Australian Government

Australian Transport Safety Bureau

Collision with terrain involving experimental ASH-25E glider VH-GOA

13 km west-north-west of Bathurst Airport, New South Wales, on 21 January 2018

ATSB Transport Safety Report

Aviation Occurrence Investigation

AO-2018-009

Final – 17 December 2019

Released in accordance with section 25 of the *Transport Safety Investigation Act 2003*

Publishing information

Published by: Australian Transport Safety Bureau
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Addendum

Page	Change	Date

Safety summary

What happened

At about 1250 Eastern Daylight Time on 21 January 2018, a Schleicher ASH-25E (AMT Jet) experimental powered glider, registered VH-GOA (GOA), was launched from the Bathurst Soaring Club facilities (Piper's Field) New South Wales. The experienced pilot intended to conduct a cross-country flight, and was the sole occupant.

Eight minutes into the flight, the glider had climbed to about 2,200 ft in a thermal. Shortly after, it abruptly started to descend and track back towards the airfield. Witnesses saw smoke or liquid trailing from the glider and flames in the area behind the cockpit.

At about 1300, when at about 1,100 ft AGL, the pilot jettisoned the front-seat canopy but did not exit the glider. Fire engulfed more of the rapidly descending aircraft's fuselage before it collided with the ground in a nose-down attitude. The pilot was fatally injured, and the aircraft was destroyed.

What the ATSB found

The glider caught fire in-flight, with flames seen near the engine housing. However, due to the severe post-impact fire damage, the ignition source of the fire could not be determined. The pilot was probably attempting to return the burning glider to the airfield when it departed controlled flight and collided with terrain. The loss of control was probably due to the effects of fire incapacitating the pilot and/or affecting the aircraft's flight controls.

The ATSB found that the pilot had the necessary equipment to make an emergency egress from the glider to escape the effects of the fire. He jettisoned the glider's canopy but possibly due to incapacitation, did not exit.

Finally, the glider's cockpit and engine housing were not separated by a firewall. That resulted in limited containment of smoke and fire, and reduced the available time to make an emergency exit.

What's been done as a result

Following the occurrence, the Gliding Federation of Australia published an Airworthiness Directive and Airworthiness Advice Notice, both entitled *Engine Compartment Fire Containment and Retardation*, which provide guidance regarding fire safety. The Airworthiness Directive requires all powered glider operators to inspect and repair fire retardant paint, fit 'in case of engine fire' cockpit placards, and ensure there is no flammable material on the cockpit side of any firewalls.

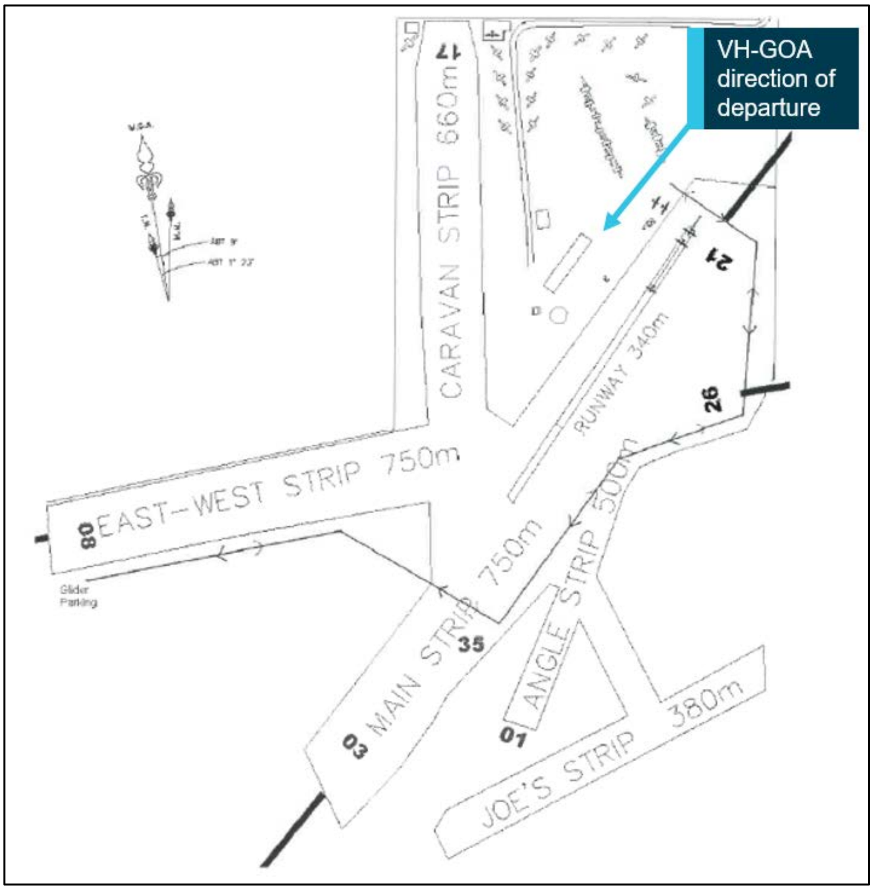
Safety message

Although not an airworthiness requirement, pilots of powered experimental gliders are strongly encouraged to install fire protection between themselves and the engine housing. The ability to exit a glider relies on avoiding incapacitation that can happen quickly in the event of in-flight fires.

The occurrence

At about 1250 Eastern Daylight-saving Time[1] on 21 January 2018, a Schleicher ASH-25E (AMT Jet) experimental powered glider, registered VH-GOA (GOA), launched from the Bathurst Soaring Club's facility at Piper's Field, New South Wales (Figure 1). The glider was launched by an aero-tow aircraft from runway 21 with the pilot as the sole occupant. The purpose of the flight was for GOA and another glider to conduct a cross-country flight. The other glider launched about 5 minutes before GOA.

Figure 1: Bathurst Soaring Club facilities at Piper's Field



Source: Bathurst Soaring Club, with permission, modified by ATSB

Witnesses at the airfield reported that, after departing, (Figure 2, item 1), GOA tracked out for about 1.5 NM. The pilot released from the aero-tow aircraft at 800 ft above ground level (AGL)[2] (Figure 2, item 2), made a radio call on the Soaring Club frequency that he had disengaged from the aero-tow. On-board GPS position and altitude information showed that by 1258:58 GOA had climbed to 2,205 ft AGL in a thermal situated to the south of the airfield. The glider then abruptly departed the thermal and started to descend and track back towards the northern end of the airfield (Figure 2, item 3).

Witnesses reported seeing something trailing from GOA, which they thought was smoke or a liquid, while the glider was in a steep nose-down attitude. They then saw flames emanating from the top and bottom of the airframe, behind the cockpit (Figure 3). The pilot jettisoned the front seat canopy at 1259:52, at a height of about 1,100 ft AGL (Figure 2, item 4), but despite wearing a parachute, he did not exit the glider.

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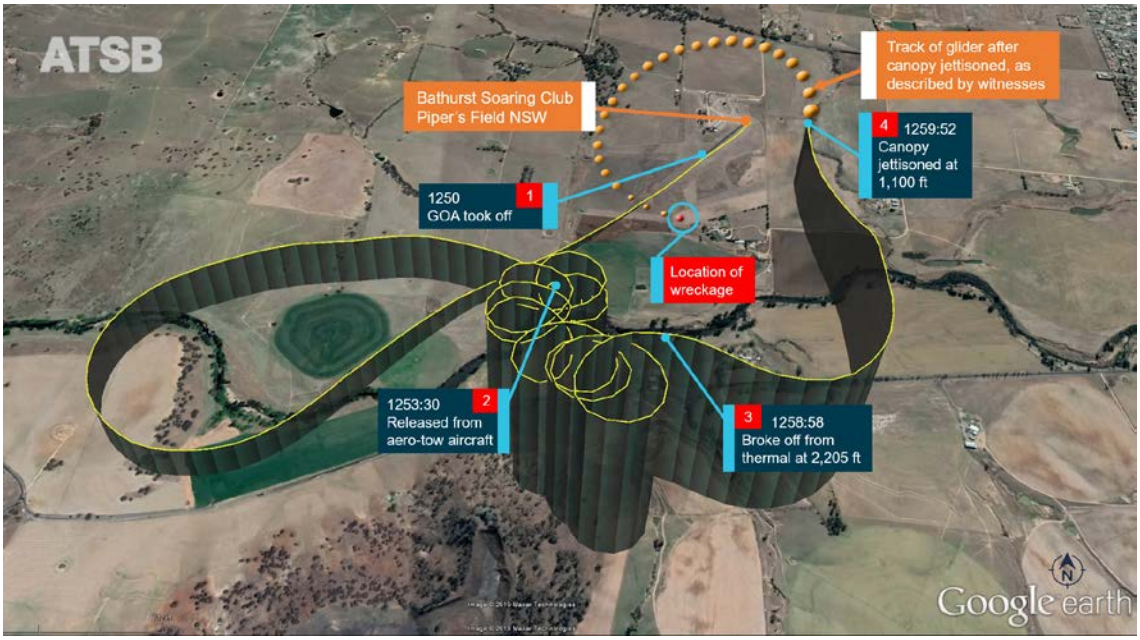
1 Eastern Daylight-saving Time (EDT): Universal Coordinated Time (UTC) + 11 hours.

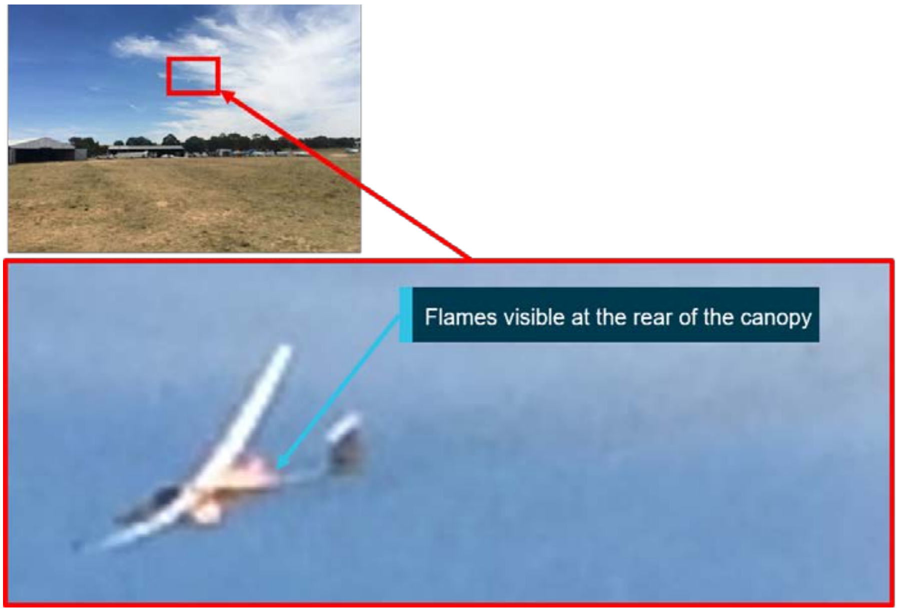
2 Above Ground Level (AGL): the height measured with respect to the underlying ground surface.

Figure 2: Aircraft track as recorded by the on-board GPS and as recalled by witnesses



Source: GPS data overlaid on Google earth, annotated by ATSB

Figure 3: Photograph of GOA after the front canopy was jettisoned



Source: Witness photograph, modified by ATSB.

At this stage, GOA was seen maintaining a steep nose-down attitude and high speed with a bank angle of about 15°. Witnesses also recalled that there did not appear to be any discernible control inputs after the canopy was jettisoned and by the time the glider descended to about 500 ft AGL, more of the fuselage was engulfed in fire. At about this time, at least one of them called emergency services.

The soaring club's closed-circuit television camera recorded that the glider banked left just prior to impact (Figure 4). A witness similarly reported that the glider's left wing tip impacted the ground first, before it came to rest in an inverted position. The wreckage continued to burn after impact, and a fire spread to the surrounding grass.

Some witnesses moved to the accident site with handheld fire extinguishers to control the fire. About 10 minutes later, fire services arrived on the scene and extinguished the fire before it spread to neighbouring properties.

The pilot received fatal injuries and the aircraft was destroyed.

Figure 4: The glider immediately before impact

Source: CCTV camera still image, modified by ATSB

Context

Pilot information

The pilot held a valid Glider Pilot Certificate issued by the Gliding Federation of Australia (GFA) in October 2017. He also held a Private Pilot (Aeroplane) License that was issued in July 1977. In addition to holding all necessary qualifications for gliding operations, his endorsements included:

- carriage of private passengers
- cross-country/touring (self-launching sailplane)
- low level finish
- self-launching sailplane

At the time of the occurrence, the pilot had accrued between 8,000 and 11,000 hours of gliding experience over more than 2,000 flights. The pilot also held a maintenance authority to conduct specific powered glider and airframe maintenance.

The pilot held a valid medical Certificate of Fitness issued by a Medical Practitioner as required by GFA. The criteria for issuing a Certificate of Fitness were based on the medical standards that Austroads set for issuing a driver's license medical certificate for a private motor vehicle. He had previously held a class 2 aviation medical certificate, which expired in 2012.

Evidence to assess the likelihood of the pilot experiencing fatigue was gathered, including available information on sleep obtained, any factors potentially affecting his ability to maintain adequate alertness during the flight, and other aspects that affects sleep opportunity. However, there was insufficient evidence to ascertain whether the pilot was likely to have been experiencing a level of fatigue known to affect performance.

Aircraft information

The Alexander Schleicher ASH-25E is a two-seat, mid-wing, powered sailplane with camber changing flaps, t-tail unit, retractable landing gear, and provision for water ballast. The aircraft also has a retractable engine pylon that accommodates a Rotax 275 engine, designed for self-sustaining flight. The engine pylon extension/retraction mechanism was powered by a 12 V lead-acid battery. The glider had front and rear canopies, each of which could be separately jettisoned in-flight by the pilot.

The major construction materials for the ASH-25E airframe included carbon fibre-reinforced polymer rebar in the wings and winglets, carbon and aramid fibres in the fuselage, hard foam sandwich in the fin, wings and control surfaces, and fibreglass in the winglets. The flight control cables were steel ropes, the long push rods were aluminium alloy, and the shorter push rods were steel.

VH-GOA was manufactured in Germany in 1988. In 2010, the pilot removed the Rotax engine and propeller and replaced them with two diesel-fuelled Titan AMT gas turbine engines. Two 25 L collapsible fuel cells were installed into the wing root to supply the replacement engines. Information about the design standards, the cockpit and canopy, the engines, fire protection and maintenance is summarised below.

Design and airworthiness

Following the engine modification, the glider was re-classified as experimental, and listed as an ASH-25E (AMT Jet). This re-classification meant there was no regulatory requirement for GOA to comply with existing design standards.

A special Certificate of Airworthiness (CoA) was issued in 2014 under the Civil Aviation Safety Regulations (CASR) Part 21.191 *(i) Private Operation of a Prototype Aircraft* for the purposes of research and development, showing compliance with regulations, exhibition and air racing. Under the CoA, the glider was expressly limited to using the jet engines for 'sustainer flight'[3] only. Once the glider was listed as an experimental aircraft, the aircraft could be modified, but operated under the GFA under Civil Aviation Orders (CAO) 95.4 *Power-assisted sailplanes, powered sailplanes and sailplanes*.

The Gliding Federation of Australia published the Manual of Standard Procedures (MOSP) Volume 3 *Airworthiness Procedures* and, under Section 2.6 *Experimental Certificate*, it outlined that:

> Flying in an aircraft under an [Experimental Certificate] is entirely on the basis of voluntary acceptance of risk by the persons who elect to do so [and that person] should ensure they have sufficient knowledge to understand the nature of the risk...GFA promotes innovation and some member's desire to build, modify and service their own aircraft.
>
> EC's may only be issued in accordance with CASR Part 21.191 to 21.195B. All ECs will clearly list the terms and limitations applicable to the allowed flight(s)…

Cockpit and canopy

The cockpit of GOA contained two seats, one behind the other. The pilot operated the glider from the front seat on solo flights. In addition to the standard instruments, installed equipment included two engine control unit (ECU) displays, a rear-facing camera (to see the engines when operating) and an 'LxNav' flight recorder.

A placarded canopy jettison release handle was positioned on the top right side of the instrument panel (Figure 5).

Figure 5: View from front seat in GOA's cockpit

Source: Flight Manual, amended by the ATSB

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[3] Sustainer flight: to sustain or extend the glider in flight including maintaining level flight or initiating a climb.

Engine start system

The two vertically-aligned Titan AMT Netherlands gas turbine engines were installed on the existing dual-sided pylon. The Titan was constructed from a single radial compressor and an axial flow turbine stage (Figure 6). Fuel attachments on the front cowl of the engine, with Teflon tubing and push-in Polytetrafluoroethylene (PFTE) fittings were used. The engines were housed in the engine bay when not in use, and were raised as part of the one-switch start sequence.

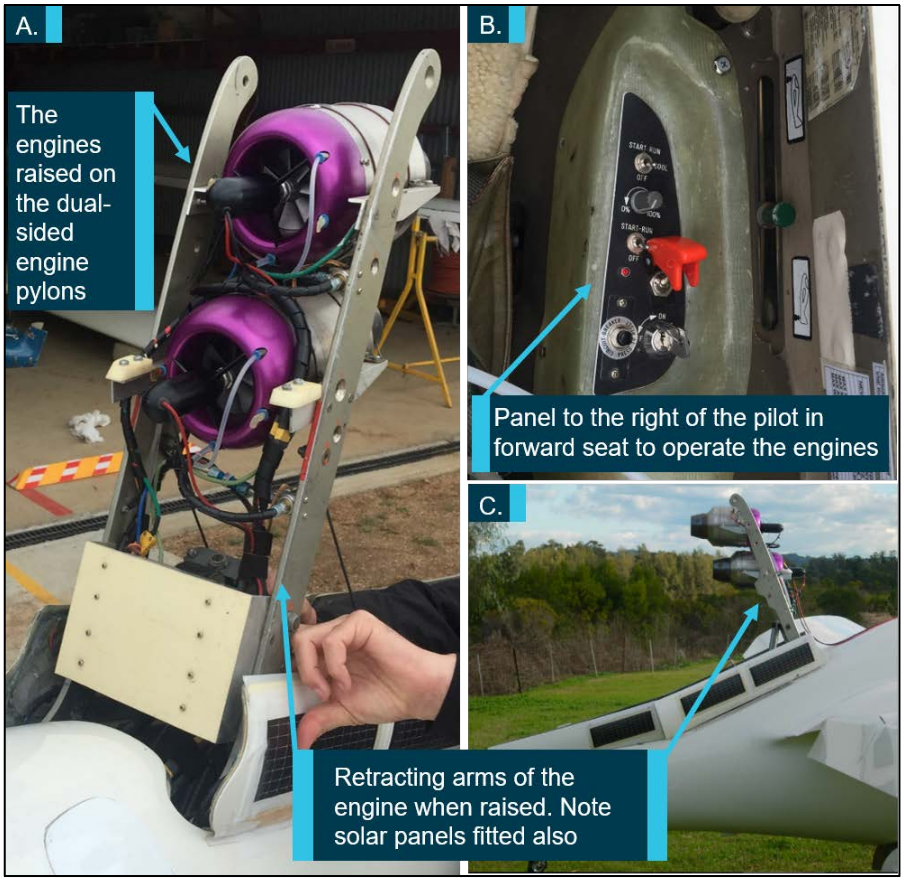
The Titan engines' fuelling and operating speed were controlled by the two electronic control units (ECUs), which also regulated performance, and were each powered by a lithium polymer battery. The ECU displays were fitted inside the cockpit (Figure 5). The engines' ignition system was designed in a manner to prevent start-up when the pylon was lowered. In the event of an emergency, the flight manual recommended lowering the pylon, which would cause the fuel flow to stop immediately.

The ignition system for the engines comprised a disposable propane gas bottle installed in the engine bay. The specially developed *ASH-25J Flight Manual* for GOA contained further information on the propane system:

> A disposable canister of propane connects to two solenoid operated valves which are controlled by the ECU. These valves are open only during the start up phase. PFAN tubing is used to carry the propane gas...Since the valves are open only during the start phase of the engine, the risk of gas release through ruptured hoses is minimised.

The engines were started sequentially. An electric starter would spin up the turbine, a glow plug activated, and propane was then fed into the engine. If the propane ignited successfully, the EGT would start to increase and the fuel pump would switch on. The solenoid valve to the propane was then closed.

Figure 6: Images of the engines fitted to GOA



Source: ASH-215J Flight Manual

The ATSB conducted a bench test on the fuel system plumbing, constructed from plastic tubing to confirm the product was fire-resistant. The test results showed that the tubing had high temperature resistance and did not support combustion.

ECU batteries

A dedicated rechargeable lithium polymer (LiPo) battery powered each engine's running circuit. The batteries were situated at the rear of the cockpit along with the other ECU components, the lead-acid battery, fuel lines, and other electrical leads and components (Item B in Figure 7). The fuel lines from the wing fuel cells were situated next to the batteries.

Thermal runaway describes an accelerating process whereby increased temperature releases energy that in turn further increases temperature. If defective, or handled improperly, some rechargeable batteries with sealed cells can explode during thermal runaway. The ASH-25J Flight Manual noted that 'LiPo batteries are potentially dangerous', and that it was important to ensure that they were protected from mechanical forces and the effects of heat due to their 'high energy density'. The GFA investigation report for this occurrence stated that:

> [LiPo batteries] can undergo thermal runaway…due to overcharge, over-discharge, over-temp, short circuit, mechanical damage…

Witnesses reported seeing the pilot removing the LiPo batteries after a flight the day before, and recharging them.

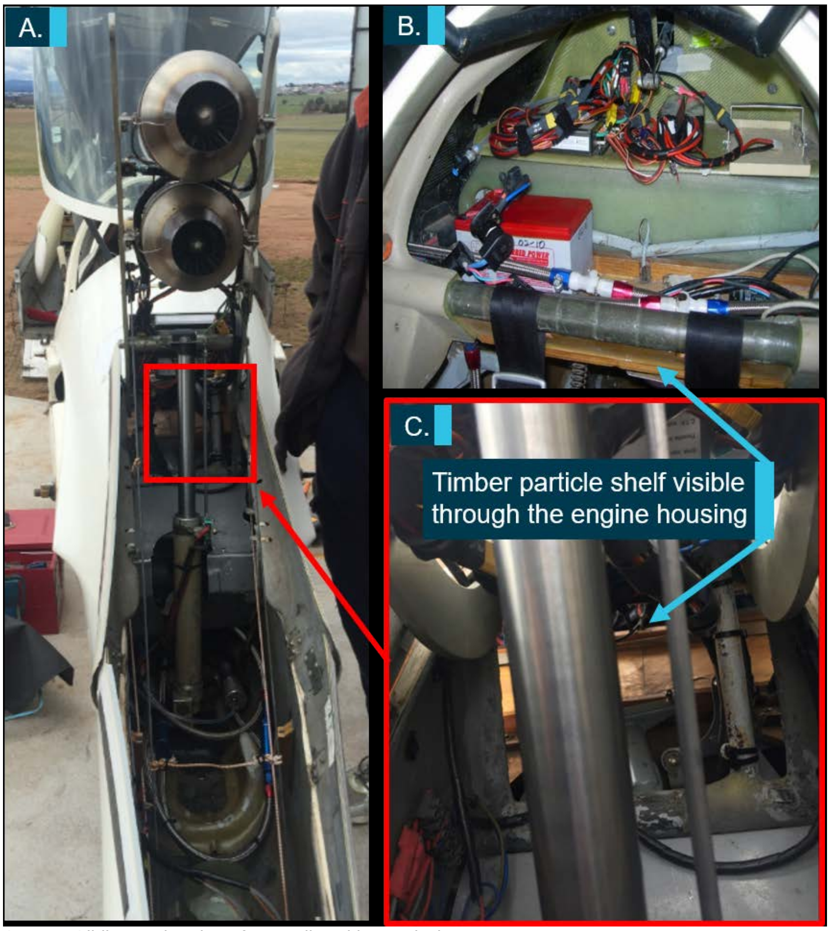
Fire protection

Sealed firewalls reduce the spread of fire and prevent the leakage of flammable substances, like propane gas or diesel, reaching the cockpit.

When lowered, the engines were accommodated within the fuselage tail boom (Figure 7, item A). Regarding the aircraft design, Schleicher confirmed that the 'ASH-25E was not [originally] equipped with a forward firewall' and it appeared that during the subsequent modification, one was not added. Schleicher also confirmed that 'the factory-made engine compartment was primed with a fire protection paint'.

Between the engine housing and the shelf in the cockpit, there was an unobstructed opening through to the timber particle shelf (Figure 7, item B and C). In their investigation report, GFA stated that 'it is likely that when the two stroke engine removal [was done], the electronic shroud cover and carbon fibre electronics bay were removed from the aircraft and not refitted.' An inspection of the images of the particle shelf, and remnants of fuel lines, indicated that there did not appear to be any heat protective sleeves used.

Figure 7: Engine housing and cockpit (A. Engines – rear view, B. Cockpit area – rear view, C. Area between engine housing and particle shelf)



Source: Gliding Federation of Australia, with permission

The European Aviation Safety Agency (EASA) Certification Specification CS-22 *Sailplanes and Powered Sailplanes* (introduced in 2003) set design specifications applicable to the manufacturing of Schleicher gliders. Under *Power-Plant Fire Protection*, it outlined that:

> The engine must be isolated from the rest of the sailplane by a firewall, shroud or equivalent means.
>
> The firewall or shroud must be constructed so that no hazardous quantity of liquid, gas or flame can pass from the engine compartment to other parts of the sailplane…The firewall and shroud must be fireproof...

The materials accepted as fireproof included stainless steel (0.38 mm thick), mild steel sheet (0.5 mm thick), and/or steel or copper-based alloy firewall fittings.

The CASR 1988 Part 22 *Airworthiness standards for sailplanes and powered sailplanes* stated that the standards set out in EASA CS-22 were in force. The engineering report to support the experimental CoA stated that there was little risk of fire in the engine bay, as the engines were only able to operate in a raised configuration. That report did not document any specific consideration of compliance with the firewall requirements outlined in CS-22, although due to its experimental classification there was no regulatory requirement to comply.

Aircraft maintenance

General information

The special CoA stipulated that glider maintenance was to be conducted in accordance with the manufacturer’s recommendations, the requirements of the GFA *Manual of Standard Procedures* (MOSP) 3 and the *Maintenance Manual ASH 25-J Turbo Engine Project*. A review of the aircraft’s maintenance documentation indicated that there was no history of issues associated with the fuel system, batteries or engines.

Pre-flight maintenance issues

On the day before the occurrence, the pilot was observed performing ground testing on the glider's engines. A video was also taken of the tests. Significant observations included:

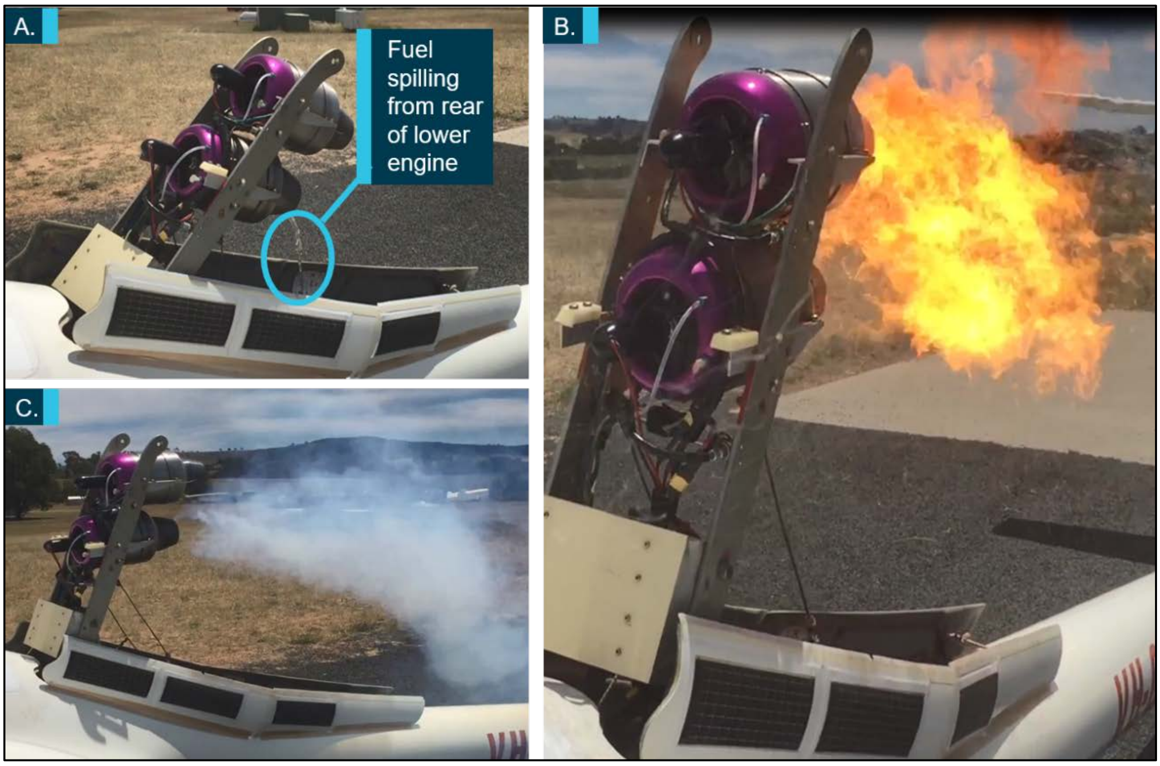
- fuel pouring out of the lower engine on lowering (Figure 8, item A)
- significant engine flaming (Figure 8, item B)
- white smoke billowing from the lower engine (Figure 8, item C)

After shutting down the engines, the pilot was heard on the video commenting that the exhaust gas temperature (EGT) read 906 °C. The maintenance manual for the engines listed an EGT of 700 °C as normal. Following the engine testing, the pilot took a passenger for a flight. The passenger reported that the pilot did not start the engines during the flight. After landing, the passenger helped the pilot with further engine testing.

The ATSB considered how the recorded fuel leak from the lower engine may have occurred, and consulted with gliding experts and the manufacturer. They advised that there may have been a leak within the fuel lines, or at the connection point between the PFTE tubing and the engine cowling. It was the manufacturers' opinion that this can occur when the lines are roughly cut (for example using pliers).

It was evident from the video taken that the radial compressor on the lower engine was not rotating. Therefore, another possible source of the leak may have been the way the fuel flow was initiated. The system was designed to engage the fuel pump only when the engine speed reached a certain level. Therefore, it should not have been possible for fuel to flow while the compressor was not rotating.

Figure 8: Photographs from engine testing



Source: witness, with permission

Operational information

The ASH-25E flight manual listed operating limitations, including a 'never exceed speed' (V_{NE}) of 151 kt. The normal operating speed range for the glider was between 52-97 kt.

Pre-flight checks

According to the ASH-25J flight manual, a pre-flight inspection of the engines was required, including raising the engine pylon, inspecting all hoses for leaks, all electrical cables and connections for integrity, and checking the security of restraining wires and the engine bay floor for leaks. The GFA Inspector's handbook for powered sailplanes stated that a daily walk-around was required, which included an inspection of the battery installation, instruments and radio, oxygen bottle and systems and powerplant, and a 'check [that] there are no fuel or oil leaks'.

Witnesses, and others who knew the pilot, reported that he would often perform an engine run prior to departure, but they did not see him do so on the day of the occurrence.

In-flight engine use

In order to deploy and operate one or both of the engines in-flight, the pilot needed to:

- turn on the key switch
- activate the master circuit breaker
- move the engine pylon switch forward and wait till it had raised (which the pilot could see via a rear-facing camera) then, after seeing START CLEARANCE on the ECU,
- move one or both of the engine control switches forward to START/RUN and then open up the throttle once the ECU displayed STARTED UP.

The ASH-25J Maintenance Manual outlined that the engine's pylon circuit was powered from the glider's 12V battery, and triggered the START CLEARANCE on the ECU, without which the engines could not be started.

Stopping the engines in flight was achieved by selection of a POWER DOWN switch. In an emergency, selection of the STOP/OFF position or movement of the pylon switch rearwards would instantly stop the fuel.

Recorded data

The ATSB recovered data from a flight recorder unit that the pilot had fitted to the canopy of GOA. The device was a LxNav Nano flight recorder, which is a 66-channel GPS receiver, altimeter and effective noise level sensor. The standard recording rate is once per second, and the unit was configured to automatically start recording once movement above 1 m/s was detected.

Medical and pathology

Post-mortem/toxicology reports and consultation with aviation medical experts identified that:

- With regard to possible smoke inhalation, examination results 'suggest that the deceased may not have had the chance to inhale the smoke related to the fire'.
- The pilot suffered from advanced stage coronary artery disease at the time of the occurrence but there was insufficient evidence to determine if that may have influenced the development of the accident.

Survivability

Egress assist cushion

The pilot had designed his own egress assistance cushion to allow an easier in-flight exit from the glider, particularly if the occupants needed to egress in the case of a mid-air collision. It consisted of two hermetically-sealed carbon dioxide cartridges from commercially-available life jackets that fed the gas through to an inflatable bag via a manifold and flexible hose (Figure 9). Using it required both hands – one to steady the pouch, and the other to manipulate a lanyard.

In the case of an emergency that required abandoning the aircraft, the pilot would jettison the canopy first, undo the seat harness, open the flap of the pouch to reveal a lanyard attached to the actuators, and then pull the lanyard to activate the flow of gas.

Due to the extent of fire damage, it could not be determined whether the pilot deployed the egress assistance cushion.

Figure 9: The components of the egress assist cushion

Source: ATSB

Pilot parachute

Glider pilots typically wear a parachute to exit a glider in an emergency. The passenger that the pilot had taken flying the day before recalled that they both wore a parachute, and the egress assistance cushions (described above) were in both the front and rear seats on the glider. Images from the wreckage indicated the pilot was wearing a parachute.

The most common minimum deployment height of parachutes typically worn by glider pilots was 500 ft AGL.

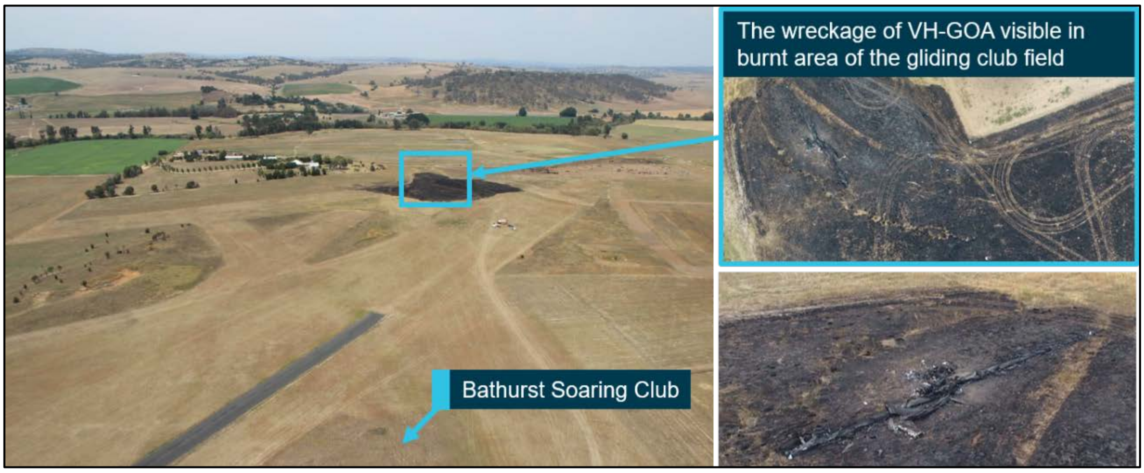
Site and wreckage

Wreckage location

The aircraft wreckage was located in a large burnt patch of grass on the property of Bathurst Soaring Club, about 445 m away from the threshold of airstrip runway 03. The wreckage trail was spread across about 125 m. Ground scars and evidence from the wreckage indicated that GOA impacted the ground in a nose-down, left wing configuration in a northerly direction, then rolled or tumbled after the initial impact and came to rest inverted. It was determined that the impact sequence was likely not survivable. The in-flight fire continued and spread to the surrounding area (Figure 10).

The shattered components of the canopy, as well as the GPS unit and flight recorder, were found on private property adjacent to Piper's Field, about 440 m away from the fuselage.

Figure 10: Location of the wreckage on the Bathurst Soaring Club property



Source: ATSB

On-site examination

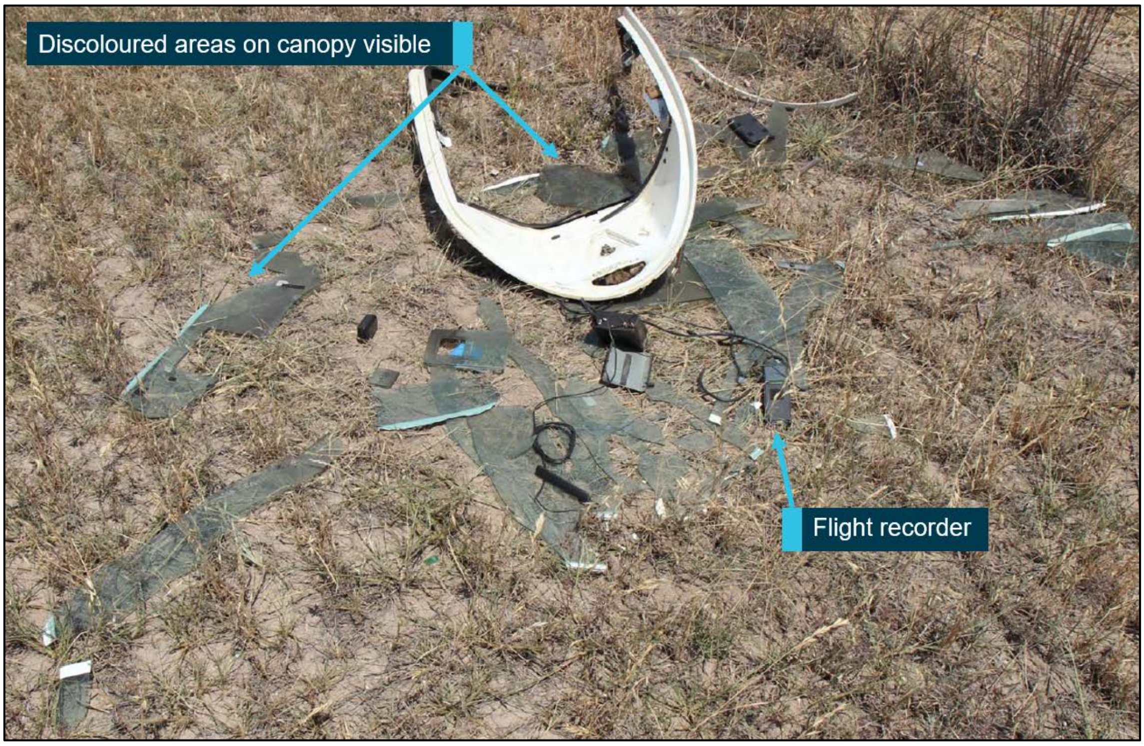
On-site examination of the severely fire- and impact-damaged fuselage, wings (Figure 11) and engines did not identify any obvious pre-existing faults that could have contributed to the accident. The wings, although destroyed in the post-impact fire, had all carbon fibre structures accounted for. The flap position at time of impact could not be determined. The engine pylon appeared to have been lowered at the time. A propane canister was found, but damage from the fire meant that it was not possible to determine whether it had contained any gas. The landing gear mechanism was found in the extended position, suggesting it had been lowered prior to the impact. The pilot was located within the wreckage around the area of the cockpit, although it could not be determined if he was secured in his seat.

A small number of components were retained for further examination and testing. The shattered components of the canopy's Perspex were also examined. There was evidence of smoke residue on some of the shards (Figure 12) on the internal side of the canopy. There was also some residue on the forward third on the external side of the canopy's 'clearview' hatch. These indicated that there was some smoke inside the cockpit, and it had passed through that hatch.

Figure 11: Wreckage of VH-GOA

Source: NSW Police

Figure 12: Canopy in-situ (in a field adjacent to the Bathurst Soaring Club)



Source: ATSB

Related occurrences

The pilot and the same glider were involved in a previous occurrence reported to GFA. On that occasion, during the launch of the glider, the pilot 'noticed abnormal engine readings and saw flames coming from the jet engine via the monitor.' In response, the pilot shut down and then lowered the engine and continued the flight.

Other related occurrences

In 2007, GFA completed its investigation into an occurrence involving a Stemme model powered glider S-10, registration VH-ZVT involved in in-flight fire, which resulted in two fatalities. The investigation identified that at some stage before impact, the pilot jettisoned the canopy. The GFA also determined that the complex nature of the fuel systems on board, and the use of fuel lines that were not fireproof, would have allowed any leaking fuel to come into contact with engine-related heat sources.

The United States National Transport Safety Board investigated an accident involving a Stemme S10-VT in Wisconsin on 14 July 2001. The pilot took off using the engine in its self-launching capacity. Shortly after, the engine began running rough and smoke entered the cockpit. The pilot shut down the engine, initiated an emergency landing and exited the glider. Within five minutes of the engine failure, the aircraft was engulfed in flames. The fire originated in or around the engine compartment. Following that occurrence, it was recommended that certification standards require the evaluation of the engine compartment such that liquids, smoke and gases cannot pass freely between it and the cockpit, and for extinguishing systems be installed.

In 2017, the Air Accident Investigation Branch in the United Kingdom issued a special bulletin relating to a battery fire on board an HPH Glasflugel 304 eS powered sailplane. It was determined that there was insufficient warning to the pilot of a fire in the front electric sustainer (FES) battery compartment, and that fires behind the pilot are difficult to see. This reduced the time available for a pilot to make a decision about abandoning the aircraft by parachute. One of the recommendations was for the European Aviation Safety Agency to require manufacturers to install a FES warning system in all powered sailplanes to alert the pilot to fire or smoke.

Safety analysis

In-flight fire

From the available information, in-flight flames were first seen near the engine housing, at the rear of the cockpit. Therefore, the ATSB considered potential ignition sources associated with the engines and the lithium polymer (LiPo) batteries.

Engine-related ignition source

Normal operation of the engines only provided an ignition source during the start sequence or when operating. The design of the engine systems prevented the engines from starting while lowered and stowed. Specifically, the START CLEARANCE on the ECU was not displayed until the pylon was fully raised, and an interlock prevented engine start in the lowered position. While a malfunction that bypassed these mechanisms could not be ruled out, it was considered unlikely that the start sequence initiated while the engines were housed inside the fuselage.

The pilot had experienced an in-flight engine fire on VH-GOA (GOA) in the past, and had reportedly lowered the engine into the housing to extinguish it. While it was therefore likely that he would have performed the same action if faced with another in-flight fire, the ATSB could not find any supporting evidence that the pilot attempted to start the engines in flight. Specifically:

- The pilot did not run the engines on the ground before the occurrence flight. Given his reported past practice, this indicated that he was not intending to use them.
- Witnesses reported that they did not hear the distinctive sound of the engines either before or after the departure of GOA. It was also not possible to discern from the witness photos whether the engines were raised.
- The rate of climb that GOA achieved in the thermal was possible without the engines.
- The engines were likely lowered at the time of the impact (although it was not possible to determine what their position was at all times during the flight).

The ATSB was therefore unable to determine if the source of the fire was related to an attempt (successful or not) to raise and start the engines. However, given the recorded engine operation the previous day - fuel leakage and excessive flaming, similar in-flight behaviour during the accident flight could have resulted in an airborne fire. Additionally, as propane ignites at lower temperature than the diesel fuel, a propane leak could also have plausibly ignited.

Prior to the installation of the jet engines in 2010, the ASH-25E had a forward shroud and fire protection paint within the engine housing, but it appears the shroud was removed with the original engine. Based on several sources of evidence, there was no effective fire protection between the engine housing and the cockpit on GOA.

Thermal runaway

The pilot had charged the batteries on the evening before the occurrence. If a battery experienced thermal runaway, the resulting heat would be sufficient to ignite any diesel or propane nearby, as well as causing the fuselage to combust. However, due to the intense post-impact fire, the battery was not identifiable within the wreckage so it was not possible to assess the likelihood that it was the source of ignition.

Summary

The investigation found that the in-flight fire probably started near the aircraft's engine housing. However, the extent of fire damage precluded identification of the specific ignition source.

Despite that, the circumstances of this accident (and previous occurrences) clearly illustrate the importance of having a sealed firewall to prevent, or at least delay, the effects of fire reaching the cockpit area. In that context, the ATSB recommends that any modifications to powered gliders are conducted with reference to the European Aviation Safety Agency Certification Specification CS-22 *Sailplanes and Powered Sailplanes*.

Loss of control and collision with terrain

After disengaging from the aero tow aircraft, the glider started to climb in a thermal. The other glider that departed a few minutes before GOA climbed to about 10,000 ft in the same thermal, indicating that it would likely have supported the continuation of a positive climb for GOA. Therefore, when the pilot of GOA broke off from the thermal, this was probably a result of identifying the fire behind the cockpit. The glider then tracked back towards the direction of the airfield.

The subsequent high rate of descent indicated that the pilot probably deployed the glider's air brakes to expedite the descent. The glider passed by the threshold of runway 21 when in the continuous nose-down, left-bank attitude, a configuration that could indicate the pilot was no longer in control. It collided with terrain in this same configuration at a relatively high speed.

The ATSB assessed that the control loss was probably due to the effects of fire incapacitating the pilot and/or affecting control of the glider.

It is possible that the pilot became incapacitated, for the following reasons:

- exposure to smoke, fumes or fire (there was evidence that smoke entered the cockpit)
- a medical event, possibly linked to the stress of the in-flight fire and/or his coronary heart disease
- the canopy or associated airflow may have impacted the pilot as it was jettisoned.

Based on the available evidence, the ATSB was not able to determine whether the pilot became incapacitated prior to the impact with terrain. However, as discussed further below, the apparent partial completion of the egress sequence could support that conclusion.

Images of GOA just prior to impact indicated that the glider was structurally intact prior to impact however, it is possible that the flight control cables and/or pushrods were damaged by the in-flight fire. Due to the severity of the post-impact fire, it was not possible to ascertain if the flight controls were fire-damaged before the ground impact.

Glider egress

The ATSB established that the pilot was wearing a parachute, which probably had a minimum deployment height of 500 ft, and that he was probably sitting on his egress assist cushion. He therefore had the necessary equipment to be able to exit the glider.

The time between the pilot breaking off from the thermal and then jettisoning the canopy was about 54 seconds, and it appeared as though the glider was under control. However, witnesses reported the fire visibly became more intense over that time. There was smoke residue on the inside of the canopy, which indicated that the pilot was exposed to at least one incapacitating factor before jettisoning the canopy. Fire smoke contains a mixture of narcotic and irritant gases, and incapacitation results from exposure to this combination, where 'incapacitation' encompasses a range of possible conditions, including unconsciousness, severe physical distress, or inability to determine how to escape (Gann, 2004).

Jettisoning the canopy required the pilot to pull a handle in the cockpit. This indicated that he was not incapacitated up to that moment. However, it is possible that after jettisoning the canopy, the pilot was not able to exit due to incapacitation. Alternatively, he may have assessed that he was now too low to exit the aircraft, or made a conscious decision to land the glider.

Findings

From the evidence available, the following findings are made with respect to the collision with terrain on the experimental ASH-25E glider, registered VH-GOA that occurred 13 km west-north-west of Bathurst Airport (Piper's Field) on 21 January 2018. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- Shortly after launch, an in-flight fire commenced near the engine housing. The ignition source of the fire could not be determined due to severe post-impact fire damage.
- The pilot was probably attempting to return the burning glider to the airfield when it departed controlled flight and collided with terrain.
- The pilot had the necessary equipment to make an emergency exit from the glider and escape the effects of the fire. He jettisoned the glider's canopy but possibly due to incapacitation, did not exit.

Other factors that increased risk

- The glider's cockpit and engine housing were not separated by a firewall. This limited containment of the in-flight fire, resulting in greater exposure of the pilot to fire/smoke and reduced egress time.

Safety action

Whether or not the ATSB identifies safety issues in the course of an investigation, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following proactive safety action in response to this occurrence.

The Gliding Federation of Australia

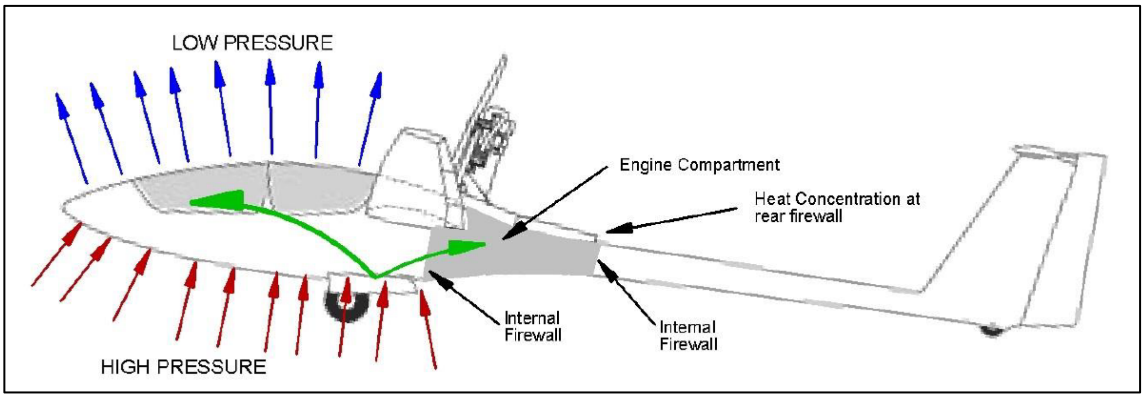
As a result of this occurrence, and others throughout the gliding and recreational aviation sectors, GFA advised the ATSB that on 11 March 2019, GFA published an Airworthiness Advice Notice (AAN), and on 15 March 2019 published an Airworthiness Directive (AD), both entitled *Engine Fire Containment and Retardation.* The affected aircraft types included all self-launching and power-assisted sailplanes, including those fitted with jet engines.

The AAN stated that:

> …many instances have been found of potential fire hazards in the form of fuel leaks, oil leaks and deficient exhaust systems. Instances found of fires starting, then self-exhausting. Adding to the mix are some powered sailplane types that may not fully meet the fire protection standards…'

The AAN outlined the fire protection standards from EASA publication CS-22 (summarised in the *Context* section of this report), the engine installations of key concern (including the 'fully buried' engine such as GOAs), and the risks of defects in any fire retarding paint. Intumescent paint was suggested for use, which is 'a paint cover which, when heated, expands [to shelter] the material it is covering, from heat and combustion...' Glider pilots were also encouraged to consider the effects of airflow on fire propagation, and used a diagram of the ASH 25E (Figure 13). Lastly, the AAN covered pilot actions in the case of an engine fire, with the key advice being to shut off the fuel supply and contain the fire.

Figure 13: ASH 25E diagram displaying pressure, airflow in and out of the airframe



Source: Gliding Federation of Australia

The AD provided pilots with inspection guidelines and procedures to meet a minimum standard for fire containment and retardant. Before 30 June 2019, all glider operators and inspectors needed to complete a Form 2 inspection, inspect the condition of fire retardant paint, determine the configuration of the firewall(s), and provide the Inspection Schedule to GFA. By 30 November 2019, all paint deficiencies were required to be rectified. All subsequent inspections then needed to include a paint inspection, and also an assurance that no flammable material is attached to the cockpit side of the firewall. If the glider cannot be fitted with a firewall, a 'strong case for non compliance' must be made to GFA.

General details

Occurrence details

Date and time:	21 January 2018 – 1300 EST	
Occurrence category:	Accident	
Primary occurrence type:	In-flight fire	
Location:	13 km west-north-west of Bathurst Airport (Piper's Field)	
	Latitude: 33° 22.95' S	Longitude: 149° 30.99' E

Pilot details

Licence details:	Glider Pilot Certificate, issued October 2017
Endorsements:	Air experience instructor; carriage of private passengers; controlled airspace; cross country/touring (self-launching sailplane); independent operator level 2; low-level finish; self-launching sailplane.
Ratings:	Nil
Medical certificate:	Certificate of Fitness issued in 2016
Aeronautical experience:	Between 8,000 and 11,000 hours
Last flight review:	Not applicable

Aircraft details

Manufacturer and model:	Alexander Schleicher GmbH & Co. (experimental) ASH-25E	
Year of manufacture:	1988	
Registration:	VH-GOA	
Operator:	Private	
Serial number:	25045	
Total Time In Service	over 3,974 hours	
Type of operation:	Gliding	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 1 (Fatal)	Passengers – 0
Damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- Alexander Schleicher
- the AMT Netherlands
- Bathurst Soaring Club and its members
- the Civil Aviation Safety Authority
- the Gliding Federation of Australia and members of the gliding community
- New South Wales Police
- Witnesses and neighbours of the Soaring Club

References

AAIB, Special Bulletin *S3/2017 on HPH Glasflugel 304 eS, G-GSGS, 25 September 2017*, Air Accidents Investigation Branch United Kingdom

CASA, CASR Part 22 – *Airworthiness standards for sailplanes and powered sailplanes,* Civil Aviation Safety Authority

EASA 2003, Certification Specification CS-22 – *Sailplanes and Powered Sailplanes*, European Union Aviation Safety Agency

NTSB, Docket *CHI01LA216, accident involving a Stemme S10-VT in Wisconsin on 14 July 2001*, National Transport Safety Board

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003* (the Act), the Australian Transport Safety Bureau (ATSB) may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. Section 26 (1) (a) of the Act allows a person receiving a draft report to make submissions to the ATSB about the draft report.

A draft of this report was provided to the Gliding Federation of Australia and the Civil Aviation Safety Authority.

Submissions were received from the Gliding Federation of Australia and the Civil Aviation Safety Authority. The submissions were reviewed and, where considered appropriate, the report was amended accordingly.

Australian Transport Safety Bureau

The ATSB is an independent Commonwealth Government statutory agency. The ATSB is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers. The ATSB's function is to improve safety and public confidence in the aviation, marine and rail modes of transport through excellence in: independent investigation of transport accidents and other safety occurrences; safety data recording, analysis and research; fostering safety awareness, knowledge and action.

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 operations involving the travelling public.

The ATSB performs its functions in accordance with the provisions of the *Transport Safety Investigation Act 2003* and Regulations and, where applicable, relevant international agreements.

Purpose of safety investigations

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

It is not a function of the ATSB to apportion blame or determine liability. At the same time, an investigation report must include factual material of sufficient weight to support the analysis and findings. At all times the 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.

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 initiate proactive safety action that addresses safety issues. Nevertheless, the ATSB may use its power to make a formal safety recommendation either during or at the end of an investigation, depending on the level of risk associated with a safety issue and the extent of corrective action undertaken by the relevant organisation.

When safety recommendations are issued, they focus on clearly describing the safety issue of concern, rather than providing instructions or opinions on a preferred method of corrective action. As with equivalent overseas organisations, the ATSB has no power to enforce the implementation of its recommendations. It is a matter for the body to which an ATSB recommendation is directed to assess the costs and benefits of any particular means of addressing a safety issue.

When the ATSB issues a safety recommendation to a person, organisation or agency, they must provide a written response within 90 days. That response must indicate whether they accept the recommendation, any reasons for not accepting part or all of the recommendation, and details of any proposed safety action to give effect to the recommendation.

The ATSB can also issue safety advisory notices suggesting that an organisation or an industry sector consider a safety issue and take action where it believes it appropriate. There is no requirement for a formal response to an advisory notice, although the ATSB will publish any response it receives.

Terminology used in this report

Occurrence: accident or incident.

Safety factor: an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence. Safety factors include the occurrence events (e.g. engine failure, signal passed at danger, grounding), individual actions (e.g. errors and violations), local conditions, current risk controls and organisational influences.

Contributing factor: a factor that, had it not occurred or existed at the time of an occurrence, then either:

(a) the occurrence would probably not have occurred; or

(b) the adverse consequences associated with the occurrence would probably not have occurred or have been as serious, or

(c) another contributing factor would probably not have occurred or existed.

Other factors that increased risk: a safety factor identified during an occurrence investigation, which did not meet the definition of contributing factor but was still considered to be important to communicate in an investigation report in the interest of improved transport safety.

Other findings: any finding, other than that associated with safety factors, considered important to include in an investigation report. Such findings may resolve ambiguity or controversy, describe possible scenarios or safety factors when firm safety factor findings were not able to be made, or note events or conditions which 'saved the day' or played an important role in reducing the risk associated with an occurrence.