Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY INVESTIGATION REPORT

Aviation Occurrence Report – 200600851

Final

Aircraft loss of control - 20 km SSW Cootamundra, NSW
16 February 2006
VH-FVF
PZL M-18A, Dromader

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Aircraft loss of control – 20 km SSW of Cootamundra, NSW – 16 February 2006, VH-FVF, PZL M-18A, Dromader

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Base topographic map in Figure 3, and photographs in Figures 1 and 4 courtesy of the NSW Rural Fire Service.

Diagram in Figure 2 from the Delta Turbines Inc. aeroplane flight manual supplement.

Abstract

At about 1922 Eastern Daylight-Saving Time on 16 February 2006, the pilot of a turbine PZL-Warszawa-Ockie M-18A, Dromader, registered VH-FVF, was fatally injured when the aircraft impacted terrain during fire-bombing operations approximately 20 km south-south-west of Cootamundra, NSW.

The pilot was an experienced agricultural pilot with previous fire-bombing experience. Although he had considerable flying experience on radial-engine Dromader aircraft, and in other turbine agricultural aircraft, his total flying experience in the modified turbine Dromader was 4.7 hours. Prior to commencing fire-bombing duties two days before the accident, the pilot had not recorded any fire-bombing flights in the previous 3 years.

The pilot's limited familiarity with the handling characteristics of the modified and heavily-loaded aircraft might not have allowed him adequate recognition of an impending stall. The pilot had not jettisoned the load of retardant when the aircraft stalled. The ensuing loss of control occurred at a height that did not permit recovery before the aircraft collided with the ground. The possibility that the pilot was distracted by a problem with the operation of the fire doors or some other activity could not be determined.

Subsequently, the state fire authority reviewed its minimum pilot experience levels for aerial fire suppression. The minimum aircraft type experience for fire-bombing pilots was made more specific to the type of aircraft. It also introduced a recency requirement for fire-bombing operations.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

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

The ATSB is responsible for investigating accidents and other transport safety matters involving civil aviation, marine and rail operations in Australia that fall within Commonwealth jurisdiction, as well as participating in overseas investigations involving Australian registered aircraft and ships. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

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Purpose of safety investigations

The object of a safety investigation is to enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

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Developing safety action

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues in the transport environment. The ATSB prefers to encourage the relevant organisation(s) to proactively initiate safety action rather than release formal recommendations. However, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation, a recommendation may be issued either during or at the end of an investigation.

The ATSB has decided that when safety recommendations are issued, they will focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on the method of corrective action. As with equivalent overseas organisations, the ATSB has no power to implement its recommendations. It is a matter for the body to which an ATSB recommendation is directed (for example the relevant regulator in consultation with industry) to assess the costs and benefits of any particular means of addressing a safety issue.

About ATSB investigation reports: How investigation reports are organised and definitions of terms used in ATSB reports, such as safety factor, contributing safety factor and safety issue, are provided on the ATSB web site www.atsb.gov.au.

1 FACTUAL INFORMATION

1.1 History of the Flight

At about 1922 Eastern Daylight-saving Time[1] on 16 February 2006, the pilot of a turbine PZL-Warszawa-Ockie M-18A Dromader, registered VH-FVF (call sign Bomber 223), was fatally injured when the aircraft impacted terrain during fire-bombing operations approximately 20 km south-south-west of Cootamundra, NSW.

The aircraft was one of two fixed-wing fire-bombing aircraft that were despatched from Wagga Wagga to drop retardant on an active fire area east of Mount Ulandra, 46 km north-north-east of Wagga Wagga that afternoon.

At 1733, the Dromader departed Wagga Wagga on a fire-bombing flight in company with the other aircraft. Both aircraft circled the fire area for more than 20 minutes while the lead pilot in the other aircraft determined a suitable drop location. After the pilot of the lead aircraft had dropped his load of retardant, the pilot of the Dromader then dropped his load nearby. The two aircraft then returned to Wagga Wagga for another load of retardant.

The pilot of the other aircraft observed the Dromader landing at Wagga Wagga and reported that it appeared to be a heavier than normal landing. He heard the pilot of the Dromader broadcast that the rough landing was the result of a partial load of retardant remaining in the hopper. The Dromader pilot taxied to the grass loading bay to commence replenishment and did not communicate to the ground crew that there was any problem. The pilot was not seen to make any external examination of the fire-door on the aircraft.

The loading was performed with the engine running, while the pilot remained in the cockpit. Communication between the pilot and ground crew was by prearranged hand signals or notes. The ground crew reported that the pilot indicated that the aircraft required fuel and they summoned the refuelling truck while they commenced to pump retardant into the aircraft. They awaited a signal from the pilot instructing them to stop pumping. However, when they saw retardant flowing out of the hopper overflow outlets they shut off the valve immediately. The ground crew reported that the pilot may have been distracted while making fuel calculations and had not monitored the hopper gauge during filling.

The pilot decided to decant the excess retardant and had the ground crew open the aircraft's intake valve and allow the excess retardant to spill on to the ground. On a signal from the pilot that the desired quantity of retardant remained in the hopper, the ground crew closed the valve. The pilot did not refuel and indicated he would do so on his return.

At 1851, the Dromader departed Wagga Wagga for the fire area. The pilot of the other aircraft was returning to Wagga Wagga and reported passing the Dromader and advised the Dromader pilot to make the drop in the same area where the previous drops had been made. The crew of a helicopter, inbound to the fire area,

1 The 24-hour clock is used in this report to describe the local time of day, Eastern Daylight-saving Time, as particular events occurred. Eastern Daylight-saving Time was Coordinated Universal Time (UTC) +11hours.

reported hearing the pilot of the Dromader broadcast that he was ‘lining up for a drop’. A few moments later they heard the pilot of the Dromader transmit three short expletives.

At about 1921, volunteer firemen working to the west of the fire area, saw the Dromader on a northerly heading, just above the horizon and turning left at an angle of bank they estimated to be about 45°. They returned to their duties and although they could not recall the sound of the aircraft, they reported that there was no unusual noise or change to the noise level to attract their attention.

Another fireman, working to the east of the aircraft’s flight path, reported briefly seeing the aircraft travelling away from him but in a left bank of nearly 90° before he lost sight of it.

The sound of an impact alerted the firemen to the accident. They looked up to see the aircraft moments after its collision with the ground and immediately went to render assistance. The aircraft was destroyed by impact forces (Figure 1).

Figure 1: Accident site

1.2 Injuries to persons

	Crew	Passengers	Others	Total
Fatal	1			1
Serious				
Minor/None				
Total	1			1

1.3 Damage to aircraft

The aircraft was destroyed by impact with the ground.

1.4 Other damage

The aircraft was loaded with a considerable quantity of ammonium polyphosphate fire retardant chemical (PHOSCHECK) in solution, which was dispersed over the wreckage site when the fibreglass hopper disintegrated during the accident sequence. Additionally, there was a smaller quantity of JET A-1 fuel spilled from the ruptured fuel system.

1.5 Personnel information

Pilot	32 years
Licence and ratings	Commercial pilot licence (aeroplane), Grade 1 agricultural rating
Aircraft class endorsements	All single engine aeroplanes not exceeding 5,700 kg maximum take-off weight, including special design features for; Constant speed propeller [manual propeller pitch control], tail wheel undercarriage [landing gear], retractable undercarriage [landing gear] Ayers Turbo Thrush/Airtractor (TPE 331), Ayers Turbo Thrush/Airtractor (PT6). PZL M-18 Dromader (TPE 331)
Medical certificate	Class 1, valid to 2 April 2006 No restrictions
Last aeroplane flight review	Night VFR agricultural rating qualification test on 19 December 2004
Flying experience	Total aeroplanes 4,921 hours Total last 90 days 114 hours Total on type 4.7 hours
Duty time	About 10.5 hours (including 7.5 hours resting standby)
Rest before duty	About 13.5 hours

The pilot had in excess of 4,000 hours in agricultural flying operations, of which 127 hours were flown in fire-bombing operations over a period of six seasons. Prior to commencing duty at Wagga Wagga, the pilot had not recorded any fire-bombing flying since 30 January 2003, although he had routinely flown aerial spraying flights since then.

The pilot had nearly 700 hours experience on radial (reciprocating) engine Dromader aircraft. The endorsement for the PZL M-18 aircraft was included in a class endorsement for all single-engine aeroplanes with a maximum take-off weight not exceeding 5,700 kg, and the special design feature endorsements for a constant speed propeller and a tail wheel landing gear configuration.

Civil Aviation Order 40.1.0 classified the turbine Dromader as a PZL M-18 (TPE 331) class endorsement that was distinct from the class endorsement for the unmodified aircraft.

On 11 August 2005, the pilot recorded 2.8 hours solo flying time on the PZL M-18 (TPE 331) as endorsement training. Training for an endorsement on single-place aircraft, like the Dromader, consisted of a briefing on the aircraft systems and handling and supervised solo flying. The pilot who conducted and supervised the pilot's endorsement training reported that he could not recall the specific details of that flying, but that normally he would get a pilot to perform general aircraft handling flying sequences, at altitude, that included turning and stalling, followed by a series of circuits and landings, and then some low-level flight. He did not incorporate any operational training in the endorsement flying. The Chief Pilot/operator reported that he had not observed the pilot perform any stall manoeuvres, but had the pilot make several practice water drops.

Although the pilot's experience on the turbine Dromader was limited to endorsement and familiarisation flying, the Chief Pilot reported that he had assessed the pilot as competent to conduct fire-bombing operations in the turbine Dromader. His assessment had taken into consideration the pilot's 700 hours radial engine Dromader flying, his over 600 hours in other turbine agricultural aircraft, his previous fire-bombing experience and his recent agricultural flying.

On 14 February 2006, prior to commencing fire-bombing duty, the pilot flew 0.6 hours at Wagga Wagga to re-familiarise himself with the aircraft. That flight consisted of unspecified aircraft handling manoeuvres and practice water drops. The pilot subsequently reported to the Chief Pilot that he was confident to be tasked for fire-bombing duties in the turbine Dromader. The following day, the pilot made a flight of 0.7 hours to drop retardant on an active fire near Wagga Wagga. That was his first fire-bombing flight in over 3 years and his first in the aircraft.

Since commencing fire-bombing duty two days before, the pilot had flown 2.5 hours and had a total of 4.7 hours on the turbine Dromader. The pilot's duty time at Wagga Wagga was reported to have been spent mostly in motel accommodation on standby. He was reported to have been well rested and in good spirits.

1.6 Aircraft information

Manufacturer	PZL- Mielic, Poland
Type and Model	M-18A (Dromader)
Year of Manufacture	1988
Serial number	1Z019-03
Certificate of Airworthiness	RESTRICTED (No. BK/11133)
Total airframe time	1210 hours
Engine	Honeywell TPE331-12-UHR-703H
Propeller	Hartzell HC-B5MP-5BL/LM11692N
Fuel type used	Aviation JET A1

1.6.1 Aircraft general

The PZL M18A Dromader was a single-pilot, special-purpose, medium load-carrying capacity, agricultural aeroplane. It was a low-wing monoplane of all-metal construction with fixed main landing gear and a tail wheel (Figure 2). The original

Dromader aircraft, like FVF, were powered by a Kalisz ASz-62IRm18, 9-cylinder, supercharged radial engine developing 967 Shaft Horsepower (SHP) and driving a 4-blade constant-speed propeller.

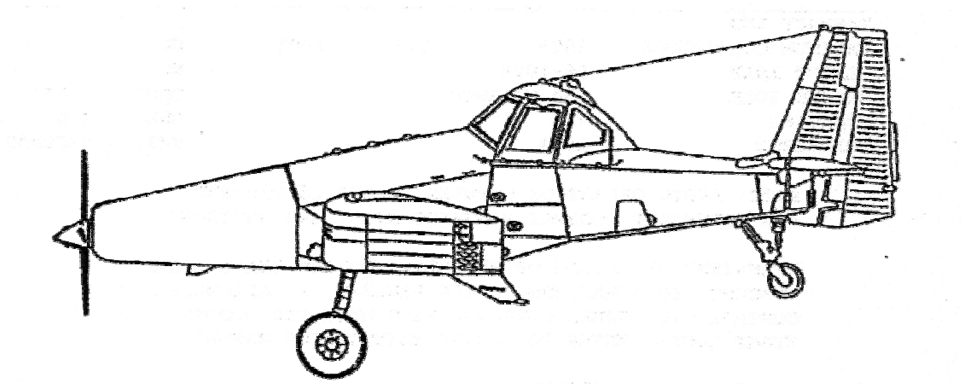
The Dromader could be configured for various aerial agricultural roles, including fire-bombing. Chemical or fertilizer was carried in a 2,500 litre capacity hopper located in front of the cockpit. The chemical or fertilizer was dispensed through controllable hopper doors attached to the base of the hopper and adapted for the different applications or through spray booms.

The aircraft was manufactured in Poland in 1988. It was registered in Germany until it was purchased in 1998 and exported to Australia. In September 1999, the aircraft was issued a Special Certificate of Airworthiness (CoA)[2] by the Australian Civil Aviation Safety Authority (CASA) and placed on the Australian register by the operator. Records indicated that the aircraft was certified and equipped in accordance with existing Australian regulations and procedures.

1.6.2 Supplemental type certificate modification

In November 2003, the aircraft was modified from the original type certificated design in accordance with a US Federal Aviation Administration (FAA) approved Supplemental Type Certificate (STC) and Australian engineering orders. The original radial engine was removed and a Honeywell turbine engine, capable of developing 1100 SHP, was installed. A Hartzell 5-blade constant speed propeller, driven through the engine's reduction gear box, replaced the original 4-blade propeller.

Figure 2: Side view of the modified Dromader



Only some Dromader aircraft were type certified by the FAA. The serial number of FVF was not listed on the FAA type certificate. The Australian Civil Aviation Regulation (CAR) 35-approved engineer, employed to assist with the STC modification, reported that the certification differences between the US and Polish authorities were insignificant and that the modifications were appropriate. The Civil Aviation Safety Authority accepts STCs approved by other national airworthiness authorities.

A search of the Australian aircraft register showed that at August 2007, there were a total of eight such modified aircraft in Australia.

2 RESTRICTED Airworthiness Category; for the purpose of Agriculture and Forest/Wildlife conservation operations.

1.6.3 Other modifications

In October 2001, a vortex generator[3] kit was installed in accordance with an STC. The kit consisted of a series of vortex generators that were adhered to the upper surface of the wings, just aft of the leading edge, and along the under surface of the tailplane. The manufacturer of the vortex generators claimed a 7% reduction in stalling speeds after fitting the kit.

In November 2003, coincident with the turbine-engine conversion, the aircraft's flight controls were modified in accordance with an STC that incorporated servo-assistance to all the control surfaces. The modification improved aircraft handling and response. The servos used aerodynamic assistance to reduce the pilot's physical input on the aircraft controls, making those forces lighter during manoeuvring and providing a faster response to some control inputs. In conjunction with those modifications, the elevator span was increased and changes to the elevator trim and balance tabs were made. The changes permitted an extension of the flap travel up to 30°, and conformed to the Dromader M-18B specification.

Additionally, at the time of the turbine-engine conversion, the aircraft's hopper was enlarged to a capacity of 800 US gallons, or just over 3,000 litres. That modification was made in accordance with an appropriate engineering order.

1.6.4 Avionics and equipment

Two very high frequency (VHF) radios were installed in the aircraft for radio communication on the aeronautical frequency band and a transponder for radar identification. An audio selector enabled the pilot to select the reception of the installed radio and communication channels and to select microphone transmission from the desired radio. A CB radio was installed for communication with the operator's ground support. A global positioning system (GPS) was installed to assist with visual navigation.

Additionally, to meet requirements for fire-bombing, extra radios and equipment had been installed, that included: two ultra-high frequency (UHF) radios and an interface for a mobile telephone for communication with fire agencies; a siren to warn fire-fighters working the fire area below that a drop was about to commence; and a satellite-based navigation and guidance (FIRENAV) system with a cockpit multi-function display and a data-entry key board.

A fire-door control panel was installed as part of the electro-pneumatic fire-door operation.

1.7 Meteorological information

Pilots flying in the fire area reported that weather conditions at the time of the occurrence were 'near perfect' for fire-bombing operations. There was little or no mechanical or convective turbulence and the wind was from the north-east at about

3 Vortex generators are a series of small, perpendicular, deflectors attached at predetermined locations along an aircraft's wings. They produce a vortex that redirects the airflow over the wing surfaces at high angles of attack, delaying the separation of the airflow that produces an aerodynamic stall. Additionally, the re-energised airflow over the aircraft's control surfaces provides more positive control at lower speeds.

5 to 10 kts. Visibility in the area was good, with smoke from the fire being blown away from the drop area. The other pilots reported that sun glare was not a problem.

There was no automatic weather station at Cootamundra. The nearest automatic weather stations were located at Temora (59 km north-west), Wagga Wagga (61 km south-west) and Young (61 km north-north-east). Recorded weather data from Temora and Young at 1900 and 1930 indicated a north to north-easterly wind between 8 and 10 kts and temperatures of 27˚C decreasing to 23˚C. The recorded weather data from Wagga Wagga at 1930 indicated a northerly wind of 13 kts and a temperature of 29˚C.

1.8 Aids to navigation

Not applicable

1.9 Communication

Communication with other aircraft operating in the vicinity of the fire area was made on a VHF discrete aeronautical frequency (132.35 MHz) that had been assigned to the fire area. The transmissions on this frequency were not recorded but transmissions reportedly made by the pilot are included in section 1.1.

Transmissions on the UHF radio transceivers were recorded by the fire agency at their Wagga Wagga and Harden bases. Terrain shielding prevented these stations from receiving signals from aircraft flying at very low altitude. At 1850, the pilot of the Dromader reported to Wagga Wagga that he would liaise with fire agency personnel on the assigned channel for the fire area. There was no other record of communication with the pilot from either base.

1.10 Aerodrome information

Not applicable

1.11 Flight recorders

The aircraft was not fitted with a flight recorder, nor was there any legislative requirement for it to be.

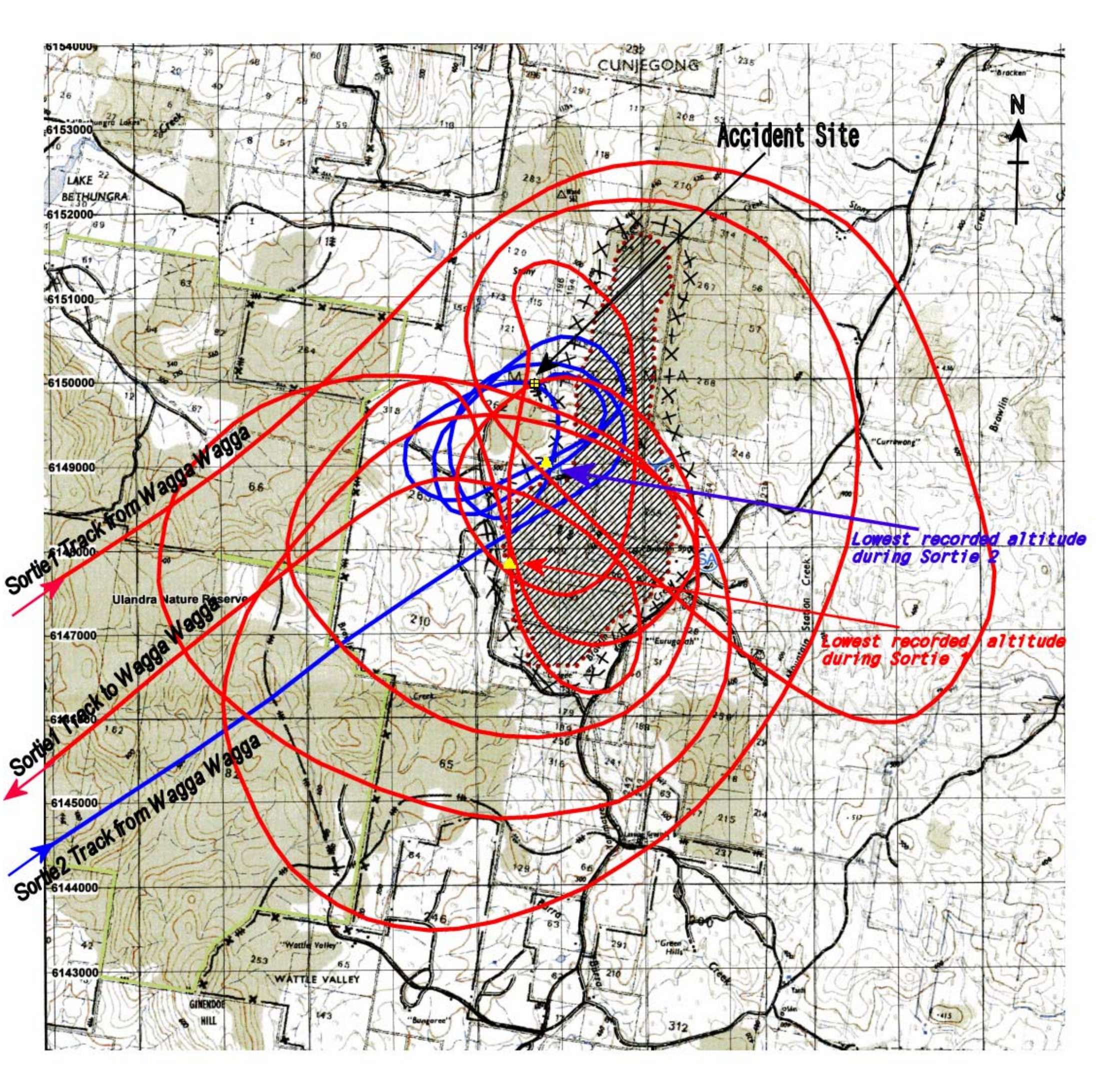
1.11.1 Global Positioning System (GPS) data

The FIRENAV system in the aircraft was not operational at the time of the accident and did not contain any recorded data. Information from the non-volatile memory of the Garmin 196 GPS navigation receiver provided a record of the aircraft’s flight path, groundspeed and altitudes. Data for those flights on which the GPS receiver was activated, dating from the 6 February 2006, was recorded at intervals that varied between 4 and 10 seconds, depending on the flight path, and averaged about one fix every 4 seconds during turns.

The data was used to plot the aircraft’s flight path for both flights made by the pilot on 16 February, a flight on 15 February (Appendix A) and compared with a flight made by another pilot in the aircraft on 6 February.

The GPS data for the first flight on 16 February 2006 (depicted in red at Figure 3), when the Dromader pilot followed the other fire bomber, showed the aircraft's flight to the fire area and a series of four, wide, right circles flown around the fire area, followed by three smaller left orbits. These were made as the pilot of the lead aircraft coordinated the best location for the retardant drop with fire fighters on the ground and with the pilot of a fire-bucket helicopter. During the last orbit, the turns were of a much smaller radius. The retardant drop was made in a southerly direction on the south-western perimeter of the fire area.

Figure 3: GPS tracks of FVF on 16 February 2006 (hatching shows fire area)



The second flight over the fire area (depicted in blue at Figure 3) was characterised by a series of left orbits over the fire area, with turns of generally smaller radius than those on the first flight. The aircraft had completed four orbits and was commencing its fifth when the accident occurred. During the third orbit, the aircraft descended briefly to a GPS altitude of 1,700 ft above mean sea level (AMSL) before climbing to approximately 2,000 ft AMSL. That low pass was made on a north-easterly heading and coincided with a swathe of retardant on the western perimeter of the fire area, north of the previous drop.

It was not possible to determine from the characteristics of the flight path if any retardant had been dropped on the fire area. A comparison with drops made on the previous flight and on the day before, showed some differences in that:

- the initial altitude gain following the descent was approximately half that of those recorded on previous occasions
- the GPS ground speed on this occasion increased to a speed approximately 10 kts less than on previous flights, and
- the aircraft made further orbits following the low pass, while on previous flights, the aircraft turned and departed the fire area.

The last indications from the GPS receiver showed that the aircraft had climbed to 2,000 ft AMSL, approximately 300 ft above ground level in the vicinity of the accident, and completed a fourth orbit at or above that level, and was descending through 2,000 ft during the final seconds of the flight. A groundspeed of just greater than 100 kts was recorded as the aircraft commenced the left turn. As the turn continued through the south-south-west, the last recorded data showed a rapid decrease in groundspeed to 80 kts and a loss of altitude.

The radius of the final turn was measured at 450 m. That radius of turn required a constant angle of bank of 33° at an estimated 110 KIAS[4]. However, computations from the GPS data based on rates of turn, indicated variations in the angle of bank up to 38° may have occurred.

1.12 Wreckage and impact information

1.12.1 Accident site and impact

The aircraft wreckage was lying in open rising terrain on the western side of a small valley at an elevation of 1,660 ft AMSL. The dry, pasture-covered ground sloped upward at an angle of 6° along the wreckage trail.

The impact damage was consistent with the aircraft having impacted the ground heavily in a nose-down, right wing-low attitude, with a high rate of descent and at a low to moderate forward speed.

The fuselage and empennage was upside down and facing in a northerly direction, 38 m south-west of the first ground impact marks. Both wings, the engine and the propeller, had separated from the fuselage during the impact sequence. Beyond the main impact point, the ground was heavily coated with the red-dyed retardant that had spilled during the destruction of the hopper (Figure 4). The three-lobed pattern of the retardant spill was consistent with a considerable quantity of the fluid bursting through the sides and top of the hopper when it was in a substantially upright attitude. No retardant was found on the ground along the aircraft's estimated flight path between the fire area and the accident site.

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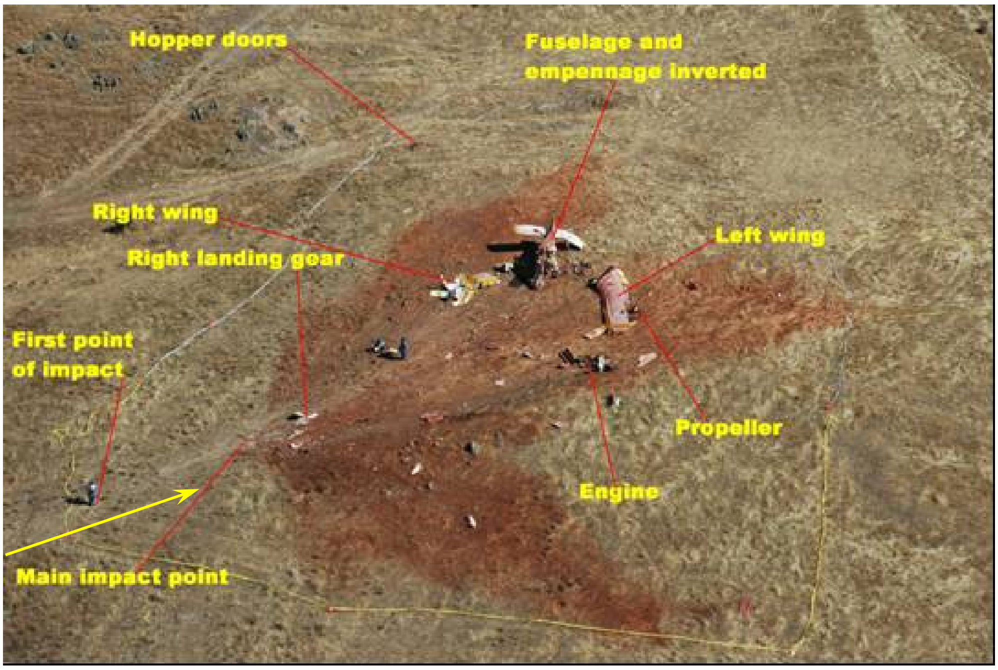
4 Indicated airspeed in knots. Indicated airspeed is used by pilots as a reference for all aircraft manoeuvres, including stalls. In this instance KIAS was calculated from average groundspeed adjusted for estimated wind correction, air density and position error correction.

Figure 4: Aerial view of the wreckage showing direction of flight



The first impact mark was made by the right wingtip. A further 10 m beyond this point was the main impact ground scar, where the engine and lower fuselage, including the hopper fire-door, had impacted the ground. A further 3 m along the wreckage trail were two of the propeller blades embedded in the ground. At this point, the engine mounts appeared to have broken away and the fibre glass hopper disintegrated as the aircraft break-up sequence commenced.

About 1 m further along the wreckage trail was the right main landing gear, which had separated from the wing. At this point the aircraft started to tumble and both main wings had separated from the fuselage. The damaged right wing lay to the east of the fuselage and exhibited considerable damage to the wing primary structure, consistent with having struck the ground. The left wing was lying on the other side of the fuselage and had separated as the aircraft tumbled. The left gear leg was attached to the wing structure but bent aft at 90°.

The right wing fuel tank had been breached and contained no fuel. The left wing fuel tank was intact and contained a significant quantity of fuel.

There was no evidence of a bird strike.

1.12.2 Propeller and engine examination

The propeller hub, with one propeller blade attached, and part of the gearbox casing had torn away from the engine and was lying behind the left wing. Two propeller blades were found buried in the ground, 3.8 m right of the initial ground contact. Those two blades were 200 mm apart and were an indication that the propeller was rotating at the time of impact. Another two propeller blades were found some distance away from the main wreckage. The separated blades had sheared from the hub at the blade root and one blade had lost 100 mm from its tip. All the blades showed substantial chord-wise damage and exhibited tip bending, tip fracture and twisting stress along the pressure side of the blades.

The engine was inspected on-site and was determined to have been developing power at the time of impact. The first stage compressor blades exhibited tip bending away from the direction of rotation. A number of blades exhibited bending along the length of the blade, indicating the rotational forces associated with an engine compressor rotating at the time of ground impact.

The engine compressor air intake walls were coated with baked-on soil that had been impregnated with fire retardant, indicating that the engine was rotating at sufficient speed to ingest the soil during the break-up sequence.

The magnetic plug (chip detector) was removed and examined and there was no evidence of contamination or metal particles. The oil and fuel filters were removed and examined and there was no evidence of contamination of either filter.

The propeller and engine both exhibited damage which was consistent with the engine developing power at the time of impact.

1.12.3 Flying and ancillary controls

All the aircraft's flying control surfaces were accounted for at the accident site and the integrity of control runs was established. The elevator trim position could not be determined. The position of the hydraulic flap actuator was found in a position that correlated to the fully retracted position. Damage to the wing flap surfaces did not indicate extension at the time of impact.

The integrity of all engine controls was established. Control positions at impact could not be established due to disruption of the control runs. The fire-door manual dump lever was in the closed position and the gate-width was found set to the maximum opening (Section 1.18.7). The fire-door switches on the pilot's left panel were removed for examination (Section 1.16). However, destruction of the fire-door and their electro-pneumatic operating mechanism prevented their testing and the determination of whether any pre-existing fault existed.

1.12.4 Stall warning

The aperture on the lower surface of the left wing for the pneumatic stall warning system was found to be clear of obstruction. Disruption of the remaining stall warning system prevented functional testing of that system. The filament from the globe in the stall warning indicator did not exhibit any evidence of stretching that would have indicated that it was illuminated at impact.

1.12.5 Emergency locator transmitter

The aircraft was equipped with an emergency locator transmitter (ELT), which was designed to transmit an emergency signal on 121.5 MHZ and 243 MHz either when manually activated or, when armed, automatically on impact.

The ELT separated from its mounting bracket and aerial during the impact sequence. Although the cockpit switch was found armed, the switch on the ELT unit was found in the off position.

No ELT signal was reported to have been detected.

1.13 Medical and pathological information

Post-mortem examination indicated that, during the impact sequence, the pilot had sustained fatal head and internal injuries.

Post-mortem and toxicology reports indicated that the pilot's performance had not been degraded by physiological or other factors.

1.14 Fire

There was no evidence of fire in flight or after impact. It is believed that the spilt retardant prevented the hot-section components of the engine igniting the dry vegetation.

1.15 Survival aspects

A damaged flying helmet was found with the wreckage. The damage to the helmet corresponded to injuries sustained by the pilot from impact forces encountered during the accident sequence, and was consistent with the helmet having been worn during flight.

The pilot was found in the inverted wreckage, still strapped to the airframe by his four-point, inertia-reel harness. Examination of the harness did not show any sign of failure.

The accident was not considered survivable due to the severity of the deceleration forces imparted during the collision with the ground.

1.16 Tests and research

1.16.1 Fire-door switches

The control switches, dump timer relay and trigger switch for the fire-door were examined and tested. The switches and dump timer relay operated normally when tested and the timer had been set to the maximum setting of 5 seconds.

1.16.2 Airframe components

A fractured aileron input lever was removed from the wreckage for further examination. Analysis of the fracture surfaces found that the component had failed as result of gross bending overload of the kind that would have been sustained during the impact. There was no evidence of any pre-impact failure.

A fractured section of the inboard, lower front spar cap, that had broken away with the separated right main landing gear, was removed from the accident site for further examination. That examination did not find any pre-existing defect and indicated a failure mode consistent with rapid bending overload, consistent with damage incurred during the impact sequence.

1.16.3 Fuel sample testing

A quantity of fuel was recovered from the aircraft's fuel system for laboratory analysis. The test laboratory report indicated that the fuel met the specification for Jet A-1.

1.17 Organisational and management information

The aircraft was operated by an organisation holding an Air Operator's Certificate issued by the Civil Aviation Safety Authority (CASA). That certificate authorised the dropping of water and fire retardant in PZL M-18 (TPE 331) Dromader aircraft as an aerial work activity. In conjunction with that certificate, CASA issued a Low Level Flying Permit to the operator, authorising flight below 500 ft above ground level that involved aerial work operations specified in the operations manual. That permit was valid for the period 1 December 2004 to 31 December 2007.

The operator had been contracted to provide fixed-wing agricultural aircraft for fire fighting operations during the summer bushfire season by a State government fire fighting authority.

The State fire authority, in its document for tender for the provision of aerial fire suppression, for the 2005/06 fire season, specified the following minimum pilot requirements for pilots in command of fixed-wing fire-bombing aircraft:

- Australian Commercial Pilot Licence or higher
- fire operations experience
- low-flying approval and experience
- Night Visual Flight Rules [rated]
- 1,000 hours Agriculture Command [experience]
- 100 hours on type
- Crew Resource Management completed.

As part of the tender process, each operator had to provide a suite of documents that were used to confirm the operator's eligibility to conduct fire-bombing operations, including a list of pilots and their aeronautical experience. The operator had provided information to the State fire authority indicating that the pilot had 702.3 hours on Dromader aircraft at 1 July 2005.

1.18 Additional information

1.18.1 Normal and Restricted category operations

The aircraft, as originally designed, was certified in the Normal Category, for use in agricultural and fire-fighting operations with a maximum certified take-off weight of 4,200 kg. That maximum weight was generally considered to be an unrealistic operating weight for fire-bombing operations.

In 1994, the manufacturer issued *Aircraft Flight Manual (AFM) Supplement No. 17 – M18B Airplane Operation*, that permitted an increase in the maximum take-off weight for aircraft operated in the Restricted Category for the agricultural and fire-fighting roles. That increased the maximum allowable take-off weight to 5,300 kg with a maximum hopper load of 2,200 kg.

Restricted category aircraft were certified by CASA in order to conduct special purpose operations as defined by the Authority. The Dromader was issued a Restricted airworthiness category for the purpose of agricultural and forest/wildlife conservation operations because it had not been shown to meet the Normal Category flight load limits at the higher weights. Accordingly, aircraft operating limitations were prescribed and restrictions on its intended use were imposed. These limitations prohibited the aircraft being flown over densely populated areas and the carriage of persons other than the operating crew. In that way, although the level of safety to the operating crew may have been reduced from that of an aircraft certified in the Normal Category, the level of safety to the public was maintained.

In October 1998, CASA issued Advisory Circular AC 21.6(0) *Restricted category aircraft – certification* that addressed overweight operations. The circular advised that aircraft structural load, airframe fatigue and flight handling studies, including flight tests, would normally be necessary before any approval for overweight operations would be granted. Any such approval would require the relevant operating conditions to be shown in a certificate of airworthiness (CoA) annex and in an amendment to the approved flight manual.

1.18.2 Operating limitations at 5,300 kg

The manufacturer's *AFM Supplement No 17* contained information specific to the operation of the M18B Dromader in the Restricted Category at take-off weights of 5,300 kg. That information included limitations on aircraft speeds and manoeuvring for structural integrity and for safety.

maximum operating airspeed in flight	104 KIAS
minimum operating airspeed in flight	92 KIAS
maximum angle of bank in turns	30˚

A note in the supplement, under the heading of 'Fire-Fighting' stated:

> The difference in the airplane behaviour during the dump of load 1,500 kg and 2,200 kg lies in the higher gain in height after dump, and is characterised by the increased pitch up moment.
>
> Gain in height after the dump of load 2,200 kg amounts to about 100 ft and a decrease in the airspeed by approximately 15 KIAS.

The section of the supplement headed 'Required Placards' stated:

> On the LH side wall of the hopper in the area of the hopper lid, the following inscription is provided:
>
> 'MAXIMUM LOAD 2200 kg,'

Amendments to the aircraft's flight manual for the engine STC modification stated that:

> This conversion has a lighter power-plant and has a lower airplane empty weight, and may allow an increased hopper load without an increase in gross weight.

That STC modification also stated that there was no change to the limitations of the certified aircraft, and that;

> Handling characteristics are essentially unchanged from the recip.-engine airplane. Stall speeds, climb speeds and approach speeds remain the same…

1.18.3 Civil Aviation Safety Authority weight exemptions

In September 2002, CASA issued exemption EX22/2002 that permitted agricultural aircraft to take off at weights greater than those specified in subregulation 235(4)[5] of the Civil Aviation Regulation (1988), provided that the excess load could be jettisoned. That exemption applied to aircraft engaged in aerial work (including fire suppression) operations, and having a Restricted Category CoA. Schedule 2 of the exemption gave operational effect to an increase in aircraft operating weights provided that the gross weight did not exceed the highest of the following weights:

- maximum weight shown in the flight manual of the aeroplane
- maximum weight shown on a placard in the cockpit of the aeroplane
- maximum weight shown on the type certificate or type certificate data sheet (TCDS) issued for the aeroplane by a national airworthiness authority.

In the first option, a flight manual supplement, such as that produced by the manufacturer of the M-18 Dromader for fire-bombing operations in the Restricted Category, met airworthiness requirements for aeroplane weights up to 5,300 kg.

Alternatively, higher aeroplane operating weights could be justified by following procedures in AC 21.6(0) for small, agricultural aircraft, or an equivalent means of airworthiness justification. That procedure required approval by CASA and could be presented in the form of either a cockpit placard or a flight manual amendment. At the time of publication of this report, CASA advised that they were not aware of any such proposals.

The third option was a reference to the notes section of the TCDS, with the weights being generally based on allowable weights derived from charts in the US Civil Aeronautics Manual (CAM) 8 and possibly flight test programs. Use of CAM 8 is basically a trade-off; allowing a weight increase at the expense of operating at lower flight load limits, with a flight test to establish that a climb gradient of 2.5% is possible.

In August 2004, CASA issued a further exemption, EX33/2004[6], which permitted pilots to operate under the previous exemption without breaching Regulation 138 of CAR (1988) that required pilots to observe the maximum take-off weights published in the aircraft flight manual. The explanatory information accompanying that exemption advised that the exemption applied to the aeroplane maximum take-off weight and that pilots continue to observe all other limitations, procedures and instructions in the flight manual. That included the manufacturer’s placard limit of 2,200 kg hopper loads.

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5 CAR 235(4) prohibited a pilot in command from taking off at gross weights in excess of the maximum take-off weight for the aircraft or a lesser weight as determined by performance considerations.

6 On 12 March 2007, CASA issued exemption number EX09/07 that in effect extended the exemption to the end of March 2009.

1.18.4 Hopper loads

Although the hopper capacity was increased to 3,000 L, the maximum hopper load depended on the specific gravity of the substance loaded into the hopper. For example, a 2,200 kg maximum hopper load of retardant, which has a specific gravity of 1.07, equated to a quantity of 2056 L.

The quantity of retardant in the hopper was only visible from the cockpit. A graduated scale, in hundreds of litres, enabled a pilot to view the level of the hopper contents through the translucent aft wall of the hopper. Pilots reported that the residual red dye of the retardant on the hopper wall could sometimes partially obscure the meniscus, making it difficult to determine the exact quantity.

The replenishment of retardant was not recorded. The ground delivery system did not have any means of measuring the quantity delivered to the aircraft and no record was made of the total quantity of retardant aboard the aircraft. Pilots reported that it was usual to carry quantities of between 2,100 L and 2,300 L (2,247 to 2,354 kg) of retardant. After the hopper overflowed during replenishment before the accident flight, the excess was discharged on to the ground. One of the ground crew reported that he estimated the discharged quantity to be approximately 200 L. Consequently, the actual quantity of retardant in the hopper of the accident flight could not be accurately determined, but was probably between 2,100 and 2,800 L (2,247 to 2,996 kg).

Although none of the pilots who flew the turbine Dromader reported operating the aircraft with a fully loaded hopper, operators of the aircraft reported that their understanding was that the hopper weight limitation applied to the original hopper and that it was not applicable to the modified hoppers. Additionally, the lighter weight of the turbine engine permitted greater payloads to be carried and the more powerful turbine engine improved aircraft performance.

The hopper modification documents did not provide justification for an increase to the manufacturer's hopper weight limitation and a few operators had sought specialist aeronautical engineering assistance in an attempt to resolve the issue. In May 2007, an operator of an M-18 obtained a pressure test report on the modified hopper from an approved aviation design office. That report recommended that the hopper limit could be increased to 3,000 kg, but would require structural analysis to confirm that the aircraft fuselage and hopper attachment fittings were able to withstand and distribute the additional load into the centre wing attachments.

In June 2007, that same design office produced a stress report for the operator, recommending that the maximum allowable hopper payload could be increased to 3,000 kg and that the hopper placard be amended accordingly. The report noted that the operation of the aircraft was still subject to all other approved limitations specified in the aircraft flight manual, including maximum take-off weight (MTOW) limitations. Significantly, that stress analysis had not included the wing and wing attachments and any increase in the hopper payload, and consequently an increase in maximum take-off weight, would have to be accommodated by a corresponding decrease in the aircraft's limit load factors. The analysis used, as an example, a MTOW of 6,100 kg.

Airworthiness Circular 21.6(0) *Restricted category aircraft – certification*, stated that in addition to any substantiating data for aircraft structural loads, fatigue and flight handling studies and flight tests would normally be necessary. Approval for operations at weights in excess of the maximum take-off weight and at reduced limit load factors required CASA approval. At the time of publication of this report, CASA advised that it was not aware of any applications for approval to operate aircraft at weights in excess of those established by the manufacturer.

1.18.5 Aircraft weight and centre of gravity

The actual quantity of retardant in the hopper at the time of the occurrence was not known. Aircraft weight and centre of gravity (C of G) calculations were made using the estimated fuel quantity at the time of the accident and hopper loads of 2,100 and 2,800 L of retardant, resulting in aircraft gross weights of 5,295 and 6,044 kg,.

The aircraft manufacturer published C of G limits for the M18B Dromader operations at weights up to 5,300 kg. The operator provided weight and balance documentation for the modified aircraft that included the manufacturer's centre of gravity envelope. Although the weight scale on that chart provided for aircraft weights in excess of 5,300 kg, the forward and aft limits on the envelope did not project beyond the manufacturer's design maximum weight limit in the Normal Category of 4,200 kg.

Computations made using retardant loads up to 2,800 L indicated that the aircraft's centre of gravity, although outside the manufacturer's published envelope, was forward of the projected aft C of G limit at those higher weights. The investigation did not determine the validity of C of G locations outside of the manufacturer's envelope.

1.18.6 Fire-door operation

The fire-door attached to the aircraft's hopper could be operated either manually or by electro-pneumatic actuators.

The electro-pneumatic actuators were controlled by two toggle switches and a rotary timer switch on the pilot's lower left panel and a trigger switch on the control column. A pilot could select a partial or full drop using the timer switch on the panel. The rotary timer switch allowed the fire-door to remain open for the selected time and was graduated from 0 to 5 seconds. One of the toggle switches on the panel armed the system and a trigger switch on the pilot's control column actuated the door. Another toggle switch on the panel operated the emergency dump by over-riding the timing system and the trigger, and opened the door.

Manual operation was via a dump lever to the left of the pilot's seat. Moving the lever forward and down manually opened the door. A manually adjusted stop controlled the gate width[7], allowing for graduated dispersion rates.

Pilots reported that before making a drop they checked the switch selections and the pneumatic pressure, then as the drop was made, physically checked the movement of the lever. If the lever did not move, indicating that the system had not activated, they would immediately open the fire-door using the lever and manually drop the retardant. They reported that a load of retardant typically took between 2 and 3 seconds to dispense.

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7 Gate width referred to the opening between the two halves of the fire-door when opened. Adjustment restricted that opening to achieve the desired rate of dispersion.

Pilots commented on the nose-up pitching moment experienced when retardant was released. The usual technique was to counter the anticipated effect by applying nose-down elevator trim before the release and applying forward elevator on the control stick as the retardant was released.

1.18.7 Aircraft stall speeds and recovery

The aircraft manufacturer published charts for the calculation of power-off stalling speeds in the flaps up and flaps 30° aircraft configurations. The chart variables allowed for calculation of stalling speeds at aircraft weights up to 5,300 kg and for angles of bank up to 60°. For example, the stalling speed at 5,295 kg in a power-off, steady flight with no flaps, was 78 kts.

Stall speeds increased with increasing aircraft weight and load factor. Weights greater than 5,300 kg would result in stalling speeds greater than 78 kts. For example, the increased aircraft weight with a hopper load of 2,800 L of retardant, resulted in a calculated 5 kts increase to that stalling speed, or 83 kts. At an angle of bank of 38º the stalling speed was calculated to increase by a further 10 kts, to 93 kts. The use of power reduced stalling speeds slightly, but that was not factored into the charts, nor was the 7 % reduction in stalling speeds claimed by the manufacturer of the vortex generator kit. In the above examples, that claimed reduction should have resulted in a stalling speed of between 82 and 87 kts, depending on the hopper load.

The aeroplane flight manual stated that the maximum altitude loss after a stall in the turn was 200 ft. The amended manual for the turbine aircraft did not specify any different values to the manufacturer’s published figure. No information was available for the affect that weights greater than 5,300 kg would have on the aircraft’s stalling speed or stall recovery characteristics.

The aeroplane flight manual stated that the stall warning device activated at speeds approximately 5 to 10 kts above the stalling speed and pilots who had performed stalls in turbine Dromader aircraft reported that there was ample aerodynamic warning of an impending stall. Pilots who had stalled Dromader aircraft with vortex generators reported that approaching a stall, the loss of control responsiveness was not as progressive, and could make stall recognition by sensing control feel less noticeable. Recovery from the stall was reported to be normal, although they thought that the loss of altitude during recovery was greater than 200 ft. Those pilots who had stalled the aircraft reported that the manoeuvre had been performed at lighter weights and with an empty or near empty hopper.

2 ANALYSIS

2.1 Accident scenarios

Without any direct evidence of the actual events that occurred in the cockpit of the aircraft immediately prior to the loss of control, it is not possible to conclusively determine why the aircraft may have stalled. At high operating weights, the aircraft's handling was more critical because of the diminished margin between stalling and safe-flight speeds, thereby limiting the opportunity for the pilot to recognise the stall symptoms and take corrective action.

It is possible that the pilot, while manoeuvring the aircraft to make another fire-bombing run, may have inadvertently allowed the aircraft angle of bank to increase, and the aircraft stalled during the turn. Once the aircraft had departed controlled flight there was insufficient altitude for the pilot to regain control of the aircraft before colliding with the ground.

Distractions during high pilot workload situations may have allowed stall symptoms to go unrecognised by a pilot with limited flying experience on the modified aircraft.

2.2 Fire-bombing operations

Fire-bombing involves a significantly higher risk than many other low-level flying operations undertaken by agricultural pilots. A heavily loaded aircraft at low level, in heat and turbulence, sometimes in reduced visibility due to smoke, and frequently over inhospitable terrain, exposes pilots to hazards that would be unacceptable in most other circumstances. Despite these risks, this was only the second fatal accident involving a fixed-wing aircraft engaged in fire-bombing operations in Australia since these commenced in the early 1960s.

On this occasion, the level of risk associated with fire-bombing should not have been as great as in more extreme conditions. The lighter wind conditions, the absence of smoke and turbulence, and the generally open, hilly terrain of the fire area, were described by the other fire-bombing pilots as benign. Additionally, the pilot had dropped retardant on the same section of the fire area less than an hour before and should have been familiar with any hazards.

Organisations that undertake fire suppression air work are conscious of the attendant risks and require of their crews a greater level of experience than required for other aerial application operations. The State contracting authority in its tender documents specified pilot qualifications and minimum levels of experience, including 100 hours as pilot in command of the aircraft type. It did not specifically require a pilot's experience on each variant of the aircraft types. The operator had supplied the agency with the pilot's total experience on Dromader aircraft, which showed that the pilot exceeded the minimum requirement. At the time of providing that information, the pilot was not endorsed on turbine Dromader aircraft that the operator primarily used for fire-bombing operations.

The pilot of the Dromader was an experienced agricultural pilot who had considerable previous fire-bombing experience in radial-engined Dromader aircraft, as well as considerable flying experience in other agricultural turbine aircraft. The chief pilot had assessed the pilot as competent to conduct fire-bombing operations in the turbine-powered Dromader, even though the pilot's total flying time on the turbine-powered Dromader consisted only of endorsement and familiarisation flying. Prior to commencing fire-bombing duties at Wagga Wagga, the pilot did not have any actual operational flying experience on the aircraft.

When operating an unfamiliar aircraft, a pilot would normally operate with increased safety margins and consequently not place as great a demand on flying skills. Although the actual hopper loads were not known, it was possible that the pilot had previously used lighter hopper loads, and that the weight of retardant on the accident flight might have been the heaviest load the pilot had ever carried in the aircraft. At greater weights, the margin between a safe flying speed and the aircraft's stalling speed narrows and requires more attention to manoeuvring and more careful manipulation of the flight controls. Experience and familiarity with the slow speed handling characteristics of an aircraft is required to recognise and avoid an aerodynamic stall.

2.3 Flight path information

Recorded data from the Global Positioning System (GPS) receiver provided only a groundspeed derived from the point-to-point fixes and resolved in a two-dimensional plane. Slight inaccuracies to that speed could be expected in all but straight flight because the information represents a chord between the two points and not the actual flight path. That would result in a slightly lower speed than that actually flown. Additionally, any vertical component of the aircraft's velocity vector is not included in the calculation, resulting in a speed less than the actual air speed. The amount by which the speed is under-represented increases as the aircraft's flight path approaches the vertical.

The aircraft's true airspeed could not be accurately determined because the actual wind vector was not known and the atmospheric conditions in the area were not recorded. Although exact calculations could not be made, airspeeds that were derived using the available wind and temperature information indicated that the aircraft's speed decreased below that of the aircraft's stalling speed during the turn.

Likewise, the aircraft's stalling speed could not be accurately determined from the information available. The exact aircraft weight was not known and the stalling speed of the modified aircraft at weights greater than 5,300 kg were not published. Similarly, the exact angle of bank was not known. Calculations using the radius of turn and rate of change of heading indicated that the angle of bank during the turn exceeded the maximum limit for operations in the Restricted Category. Using figures based on reasonable estimates of the known data, the indications were that the aircraft's speed had reduced to the range of probable stalling speeds during the turn.

The aircraft was seen to be making a left turn at a height estimated to be 300 ft above ground level. That was consistent with recorded GPS data. The observed aircraft attitude in the last moments of flight, reported as being banked left at nearly 90 °, was consistent with a wing drop following a stall. Ground scars, indicating a right wing-low, nose-down aircraft attitude at impact, may have resulted from attempted recovery action by the pilot. Insufficient altitude did not permit recovery before the aircraft collided with the ground.

2.4 Fire-door malfunction

Due the extent of accident damage it could not be determined if there had been a malfunction of the electro-pneumatic fire-door actuating system. The cockpit switches were correctly set and capable of normal operation. The reason for the reported partial drop on the previous flight could not be determined, nor was it possible to determine if any retardant had been dropped on the fire area before the aircraft collided with terrain.

Although the operation of the fire-door could not be tested due to damage, the likelihood of a malfunction in the manually-operated dump lever was considered to be most unlikely with liquid hopper contents.

2.5 Overload operations

Pilots, who loaded aircraft above weights certified by the manufacturer or as approved, did so without published performance data, stalling speeds and the assurance that the aircraft's handling met certification standards. The requirement to be able to quickly jettison the excess load meant that the aircraft would be returned to within its original certified weight limit, and that the aircraft's stall characteristics and stall recovery would be unchanged from those of the certified aircraft. If pilots were unable to jettison their loads, for whatever reason, and an aerodynamic stall occurred, pilots would be flying an aircraft in an untested area of its flight envelope.

Civil Aviation Safety Authority exemptions that permitted agricultural aircraft in the Restricted Category to take-off and operate at higher weights did not permit exceedence of other published aircraft weight limits. At the time of the accident, the maximum weight that could be carried in the hopper was 2,200 kg.

Although the cumulative affect of exceeding maximum hopper weight limits may have an adverse affect on the aircraft structure, this was not assessed to be a factor in the circumstances leading to the accident.

3 FINDINGS

3.1 Contributing factors

- The pilot lost control of the aircraft during a turn at low altitude and at a height that was insufficient to recover the aircraft to normal flight. The loss of control was most probably the result of an inadvertent aerodynamic stall.

3.2 Other safety factors

- The pilot's limited experience on the modified Dromader aircraft, and a possible distraction, may have affected his ability to recognise an impending stall condition and to respond in sufficient time to maintain aircraft control.
- There was no evidence that the pilot had ever attempted stall recovery manoeuvres during his endorsement training and familiarisation flights in the aircraft, thereby limiting the opportunity for pilot recognition of the stall.

3.3 Other key findings

- The aircraft may have been operated with hopper loads that frequently exceeded the manufacturer's published weight limit of 2,200 kg.

4 SAFETY ACTIONS

4.1 Civil Aviation Safety Authority

In June 2006, the Civil Aviation Safety Authority (CASA) issued Regulatory Policy CEO-PN008-2006 *Fire Fighting Operations.* This policy was not issued to address any safety concerns identified in this or any other occurrence, but to replace a previous policy that CASA considered 'over prescriptive, too procedural and difficult to understand'. The stated intention is to incorporate the key elements of the policy into the proposed Civil Aviation Safety Regulations Part 137.

The policy was issued to clarify that CASA considered that aerial fire fighting, while not specifically listed in Civil Aviation Regulation 206, was an aerial work activity. The policy addressed safety issues such as operations over populous areas, aircraft gross weight limits, flight crew qualifications and flight and duty limitations[8].

4.2 State fire authority

The State fire authority reviewed its minimum pilot qualifications for aerial fire suppression operations. The review was made with aviation specialist consultation and resulted in changes to the minimum pilot requirements. Pilots in command of fixed-wing aircraft had additional requirements added that included recency and turbine experience. Time on type was increased and the different aircraft types were specified to remove any ambiguity that may have previously existed. The Expression of Interest document, dated July 2006, for operators bidding for tenders for the provision of aerial fire suppression, listed the following requirements for pilots in command of fire-bombing fixed-wing aircraft:

Licence required	Commercial Pilot Licence (A) or higher
Total time	1,500 hours
Time on type	200 hours or 50 hours if other relevant type experience (see table for listing of similar types).
Total turbine (if turbine operations)	50 hours
Recency requirements	5 dumps within the previous 35 days
Agricultural work	1,000 hours
Fire experience	20 targeted dumps in fire fighting aircraft over 10 hours, and 100 hours other fire experience

8 The operation of the accident aircraft and the pilot's qualifications and experience met the criteria specified in the policy.

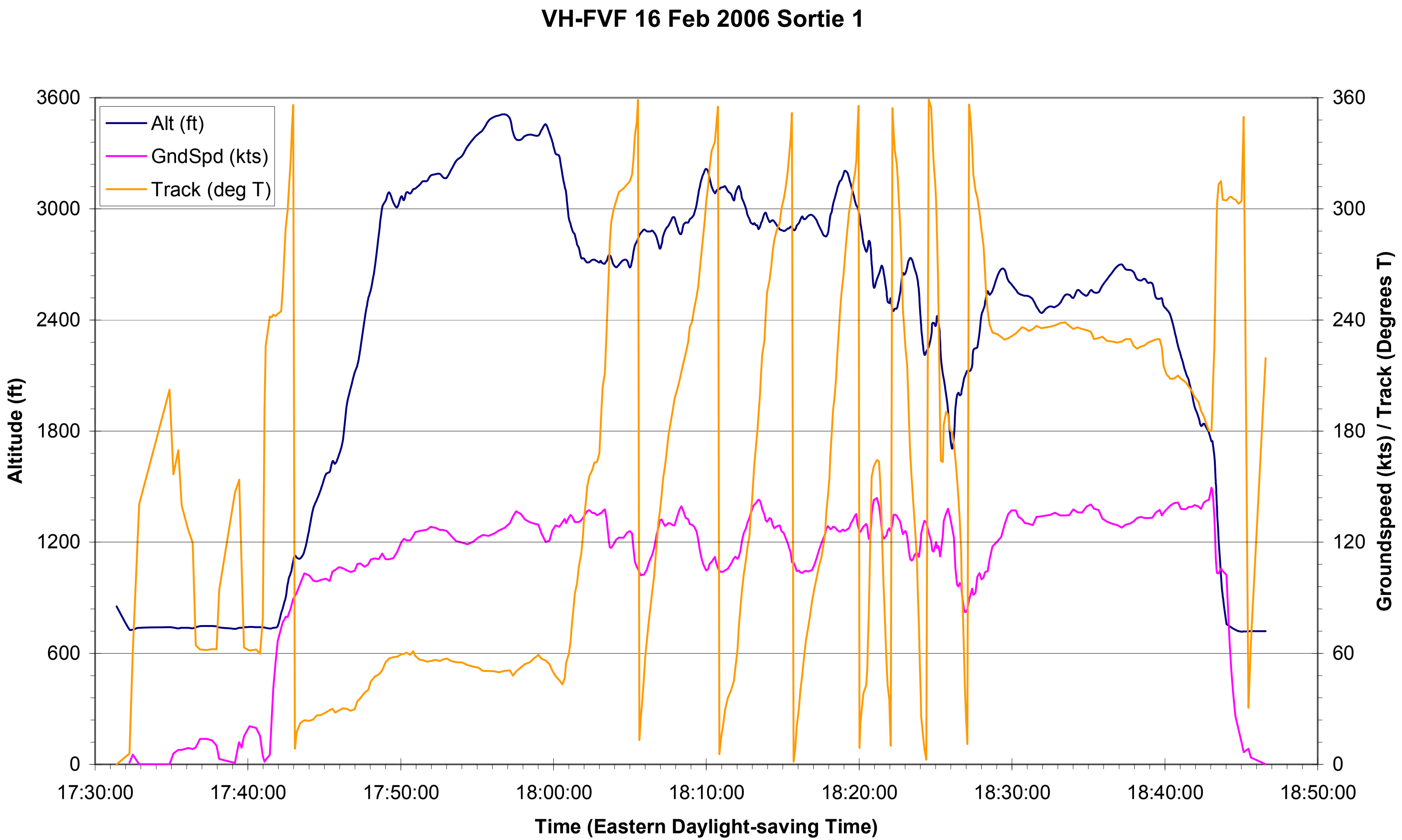
Low-flying training and experience	Agricultural pilot rating Grade 1 and including 100 hours in mountainous environment
CRM course	Required within the previous 24 calendar months
Wire-strike avoidance training*	Mandatory

* A note indicated that this requirement was still under development.

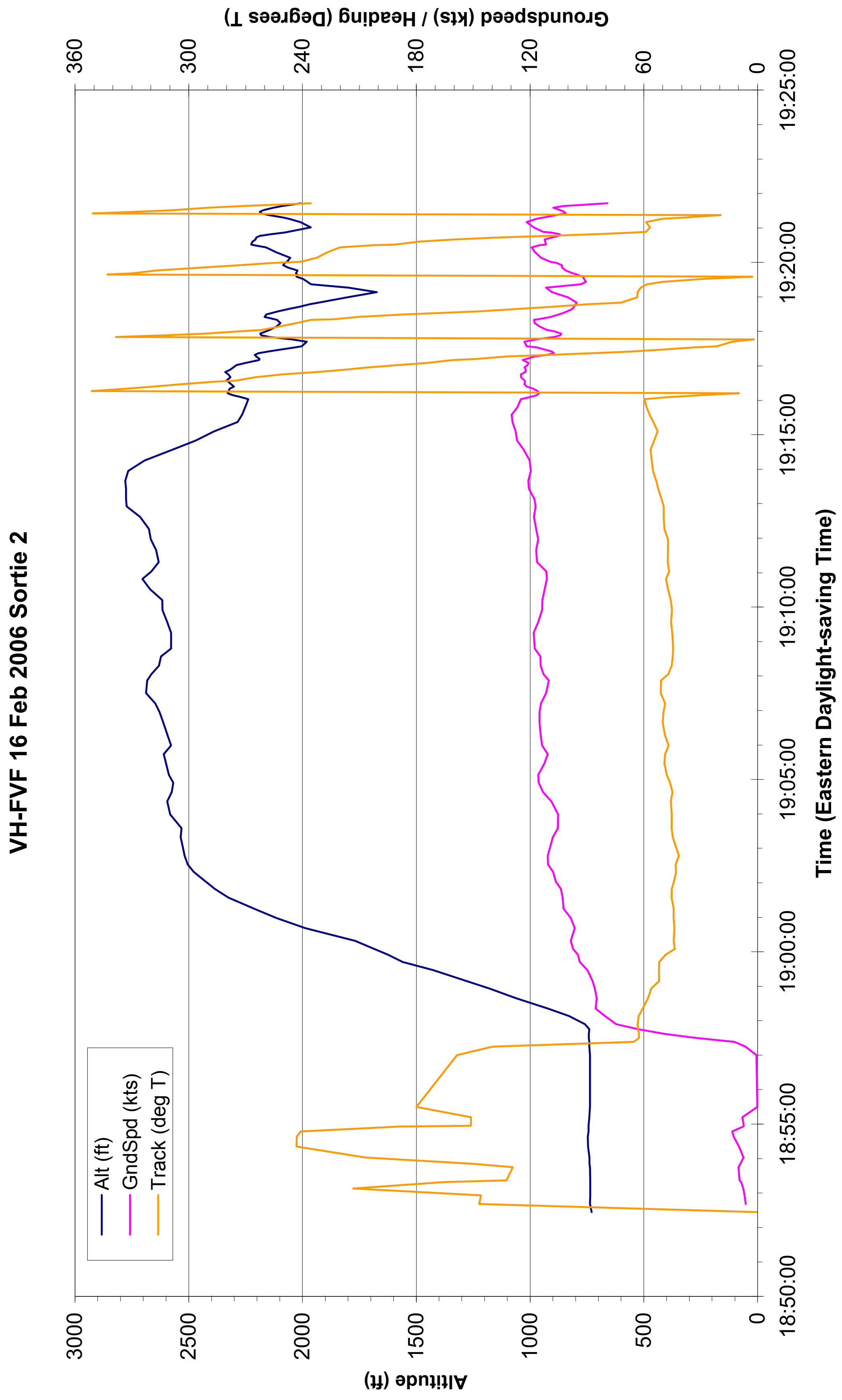
A *Schedule of Similar Aircraft* listed the Dromader 18B aircraft under *Group 1-Piston radial.* A separate list of turbine-powered agricultural aircraft, that included the turbine-powered Dromader, appeared in *Group 2 – Turbine*.

5 APPENDIX A - GPS DATA FROM VH-FVF

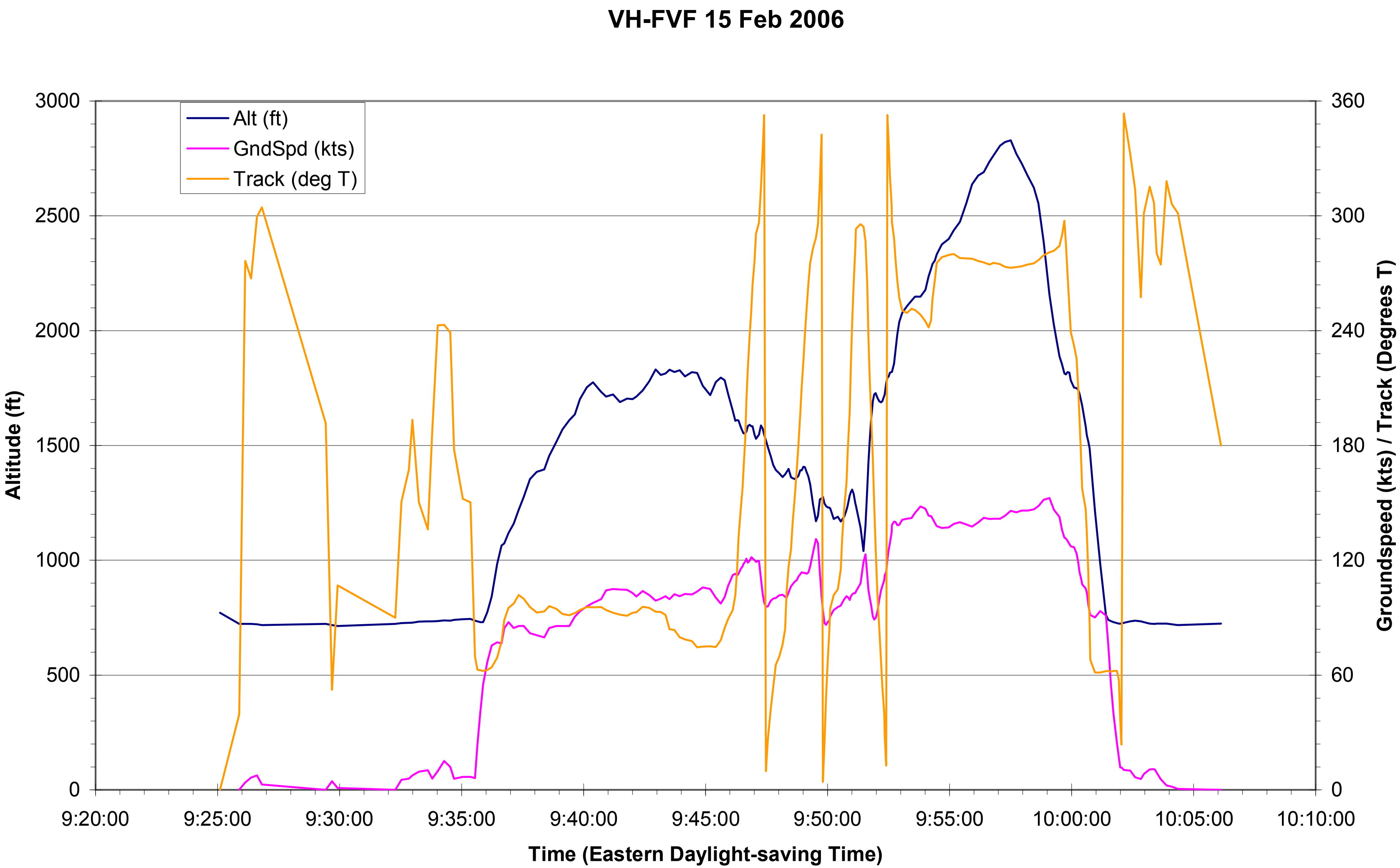
Recovered GPS data from the aircraft's receiver for the flight on 15 February 2006 and for both flights made on 16 February 2006 was downloaded and the parameters for track, groundspeed and GPS altitude was plotted and is presented on the following charts.



VH-FVF 16 Feb 2006 Sortie 1
Alt (ft)
GndSpd (kts)
Track (deg T)
Altitude (ft)
Groundspeed (kts) / Track (Degrees T)
Time (Eastern Daylight-saving Time)
0
600
1200
1800
2400
3000
3600
0
60
120
180
240
300
360
17:30:00
17:40:00
17:50:00
18:00:00
18:10:00
18:20:00
18:30:00
18:40:00
18:50:00



VH-FVF 16 Feb 2006 Sortie 2
Alt (ft)
GndSpd (kts)
Track (deg T)
Altitude (ft)
Groundspeed (kts) / Heading (Degrees T)
Time (Eastern Daylight-saving Time)
0
500
1000
1500
2000
2500
3000
0
60
120
180
240
300
360
18:50:00
18:55:00
19:00:00
19:05:00
19:10:00
19:15:00
19:20:00
19:25:00


VH-FVF 15 Feb 2006
Alt (ft)
GndSpd (kts)
Track (deg T)
Altitude (ft)
0
500
1000
1500
2000
2500
3000
Groundspeed (kts) / Track (Degrees T)
0
60
120
180
240
300
360
9:20:00
9:25:00
9:30:00
9:35:00
9:40:00
9:45:00
9:50:00
9:55:00
10:00:00
10:05:00
10:10:00
Time (Eastern Daylight-saving Time)

6 APPENDIX B - SUMMARY OF AGRICULTURAL AIRCRAFT OVERWEIGHT OPERATIONS IN AUSTRALIA

The following information was provided by the Civil Aviation Safety Authority (CASA).

The type certification process for an aircraft requires that the aircraft be designed to meet certain air load limits. For a normal category aircraft designed to FAR 23 it must be able to sustain a load of'3.8G at a nominated gross weight without showing any signs of stress after the load is removed. The aircraft must also be able to sustain a load of 5.7G without failing (although damage might be evident).

The gross weight nominated in the design then becomes the maximum take off weight specified in the flight manual. Civil Aviation Regulation (1988) 138 requires that the pilot in command of an Australian aircraft must comply with the flight manual. Civil Aviation Regulation (1988) (CAR) 235(4) prohibits the taking off' in an aircraft if its gross weight exceeds its maximum takeoff weight.

In the period soon after World War II the need for agricultural aircraft in the US was met through the use of ex-military training aircraft. These aircraft were designed for high-G loadings but a load limited to crew of two and fuel only. Since there was no requirement for the high G loading a trade off was made to reduce the G-load but increase the gross weight. This was legislated in the US by the issue of Civil Aeronautics Manual 8 that even after some fifty years is still the cornerstone that allows most agricultural aircraft in the US to operate at higher than design weights. Newer models of agricultural aircraft are designed to Federal Aviation Regulations (FAR) Part 23, with particular allowance made for restricted category agricultural aircraft.

To facilitate overweight operations in Australia, the Civil Aviation Safety Authority has issued exemptions against the requirements of CAR 138 and 235. Basically these exemptions allow operations up to weights where jettisoning the hopper load will reduce the gross weight to below the flight manual maximum takeoff weight, so long as the gross weight at takeoff does not exceed the higher of a weight shown on (a) the aircraft type certificate data sheet (TCDS), or (b) a placard, or (c) the approved flight manual.

(a) For the majority of agricultural aircraft there is a "demonstrated satisfactory operation" weight shown in their TCDS. These gross weights account for not only the ability of the aircraft structure to sustain the higher weights but also safety of flight operations, including the ability to maintain a climb rate of' around 200 feet per minute.

(b) Use of a placard weight might come about in two ways; it might be a placard put there by the aircraft manufacturer (perhaps in lieu of an approved flight manual) or put there as a modification approved by a CAR 35 delegate after appropriate flight testing at a higher gross weight. Further details of this process can be obtained from the Tamworth CASA Office.

(c) If the approved flight manual maximum weight is acceptable then there is no practical use for the CASA exemptions. It is important to note that at weights in excess of the design gross weight additional loads will be imposed on the aircraft and pilots should restrict manoeuvre loads and speeds to compensate for increased loads on the aircraft structure. The increased weight may also pose handling difficulties.

7 MEDIA RELEASE

Final ATSB investigation report on fatal fire-bombing accident

The ATSB's final aviation investigation report into a fatal fire-bombing accident south of Cootamundra last year found that the pilot lost control of the aircraft during a low altitude turn and that his lack of experience on the modified Dromader turbine-engined aircraft may have been a contributing factor.

The Australian Transport Safety Bureau notes that this was only the second fatal accident involving a fixed-wing aircraft engaged in fire-bombing operations in Australia since they commenced in the early 1960s, despite the high risks associated with that type of flying.

In contrast to frequently experienced severe conditions, this accident on 16 February 2006 occurred in warm to mild weather with good visibility, gentle winds, and over relatively benign terrain.

The deceased pilot was an experienced agricultural pilot with previous fire-bombing experience. Although he had considerable flying experience on radial-engine Dromader aircraft, and in other turbine agricultural aircraft, his total flying experience in the modified turbine Dromader was only 4.7 hours. Prior to commencing duty two days previously, the pilot had not flown fire bombing operations for three years.

The report concluded that the pilot's limited familiarity with the handling characteristics of the modified and heavily-loaded aircraft might not have allowed adequate recognition of an impending stall. The pilot had not jettisoned the load of retardant and the aircraft stalled while the aircraft was being manoeuvred at a height that did not permit recovery before colliding with the ground. The possibility that the pilot was distracted by either a problem with the operation of the fire doors or some other activity could not be determined.

Subsequently, the State fire authority reviewed the minimum pilot experience levels for aerial fire suppression. That review included more accurately reporting a pilot's experience on specific aircraft types to ensure minimum requirements were met prior to being rostered for fire-bombing operations and also introduced minimum recency requirements.