For example, passenger-carrying charter flights at night (conducted in piston-engine aircraft) must be conducted by a pilot holding a CIR, in a suitably equipped multi-engine aircraft. As

38 CASA did not provide formal training for chief pilots, nor was this a CASA responsibility.

39 The OIC was also based at Jandakot.

40 Such as based on the Australian Standard AS/NZS 4360:1999 Risk Management and its precursor (1995).

discussed in sections 1.1 and 1.5, the flight from Kiwirrkurra to Newman was conducted at night under the VFR, by a pilot who did not hold a CIR.

In the late 1990s, the WA Police Service introduced the requirement for each operational unit to develop an annual business area risk plan. A limited amount of guidance information and a 2-hour training session was provided to the management personnel required to develop the plans. That guidance material included the following statement:

> To determine the risks that affect (or may affect) your business area, ask yourself this question: '*What internal and external issues can I identify that may affect the efficient, effective and economic operations of my business area?*'

Safety issues were not specifically mentioned in the guidance material, nor were they listed in any of the examples provided. One senior commissioned officer reported that safety and/or accident risks should be included in the risk plans. Other management personnel reported that such risks were not generally considered within the scope of those plans. They also noted that they were provided with little guidance on how to conduct the plans or how to assess and identify the risks associated with their operations.

The OIC had completed a business area risk plan for the ASU for each of the previous three years. Although a number of general risks were identified, none directly related to flight safety.

None of the ASU fixed-wing pilots had any experience in commercial aviation operations or aviation safety management prior to joining the unit. ASU personnel reported that there was no formal safety program within the unit, and no formal process for identifying and assessing flight safety hazards. During ASU staff meetings, safety issues were raised from time to time, but safety was not a fixed item on the agenda. There were no safety meetings, or regular briefings or discussions on flight safety issues. The ASU staff rarely attended external courses relating to flight safety.

The OIC and chief pilot stated that the ASU was not a large organisation, and that pilots could report any safety concerns to them at any time. They also noted that employees within the police service had an obligation to report any safety concerns they held. Pilots also said that they could raise safety issues with management.

The ASU operations manual stated that all aircraft accidents and incidents were to be reported 'in accordance with current CASA and/or BASI[41] requirements'. The ASU had no system for recording incidents, or for investigating incidents to identify safety problems. Some pilots commented that they did not feel encouraged to report incidents to the ASU management because the management response tended to focus on criticism rather than trying to identify and address any underlying safety problem.

The ATSB reviewed its accident and incident database for the period 1992 to the date of the accident. Most air safety incidents relating to ASU operations had been reported by third parties. A review of CASA files indicated that several other incidents (also reported by third parties) were the subject of correspondence and discussion between CASA and the ASU, but had not otherwise been reported to the ATSB.[42]

---

41 The Bureau of Air Safety Investigation (BASI) was incorporated into the new Australian Transport Safety Bureau from 1 July 1999.

42 It is a requirement under Part 2A of the *Air Navigation Act 1920* that all air safety accidents and incidents are reported to the Director of Air Safety Investigation in the ATSB.

In discussions with ASU personnel, it was apparent that staff had a strong commitment to their role in supporting police activities. Some former and current ASU personnel also noted that the unit had a 'can do' culture and was committed to getting the job done.

1.18.5 ASU operations manual

Aviation regulations required the holder of an AOC to have an operations manual (CAR 215) and to conduct all operations in accordance with that document. The operations manual was to be provided by an operator for the guidance of the operator's personnel. It should include information, procedures and instructions with respect to the flight operation of all types of aircraft in the operator's fleet, such as are necessary to ensure the safe conduct of flight operations.

It was reported that the ASU operations manual was substantially rewritten in 1992. The last amendments were made on 1 May 1997, but were generally small in number and unrelated to the circumstances surrounding the accident. As far as could be determined, most of the ASU operations manual content had not been updated since 1992. According to the chief pilot[43] and other ASU pilots, the operator had no written procedures or instructions for flight operational matters other than the material contained in the operations manual.

The chief pilot reported that he had been in the process of reviewing the content of the operations manual during the latter half of 2000. He and other pilots stated that it was widely agreed to be out of date and did not reflect the current operations of the unit. They also reported that although they had all read the manual, they did not use it as a frequent reference source.

The ASU operations manual did not define the role of a police pilot during deployments with other police officers. There was no guidance as to how a police pilot was required to manage police operational imperatives that may conflict with issues associated with the safety of flight.

During the investigation the WA Police Service stated that they had believed that the ASU operations manual was acceptable for the intended purpose as the document had been previously accepted by CASA.

CASA personnel responsible for oversight of the ASU during the 1990s reported that the operations manual met the required standards at that time and the document was consistent with the standards for other similar operators. One of these officers also acknowledged that the ASU operations manual would probably not have met CASA standards at the date of the accident.

In September 1997, CASA published Civil Aviation Advisory Publication (CAAP) 215-1(0) which provided guidance to operators about the preparation of operations manuals. That included information about the recommended content of the operations manual, together with information for the training and checking function for an organisation such as the ASU, holding training and checking approval pursuant to CAR 217.

43 The ASU had a rotary-wing chief pilot and a fixed-wing chief pilot until May 2000, at which time these were combined into a single chief pilot position. These issues are further discussed in section 1.22.1.

During the investigation, a number of deficiencies with the ASU's policies and procedures were identified, including the content of the operations manual. The following sections discuss deficiencies relating to fuel planning and management (section 1.19.2), night operations (section 1.20.3), and training and checking (section 1.20.3 and also Attachment A).

1.18.6 Pilot qualifications

The ASU recruited fixed-wing pilots from within the sworn ranks of the WA Police Service. ASU personnel reported that pilots needed to be sworn officers for a variety of operational reasons, such as the ability to provide an additional police officer at a remote location and ensuring the confidentiality of covert operations involving the ASU's aircraft. It was acknowledged that this policy resulted in a limited group of pilots from which to recruit and lower experience levels and flight qualifications than would otherwise be available if recruiting direct-entry pilots.

Most fixed-wing pilots who joined the ASU prior to 1990 held private pilot licences at the time they were recruited to the unit, and those recruited since 1990 held a CPL. Most fixed-wing pilots recruited did not hold multi-engine endorsements or a CIR. None of the fixed-wing pilots had significant experience as a commercial pilot at the time of joining the ASU. Pilots were provided with the necessary training to obtain additional flying qualifications after joining the ASU. These qualifications could include CPL, multi-engine rating, night VFR rating and CIR.

The occurrence pilot was the most recent fixed-wing pilot recruited by the ASU. At the time of his selection, there were no other suitable applicants identified who already held a CPL. His low level of flying experience and initial flying performance were noted as a concern by some ASU staff at the time he joined the unit.

The chief pilot stated that it was decided in September 2000 to transfer the previous Karratha-based pilot back to Jandakot at the end of his assigned four-year term. The chief pilot considered that the occurrence pilot possessed the appropriate operational skills and experience for the Karratha appointment and was the logical replacement as he was mature, reliable in terms of completing paperwork, and was not a risk taker. The chief pilot believed that the experience the pilot gained in Karratha conducting regular multi-engine operations would also help consolidate his multi-engine piloting skills. He anticipated that the pilot would complete his CIR training within 6 months of transferring to Karratha.

The chief pilot stated that there was no formal analysis of the operational skills required for the Karratha appointment. As far as he was concerned, they were the same skills as required by a Jandakot-based ASU pilot. He did not consider issues such as remote area operations, night operations or 'black hole' situations required any further assessment or discussion, as the pilot would have been familiar with those issues from his flying while based at Jandakot.

The chief pilot and other ASU pilots reported that a CIR was desirable but not necessary for remote-base operations, as the vast majority of their flights were conducted in visual meteorological conditions (VMC). He also stated that other ASU pilots had previously been posted to Karratha without holding a CIR. The investigation noted that those postings were made at times when a senior pilot holding a CIR was also serving at that location.

During events in April 1999 associated with a remote-based pilot failing to pass his CIR renewal, a commissioned officer expressed the view that holding a CIR was 'integral to successfully achieving the overall objectives, roles, responsibility and operations of the ASU'.

The commissioned officers responsible for oversight of the ASU reported that prior to the accident, they were unaware that the replacement pilot sent to Karratha did not hold a CIR.

1.18.7 Flight crew training and checking

The ASU was approved by CASA as a training and checking organisation in accordance with CAR 217. That was additional to the standard requirements for an organisation holding an aerial work AOC. The CAR 217 approval was initially issued in August 1992, with a requirement for one 'check and training pilot' for fixed-wing operations and one 'check and training pilot' for rotary-wing operations. According to persons involved with the initial approval, the main reasons for introducing a CAR 217 training and checking system was associated with the sophisticated nature of the BK117 helicopter, and the requirement to conduct night helicopter operations at a height less than the minimum safe altitude. In consultation with the then Civil Aviation Authority[44] (CAA), the ASU decided to also apply the training and checking system to the fixed-wing part of their operation.

Part D of the ASU operations manual was titled 'Check and Training'. The manual stated that all pilots would be subject to a base[45] or route[46] check every 90 days, and that one of those checks would be conducted at night in every 6-month period. The manual included forms to be completed during base checks, route checks and endorsement checks. Due to the variable nature of the ASU's operations, route checks were rarely conducted.

The ASU fixed-wing chief pilot was approved by CASA as the 'check and training' pilot for fixed-wing operations in September 1998 for a 12-month period. The initial approval permitted him to conduct flying training for the renewal of command instrument ratings, aeroplane conversion training and perform duties as a check pilot during en-route operations (see also section 1.22.3). This approval lapsed in September 1999 and was reissued by CASA in May 2000.

The investigation reviewed the ASU training and checking system and noted the following:

- The ASU's operations manual (Part D 'Check and Training') did not define the roles, syllabuses of training, or information on the qualifications required for 'check and training' pilots. CASA's Air Operator Certification Manual (AOCM) required that these items be included for any organisation conducting training under a CAR 217 approval.
- The ASU fixed-wing chief pilot did not hold any previous instructional experience prior to his appointment in the training and checking role. Although he did receive

44 The regulatory parts of CAA formed CASA in 1995.

45 A test of proficiency in normal flight and during simulated emergency and abnormal operation of the aircraft's systems. Base checks should also include activities performed in preparation for flight.

46 A test of proficiency during which the crew member performs their assigned role during routine operations.

some training[47] from an external contractor, the training was reported to primarily be familiarisation with flying from the right (co-pilot) seat and training to provide airborne instruction in asymmetric and instrument flying techniques. The training, assessment and approval of the chief pilot as a CAR 217 training and checking pilot and the subsequent re-issue of approvals did not appear to extend to the administrative responsibilities and duties associated with the performance of functions authorised by the CASA delegations and approvals held. That was evident in the manner by which the chief pilot conducted a flight test for which he did not hold a delegation (see Attachment A and section 1.20.1) and his failure to use the approved CASA test form and test the required items. In addition, there were other administrative irregularities associated with the performance of functions for which he did hold a CASA delegation, such as incorrectly entering and certifying endorsement details in the pilot's logbook and failing to notify CASA that such an endorsement had been made.

- The ASU fixed-wing chief pilot did not always conduct base checks at the frequency required by the operations manual.
- The ASU fixed-wing chief pilot conducted base checks during periods when he did not hold a CASA-issued training and checking approval. In addition, most of the flights conducted following his initial approval as CAR 217 training and checking pilot were performed as base checks, and therefore appeared to be contrary to the conditions of his initial approval to perform duties as check pilot only during en-route operations.
- The ASU fixed-wing chief pilot was not subject to base and route checks as required by the operations manual. The only training and checking was in association with his annual CIR renewal.

The ASU fixed-wing chief pilot's conduct of base checks was observed by a CASA-approved ATO or a FOI on two occasions. On each occasion, the ATO/FOI acted as the pilot being checked.

All CIR renewals for the ASU's fixed-wing pilots were conducted by a CASA-approved ATO and provided an external check of the standard being attained. However, as the occurrence pilot did not hold a CIR, he was not subject to any external checking[48] as a regular part of the ASU training and checking system.

A significant issue identified during the investigation was that the ASU's training and checking system provided minimal checking of key skill areas relevant to the ASU's operations, particularly with regard to operations in remote areas. Those areas included fuel planning and management (see section 1.19) and night operations (see section 1.20).

1.18.8 Review and monitoring of ASU operations

Each unit or station within the WA Police Service had a quarterly on-site business management review. That included issues relevant to occupational and operational safety. The reviews of the ASU did not cover flight operational issues, nor did the WA Police Service expect them to be included.

---

47 This training consisted of about 12 hours ground training and 11 hours of airborne training, and was conducted over a period of approximately 12 months.

48 The occurrence pilot's training history is discussed in section 1.5.

Commissioned officers responsible for the ASU at the time of the accident reported that they had never been made aware of any safety concerns regarding the ASU's flight operations or safety management in recent years, other than the flying standards of two ASU pilots at various times. Some of them also reported that they had assumed that CASA was conducting regular surveillance activities on the ASU, and took comfort from the fact that there was no negative feedback from such activities. They were unaware that CASA had not conducted detailed audits on aspects of the ASU fixed-wing operation since October 1995 (see section 1.22.5).

As non-aviation qualified persons, the commissioned officers responsible for the ASU believed that it was desirable to have some form of external review of the unit's operational standards. As far as could be determined, no external review of the standards and safety of the ASU's flight operations had been conducted for several years prior to the accident.

During the investigation, the WA Police Service expressed the view that, given the small size of the ASU, they were reliant on CASA to provide 'ongoing practical input' to assist the ASU and ensure that the highest levels of safety were maintained. Their expectation was that CASA would conduct sufficient reviews and carefully scrutinise operations so as to identify risk management factors, deficiencies and preferred practices and to guide the AOC holder in the formulation and management of risk management protocols.[49]

The investigation noted that the expectation held by the WA Police Service, of CASA providing practical input to provide safety assurance, was inconsistent with CASA's actual activities in that sector of the industry at that time. The CASA Annual Report 2000–2001 identified core business areas that included safety surveillance, promoting awareness and understanding of aviation safety standards and encouraging greater acceptance by the aviation industry of its obligations to maintain high aviation safety standards. The actual areas of program delivery by CASA did not extend to the close and direct type of supervision expected by the WA Police Service.

In the mid-1990s, the WA Police Service introduced the 'Delta Program', which was a 'continued organisational change process aimed at applying best practices in all facets of management and operations'. As a part of that process, the various units and business areas within the organisation were reviewed.

The first review of the ASU was completed by an external organisation (non-aviation) in June 1996. Its scope included an examination of the ASU's existing functions, identification of strategic options, cost/benefit analyses on the options, identification of the associated risks, and the structure and equipment needs to support each option. According to persons involved in the review process, a major concern of senior police service management was the extent to which the ASU was involved in transportation activities that were, at that time, viewed as a non-core function of the police service. Some of the ASU's staff criticised the review's report and findings, and WA Police Service management subsequently reviewed the report and the areas in dispute. A second review was then conducted within the Police Service and with the assistance of an external aviation expert. That review was initiated in January 1997. A third review, conducted by another external organisation (non-aviation), was completed in December 1997.

49 The investigation noted that CASA had produced various advisory publications and guides, including information to assist compiling operations manuals and a guide outlining the responsibilities of a chief pilot.

The primary focus of the three reviews was the issue of whether some or all of the ASU's functions should be outsourced. An examination of available documentation from the reviews, and discussions with some of the people involved, indicated that safety of flight operations was not considered, either as a formal outcome or as a direct consequence of the reviews. For example, the reviews compared the cost of activities conducted by the ASU with the cost of the same service provided by an external, charter category operator. However, the different level of safety or regulatory requirements associated with the two options was not considered as a factor that could influence the outcome.

1.19 Defences relating to fuel planning and management

1.19.1 Regulatory requirements and advisory information

CAR 220 and 234 were relevant to all types of commercial operations. CAR 220 stated:

> (1) An operator shall include in the operator's operations manual specific instructions for the computation of the quantities of fuel to be carried on each route, having regard to all the circumstances of the operations, including the possibility of failure of an engine *en route*.
>
> (2) An operator shall maintain a record of the fuel remaining in the tanks at the end of each scheduled flight and shall review continuously the adequacy of the instructions in respect of the fuel to be carried in the light of that record, and shall make any such record available to CASA, upon request.

CAR 234(1) stated:

> The pilot in command of an aircraft must not commence a flight within Australian territory, or to or from Australian territory, unless he or she has taken reasonable steps to ensure that the aircraft carries sufficient fuel and oil to enable the proposed flight to be undertaken in safety.

CAAP 234-1(0) was titled 'Guidelines for Aircraft Fuel Requirements, March 1991'. It provided advisory information on matters to be considered when calculating fuel requirements, recommendations for fuel reserves and a number of other similar matters. The CAAP included a recommendation to carry a 45-minute fixed reserve, together with an additional 15 per cent variable reserve for aircraft engaged in charter and public transport operations.[50]

CASA published educational material relating to fuel management and planning. That included a brochure titled 'Time in Your Tanks' (see Attachment C). That brochure included the following recommendation regarding fuel management in flight 'At regular intervals (at least every 30 minutes and at turning points), compare fuel remaining from gauges with planned figures and monitor tank selection'.

In practical terms, that recommendation suggested that pilots should periodically crosscheck the indications from the aircraft fuel gauges against the anticipated rate of fuel consumption. To do that accurately required keeping a written record of the fuel consumed, calculating the quantity of fuel remaining and regularly checking that information against the indications of the fuel gauges. That technique significantly increased the likelihood of a pilot detecting a discrepancy with the fuel quantity, and in

50 The investigation also noted that the CASA-recommended fixed fuel reserve (45 minutes) did not necessarily account for situations where the 45 minutes of fuel could be contained in several tanks, and not the tanks required to be selected for descent, approach and landing.

sufficient time to correctly resolve an ambiguity. Discrepancies could result from errors made during compilation of the flight plan, an error in the quantity to which the aircraft was fuelled or abnormally high fuel consumption.

This educational material also included some practices recommended to establish the quantity of fuel contained in the aircraft's tanks before flight. This included dipping tanks to verify the contents or refuelling in such a way that a known quantity of fuel could be established. It was also a recommended practice to crosscheck the fuel quantity by at least two separate methods.

CASA and industry associations have also published a number of educational articles on fuel planning and fuel management, many of them containing similar recommendations to those outlined in the 'Time in Your Tanks' brochure.

1.19.2 ASU policies and procedures

Improper fuel planning and management has been frequently cited as a contributing factor for accidents involving Australian general aviation aircraft, in both commercial and private operations (see Attachment D). Consequently, there remains a need for commercial operators to have sound fuel management policies and procedures to reduce the possibility of fuel planning and management contributing to the circumstances of an accident.

Each of the ASU's fixed-wing aircraft was equipped with a digital fuel management system. These had a reputation amongst the ASU pilots for accurately measuring the quantity of fuel used.

The ASU operations manual required submission of flight plans for all fixed-wing flights, except local flights within 20 NM of point of departure and emergency flights. It also required pilots to record the fuel on board prior to, and at the end of each flight, the fuel consumption every flight, and the quantity of any fuel added. The chief pilot expected that a fuel plan would be completed as part of any flight plan, although this requirement was not specified in the ASU operations manual.

There was no written policy, instruction or guidance requiring the ASU pilots to use techniques and procedures such as in-flight fuel logs to regularly record the progressive consumption of fuel, fuel tank selection and the fuel quantity remaining in each of the tanks. A review of the ASU's recent flight documentation did not reveal any calculations that were consistent with the occurrence pilot maintaining such in-flight logs of fuel consumption. There was no ASU requirement for pilots to reconcile the record of fuel consumption with the fuel quantity added during refuelling.[51]

Other aspects of the ASU's operations policies, procedures and training in relation to fuel issues included:

- A requirement for the ASU's aircraft to land with a fixed fuel reserve intact, except in emergency situations. For VFR flights, the pilot was required to carry a fixed reserve of 45 minutes, and that was published as a quantity of 75 L for the C310. In addition to the fixed reserve, the pilot was required to carry extra fuel for 'operational reasons such as ATC, or as decided by the pilot in command'. There was no additional information provided about other requirements for VFR fuel planning, such as holding fuel for weather conditions, alternate aerodrome fuel,

51 The investigation identified a number of instances where the fuel added and fuel consumed could not be reconciled.

flight at night under the VFR, or other contingencies (see section 1.17.7). The ASU operations manual referred to CAAP 234-1(0).

- Fuel consumption rates for flight planning purposes were not contained in the ASU operations manual for any of its current fixed-wing aircraft, nor was reference made to which documents the pilot was expected to use for that purpose.[52]
- There was no information included in the ASU operations manual for the purpose of contingency planning in case of an engine failure and the circumstances under which those contingencies needed to be considered.
- The ASU operations manual required the aircraft to be refuelled to a standard fuel load on completion of the day's flying. However, the standard fuel load was not published for any of the current fixed-wing aircraft.
- The ASU operations manual stated that 'when refuelling from drums particular attention is to be paid for testing for water'. There was no information relating to quality control processes for using drum fuel, for example, the use of sealed versus unsealed or already open drums, filtering requirements for drum fuel, procedures and techniques to determine the quantity of fuel delivered into the aircraft, and additional safety precautions to be observed.
- No information was included in the ASU operations manual regarding the procedures to use when checking (and crosschecking) the quantity of fuel contained in the tanks during pre-flight preparation.
- A variety of measurement units were used with the ASU's tasks of fuel planning and management. The digital fuel management system recorded litres of fuel consumed and fuel was also purchased in litres. The pilot recorded fuel consumption for each flight sector in kilograms, fuel added in litres and the aircraft's fuel gauges indicated pounds of fuel as the primary scale, and US gallons as the secondary scale. Accordingly, frequent conversions and calculations were required to accurately complete the tasks associated with fuel planning and management. That mix of units was not uncommon in some aircraft used in general aviation and low-capacity RPT operations. The investigation noted that each time a conversion or calculation was performed, there was potential for an error to be introduced into the data. Consequently, a robust system of fuel planning and fuel management was required to ensure the safety of flight.
- When interviewed, some ASU pilots gave the impression that the quantity of fuel indicated by the digital fuel management system could be relied upon to provide accurate information about the quantity of fuel remaining on the aircraft. There was no specific training provided by the ASU on the extent to which the digital fuel management system should or could be relied on, or the extent to which its indications should be crosschecked with other standard techniques of determining the quantity of fuel remaining. The investigation considered that a significant limitation of the digital fuel management system was that even if it was correctly used, it did not indicate the fuel remaining in any given tank, but rather the total fuel quantity remaining in all four tanks.

52 The ASU pilots endorsed on the C310 stated that 120 L per hour was used for the purpose of flight planning.

- Fuel consumption records completed by the previous Karratha-based pilot were compiled using a fuel consumption rate of 120 L/hr, rather than recording the aircraft's actual fuel consumption. The occurrence pilot also appeared to use that practice for many of his flights in July 2000 and for one flight in January 2001. Although that type of practice was commonly used to estimate the fuel consumption in aircraft not equipped with digital fuel management systems, the estimates obtained had to be closely monitored against the fuel quantities added during refuelling operations to verify their accuracy. The investigation considered that it was sound fuel management practice to record the actual fuel quantity consumed using the most accurate information available.

ASU personnel reported that although some fuel-related information and procedures were undocumented, all their pilots were familiar with issues such as the figures to use for fuel planning and the limitations of the digital fuel management system. They also noted that by using a standard refuelling practice for the C310 of full mains and 50 L to each auxiliary tank, the fuel management task was relatively straightforward. ASU pilots reported that if aircraft loading permitted, there was no restriction for loading extra fuel.

The WA Police Service contended that the ASU's pilots observed traditional industry standards in fuel management and the means by which fuel quantity contained in the fuel tanks was determined.

1.19.3 Monitoring and supervision of fuel planning and management

According to the base check forms and from discussions with the ASU fixed-wing pilots, the base checks rarely involved discussion of fuel planning or management. Due to the short duration and predictable content of the check, fuel planning and fuel management were never a critical part of the exercise. A review of documentation associated with base checks revealed that fuel plans had not been calculated for several base checks and other pilot training conducted during 2000.

The route check report form included a section on flight planning and an assessment item titled 'fuel calculations'. There were no other fuel-related items contained on the form. As noted in section 1.18.7, route checks were rarely conducted.

The Schedule of Operations, flight plan, and other related operational documents were submitted to the fixed-wing chief pilot on a regular basis. He reported that he monitored[53] those documents to ensure their appropriateness, including checking the extent to which fuel plans had been completed.

The investigation reviewed some of the flight documentation submitted to the chief pilot between July 2000 and the date of the accident. This review noted that fuel plans had not been completed for a number of flights, including multi-sector passenger transport operations in regional areas of WA. These included flights performed by the occurrence pilot in the C310, as well as check flights and other flights with the chief pilot on board the aircraft.

---

53 The WA Police Service subsequently reported that the chief pilot employed standard auditing techniques to check flight plans submitted by the ASU pilots, regularly reviewing a cross-section of the plans submitted. It was reported that any detected deficiencies were discussed with the pilot concerned to ensure the deficiency was not repeated.

1.20 Defences relating to night operations

1.20.1 Regulatory requirements and advisory information

Flights under the VFR were required to be conducted in accordance with various provisions, including those relating to flight visibility and distance from cloud. When flying outside controlled airspace below 10,000 ft, the required flight visibility was 5,000 m (AIP ENR 1.2 paragraph 2.6). There was also a requirement for 1,500 m horizontal and 1,000 ft vertical separation from cloud when flying more than 3,000 ft above mean sea level or 1,000 above ground level (whichever is the higher). Flights conducted under the VFR at night had the same requirements for flight visibility and separation from cloud as when operating by day.

There were no aviation regulatory requirements for pilots to consider the amount of external visual reference that was likely to be available for a flight conducted at night under VFR procedures.[54] The pilot was not required to consider the amount of celestial illumination, amount of terrain lighting, and/or presence of a visual horizon either en-route or at the destination aerodrome.[55] The pilot was also not required to consider the presence of high-altitude cloud along the planned route. Aviation weather forecasts did not provide information on the amount of celestial illumination.[56]

Under certain conditions, external visual reference is not available while flying an aircraft at night under the VFR. These include operating over remote areas, in moonless conditions, and at times when the celestial horizon is obscured by cloud. On the information available, the pilot probably experienced these conditions during the flight from Kiwirrkurra to Newman. Under such conditions, the pilot could have hand-flown the aircraft using the flight instruments or alternatively, used the aircraft's autopilot. Using the autopilot would have significantly reduced pilot workload.

To conduct flights at night under the VFR, a pilot was required to hold a CASA-issued night VFR rating. CAO 40.2.2 detailed the flight tests and other requirements prior to the issue of a night VFR rating. The test requirements included basic instrument flight and recovery from unusual attitudes, night circuits and visual navigation. Recovery from unusual attitudes, basic turns and straight and level flight, were required to be conducted solely with reference to flight instruments. Takeoff, circuit, landing and asymmetric flight in the cruise for multi-engine aircraft, were each required to be conducted using external visual cues at night. The experience requirements included at least one landing at an aerodrome 'that is not in an area that has sufficient ground lighting to create a discernible horizon'.

According to instructions provided in the CASA *Flight Crew Licensing Industry Delegates Handbook*, the removal of the single-engine restriction to the night VFR rating required a flight test in a multi-engine aircraft with an ATO who was approved to conduct night rating flight tests. The CASA test report form required the applicant to demonstrate the ability to cope with an engine failure with the aircraft in the cruise configuration. The test report form also included a requirement for night circuits and a takeoff and landing at an aerodrome remote from extensive ground lighting.

---

54 With the exception of considering forecast cloud below the lowest safe altitude.

55 The investigation noted that some helicopter AFMs stipulate the requirement for external visual reference or celestial illumination for flight under night VFR procedures.

56 This information was available from a variety of other sources, and when considered in conjunction with the meteorological forecast, could provide an indication as to the amount of celestial reference likely to be available.

Once issued, a night VFR rating remained permanently valid. To exercise the privileges of the rating, the pilot needed to meet certain minimum recent experience requirements. These included completion of a 1-hour night flight during the previous 12 months and one takeoff and landing at night during the previous 6 months.[57] There was no requirement for the night VFR competencies to be demonstrated during a regular flight review or otherwise at recurrent intervals. There was no requirement for the holder of a night VFR rating to have demonstrated any recent instrument flying proficiency prior to conducting a flight at night.[58]

CASA and other organisations have published a number of pilot education documents relating to the difficulties and hazards of VFR flying at night. In December 1999, CASA published the *VFR Flight Guide* and distributed copies to all VFR pilots. That document included information from CARs, CAOs, the AIP and CAAPs regarding aspects of VFR flying, and was intended to assist VFR pilots to fly safely. A new edition was published in September 2001 with essentially the same content. Neither edition provided guidance information pertaining to the difficulties associated with VFR operations in dark night environments, or how to obtain information when flight planning, regarding the extent of external visual reference likely to be available during the flight.

1.20.2 ASU policies and procedures

With the exception of the occurrence pilot, all the ASU fixed-wing pilots held a CIR. The CIR qualification permitted them to fly at night under the IFR and also under VFR procedures at night if they met certain requirements. Those pilots reported that they rarely flew in instrument meteorological conditions and estimated that they did less than 20 hours night flying a year. The occurrence pilot generally conducted more night flying than the other fixed-wing pilots as, before his transfer, he frequently flew the C182 during night operations over the Perth metropolitan area.

The ASU operations manual contained little detail or guidance for night operations using fixed-wing aircraft. There was no reference to special precautions or restrictions to be used when flying at night in remote areas or on dark nights, or considerations of the criteria for deciding whether to conduct operations at night.

The chief pilot stated that the ASU pilots were responsible for ensuring that their flights were conducted in accordance with the VFR/IFR, flight and duty times and other related issues. The chief pilot expected that the ASU's pilots would use their judgement in determining whether to conduct a particular flight.

1.20.3 Training and checking of night operations

As noted in section 1.18.7, the ASU operations manual stated that a night check was required every 6 months. According to the chief pilot, no night checks had been conducted since he had assumed that role in May 1997, and he was unaware of the requirement contained in the operations manual. He could not recall base checks being conducted at night prior to 1997. Other ASU pilots who were based at Jandakot

---

57 To carry passengers at night under the VFR required 3 takeoffs and 3 landings within the previous 90 days.

58 The holder of a CIR was required to demonstrate instrument flying proficiency at 12-monthly renewals and also meet certain minimum recent experience requirements to fly in cloud under the IFR.

at that time stated that the previous chief pilot conducted night checks. As far as could be determined, the occurrence pilot had not undergone a base check at night.[59]

1.20.4 Accidents at night under VFR procedures

In Australia between 1991 and 2000 there was a significant number of VFR accidents at night (see Attachment E), all of which appeared to occur on dark nights. Transport Canada[60] also conducted a review of such accidents within their jurisdiction and noticed a similar trend.

As a result of the number of VFR accidents at night, Transport Canada initiated a review to clarify aspects of its definition of visual flight, particularly as it related to the availability of sufficient external visual cues to enable a pilot to maintain the aircraft's attitude and orientation with reference to the earth's surface. The Notice of Proposed Amendment (NPA 2001-117), prepared in 2001 stated:

> There is a common misconception that if the minimum visibility criteria are met, then conditions are suitable for VFR flight, particularly during daylight. There is also general agreement among pilots that flight in conditions with any reduction in visibility on a dark night over uninhabited terrain is not VFR. The difficulty in rationalising these different points of view is in determining what constitutes visual reference. Some jurisdictions have used the concept of a 'visible horizon'.

Transport Canada proposed amending their rule CAR 602.115 to give additional guidance to pilots and supervisors conducting VFR operations. Its proposed change included the following:

> No person shall operate an aircraft in VFR flight within uncontrolled airspace unless
>
> (a) the aircraft is operated with sufficient visual reference to enable the pilot to maintain the aircraft's attitude and orientation with reference to the earth's surface by the use of external visual cues; …

1.21 Defences relating to physiological factors

1.21.1 Summary of research on the effects of fatigue

As noted in the *Beyond the Midnight Oil*[61] report (p.2):

> Fatigue has been variously defined as:
>
> - the consequences of inadequate restorative sleep;
> - the progressive loss of alertness ending in sleep;
> - an all encompassing term used to describe a variety of different experiences such as physical discomfort from over working a group of muscles, difficulty concentrating, difficulty appreciating potentially important signals and problems staying awake; and

---

59 According to logbook entries, the chief pilot had flown with the pilot at night on two occasions: once in December 1997 and once for the multi-engine night VFR rating test on 2 November 2000 (see Attachment A).

60 Transport Canada is the equivalent regulatory agency of the Australian CASA.

61 House of Representatives Standing Committee on Communications, Transport and the Arts, *Beyond the Midnight Oil: An Inquiry into Managing Fatigue in Transport*, The Parliament of the Commonwealth of Australia, Canberra, October 2000.

- a reduction in or loss of physical and/or mental capability as a result of exertion, which may impair all physical abilities, including strength, speed, reaction time, coordination, decision making, or balance.

The key points taken from the above definitions are that fatigue is the result of inadequate rest over a period of time and that fatigue leads to physical and mental impairment.

Fatigue can arise from a number of different sources, including time on task, time since awake, acute and chronic sleep debt, and circadian disruption (that is, factors which affect the normal 24-hour cycle of body functioning). A US Federal Aviation Administration (FAA) review of fatigue research relevant to flight operations noted that fatigue can have a range of influences, such as increased anxiety, decreased short-term memory, slowed reaction time, decreased work efficiency, reduced motivational drive, increased variability in work performance, and increased errors of omission.[62] The review also made the following observations:

- A common symptom of fatigue is a change in the level of acceptable risk that a person tolerates, or a tendency to accept lower levels of performance and not correct errors.
- Decrements in alertness and performance intensify if the time awake is 16 to 18 hours. Performance decrements of 'high time-since-awake' crews tended to result from ineffective decision-making rather than a deterioration of aircraft handling skills.
- There is a discrepancy between self-reports of fatigue and actual fatigue levels, with people generally underestimating their level of fatigue.

A review of aviation accidents in the USA noted a significantly higher accident rate when the flight crew's duty time exceeded 10 hours.[63]

A number of factors are known to exacerbate the effects of fatigue on human performance. These include the type of work conducted, environmental conditions such as heat, and inadequate nutrition.

1.21.2 Summary of research on the effects of other physiological conditions

As noted in section 1.13, the post-mortem determined that the pilot had probably not eaten for 8 to 12 hours prior to the accident. Research has demonstrated that missed meals have a variety of effects on human performance. However, these results are not consistent and there has been little research that has specifically examined the effect of a missed evening meal.

The flight from Kiwirrkurra to Newman could have been conducted at an indicated altitude of 8,500 ft.[64] Some research has indicated that sustained exposure (for over

---

62 Battelle Memorial Institute, *An Overview of the Scientific Literature Concerning Fatigue, Sleep, and the Circadian Cycle*, 1998. (Report prepared for the Office of the Chief Scientific and Technical Advisor for Human Factors, Federal Aviation Administration, USA.)

63 Federal Aviation Administration, System Safety Engineering and Analysis Division, *Risk Analysis for Flight, Duty and Rest Requirements – Part 121*, Safety Risk Assessment News, Report Number 01-06, November 2001.

64 The pilot reported at 2134 (on descent to Newman) that he was passing 8,000 ft. It is also a required practice to fly at even numbered altitudes plus 500 ft for VFR flights heading west. It is possible that the pilot conducted some of the flight at a lower altitude, such as 6,500 ft.

2 hours) at altitudes of 5,000 to 10,000 ft can result in mild levels of oxygen deprivation (or hypoxia) that can decrease the effectiveness of night vision. Other research has indicated that sustained exposure to altitudes of 10,000 to 15,000 ft can result in mild to moderate performance decrements in areas such as peripheral vision, response time, and short-term memory. Regular smokers (such as the occurrence pilot) generally have a higher carbon monoxide level and therefore a reduced oxygen-carrying capability of their blood. Research has indicated that, at altitudes of 5,000 to 10,000 ft, a smoker may experience a physiological altitude of 2,000 to 3,000 ft more than the actual altitude. Fatigue and a lack of nutrition can exacerbate the effects of hypoxia.[65]

1.21.3 Regulatory requirements and advisory information relating to physiological factors

CAO 48 applied to aerial work, charter and regular public transport operations, and required pilots to observe limitations which related to prescribed flight and duty times. The limitations for flight time included a limit for the maximum permitted hours flown during one duty period and also cumulative limits for 7, 30 and 365 consecutive day periods. Limitations for duty periods were specified for the maximum duty time during one duty period, prescribed rest periods between successive duty periods and a cumulative duty time limit for a stand alone fortnightly period. In particular, the maximum rostered period of consecutive duty was 11 hours, which could be extended to 12 hours once the duty period had commenced.[66]

CASA and other organisations have published a number of pilot education documents relating to the difficulties and hazards associated with fatigue, hypoxia and other physiological conditions. However, much of that material focused on background information rather than providing recommendations or guidelines on how to incorporate that information into operational procedures. There is no formal advisory material from CASA on human factors issues such as fatigue and hypoxia.

During 1991, the then CAA published an advance copy of the Day VFR Syllabus that specified the aeronautical knowledge training required for private and commercial pilot licences. That syllabus was formalised in December 1992 with *Issue 1 of the Day VFR Syllabus – Aeroplane*. It included a list of required competencies for human performance and limitations, together with the definition of the level of the knowledge required for each licence category. Although the syllabus included the requirement for pilots to receive training in the area of human performance, the subject matter was not initially examined as part of the CAA private and commercial pilot composite theory examinations.[67] The current syllabus listed two introductory reference texts on aviation human factors.

---

65 It is important to note the difference between the mild to moderate effects of hypoxia from sustained exposure to altitudes less than 15,000 ft, relative to the more sudden and severe effects of exposure to higher cabin altitudes (as may occur during the depressurisation or failure to pressurise a pressurised aircraft at altitudes much greater than 15,000 ft). The ATSB is conducting a safety study of issues associated with the possible influence of hypoxia on pilot performance in a variety of different circumstances.

66 Provided additional specified rest periods were observed prior to the next duty period.

67 The occurrence pilot sat and passed a CAA composite CPL theory examination during May 1992. At that time, competencies associated with human performance and limitations were not examined.

1.21.4 ASU policies and procedures

The ASU operations manual included:

> Since crew fatigue constitutes a severe threat to flight safety, crew members must use their own discretion to avoid flying when very fatigued. Normal hours of flying and duty hours will be subject to CAO 48.

It was reported that the chief pilot had reinforced the importance of complying with CAO 48 (flight and duty time limitations) on at least one occasion. However, it was also reported that the emphasis of that action appeared to be on the need to comply with the regulatory requirements rather than the possible issues of fatigue affecting flight safety.

Other than the operations manual statement on fatigue, the ASU appeared to have no process to ensure that pilots were aware of the potentially negative effects of fatigue and other physiological conditions during flight operations. During the investigation the WA Police Service reported that human factors training was included as part of ongoing ASU training programs. It was reported that this training was conducted by the chief pilot, and consisted of verbal tuition on an informal basis. It was also reported that safety issues were discussed, including human factors relevant to safety. The investigation noted that several ASU pilots were unaware that such training programs existed and indicated that the ASU did not provide training or other guidance in these areas.

The WA Police Service reported that the ASU maintained a library of reference material for pilots to develop their knowledge of flight safety issues and that this library included copies of the CASA Flight Safety magazine. CASA also distributed individual copies of this magazine to each holder of an aviation licence.

At the time of the accident, there was no specific aviation regulatory requirement for operators such as the ASU to conduct human factors training.

Observation:

At the time of the accident, the pilot had been on duty for about 14 hours, including 7 hours flight time (see section 1.5). That long duty period, in combination with a number of other issues, would have probably contributed to the pilot experiencing a mild to moderate level of fatigue, particularly towards the end of the occurrence flight. Those other issues included a probable lack of recent nutrition, high temperatures throughout the afternoon, a period of physical activity prior to the flight, and the possible effects of a mild level of hypoxia.

It is also possible that, given the environmental conditions, the pilot may also have been experiencing dehydration. There was no conclusive evidence from the post-mortem examination or from witnesses to indicate whether that was likely. Any dehydration would compound the effects of fatigue on the pilot's overall physiological wellbeing and performance.

Overall, the pilot's physiological condition and performance capability was probably somewhat degraded during the flight, but the level of degradation could not be reliably determined.

There was no evidence to suggest that the pilot was aware of the potential extent to which those physiological factors could have affected his performance during the flight. As far as could be determined, he had received no formal education on those issues, either within the ASU or from other sources. Although human performance and limitations topics were included in the CASA CPL theory syllabus at the time the pilot completed his composite CPL theory examination (1992), the material was not formally assessed or otherwise examined at that time.

1.22 Regulatory oversight of ASU activities

1.22.1 Overview of CASA's relationship with the ASU

Prior to 2000, the CASA Jandakot office had oversight of the ASU's activities. The officer assigned as the FOI to the ASU was the Jandakot District Field Office Manager (DFOM). The previous ASU fixed-wing chief pilot joined CASA as a FOI at Jandakot in April 1997. Following his appointment he assisted the DFOM with various oversight activities of the ASU (see section 1.22.6).

In early 1999, CASA commenced reorganising its district offices. As a result of the restructure, the Jandakot office was closed during early 2000, with the Jandakot staff and regulatory oversight activities transferred to CASA's Perth office.

CASA staff detected a number of administrative irregularities with aspects of the ASU's AOC during the first part of 2000. These irregularities included aspects of CASA-issued approvals and the existence of two chief pilots for an organisation holding a single AOC. During May 2000, CASA held meetings with WA Police Service commissioned officers and ASU staff to resolve those issues.

1.22.2 CASA approval of the chief pilot

CAO 82.0 Appendix 1 outlined the responsibilities and qualifications of a chief pilot. Section 4.1 of the appendix stated that the pilot must hold certain minimum qualifications, in terms of total flying time on relevant aircraft types and duration of experience in commercial aviation, with the amounts varying depending on the number and complexity of an operator's aircraft fleet. Section 5.1 of the appendix stated the following:

> A person will not be approved as a Chief Pilot unless:
>
> (a) in the opinion of CASA, he or she has maintained a satisfactory record in the conduct or management of flying operations; and
>
> (b) before being approved as a Chief Pilot, the person has:
>
> (i) been assessed by an examiner appointed by CASA as suitable to carry out the responsibilities of a Chief Pilot; and
>
> (ii) passed an oral examination conducted by such an examiner covering the regulatory requirements for the safe conduct of commercial operations; and
>
> (iii) passed a flight planning, loading and performance examination conducted by such an examiner based on the operator's most complex aircraft.

CASA did not provide formal training for chief pilots or specify competencies in terms of managerial ability or knowledge of safety system concepts, nor was this required by aviation regulations at the time of the occurrence. In March 1999, CASA issued a document titled 'Chief Pilot Guide'. The document outlined the chief pilot's responsibilities under CAO 82, and provided general guidance on how to meet those responsibilities. The document's introduction included the following statement:

> Although management skills are not written into the minimum requirements for a Chief Pilot, depending on the size of the organisation, some formal training may be required. Management skills can be learned and to be fully effective Chief Pilots will need those skills as they commence their role.

The AOCM outlined the policy and procedures to be used by CASA in assessing an application for, and issuing, an AOC. That also included assessing applicants for positions such as chief pilot and training and checking pilot. Version 2.0 of the AOCM was issued in May 1997, version 3.0 in February 1998, and version 4.0 in August 1999. Although the layout of the manual changed, the content relating to the approval of chief pilots and approval of training and checking pilots remained essentially the same.[68]

A section in the AOCM on the approval of a chief pilot contained some guidance information and a checklist for FOIs. In the guidance information, the following observations were made:

- The quality of the chief pilot was critical to the safety of the flying operations of the operator, and therefore the assessment of the nominee was equally important.
- In addition to aeronautical knowledge, leadership and credibility were also vital.
- An ability to manage 'the system' was more important than manipulative skill. An appointment 'should only be approved if the nominee shows the capability to manage the operator's objectives within the boundaries imposed by aviation safety legislation'.
- The interview component of the assessment process was to consist of an oral examination, a flight planning, loading and performance examination, a flight check (optional), and a briefing.
- The oral examination was to include a list of questions developed by the FOI to suit the situation, including 'some that are relevant to management situations and some that relate to the proposed operation'. Those included questions on the operator's AOC authorisations, CAO 82 and the operator's operations manual.
- The briefing was to be conducted by the FOI after the candidate was assessed as being suitable. It was to include aspects such as particular responsibilities or regulatory aspects requiring emphasis, the chief pilot's role in the chain of regulatory responsibility, and CASA surveillance.

The AOCM also contained a checklist to be used by the FOI during the chief pilot approval process. That checklist contained items reflecting the nature of the guidance material. However, there were no items that specifically requested that the FOI note qualifications, experience, knowledge or ability of an applicant in fields such as management or system safety.

In February 1999, BASI issued recommendation R19980277 to CASA that stated, in part 'that CASA develop a process to assess the ability of a chief pilot applicant to administer and manage regulatory and safety compliance'.

CASA responded in February 2000 that it agreed with the recommendation, and would amend the AOCM to 'more adequately address system safety management'.

In May 2001 (version 4.3 of the AOCM), a fifth component was introduced in the interview stage of the assessment process. That component, titled 'system management assessment' stated:

> A Chief Pilot elect is to be assessed for managerial ability for the various essential systems that make up a sound, well managed flying operation. The Chief Pilot should

[68] Version 2.0 of the AOCM contained separate parts for high-capacity RPT operators (in Volume 1), low capacity RPT operators (Volume 2), charter operators (Volume 2) and aerial work operators (Volume 2). Chapters specific to charter and aerial work were listed as 'to be issued'. Volume 2 contained a list of appendices relating to the chapters contained in the volume. In versions 3.0 and 4.0, low capacity RPT, charter and aerial work operations were included in the same part.

> be able to clearly demonstrate an ability to implement, manage and audit systems which will enable compliance with those responsibilities defined in Appendix 1, CAO 82.0.
>
> An effective method of ensuring a base skill level in this are is to have the applicant brief the FOI on the systems in place in the company. In this way, a check can be made on their completeness. Particular attention should be paid to areas of high operational importance…
>
> On completion of this, the FOI should 'walk' the applicant through *ASSP176-K2 Periodic Inspection* (form 524) to reinforce the Chief Pilot's responsibilities with respect to the AOC.

During the investigation, CASA managerial personnel responsible for oversighting activities such as chief pilot approvals made the following observations:

- In recent years, FOIs were provided training on safety systems and related concepts, and therefore understood the importance of a chief pilot being familiar with such concepts.
- Specific competencies for chief pilots in terms of management and safety systems/awareness had not yet been defined by CASA.
- CASA FOIs could not enforce requirements in terms of chief pilot qualifications that had not specifically been required in the legislation.
- The overall suitability of an applicant's qualifications was assessed in light of the type of operation under consideration, with more managerial experience and skills required for a large airline versus a single pilot aerial work operation.

The Jandakot DFOM had assessed the ASU fixed-wing chief pilot during May 1997, prior to approving his appointment in that role. This assessment found that he was a suitable candidate to hold the position. The investigation noted that the CASA files did not contain any record of the chief pilot interview. According to the recollection of the chief pilot, the interview lasted about 90 minutes, which included a written aircraft performance exam. The chief pilot could recall having only general discussions regarding his roles and responsibilities at the time of his appointment. Information on the chief pilot's training and experience for the role is provided in section 1.18.3.

Up until the time of the accident, CASA had not detected any problem with the performance of the ASU fixed-wing chief pilot and the manner by which he was supervising flight operations at the ASU.

1.22.3 CASA approval of the training and checking pilot

As discussed in section 1.18.7, the ASU operated with a CAR 217 training and checking system and ASU's training and checking pilot(s) required CASA approval. CASA's AOCM outlined the policies and procedures to be used by FOIs performing assessments of candidates for training and checking pilot approvals.

The investigation noted several administrative deficiencies with the content and management of the ASU's training and checking system (see section 1.18.7). The approval process used by CASA to issue the ASU fixed-wing chief pilot with his initial CAR 217 training and checking approval did not detect the deficiencies with the ASU's training and checking system. For example, the initial approval (September 1998) did not detect that the ASU's operations manual was deficient and did not contain information on the required qualifications and training syllabus for training and checking pilots. Such a check was outlined in the AOCM for training and checking pilot approvals.

The AOCM also stated that the candidate would undergo an oral test covering the standards applicable to the check, technical knowledge appropriate to the approval being sought, the ability to satisfactorily impart knowledge (for conversion training approvals), and the responsibilities of a check person to CASA and the CAR 217 organisation. As noted in section 1.18.7, the ASU chief pilot did not appear to possess an appropriate understanding of the responsibilities of a check person.

The initial CAR 217 training and checking approval for the fixed-wing chief pilot was issued by the Jandakot DFOM following a flight test conducted by the CASA FOI who had previously held the position of ASU fixed-wing chief pilot/training and checking pilot. The FOI reported that he performed that component of the assessment associated with the flight test, with the remainder of the decisions being made by the DFOM. It was the first time that the FOI had conducted such a flight test.[69] After completing the test, the FOI submitted his certification on the AOCM checklist for the approval of check pilots, together with a memorandum stating that the candidate could carry out 'base, route and instrument training' to a safe acceptable standard.

The DFOM reported that he was initially reluctant to grant full training and checking approvals to the fixed-wing chief pilot, as he did not believe he had an appropriate background at that time. The initial CAR 217 training and checking approval was issued by the DFOM on 23 September 1998 (valid until the end of September 1999) and stated that the ASU fixed-wing chief pilot was approved to give training to the ASU's pilots for the renewal of command (multi-engine) instrument ratings (in C310, BE58 and PA31 aircraft) and to also give aeroplane conversion training in the same aircraft types. It also approved the chief pilot to act as a check pilot in these aircraft types 'only during en-route operations'. That is, the initial approval issued did not include the performance of base checks. There did not appear to be any process used by the CASA staff issuing the initial approval to ensure that the ASU chief pilot was aware of the limitation that this imposed, nor was there any recognition by CASA that the ASU check and training system could not effectively function as specified in its operations manual unless the fixed-wing chief pilot was also permitted to perform base checks.

The initial CAR 217 training and checking approval issued to the fixed-wing chief pilot expired at the end of September 1999. CASA issued a subsequent approval in May 2000 without restriction on the types of check that could be performed.[70] The basis on which this approval was issued was not documented on CASA files and did not appear to incorporate any reassessment of the chief pilot's ability to perform the tasks.

However, the chief pilot's CIR renewal (conducted by an external contractor as a CASA ATO) in September 2000 recommended renewal of the chief pilot's approval as check pilot, to give endorsement training and instrument flying training in C310 and PA31

69 The FOI reported that he had received no specific training to perform these tasks, although he had observed other CASA staff perform flight tests to issue other types of approval. Another senior FOI reported that this was not unusual, as most inspectors employed by CASA already possessed extensive experience in these roles prior to their appointment to the Authority.

70 Due to an administrative oversight, the original approval issued May 2000, permitted the ASU fixed-wing chief pilot to conduct flight tests in relation to multi-engine CIRs. Subsequent approvals were issued in September 2000 and November 2000 to correct this deficiency and cancelled the first approval issued in error.

Navajo aircraft. CASA issued the chief pilot with a CAR 217 training and checking approval authorising him to conduct flying training for the issue or renewal of a command (multi-engine) instrument rating, aeroplane conversion training and performance of duties as a check pilot, but excluding CAR 5.19 flight tests.[71]

1.22.4 CASA issue of the Air Operator's Certificate

As noted in section 1.18.2, the ASU was reissued with an aerial work AOC in May 2000 for a period of 3 years. During the process of reissuing an AOC, the CASA FOI was required to complete a checklist that listed a number of elements or aspects of an operation, noting if those were satisfactory or not. According to the covering page of the checklist, 'satisfaction may be based on previous surveillance, another check or personal knowledge'. This checklist was held on CASA's AOC file for the ASU.

There was no evidence that a periodic inspection of the ASU was completed immediately prior to the reissue of the AOC, nor was there a requirement for one to be completed (see section 1.22.5). It was not clear to what extent the FOI responsible for reissuing the AOC had personal knowledge of the items listed on the AOC renewal checklist, or the extent to which he may have relied on the knowledge and opinions of other CASA staff during that process.

The checklist completed prior to the reissue of the ASU's AOC indicated that the operations manual, load control, fuel policy, and training and checking manual were all 'satisfactory'. The checklist noted that several items were under review by the ASU and would be the subject of further assessment. Those included key personnel, specifically, the head of flying operations and head of training and checking, organisational structure and staffing, chief pilot approvals, flight and duty times, low flying and outstanding surveillance matters. The reissue of the AOC was approved on the basis that those items were acceptable to CASA at that time, and they would be reviewed in due course, together with the revised ASU operations manual.

1.22.5 CASA surveillance policy

CASA used a program of surveillance for operators holding an AOC. That program was known as the Aviation Safety Surveillance Program (ASSP) and consisted of both scheduled and unscheduled surveillance activities. CASA issued the ASSP manual to staff with responsibilities for planning and conducting surveillance activities. During 2000 and 2001, that program was being progressively replaced by Compliance Management Instructions as CASA reviewed its surveillance planning activities. It also changed the focus of its airline surveillance activities from product-based to systems-based auditing.

Due to limited resources, CASA prioritised its surveillance activities. In recent years, the primary focus of scheduled surveillance activities was on operations carrying fare-paying passengers. For the financial years 1997–98 to 1999–00, CASA's national scheduled surveillance program did not include any scheduled surveillance for aerial work operators.

For the financial year 2000–01, the surveillance planning for general aviation operators changed to a system where AOCs were reissued for 3-year periods. Surveillance activity (periodic inspection) was required prior to the reissue of a 3-year AOC for charter

---

71 CAR 5.19 related to flight tests conducted to issue types of flight crew rating.

operations and aerial work operations with passengers. No surveillance activity was required to be planned for other aerial work operations, such as agricultural operations. The ASU AOC was reissued in May 2000 prior to those new arrangements taking effect (June 2000).

A review of CASA files indicated that the last periodic inspection of the ASU fixed-wing operation occurred in October 1995, when the facilities at the Karratha regional base were examined.[72]

During recent years, the ASSP and Compliance Management Instructions have also stated that organisations with a known indication of higher risk were to be subject to additional surveillance activities. In 2000, CASA commenced a program to better enable FOIs to identify high-risk organisations. As part of that program, district offices were required to complete a Safety Trend Indicator (STI) questionnaire in early 2000 and then every 6 months on each organisation. STIs were completed on the ASU in February 2000 and December 2000. The FOI completing both of these indicators was the former ASU fixed-wing chief pilot. Neither STI indicated that the ASU was a significant risk operation.[73]

CASA personnel reported that, prior to the accident, they held the view that the ASU was a low-risk operator. That view was based on a variety of factors, including that the ASU was part of a state government department and therefore the normal commercial pressures did not apply.[74] In addition, the ASU had a low turnover of staff, the chief pilot had been in place for some time, and CASA had received no significant complaints or other negative comments.

As discussed in 1.22.1, during early 2000 CASA identified a number of administrative irregularities with aspects of the ASU's AOC. During May 2000 CASA held discussions with the WA Police Service to resolve those issues, and CASA identified a need to conduct an audit of the ASU to examine the extent to which other irregularities may exist. CASA reported that, due to staffing restrictions in the CASA West Area and the priority placed on completing scheduled tasks for (fare paying) passenger-carrying operations, that audit task had not been completed at the time of the accident.

1.22.6 CASA conflict of interest policy

As noted in section 1.22.1, the FOI responsible for the ASU from 1992 until the end of 1999 was the Jandakot DFOM. The DFOM had previously conducted line operations as a helicopter pilot with the ASU from approximately 1993 until 1996. He also conducted regulatory oversight duties associated with the ASU's flying operations during that time. The CAA and the WA Police Service approved the DFOM's line flying activities. It was reported that the decision to discontinue the DFOM's line flying was made primarily because there was insufficient flying time available to maintain the currency of the ASU's rotary-wing pilots.

---

72 A review of CASA's ASSP Support System database indicated that CASA had performed a Periodic Inspection on the ASU on 28 July 1999. However, no information was found on CASA files to confirm that the inspection was actually completed.

73 Some CASA personnel commented that one limitation of the STI was that a large proportion of the 30 questions could not be answered, as the FOI did not know enough about the organisation (without doing an audit). CASA reported that it was reviewing the STI process in 2001 to overcome some of those difficulties.

74 However, the investigation noted that the ASU's pilots would still be subject to numerous operational pressures and imperatives, particularly those that may apply to police operations.

During the investigation, CASA management reported that FOIs were no longer allowed to conduct line operations with operators under CASA's regulatory oversight. It was also reported that there were no FOIs currently conducting line operations in the general aviation sector.

A review of CASA files on the ASU indicated that the FOI who was formerly the ASU fixed-wing chief pilot was involved in correspondence with the ASU on numerous regulatory issues from June 1997 onwards. This FOI also conducted the flight test component of the initial training and checking approval for the new ASU fixed-wing chief pilot during September 1998. It was reported that these activities were conducted at the request of, and under the supervision of the Jandakot DFOM, who had formerly undertaken helicopter line flying with the ASU.

The FOI stated that he declined a number of regulatory tasks associated with the ASU due to conflict of interest. The FOI also annotated CASA files on two occasions, indicating that he did not wish to conduct certain regulatory oversight activities of the ASU due to conflict of interest. Those occurred in December 1999 and June 2000 and were associated with approving temporary replacements for the ASU's chief pilot positions.

The investigation reviewed CASA's policies and procedures relating to conflicts of interest. Since at least 1993, all FOIs were required to sign 'conflict of interest' declarations. The declaration form, associated guidance material, and the CAA Code of Conduct policy (dated September 1993) outlined various types of potential conflicts of interest. Those included business interests, current outside employment and social connections. There was no reference to recent previous employment.

The CASA Code of Conduct policy dated September 2000 stated that a conflict of interest in the form of a 'material personal association' with an organisation would exist if the officer had been an employee of the organisation in question within the preceding 12 months.

Since at least January 1995, CASA's ASSP manual stated that no CASA FOI could interact with an operator or person if a real or perceived conflict of interest existed. The manual also listed a number of potential conflicts of interest, including former employment with an assigned organisation.

2 ANALYSIS

The investigation established that the circumstances of the accident were consistent with the failure of both engines, resulting in a loss of aircraft control and the consequent unintended flight into terrain. As there was probably about 165 L of fuel on board the aircraft, but fuel was not being supplied to the engines (see section 1.12.3), the engine failures were the result of fuel starvation. There was no evidence that fuel contamination, mechanical malfunction, structural failure or pilot incapacitation were factors in the occurrence.

In common with most transport accidents, this occurrence involved a number of contributing factors. Contributing factors are events and conditions that probably increased the likelihood of the accident, or the severity of its consequences. In this investigation report, these factors have been classified into the following four categories, adapted from James Reason's model of organisational accidents:[75]

- **Operational events**, or the observable actions of the operational components of a transportation system. When such events are safety issues or increase accident risk, they are generally termed 'unsafe acts' (if associated with operational personnel[76]) or 'technical failures' (if associated with technical components such as aircraft systems). Many accidents and serious incidents involve a number of unsafe acts. It is important to view such acts as events that should not be reproduced under similar conditions in the future, rather than consider them 'failures' of the individual(s) involved.
- **Local conditions**, or conditions associated with the immediate context or environment in which operational events occur. These conditions include characteristics of individuals and/or technical components, the task and/or the physical environment. For example, fatigue, insufficient knowledge or skill, and high workload could be local conditions associated with unsafe acts. When local conditions are safety issues or increase accident risk, they can be termed 'local hazards' or 'local threats'.
- **Defences**, or the measures put in place by an organisation to facilitate and assure safe performance of the operational components of the system. An organisation cannot control the existence of many undesirable local conditions and operational events, and it can only indirectly control or manage the influence of others (such as weather). Preventative defences include procedures, training, task design, work schedules, equipment design and equipment availability. Recovery or 'last-line' defences include warning systems, emergency equipment, and emergency procedures.
- **Organisational conditions**, or those conditions that establish, maintain or otherwise influence the effectiveness of an organisation's safety defences. Such conditions can include safety management processes (for example, hazard identifi-

75 J. Reason, *Managing the Risk of Organisational Accidents,* Ashgate, Aldershot, 1997.

76 The term 'operational personnel' is used to refer to any person that can have a relatively direct impact on the safety of a transport activity. In aviation, these include flight crew, cabin crew, air traffic controllers, maintenance personnel, dispatch and loading personnel, and meteorological personnel.

cation, risk assessment, change management, job and task design, training needs analysis, internal auditing and review) and other organisational characteristics (for example, organisational structure, resources, decision-making style, and corporate memory). Organisational conditions are usually the result of management decisions, and usually have existed for a significant period of time prior to the accident.

A variety of external conditions can also influence the effectiveness of an organisation's defences, including regulatory requirements and financial pressures. These conditions may include defences or conditions associated with other organisations.

When defences or organisational conditions are safety issues or increase accident risk, they can be termed 'safety deficiencies'. Such deficiencies should be viewed as conditions that should not be reproduced or continued in the future, rather than be considered as 'failures' of the organisation or management personnel involved. When assessing whether a certain condition is a safety deficiency, it is important to also consider the extent to which it is reasonable or practicable for an organisation to implement (or to have implemented) any improvements.

Although some of the contributing factors which may be identified during an investigation are associated with actions of individuals or organisations, it is essential to note that a key objective of a safety investigation is to identify safety deficiencies or weaknesses in the safety system and to learn how to minimise the risk of future accidents.

2.1 Operational events

2.1.1 Pre-flight planning and preparation

As noted in section 1.17.7, the pilot had conducted minimal pre-flight preparation or planning for the three flights conducted that day. Although these safety-related issues did not necessarily contribute directly to the circumstances of the accident, they did indicate that the pilot had probably not fully considered a range of factors that could have impacted adversely on the safety of the flight.

The investigation identified a range of potential hazards relating to the conduct of the accident flight. These included the dark night conditions, meteorological conditions, the level of the pilot's experience/qualifications for flying in such conditions, and the potential adverse effects of fatigue and other physiological issues. The investigation could not determine which of these issues the pilot had considered when preparing for the flight. According to witnesses, there was no indication that any issue other than fuel was discussed between the police officers prior to departing Kiwirrkurra (see section 1.17.5).

Given the combined nature of these hazards and their potential to significantly affect the safety of flight, the investigation concluded that there was sufficient reason to have postponed the flight until the next day.

Based on this information, the investigation concluded that the pilot's pre-flight planning and preparation had probably not identified or fully considered the hazards associated with the flight.

2.1.2 Management of fuel tank selections

Both engines failed due to fuel starvation and both fuel selectors were switched to the main tanks at the time of impact. This indicates that the quantity of fuel contained in the main tanks was probably low towards the end of the flight. As noted in section 1.12.3, there was no evidence of a mechanical problem with the fuel system, and there was no evidence of an in-flight fuel leak. Therefore, it is reasonable to conclude that the low fuel quantity was probably the result of pilot actions.

The exact pilot actions that led to the main tanks having a low quantity of fuel could not be reliably determined. Potential scenarios include:

- The pilot may have inadvertently omitted to use fuel from the auxiliary tanks during the flight. Such errors of omission are not uncommon in procedural tasks that are performed at a skill-based or relatively automatic level of behaviour. Those errors are more likely to occur if there had been some form of distraction at a critical time. It is also worth noting that performance on a task which requires a person to remember to carry out a certain action at a future point in time (or prospective memory) can be quite variable, particularly if there are no clear prompts for completing the action at the required time. The pilot did not appear to have any consistent method for managing the selection of the auxiliary tanks, and the company had not provided him with guidelines for this task. Research into the effects of fatigue has also demonstrated that errors of omission are more likely to occur if a person is fatigued.
- The pilot may have selected the auxiliary tanks for an unusually short period of time. If the main tanks were at or near empty at the time of impact, then most of the 165 L of fuel estimated to have been on board would have been in the auxiliary tanks. It would be unusual for a pilot to intentionally leave such a significant quantity of fuel in the auxiliary tanks.
- The pilot may have made a fuel tank selection error during the flight, which resulted in one main tank containing a lower quantity of fuel than the other tank.

The investigation considered it was unlikely that surplus fuel returned to the main fuel tank had contributed to any significant quantity of fuel being vented overboard as a consequence of overfilling the main tanks. This assessment was based on the times recorded by the pilot on the previous sector during which the auxiliary tanks were selected and the estimated outflow rate of the auxiliary tanks.

Based on this information, the investigation concluded that the pilot probably did not manage his fuel tank selections effectively.

2.1.3 Detection of low fuel situation

There was no evidence to indicate that the pilot was aware of, or had concerns about, any fuel-related problem prior to the first engine failure in the circuit at Newman. The pilot did not contact ATS or any other agency to indicate the aircraft was experiencing abnormal operations. In addition, the pilot was making a circuit to land, when it was possible to make a straight in approach to runway 23. It is unlikely that the pilot would have conducted a circuit if he had been aware of, or had concern about, a low fuel situation.

The investigation could not conclusively determine to what extent the pilot was actually monitoring the fuel gauges during the flight. However, there was no written record of the fuel that had been consumed from each tank during the flight and the pilot was not known to routinely use such recommended practices (see sections 1.19.1 and 1.19.2). In addition, the ASU did not promulgate or reinforce the use of such practices. The omission by the pilot to maintain fuel records was most likely a reflection of his normal practices for managing fuel and had possibly been influenced by his extensive experience operating the ASU's single-engine C182. This aircraft had a simple fuel system, which did not usually require tank changes in flight.

The digital fuel management system may have given the pilot a false confidence of the fuel status. Had the pilot adopted a more structured approach to monitoring his fuel, and crosschecked other information available to him, it is likely that he would have detected that the main tanks contained a critically low quantity of fuel towards the end of the flight.

In-flight indications of fuel gauges frequently fluctuate, and some pilots are taught to 'never trust their fuel gauges'. The intention of that training is to emphasise the importance of maintaining accurate alternative fuel records and logs. However, that emphasis may also have the unintended and undesirable consequence of pre-conditioning or biasing some pilots to either not regularly scan their fuel gauges or to otherwise disregard abnormal or unexpected gauge indications. The extent to which the occurrence pilot may have been predisposed to such a bias could not be determined.

Based on this information, the investigation concluded that the pilot probably did not detect the critical fuel situation.

2.1.4 The engines failed due to fuel starvation

As noted in section 1.12.3, no fuel was recovered from either engine's fuel distribution manifold or the associated fuel lines. This indicates that both engines ceased operating because of fuel starvation.

No fuel was recovered from the right main tank, and the right lateral transfer pump did not contain any significant quantity of fuel. The tip of the left main tank did contain a small quantity of fuel. Technical examination determined that the left propeller was feathered at the time of impact and this was probably the result of a pilot selection. It could not be determined if that was in response to the failure of the left engine, or the pilot incorrectly identifying which engine had failed.

Irrespective of which engine failed first, it is likely that the fuel supply to the other engine was interrupted as a consequence of the forces acting on the aircraft following the initial engine failure. Those forces, combined with a low quantity of fuel in the main tank, could have resulted in the displacement of the remaining fuel away from the tank's fuel pick-up point and the subsequent failure of the second engine, also due to fuel starvation.

2.1.5 Loss of control following engine failures

The pilot was required to make specific control inputs and complete additional actions to correctly identify and respond to the initial engine failure. The second engine probably failed very soon after the first engine, and at a time when the pilot's attention was focussed on responding to the initial event.

The investigation could not positively determine at what stage the pilot had lost control of the aircraft. The aircraft should have been controllable following the failure of its engines, but a number of factors significantly increased the difficulty of this task.

Those circumstances included dark night conditions, the limited height available at circuit altitude and the pilot's low level of experience and training to operate a multi-engine aircraft at night.

The investigation concluded that the pilot did not maintain control of the aircraft following the failure of the engines.

2.1.6 Other operational events

As noted in section 1.17.7, the investigation identified several other safety-related issues that occurred during the day of the accident. These were primarily tasks associated with pre-flight planning and preparation. For example, no weather or other pre-flight briefing information was obtained, flight plans or flight notes were not submitted, uncorrected errors existed in the pilot's flight plan calculations and the pilot did not appear to have considered various contingencies such as holding and alternate aerodrome fuel. The investigation considered that none of these actions by themselves were contributing factors to the accident.

2.2 Local conditions

2.2.1 Pressure to conduct the flight

The requirement for police to attend Kiwirrkurra resulted from a serious incident requiring urgent police attendance. It is possible that the seriousness of the situation had influenced the pilot's pre-flight preparation and the decision to depart Karratha without obtaining relevant pre-flight briefings.

A number of other issues may also have had an influence on the pilot's decision to conduct the return flight that night. For example:

- Due to the lack of commercially available accommodation at Kiwirrkurra and because they did not have their own bedding material or food for an overnight stay, the officers may have been reluctant to delay their departure until the next day, despite the offer of accommodation in a private residence.
- During aspects of the dispute resolution there had also been tension with members of the local community. That aspect may have also influenced the officers' desire to depart Kiwirrkurra.
- The pilot had only recently moved to Karratha. At such an early stage of his appointment, he may have been trying to create a positive impression and accordingly, could have been reluctant to not complete the flight back to Newman, particularly as that would have entailed a degree of inconvenience for the passengers.

The investigation did not find evidence of any overt pressure on the pilot to complete the return flight that night. However, there were potential sources of self-imposed pressure that could have influenced the pilot's decision to undertake the flight back to Newman.

Based on this information, the investigation concluded that the pilot was probably experiencing self-imposed pressure to conduct the flight.

2.2.2 Fuel management practices

The pilot used fuel management practices that were probably not robust enough to maintain accurate fuel situation awareness. As far as could be determined, the pilot did not keep written fuel logs or use a structured approach to monitoring fuel consumption during flight. In addition, the pilot did not appear to maintain accurate fuel consumption and fuel planning records, use consistent refuelling practices, or use consistent practices for managing the consumption of fuel from the auxiliary tanks.

In terms of the accident flight itself, the pilot did not make an accurate assessment of the fuel required to conduct the flight from Kiwirrkurra to Newman. Furthermore, the pilot did not maintain records to indicate how the fuel that was on board the aircraft was distributed between the aircraft's fuel tanks. The pilot had probably overestimated the quantity of fuel added at Kiwirrkurra and there was likely to have been a difference between the quantity of fuel added to each of the auxiliary tanks. He probably did not refuel any of the tanks to a known capacity.

It is also probable that the digital fuel management system was not providing an accurate indication of the quantity of fuel in the aircraft fuel tanks. Data recovered during examination of the digital fuel management system indicated that 108 L of fuel was on board at the time of impact. The investigation calculated that probably about 165 L of fuel was on board at impact. As discussed in section 1.17.6, the investigation could not determine the reason for this discrepancy.

Overall, the pilot's normal practices for fuel management were probably not adequate to ensure an accurate awareness of the aircraft's fuel situation. As a result, he was less likely to be able to detect significant anomalies or critical situations.

2.2.3 Workload during the flight

Because the flight was conducted over featureless terrain on a dark night, the investigation concluded that the pilot probably used the GPS to navigate the aircraft to Newman and that would have reduced his workload. The aircraft was also equipped with a two-axis autopilot, although the investigation could not conclusively determine if the pilot was in the habit of using that equipment. Use of the autopilot during the flight would have significantly reduced the pilot's workload.

Middle-level cloud would have obscured the celestial horizon for some parts of the flight. Lightning strikes were detected in the region, and were close to the aircraft's probable position during the latter stages of the flight. It is likely that those conditions were of concern and a potential source of distraction to the pilot, who had limited experience flying in instrument meteorological conditions (IMC), and possibly increased his workload. Those distractions could have reduced his consideration or monitoring of other aspects of the flight, such as the routine tasks associated with in-flight fuel management. The pilot's physiological condition (see section 1.21) may also have reduced his capacity to cope with distractions and high levels of workload.

During the circuit at Newman, the pilot's attention would have been focussed on flying the aircraft with reference to the flight instruments and monitoring the aircraft's position in the circuit with reference to the aerodrome's runway lighting. At the time of the initial engine failure, the pilot probably had little spare information processing capacity to respond promptly and correctly.

Based on this information, the investigation concluded that the pilot was probably experiencing a relatively high workload and narrow focus of attention during stages of the flight, in particular the final stages.

2.2.4 Dark night conditions

During some of the circuit, the pilot was operating in an environment where there was insufficient visual reference available to maintain the aircraft's orientation to the earth's surface using external visual cues. It was likely that the lack of external visual reference significantly increased the pilot's workload, as he was required to control the aircraft primarily by reference to the flight instruments. The dark night conditions also reduced the external visual cues available to control the aircraft following the initial engine failure.

2.2.5 Skills for responding to engine failure without external visual reference

As noted in section 2.1.5, the pilot did not maintain control of the aircraft following the engine failures. That was probably due to a combination of the dark night conditions, the lack of external visual reference, and the pilot's low level of instrument flying proficiency and experience. Additionally, following the failure of the second engine, the vacuum operated primary flight instruments would not have provided the pilot with reliable attitude and direction information. The investigation also considered that successful control of a multi-engine aircraft following multiple simultaneous emergencies, would require a high level of skill, even for pilots holding a CIR.

As discussed in section 1.5, the pilot had previously experienced difficulty with instrument flying and, despite substantial training, had not progressed to the standard to undertake a CIR test. Most of the pilot's night flying experience had been conducted in single-engine aircraft over the Perth metropolitan area, with significant external visual reference in terms of an external horizon and ground illumination.

Although the pilot had completed a number of multi-engine flights with the chief pilot during the 12 months prior to the date of the accident, those flights had been conducted under the VFR with external visual reference. The chief pilot reported that he had not detected any problems with the pilot's performance during those flights, including his handling of simulated engine failures. No instrument flying practice was recorded in the pilot's logbook for any of those flights.

The investigation found no evidence that the pilot had recently received training to control a multi-engine aircraft solely by reference to the flight instruments following an engine failure. As discussed in section 1.20.1, the CASA night VFR syllabus did not require a pilot to demonstrate proficiency controlling a multi-engine aircraft solely by reference to the flight instruments following an engine failure.

Based on this information, the investigation concluded that the pilot probably did not have the appropriate skills to enable him to respond to an engine failure in a multi-engine aircraft without external visual reference.

2.2.6 Other local conditions

As noted in section 1.21, fatigue and other possible issues probably degraded the pilot's overall physiological condition. However, the extent to which these issues had influenced his performance during the accident flight could not be reliably determined. His physiological condition could have reduced his ability to monitor several tasks at once (including fuel management), and may also have slowed his response time in an emergency situation. Overall, there was no conclusive evidence to indicate that the pilot's physiological condition actually contributed to the accident.

2.3 ASU defences

2.3.1 ASU fuel planning and fuel management

Aviation regulations required operators to provide specific instructions for pilots to calculate the quantity of fuel required to complete a flight and for that information to be published in the operations manual. The ASU operations manual did not contain detailed instructions or guidance on the contingencies required for fuel planning. The ASU's pilots had previously submitted flight documentation that indicated fuel plans had not been completed. The chief pilot had not detected that deficiency or taken action to ensure that flight planning and fuel recording practices complied with his expectations.

CASA had also published comprehensive information on the subject of fuel management. Some of that information contained recommendations, such as dipping tanks to verify the contents or refuelling in such a way that a known quantity of fuel could be established, and advocated crosschecking the fuel quantity by at least two separate methods. It also emphasised the importance of monitoring fuel tank selection in flight and regularly comparing the remaining fuel quantity from gauge readings against planned figures. None of those techniques were incorporated into the ASU's operations manual. A review of flight documentation did not reveal any evidence that the occurrence pilot was using such recommended practices.

The installation of digital fuel management systems on each of the ASU's fixed-wing aircraft was a proactive contribution to the safety of its operations, provided procedures were used to ensure that the system was correctly operated and had regard to its limitations. The availability of the digital fuel management system in the ASU's aircraft may have reduced the perceived importance of, and emphasis placed on, traditional methods of monitoring fuel consumption.

In summary, the investigation assessed that the ASU policies, procedures and operational supervision relating to fuel planning and management were deficient, particularly for operations in remote areas. Overall, the ASU's practices in that area indicated that fuel planning and fuel management were considered important, but not necessarily a critical safety issue.

The lack of robust and structured procedures for fuel management had probably contributed to the pilot not using appropriate practices during the flight that would have had a greater likelihood of detecting a developing, critical situation. The lack of formalised procedures in a number of other areas of fuel planning and fuel management had probably contributed to the pilot not using practices that could have provided him with a greater level of awareness regarding his fuel situation.

2.3.2 ASU night operations

The ASU did not have any specific policies or procedures relating to flight planning for night operations, particularly for remote areas and/or dark night situations. There was almost no training and checking conducted at night in recent years, even though the operations manual required such activities, and no training and checking that emphasised the difficulties of approaches into 'black hole' environments and handling emergencies in dark night situations. In effect, the ASU had not ensured that the pilot was able to respond to emergency situations in dark night environments, or prevented the pilot from conducting such operations.

Overall, the ASU had not formally recognised the risks of night operations in remote areas during dark nights, and their procedures, training and supervision for night operations were deficient. Given the nature of the ASU's work, defences in those areas were of critical importance.

The ASU's lack of effective defences for night operations may in part be the result of no specific Australian regulatory requirements or other material providing formal guidance in that area (see section 2.5.1).

2.3.3 ASU chief pilot

Since May 2000 the ASU had one chief pilot. The chief pilot position was of critical importance in ensuring that appropriate procedures and training processes were developed and maintained. As discussed in sections 1.18.3 and 1.22.2, the ASU chief pilot was provided with minimal training, guidance and professional development, and was therefore not appropriately prepared to effectively perform his role. In addition, his performance in safety management areas was not monitored. Those limitations had contributed to deficiencies in other ASU safety defences, such as those outlined in sections 2.3.1 and 2.3.2.

2.3.4 Other ASU defence issues

The ASU had no clearly defined policy that related to the role of a police pilot during operational deployments with other police officers, as was the case on the day of the accident. Under such circumstances, a police pilot could become involved with police duties and accordingly, be influenced by operational imperatives, to the extent that routine duties as a pilot were not properly performed. The investigation identified that these two tasks could be incompatible and that procedures were required to ensure that these potential sources of conflict did not affect the safety of flight. However, there was no conclusive evidence that the lack of guidance in this area contributed the pilot's decision to conduct the flight from Kiwirrkurra that night.

In terms of human factors issues, the chief pilot had been known to emphasise compliance with CAO 48 (flight and duty times). However, there was no evidence to indicate that the ASU had provided its pilots with any structured training or guidance on issues such as the nature and effects of fatigue and hypoxia, or the effects of missed meals and dehydration on human performance. Although CASA did not stipulate that operators must conduct recurrent training in these areas, the investigation concluded that this type of training was desirable and the lack of specific training in these areas was consistent with the limited nature of the ASU's safety management system.

The conditions listed in sections 2.3.1 and 2.3.2 were each considered contributing factors to the accident. That is, they had probably contributed to the circumstances of the accident or the severity of its consequences. The investigation considered that neither condition by itself could be considered a significant factor. That is, an element in the circumstances of an occurrence without which the occurrence would (definitely) not have occurred.

However, the investigation considered that the pilot was not provided with the requisite training and did not possess the appropriate skills and experience to safely undertake the flight. This included skills in several key areas, such as fuel management and planning, and operations in dark night environments. This was considered to be a significant factor in the occurrence.

2.4 ASU organisational conditions

2.4.1 ASU safety management

As the holder of a CASA-issued aerial work AOC, the ASU was required to comply with minimum safety standards. In some areas, the ASU was operating above those minimum standards, such as the use of a CAR 217 training and checking system, and the fitment of GPS and digital fuel management systems on all their aircraft. However, there were also a number of limitations with respect to their safety defences (see section 2.3).

Overall, the investigation concluded that the ASU did not have a proactive safety culture, and that its safety management program was limited. There were insufficient management processes to ensure that adequate defences were in place at the operational level for the wide range of situations that could reasonably be anticipated. Those processes included hazard identification, risk assessment, pilot selection, and training needs analysis. If the ASU had a more proactive safety culture prior to the accident, this may have helped it overcome some specific deficiencies in its management processes.

Ultimately, the lack of safety management processes within the ASU contributed to deficiencies in the ASU's procedures and training in key areas (see sections 2.3.1 and 2.3.2).

2.4.2 WA Police Service safety management

As outlined in section 1.18, the WA Police Service provided limited guidance information and materials to the ASU personnel in areas such as developing safety management programs, risk management processes, and monitoring safety performance. It placed a heavy emphasis on the chief pilot to ensure safety of flight operations. The chief pilot was a key person in the organisation with defined legal responsibilities in that area. Despite the responsibilities of his position, the chief pilot had received minimal training, guidance and preparation for his role. He did not receive any additional payment for the extra duties and responsibilities as chief pilot.

Overall, it was unreasonable to expect that an individual could adequately perform all relevant safety management tasks, when that person had not been appropriately prepared for the role, and when there were insufficient safety management processes already in place. The WA Police Service also appeared to have no way of assuring itself that the chief pilot was supervising operations to an appropriate safety standard.

2.4.3 WA Police Service safety oversight

Deficiencies in the ASU's flight operational defences had existed for many years. Many of those deficiencies had not been detected or corrected by any processes within the ASU or the WA Police Service as a whole. In recent years, the WA Police Service had introduced formal risk assessment processes for each business area, including the ASU.

However, those processes did not appear to apply to safety issues, and were not interpreted as such. The WA Police Service had also instigated three reviews of the ASU's operations in recent years, but none of those reviews had placed any noticeable emphasis on safety issues.

All of the ASU's fixed-wing pilots had been serving police officers prior to being appointed as pilots. They all had limited aviation experience prior to joining the ASU. None of the officers with responsibility for overseeing the ASU's fixed-wing operations had any noteworthy aviation safety management knowledge and/or experience. Those conditions were not necessarily problematic, although they placed an onus on the organisation to actively engage in various research, benchmarking and learning processes to ensure that their flight operations and flight safety programs were appropriate for their operational requirements. However, only limited activities had been conducted in such areas. Most of those activities were conducted during the external reviews of the ASU, and focussed on cost issues of various services rather than safety management processes and defences. A more comprehensive organisational learning approach would have led to the organisation detecting that improvements were clearly possible and desirable.

Based on this information, the investigation concluded that the WA Police Service had limited processes for identifying safety deficiencies in the ASU.

2.5 Defences associated with CASA's activities

2.5.1 VFR procedures for flights conducted in dark night conditions

The investigation concluded that the lack of significant external visual reference was a factor in the pilot being unable to control the aircraft following the engine failures (see section 2.2.5). The ASU also had limited procedures, training and supervision in night operations (see section 2.3.2).

Australian legislation for flight under the VFR did not refer to, or otherwise define, 'visual reference' as it may relate to VFR flight. A pilot can legally fly at night under the VFR without 'external' visual reference. Such conditions are most likely to occur on a dark, overcast moonless night in remote areas and when on approach and during circuits at isolated aerodromes. When such conditions exist, the risk involved in handling the aircraft is increased, particularly for pilots who do not possess adequate instrument flying skills. That increased risk applies in normal operations and during the handling of emergency situations.

In addition, the flight test for the issue of a multi-engine night VFR rating included the requirement that the applicant demonstrate the ability to safely control the aircraft using 'external' visual cues at night during asymmetric flight in the cruise configuration. However, the actual conditions sometimes experienced during night flights are such that 'external' visual cues are not available. In those circumstances a pilot would need to rely on the flight instruments to maintain control of the aircraft.

There was also no recurrent examination of the competencies required for issue of the night VFR rating. A pilot was not required to demonstrate any recent instrument flying proficiency prior to attempting a flight under VFR procedures at night, despite the likelihood that under certain conditions, the pilot would need to control the aircraft by sole reference to the flight instruments.

In summary, a pilot could legally fly at night under the VFR without 'external' visual reference and the training and currency requirements placed limited emphasis on flight under such conditions. Although various educational articles have emphasised the problems associated with dark night environments, there is no formal advisory material in that area to assist pilots in identifying higher risk situations and encouraging the use of various mitigation strategies.

Based on this information, the investigation concluded that the regulatory requirements and advisory material placed limited emphasis on the potential difficulties of conducting VFR flight in dark night conditions.

2.5.2 CASA approval of chief pilot

CAO 82 Appendix 1 stated that a chief pilot was required to have 'maintained a satisfactory record in the conduct or management of flying operations'. Various CASA publications also emphasised the importance of managerial ability for a chief pilot. However, CASA had not formally specified required qualifications or competencies in terms of managerial ability or knowledge of system safety concepts. Although there had been some developments, up until the time that the ASU fixed-wing chief pilot was appointed (May 1997), FOIs were provided with minimal guidance on how to assess the suitability of a prospective chief pilot in those critical areas. There have been some improvements in these areas since this time. CASA has not provided formal training or specified competencies required for chief pilots, but did produce guidance material of a general nature during 1999.

A CASA FOI assessed the ASU fixed-wing chief pilot prior to approving his appointment to that position, although this process was not documented on CASA files. However, based on the information contained in sections 1.18.3, 1.18.4, 1.19 and 1.20, the investigation concluded that there was significant evidence to suggest that the chief pilot was not adequately prepared for his role, either prior to, or following his appointment to the position. It is reasonable to suggest that, if CASA had structured assessments of chief pilot applicants against specific criteria, then these deficiencies would have been evident during the initial assessment process.

Based on this information, the investigation concluded that the processes used by CASA for the approval of chief pilots were not robust.

2.5.3 CASA surveillance of ASU

CASA had scheduled no surveillance of aerial work operators (including the ASU) during recent years. Consequently, as outlined in section 1.22, CASA had not detected the deficiencies with the ASU's policies, procedures and management processes noted in sections 2.3 and 2.4 prior to the accident. CASA had not performed any significant assessment of the ASU's fixed-wing operations during recent years or otherwise examined the extent to which the ASU was compliant with the intent of the legislation.

It is likely that some of the identified deficiencies associated with the ASU's policies, procedures and management processes, would have been detected during the completion of a periodic inspection. The investigation could not determine why those deficiencies were not detected during earlier periodic inspections, during reviews of documentation associated with checklist completion for the reissue of an AOC, and at other times CASA staff had contact with the ASU.

CASA has recently modified its surveillance planning to ensure that all operators are subject to a recertification audit prior to the reissue of an AOC. CASA is also progressively working on its capacity to identify organisations requiring additional surveillance activity on the basis of risk.

2.5.4 Other issues

In addition to the deficiencies associated with his chief pilot approval, the ASU chief pilot was given limited training and preparation for his role as training and checking pilot, which impacted on his performance as check pilot and when acting as a delegate of CASA. This was apparent by the manner in which he conducted a flight test to issue a night VFR rating without holding an appropriate CASA delegation and the manner by which the rating was entered into the occurrence pilot's logbook. The investigation found no evidence to indicate that CASA had provided the chief pilot with training in his administrative responsibilities as a delegate of CASA, or other training associated with the performance of functions authorised by the delegations held. However, the investigation did not consider that this deficiency necessarily reflected any systemic deficiency in CASA's processes in this area.

There was a series of potential conflicts of interest associated with the regulator's oversight of the ASU flight operations during the 1990s. It was not possible to determine if any of those potential conflicts of interest had any influence on the level or nature of CASA's regulatory oversight activities. The investigation noted that CASA's current policies to manage issues of potential conflict of interest appeared to address the series of potential deficiencies in this area.

The ASU conducted its operations under an aerial work AOC, but legally could have conducted operations carrying employees and related personnel as passengers as a private operation. As noted in Attachment B, from the perspective of risk management, and the view that safety of persons is of significant importance, the investigation considered that passengers on corporate operations for which they generally have no alternative, should be provided with a higher level of required minimum safety standards than those required for private operations.

3 CONCLUSIONS

3.1 Findings

3.1.1 Findings as to contributing factors

1. The pilot's pre-flight planning and preparation had probably not identified or fully considered the hazards associated with the flight.
2. The pilot probably did not manage his fuel tank selections effectively.
3. The pilot probably did not detect the critical fuel situation.
4. The engines failed due to fuel starvation.
5. The pilot did not maintain control of the aircraft following the failure of the engines.
6. The pilot was probably experiencing self-imposed pressure to conduct the flight.
7. The pilot's normal fuel management practices were probably not adequate to ensure an accurate awareness of the fuel situation on the aircraft.
8. The pilot was probably experiencing a relatively high workload and narrow focus of attention during stages of the flight, in particular the final stages.
9. Dark night conditions existed in the vicinity of Newman aerodrome on the night of the accident. Consequently, during some of the circuit there was insufficient visual reference available for the pilot to maintain the aircraft's orientation to the earth's surface by the use of external visual cues.
10. The pilot probably did not have the appropriate skills to enable him to respond to an engine failure or engine failures in a multi-engine aircraft without external visual reference.
11. The ASU's procedures, training and supervision of fuel planning and fuel management were deficient, particularly for operations in remote areas.
12. The ASU's procedures, training and supervision for night operations were deficient.
13. The ASU chief pilot was not appropriately trained or prepared for his role.
14. The ASU's safety management program was fundamentally limited.
15. The WA Police Service provided limited guidance to the ASU for developing safety management processes.
16. The WA Police Service had limited processes for identifying safety deficiencies in the ASU.
17. The regulatory requirements and advisory material placed limited emphasis on the potential difficulties of conducting VFR flight in dark night conditions.
18. The processes used by CASA for the approval of chief pilots were not robust.
19. Deficiencies with the ASU's policies, procedures and management processes had not been detected by CASA.

3.1.2 Other findings

1. The pilot held a commercial pilot (aeroplane) licence and a night VFR rating that was valid for single-engine aircraft only. He was correctly licensed to conduct a night VFR flight in single-engine aircraft.
2. The pilot was endorsed to fly the C310R, multi-engine aircraft.
3. The pilot was probably unaware that he did not hold a valid multi-engine night VFR rating.
4. There was no evidence that a pre-existing medical condition contributed to the circumstances of the accident.
5. The pilot's duty time on the day of the accident (almost 14 hours) exceeded the limitations of CAO 48. He did not have access to rest facilities during the day.
6. The pilot had probably not eaten during the period 8 to 12 hours prior to the accident.
7. The pilot's physiological condition during the accident flight was probably somewhat degraded as the result of multiple factors, but the extent to which this contributed to the accident could not be reliably determined.
8. The pilot's pre-flight planning and preparation contained numerous deficiencies. There was no indication that the pilot obtained weather and/or other pre-flight briefing information, submitted a flight plan, or left a flight note with a responsible person.
9. The aircraft departed Kiwirrkurra after last light and the flight was conducted at night under VFR procedures.
10. Aspects of the area and terminal forecasts were below the specified minima for VFR flight.
11. Lightning activity was recorded proximal to the Kiwirrkurra to Newman track during the flight.
12. There was no indication that the pilot had considered operational requirements relating to the provision of holding fuel due to the forecast weather conditions or provided for the contingency that he may have been unable to activate the Newman runway lighting.
13. The aircraft was correctly equipped for flight at night under VFR procedures.
14. The propeller of the left engine was feathered at the time of impact.
15. The fuel selectors were positioned to the main tanks at the time of impact. The quantity of fuel contained in the main and auxiliary tanks at the time of impact could not be verified by examination of the wreckage.
16. There was no evidence that mechanical malfunction or any pre-existing defect had contributed to the circumstances of the engine failures.
17. There was no evidence of pre-impact contamination of the fuel.
18. There was no evidence that the pilot was experiencing abnormal aircraft operations prior to the aircraft's arrival in the circuit area.
19. The aircraft was intact at the time of impact with the ground. Due to high impact forces, the accident was not survivable.

20 The aircraft's weight and balance was within limits at the time of impact.

21 The aircraft was fully fuelled prior to departing Newman.

22 The pilot refuelled the aircraft's auxiliary tanks with about 125 L of fuel at Kiwirrkurra, but had overestimated the fuel quantity added.

23 At the time of impact, the aircraft probably had about 165 L of fuel on board.

24 There was no evidence of an in-flight leakage of fuel.

25 The aerodrome lighting was illuminated prior to the aircraft's arrival in the Newman circuit area. There was no evidence that aerodrome ground facilities or ground-based navigation aids were factors in the accident.

26 The ASU's procedures and training relating to human factors issues were deficient.

27 There were potential conflicts of interest associated with the regulator's oversight of the ASU during the 1990s, but it was not possible to determine the significance of these.

28 The ASU was operating in accordance with an Air Operator's Certificate issued by CASA in the aerial work category.

3.2 Significant factors [77]

Of the findings as to contributing factors, the following were considered to be significant factors.

1 The engines failed due to fuel starvation.

2 The pilot did not maintain control of the aircraft following the failure of the engines.

3 The pilot did not have the appropriate skills or experience to safely undertake long distance flights in dark night conditions.

[77] That is, an element in the circumstances of an occurrence without which, the occurrence would not have occurred.

4 SAFETY ACTION

4.1 ASU safety management processes and defences

Following the accident, the ASU implemented a number of changes to the conduct of its operations. A significant number of those changes have addressed deficiencies discussed in this investigation report.

Those changes included:

- Rewriting of the operations manual.
- Amendment of the operations manual has corrected deficiencies identified in relation to fuel planning/management.
- Introduction of a new training and checking manual addressing deficiencies identified with the ASU's training and checking organisation.
- Improved ASU procedures for checking fuel quantity, completion/checking of fuel consumption records and policies for aircraft load control.
- Appointment of a safety manager within the ASU and implementation of aspects from the ATSB INDICATE (hazard identification and communication) program.
- Regular safety meetings between the chief pilot, safety manager and OIC.
- Increased supervision of remotely-based pilots and requirement for all pilots transferred to remote base locations to hold CIR qualifications.
- WA Police Service Business Area Management Review for the ASU expanded to include items from the CASA Periodical Audit form.
- Review of the ASU's structure to establish direct link between the Commissioner of Police (as the AOC holder) and the ASU chief pilot.
- Formal recognition by the WA Police Service of the chief pilot position, roles and responsibilities in the organisational structure of the service.
- Implementation of a reform process to address improved pilot and crew selection, training, flight risk management, fatigue management, professionalism, external crosschecking and validation of the ASU's systems against industry best practice.

4.2 Regulatory requirements for fuel management and fuel planning

CASA initiated a program of regulatory reform in June 1996. The objective of that program was the complete review of the Australian aviation safety requirements contained in the CARs and CAOs. The revised legislation was called the Civil Aviation Safety Regulations (CASRs). The development of CASRs was a joint industry initiative, with the objective of introducing regulations that were simple, unambiguous and generally harmonised with those of other major aviation nations.

As part of that process, CASA issued Discussion Papers (DPs) and Notices of Proposed Rulemaking (NPRMs) on proposed legislation. A discussion paper was a consultative product used by CASA to seek aviation community and public comment, on whether

CASA should proceed with a particular rule change. A NPRM was CASA's preferred method of articulating the final policy and proposed rules for aviation community and public comment.

As part of this process, CASA has proposed a number of regulatory changes in the area of General Operating and Flight Rules that relate to fuel planning and fuel management. During September 2001 CASA issued NPRM 0101OS General Operating and Flight Rules (GOFR), Proposed Civil Aviation Safety Regulation (CASR) Part 91. This includes the following points:

- a pilot in command required to check the quantity of fuel in the aircraft's tanks by visual inspection or by two different methods and is required to ensure the aircraft lands with the required fuel reserves intact; and
- a draft Advisory Circular recommending the use of suitable techniques to monitor fuel consumption en-route to verify fuel flow/fuel used against planned values; the keeping of a comprehensive in-flight fuel log; the recording the quantity of fuel on board at start-up; time of starting up engine(s) and time of take-off; time of landing and time of shutting down engine(s); cruising level, power setting and TAS, with fuel flows and times for each significant phase of flight; any delays incurred; any holding; and the quantity of fuel on board after flight.

During January 2001, CASA issued discussion paper DP 0101OS Aerial Work Operations, Proposed Civil Aviation Safety Regulation Part 137. This part was subsequently renamed Part 136, Aerial Work Operations (excluding those covered by Parts 133, 137, 138, 141 and 142). This part is applicable for aerial work operations such as those conducted by the ASU's fixed wing aircraft. The discussion paper included proposed requirements for aerial work operators to establish procedures to ensure that in-flight fuel checks and fuel management are carried out, and promulgating these procedures in the operations manual. These include requirements for in-flight fuel checks at regular intervals, recording of remaining fuel and comparing actual consumption with planned consumption, checking that the remaining fuel is sufficient to complete the flight, assessment of the expected fuel on arrival at the destination, and the requirement to record this information.

The ATSB notes the process of regulatory reform being conducted in the areas of fuel planning/management.

The contents of CASA's advisory publication CAAP 234-1 and current at the time of the accident, recommended pilots of piston-engine aircraft allow a 45-minute fixed fuel reserve. However, this publication did not otherwise recommend any consideration of the tanks in which this fuel should be contained.

In addition, CASA's NPRM 0101OS General Operating Flight Rules, proposed a requirement for pilots to provide a mandatory fixed fuel reserve, to permit the aircraft to hold 1,500 ft overhead the destination aerodrome for at least 30 minutes (and 45 minutes recommended for piston-engine aircraft). However, this proposal and supporting draft Advisory Circular did not specify or recommend that this fixed fuel reserve was to be contained in the fuel tank(s) required to be selected for approach and landing. Accordingly, the ATSB issues the following recommendation concurrently with the release of this report:

Safety Recommendation R 20020205

The Australian Transport Safety Bureau recommends that the Civil Aviation Safety Authority review the provisions for planning a fixed fuel reserve and determine if this fuel should be contained in the fuel tanks that are to be used during the approach and landing.

4.3 Night operations

During March 2002, CASA issued discussion paper DP 0202FS Pilot Licensing, Proposed Part 61 of the Civil Aviation Safety Regulations. Broadly speaking, this document proposed a new licensing framework, specifying competency-based standards for all pilot qualifications.

The discussion paper proposed that once issued, all operational ratings (including CIR and night VFR) will be perpetually valid, but with a requirement to undergo regular flight reviews to demonstrate ongoing competency in the use of any rating held.

Subpart J of DP 0202FS detailed proposals for conducting night VFR operations. These included:

- a night VFR rating permanently valid once issued;
- a requirement for biennial flight reviews to demonstrate ongoing competency; and
- additional night VFR authorisations available for different aircraft categories (single-engine aeroplanes, multi-engine aeroplanes etc), that can be issued by the holder of a flight instructor rating.

The ATSB notes the positive regulatory changes recently proposed by CASA, but believes that a safety deficiency will still exist in the area of night VFR operations, particularly in dark night flight situations. Consequently, the ATSB issues the following recommendation concurrently with the release of this report:

Safety Recommendation R20020193

The Australian Transport Safety Bureau recommends that the Civil Aviation Safety Authority review the general operational requirements, training requirements, flight planning requirements and guidance material provided to pilots conducting VFR operations in dark night conditions.

4.4 Classification of operations

On 7 September 2001, the ATSB issued the following recommendation:

Safety Recommendation R20010195

The Australian Safety Transport Bureau recommends that the Civil Aviation Safety Authority consider proposing an increase in the operations' classification, and/or the minimum safety standards required, for organisations that transport their own employees and similar personnel (for example contractors, personnel from related organisations, or prisoners, but not fare-paying passengers) on a regular basis. This recommendation applies to all such operations, regardless of the take-off weight of the aircraft involved.

CASA provided the following response to this recommendation on 1 February 2002:

> As you are aware, CASA is presently reviewing the standards contained within the existing Civil Aviation Regulations (CARs) and Civil Aviation Orders (CAOs) with regard to the Classification of Operations. The input and recommendations contained within Air Safety Recommendation R20010195 will be taken into consideration and addressed as part of this Project.
>
> The outcome of the review will determine which category employees (and similar personnel such as contractors) are placed and the standards that will apply to their transportation in aircraft.

Response status: MONITOR [78]

4.5 Safety management programs and systems

As part of its Regulatory Reform Program, CASA issued NPRM 0201OS Air Operator Certification – Air Transport, Proposed Civil Aviation Safety Regulation Part 119 in April 2002. The NPRM stated that these proposals applied to air transport operations, and were defined as operations involving the transport of passengers or cargo for remuneration or hire with certain exceptions, such as parachuting operations, gliders, balloons and carriage of passengers as permitted under CASR Part 136 (for example, emergency and medical services, observation and patrol and law enforcement). The proposed CASR 119 outlined a requirement for air transport operators to establish and maintain a safety management system, and outlined various requirements for such a system. It also outlined a requirement for air transport operators (with certain exceptions) to appoint a 'safety manager', and for this person to have certain qualifications and/or experience in a relevant discipline.

To date, there have been no proposed, specific requirements for aerial work operations in terms of safety management programs or safety management systems.

In recent years, CASA has conducted a large number of training/education seminars for the aviation industry on a variety of aviation safety topics. Since 2001, these have included a number of seminars on safety management systems.

4.6 Chief pilots

As noted in section 1.22.3, in March 1999 CASA produced a document titled 'Chief Pilot Guide'. In May 2001, CASA added an additional component to their assessment process for chief pilots titled 'system management assessment'. In addition, CASA has in recent years also conducted seminars on a variety of aviation safety topics, including some seminars directed at chief pilots.

The processes used by CASA to approve chief pilots now requires all appointments to be ratified by the Area Manger, following a review of a full report detailing tests and interview results.

As noted in section 1.22.2, at the time of the accident CASA did not formally specify competencies for chief pilots in terms of managerial ability or knowledge of safety system concepts.

---

78 The status of this recommendation is being monitored pending evidence that the identified safety deficiency has been addressed.

As noted in section 4.5, NPRM 0201OS, Air Operator Certification – Air Transport proposes that (most) air transport operators will be required to appoint a safety manager, and for this person to have certain qualifications and/or experience in a relevant discipline. The NPRM also proposed that chief pilots (termed 'head of flying operations') would be required to have certain qualifications and/or experience, although the nature of these qualifications did not vary greatly from current requirements.

DP 0101OS Aerial Work Operations proposed no additional requirements for chief pilots to demonstrate competencies in terms of managerial ability or knowledge of safety systems concepts.

Consequently, the ATSB believes that a safety deficiency exists in this area, and issues the following recommendation concurrently with the release of this report:

Safety Recommendation R20020194

The Australian Transport Safety Bureau recommends that the Civil Aviation Safety Authority review the required qualifications and/or competencies for chief pilots, with particular reference to management and system safety issues.

4.7 Training and checking personnel

CASA DP 0202FS, Pilot Licensing outlines a significant number of changes proposed for persons holding instructional and check pilot qualifications. More specifically, the discussion paper proposes that training and checking pilots and other approved persons conducting training under approvals from CASA, will be required to hold instructor ratings. In addition, instructors will be required to be trained and demonstrate competence in each activity for which they wish to give instruction, and all instructors will be required to undergo training in instructional techniques.

4.8 Human factors education issues for pilots

Since 2001, CASA personnel have been actively advising a large number of operators on how to develop fatigue management systems. CASA is also reviewing CAO 48 (Flight & Duty Time Limitations) as part of its program of regulatory reform.

During 2001, CASA conducted a series of educational seminars and produced (and widely distributed) a video on the effects of hypoxia. As noted in section 4.6, CASA has also been conducting a number of other types of training /educational seminars on a range of flight safety issues, which included human factors content.

CASA DP 0202FS, Pilot Licensing (Proposed CASR Part 61) issued March 2002 outlined proposals that all CASA-issued pilot licences will be competency-based. Included in these competencies for various levels of licence will be competencies relating to knowledge of human factors issues.

CASA NPRM 0201OS, Air Operator Certification – Air Transport (Proposed CASR Part 119) issued April 2002 (see section 4.5) proposes a requirement that commercial air transport operators include relevant regulations and guidance information to crew members on health issues such as drugs, sleep and rest, and meal precautions prior to and during flight.

ATTACHMENTS

Attachment A: Issue of pilot's night VFR rating

During the course of the investigation, it became apparent that the pilot's night VFR rating had been invalidly issued and therefore, the pilot was not legally qualified to conduct the occurrence flight in a multi-engine aircraft. CASA requirements for night VFR ratings are outlined in section 1.20.1.

Following a flight conducted on 2 November 2000, the ASU chief pilot (in his capacity as check pilot and delegate of CASA) made an entry in Part XII of the pilot's logbook (Certificates of Endorsement on Aircraft Types, Classes and Design Features), issuing a 'PA-31 multi-engine night VFR rating'.

The chief pilot did not hold a CASA delegation to conduct flight tests for issue of night VFR ratings (see section 1.18.7). CASA was not provided with a flight test notification or booking, CASA's night VFR rating application form was not completed, and the test was conducted without reference to CASA's night VFR 'Flight Test Report Form'. The chief pilot was unaware that flight tests conducted to issue multi-engine night VFR ratings were required to be conducted in that manner and by reference to the test report form.

The logbook entry made by the chief pilot was incorrect and CASA did not receive the original copy of the Logbook Certification Form. Accordingly, CASA could not check the validity of the logbook entry against delegations held by the testing officer.

The chief pilot reported that he did not use any published criteria or test forms when conducting the flight to issue the pilot's multi-engine night VFR rating. He tested items he thought were appropriate, based on his previous experience, although he could not recall specific aspects of the test or the skill areas that were examined.

Based on flight records, log book entries and landing records, the night portion of the flight on 2 November 2000 was conducted during a series of circuits at Jandakot, with the aircraft landing about 34 minutes after last light.

The duration of the test and the failure to use the CASA test report form, did not provide assurance that the flight was sufficient to assess the pilot's capabilities. Based on the flight duration after last light, the chief pilot's recollection of the test and the absence of any logged instrument flying, together with the standard techniques used by the chief pilot during check flights, the ATSB investigation considered it unlikely that the pilot had demonstrated his ability to control the aircraft in asymmetric flight (as required under Civil Aviation Order (CAO) 40.2.2, subsection 2.1 (b)(iv)).

Despite the basis on which the rating was issued, it should also be noted that the occurrence pilot had significant night flying experience, albeit almost exclusively in single-engine aircraft and for the most part, in good visual conditions over terrain with significant ground illumination.

Attachment B: Classification of operations

B.1 Overview

In a recent Notice of Proposed Rule Making (NPRM 0102OS, August 2001), the Civil Aviation Safety Authority (CASA) summarised the situation with regard to the classification of aircraft operations.

According to that document, Australia had four classifications of civil air operations: ‘regular public transport (RPT)’, ‘charter’, ‘aerial work’ and ‘private’. The purpose of different classifications was to apply a range of safety standards appropriate to the operation undertaken.

For example, compared with private flights, fare-paying passenger flights (RPT and charter) had higher safety standards, mandatory insurance requirements, and greater regulatory oversight by CASA. When compared to aerial work, a charter operation had additional minimum safety standards. Those included:

- Passenger carrying operations at night were not permitted under the VFR unless the pilot also held a CIR and the aircraft was equipped for flight under the IFR;
- Mandatory submission of flight notification (full flight details, SARTIME or flight note) for all flights;
- Increased obligations in relation to flight crew requirements;
- Requirement for route qualifications of the pilot in command;
- Recommendation in advisory publications to carry 15 per cent variable fuel reserve.

The NPRM stated that the current aviation safety legislation divided aircraft operations into two broad categories — those that required a CASA–issued Air Operator's Certificate (AOC), and those that did not. Historically, the requirement was based on flights that were conducted as ‘commercial operations’ or for ‘commercial purposes’. Although the word ‘commercial’ was removed from section 27 of the Civil Aviation Act 1988, it still appeared in the Civil Aviation Regulations (CARs) 1988. CAR (1988) 2 defined ‘commercial operations’ as all civil air operations other than private operations, while CAR 206 prescribed certain ‘commercial purposes’. By inference, RPT, charter and aerial work operations were commercial and required an AOC, while private operations did not.

B.2 Corporate operations

Many organisations in Australia own and/or lease aircraft and operate those aircraft regularly to transport employees and related personnel (for example contractors or personnel from related organisations). Those passengers do not pay to be transported and the flights are therefore not classified as ‘commercial’ in nature. Unless the same organisation conducts other operations requiring an AOC, corporate aviation operations are classified as ‘private’ and therefore have the lowest minimum level of required civil aviation standards.

Based on discussions with several personnel involved in providing corporate aviation operations, the following observations can be made regarding such operations:

- passengers generally have little choice regarding whether they travel or not (that is it is part of, or a condition of, their employment);

- passengers generally have similar expectations regarding safety as with passengers on commercial passenger-carrying operations.

In addition, under the CARs, if a corporate transport activity was outsourced to an external organisation, that operation would then have to be conducted to the ‘charter’ standard.

It is difficult to obtain information on the extent to which corporate aviation operations are conducted in Australia. A search of the ATSB OASIS database for the period 1 January 1995 to 21 June 2001 identified over 100 organisations that owned aircraft involved in an air safety occurrence, and where the statistical group was listed as ‘business’ and/or the operator type was listed as ‘corporate’.

The extent of those operations varies significantly. Many organisations would have a small number of employees, or may use their aircraft to transport a small number of managerial personnel. In contrast, one non-government organisation conducts over 100,000 passenger movements a year as a private operation. (Passenger movements are defined as the number of landings multiplied by the number of passengers on board.) Three state police departments conduct over 1,000 passenger movements a year. That includes the transport of ‘non-employees’ such as prisoners, contractors, and employees from other government departments. The Air Support Unit was one of those three organisations, and it was classified as aerial work because of the nature of its non-passenger carrying activities. The other two organisations did not have an AOC.

As it is difficult to obtain an overall indication of the extent of corporate aviation activities, it is also difficult to evaluate their relative safety compared with commercial operations. Based on interviews with the relevant chief pilots, some of the larger corporate operations appear to be operating voluntarily to self-imposed standards that, in some areas, exceed the minimum requirements for private operations.

B.3 Regulatory change activities

In June 1996, CASA began the Regulatory Framework Program. That program has, as its objective, the complete review of the Australian aviation safety requirements contained in the CARs and Civil Aviation Orders (CAOs). The revised legislation is called the Civil Aviation Safety Regulations (CASRs). The development of the CASRs is a joint industry and CASA initiative, having as its aim the introduction of regulations that are simple, unambiguous and generally harmonised with those of other major aviation nations. To date, a number of discussion papers and notices of proposed rule making have been issued. Many more are in preparation.

In April 1997, the then Minister of Transport and Regional Development and the CASA Board approved a new Classification of Operations Policy. The policy stated that the document was:

> a matter of public policy and for the purposes of providing a framework for establishing aviation safety regulations under the Civil Aviation Act.

That document was a proposal only, intended to help guide the development of new CASRs. CASA reported that, before any changes to Australia’s current classification of operations (as defined by regulations) are considered, it will undertake extensive industry consultation. Any proposed changes are also subject to independent scrutiny from the Government’s Office of Regulation Review.

In developing the policy, CASA considered the classifications used by ICAO and foreign civil aviation authorities, previous CASA attempts to redefine its classifications, recommendations of external agencies, and broad-based industry consultation.

A section titled 'Policy Framework', outlined the principles that were adopted in developing the policy. Those included:

- safety of people is more important than safety of property;
- the level of safety provided should be cognisant of the degree to which participants in an aviation activity are able to inform themselves of and avoid risk; and
- since CASA's mandate is limited to safety regulation, economic and commercial indicators were not considered as major determinants of an operation's classification.

The section titled 'Operations Classifications' stated the following:

> Three classes of operations are established under the policy:
>
> - Passenger Transport amalgamates the current Charter and Regular Public Transport (RPT) categories into one new classification which attracts the highest level of regulation and safety oversight.
> - Aerial Work encompasses a wide variety of aircraft operations in which only essential crew are carried. In addition to aircraft applications such as crop-dusting, this classification also includes all air freight operations, both scheduled and non-scheduled.
> - General Aviation brings within its ambit those aircraft activities which have historically been considered 'private', 'recreational' or 'sport' in nature. This classification involves the lowest level of aviation regulation. Participants are taken to be knowledgeable of the risks they are exposed to and voluntarily assume those risks.

A synopsis, attached to the policy, outlined a definition, attributes, inclusions, regulatory requirements and CASA's role for each of the three categories specified. General aviation was defined as 'broadly means personal transportation plus pure sport/recreational uses of aircraft'. Attributes included that the operator was not engaged in the passenger transport business, and participants (crew and non-crew) were knowledgeable of, or informed of risks, and consented to them. Corporate aircraft operations were listed as inclusions.

Aerial work was defined as 'broadly means operations by persons in the business of operating aircraft (on a non-recreational basis) in which only personnel essential to the flight are carried'. Attributes included that the personnel on board were knowledgeable of, or informed of risks, usually on the basis of their employment. Police operations and aerial surveys were listed as inclusions.

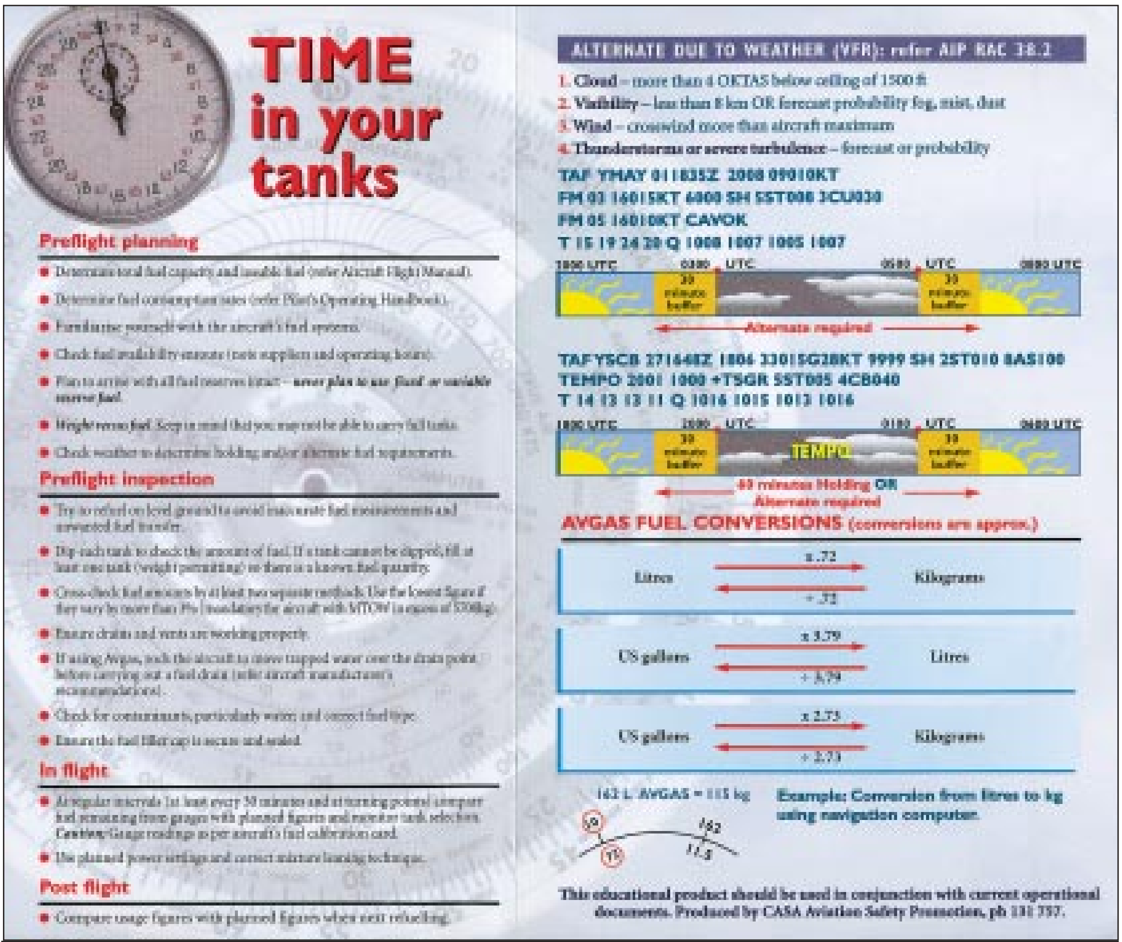
Passenger transport was defined as 'broadly means operations by persons in the business of operating aircraft (on a non-recreational basis) to carry passengers'. Attributes included that passengers were at an arms length from the operator, with passengers having some knowledge of, but little control over, risk factors. All RPT and passenger carrying charter operations were listed as inclusions.

Observations:

A significant number of passengers are transported during corporate aviation operations each year. The minimum safety standards required for such operations are significantly less than for fare-paying passenger operations. However, passengers on corporate operations have similar expectations as fare-paying passengers regarding safety and usually have little control over factors associated with risk. In addition, corporate operations' passengers generally have little choice regarding whether they travel or not.

From the perspective of risk management, and the view that safety of persons is of significant importance, passengers on corporate operations should be provided with a higher level of required minimum safety standards than those required for private operations.

Attachment C: Time in your tanks brochure



TIME in your tanks

Preflight planning

- Determine total fuel capacity and useable fuel (refer Aircraft Flight Manual).
- Determine fuel consumption rates (refer Pilot's Operating Handbook).
- Familiarise yourself with the aircraft's fuel systems.
- Check fuel availability enroute (note suppliers and operating hours).
- Plan to arrive with all fuel reserves intact – ***never plan to use fixed or variable reserve fuel.***
- ***Weight versus fuel.*** Keep in mind that you may not be able to carry full tanks.
- Check weather to determine holding and/or alternate fuel requirements.

Preflight inspection

- Try to refuel on level ground to avoid inaccurate fuel measurements and unwanted fuel transfer.
- Dip each tank to check the amount of fuel. If a tank cannot be dipped, fill at least one tank (weight permitting) so there is a known fuel quantity.
- Cross-check fuel amounts by at least two separate methods. Use the lowest figure if they vary by more than 5% (mandatory for aircraft with MTOW in excess of 5700kg).
- Ensure drains and vents are working properly.
- If using Avgas, rock the aircraft to move trapped water over the drain point before carrying out a fuel drain (refer aircraft manufacturer's recommendations).
- Check for contaminants, particularly water, and correct fuel type.
- Ensure the fuel filler cap is secure and sealed.

In flight

- At regular intervals (at least every 30 minutes and at turning points) compare fuel remaining from gauges with planned figures and monitor tank selection. ***Caution:*** Gauge readings as per aircraft's fuel calibration card.
- Use planned power settings and correct mixture leaning technique.

Post flight

- Compare usage figures with planned figures when next refuelling.

ALTERNATE DUE TO WEATHER (VFR): refer AIP RAC 38.2

1. **Cloud** – more than 4 OKTAS below ceiling of 1500 ft
2. **Visibility** – less than 8 km OR forecast probability fog, mist, dust
3. **Wind** – crosswind more than aircraft maximum
4. **Thunderstorms or severe turbulence** – forecast or probability

TAF YMAY 011835Z 2008 09010KT
FM 03 16015KT 6000 SH 5ST008 3CU030
FM 05 16010KT CAVOK
T 15 19 24 20 Q 1008 1007 1005 1007

TAF YSCB 271648Z 1806 33015G28KT 9999 SH 2ST010 8AS100
TEMPO 2001 1000 +TSGR 5ST005 4CB040
T 14 13 13 11 Q 1016 1015 1013 1016

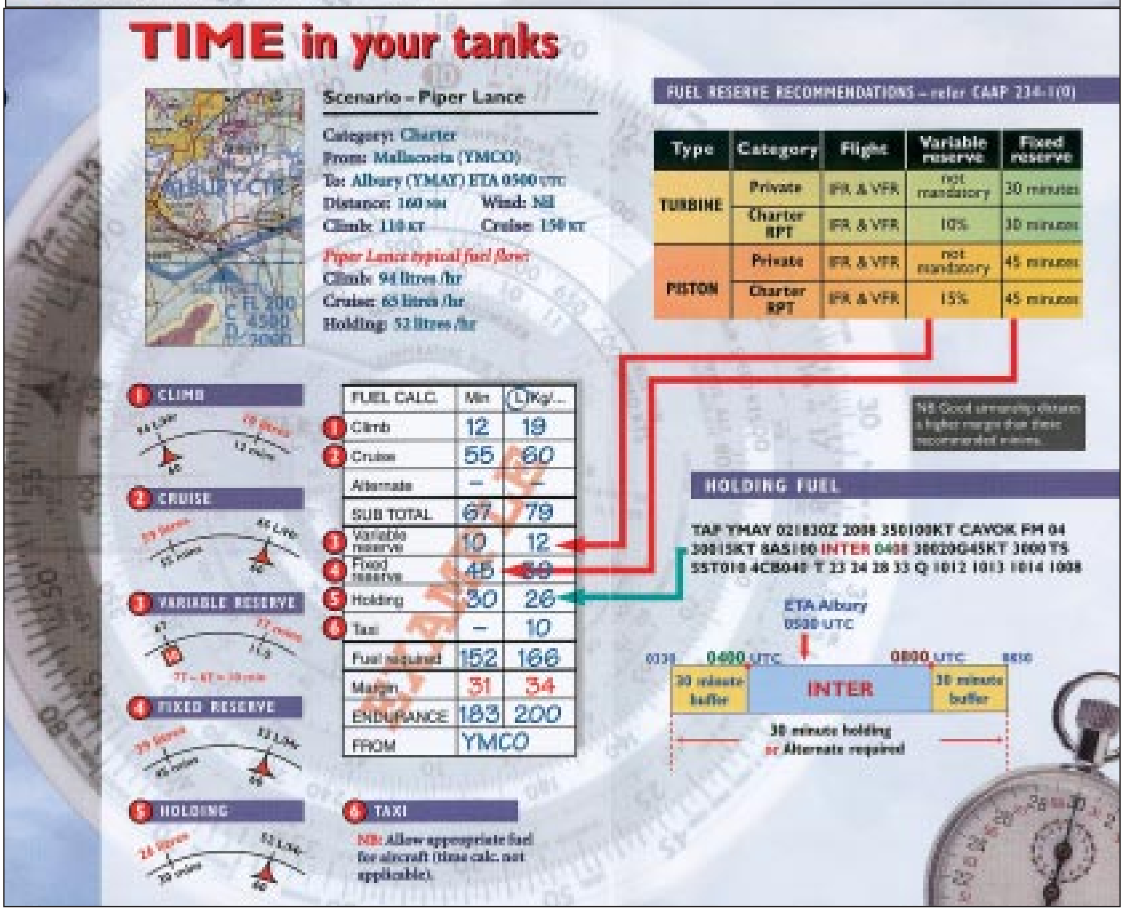
AVGAS FUEL CONVERSIONS (conversions are approx.)

Litres	x .72 / ÷ .72	Kilograms
US gallons	x 3.79 / ÷ 3.79	Litres
US gallons	x 2.73 / ÷ 2.73	Kilograms

162 L AVGAS = 115 kg

Example: Conversion from litres to kg using navigation computer.

This educational product should be used in conjunction with current operational documents. Produced by CASA Aviation Safety Promotion, ph 131 757.



TIME in your tanks

Scenario – Piper Lance

Category: Charter
From: Mallacoota (YMCO)
To: Albury (YMAY) ETA 0500 UTC
Distance: 160 NM   Wind: Nil
Climb: 110 KT   Cruise: 150 KT

Piper Lance typical fuel flow:
Climb: 94 litres /hr
Cruise: 65 litres /hr
Holding: 52 litres /hr

FUEL CALC.	Min	L/Kg/...
1 Climb	12	19
2 Cruise	55	60
Alternate	–	–
SUB TOTAL	67	79
3 Variable reserve	10	12
4 Fixed reserve	45	39
5 Holding	30	26
6 Taxi	–	10
Fuel required	152	166
Margin	31	34
ENDURANCE	183	200
FROM	YMCO	

1 CLIMB
2 CRUISE
3 VARIABLE RESERVE
4 FIXED RESERVE
5 HOLDING

6 TAXI

NB: Allow appropriate fuel for aircraft (time calc. not applicable).

FUEL RESERVE RECOMMENDATIONS – refer CAAP 234-1(0)

Type	Category	Flight	Variable reserve	Fixed reserve
TURBINE	Private	IFR & VFR	not mandatory	30 minutes
	Charter RPT	IFR & VFR	10%	30 minutes
PISTON	Private	IFR & VFR	not mandatory	45 minutes
	Charter RPT	IFR & VFR	15%	45 minutes

NB: Good airmanship dictates a higher margin than these recommended minima.

HOLDING FUEL

TAF YMAY 021830Z 2008 35010KT CAVOK FM 04 30015KT 8AS100 INTER 0408 30020G45KT 3000 TS 5ST010 4CB040 T 23 24 28 33 Q 1012 1013 1014 1008

Attachment D: Research on fuel starvation accidents

The ATSB recently conducted a safety study of fuel exhaustion[79] and fuel starvation[80] accidents in Australia. Over the 10-year period (1991–2000), there were a total of 78 fuel starvation accidents. Twelve of those accidents resulted in fatalities. There was also a total of 61 fuel exhaustion accidents, which included 7 accidents resulting in fatalities. Overall, fuel-related accidents formed 6 per cent of all aircraft accidents, and 8 per cent of all fatal aircraft accidents. Those figures did not include accidents involving unregistered aircraft, gliders or balloons.

The primary contributing factors to fuel starvation accidents were a number of events during flight, including: mismanagement of the fuel system in terms of fuel system controls and selections (involved in 42 per cent of accidents); and inattention to the fuel supply, or the pilot seemingly being unaware of a fuel problem or low fuel situation in the selected tanks, which was involved in at least 16 per cent of accidents. Technical factors (such as a component failure or foreign matter blocking a part of the fuel system) were involved in 43 per cent of fuel starvation accidents.

Inattention to the fuel supply was also a factor in at least 27 per cent of the fuel exhaustion accidents.

---

79 Fuel exhaustion refers to an occurrence where all of the useable fuel on board the aircraft has been consumed.

80 Fuel starvation refers to an occurrence where a quantity of fuel remained on board the aircraft, but where the selected fuel tank was empty.

Attachment E: Research on VFR accidents at night

The investigation conducted a review of the ATSB OASIS database for all accidents at night in Australia from 1991 to 2000, conducted under VFR procedures by night VFR-rated pilots, and involving either controlled flight into terrain or a loss of effective aircraft control (that did not appear to be due to any technical problem). That search identified 17 accidents.[81] Those included:

- Six accidents involved flight into IMC or probable flight into IMC. One occurred shortly after take-off, two en-route, and three during descent or approach. One occurred during an aerial work operation, with the other five during private or business operations. Four of the accidents were fatal.
- Three accidents involved low level flight and some pilot distraction. One occurred shortly after takeoff (aerial work), whereas the other two were during low-level operations (both aerial work). None of the accidents were fatal.
- Two accidents occurred during VFR training at night, with an appropriately qualified instructor in a control position. One occurred shortly after takeoff from a touch and go landing (not fatal), and one during cruise (fatal).
- Six other accidents, all of which were fatal. Five occurred during private operations and one during a (non-passenger carrying) charter flight. One occurred shortly after takeoff, two with the aircraft en-route, and three during descent or approach. Two of the pilots also held a CIR, but one had a low level of night flying experience. Two of the other pilots had low levels of night flying experience, and another had not complied with the recency requirements for a night VFR rating. The experience levels of the other pilot were not available.

As far as could be determined, all of the accidents occurred in 'dark night' conditions. Unfortunately, the investigation could not obtain information on the rate of those accidents (per flight or 100,000 flying hours) versus similar accidents in day VFR operations or IFR operations.

Canada is often regarded as having a similar flying environment with respect to issues of flying at night under the VFR. The Canadian regulator (Transport Canada) requires pilots to hold a rating to fly at night under the VFR. Like Australia, much of Canada consists of remote and unpopulated areas that are without extensive ground lighting. Transport Canada conducted a review of accidents from 1984 to 1995 that involved controlled flight into terrain or (pilot) loss of control.[82] During that review (of 129 accidents), they identified 27 accidents during VFR operations at night. Most of the accidents occurred during dark night conditions.

A summary of that review noted 'although several of those accidents involved flying into IMC, …the most salient common feature was the decision to attempt cross country VFR flight over unlit terrain in dark night conditions'; and 'on a dark night in Canada, a pilot may see for miles, but there is 'nothing' to see'.

---

81 A number of other accidents involving VFR flights at night were also identified where the pilot did not have a night VFR rating or had a rating but had not planned to conduct a VFR flight at night.

82 J. McMenemey, D. Balfour, P. Carrierre, M. Gaudreau, J. Taylor and P. Traversy, *A Study of the Safety of Flight in Degraded Visual Conditions,* in Proceedings of the Ninth International Symposium on Aviation Psychology, 87-95, 2000.