Australian Government
Australian Transport Safety Bureau

ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation – AO-2007-066
Final

Controlled flight into water
Lake Liddell, NSW – 7 December 2007
VH-LIS
Air Tractor Inc. AT-802

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

Published by: Australian Transport Safety Bureau
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ISBN and formal report title: see 'Document retrieval information' on page v.

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DOCUMENT RETRIEVAL INFORMATION

Report No.	Publication date	No. of pages	ISBN
AO-2007-066	25 June 2009	37	978-1-921602-66-5

Publication title

Collision with terrain – Lake Liddell, NSW - 7 December 2007 - VH-LIS, Air Tractor Inc. AT-802

Prepared by

Australian Transport Safety Bureau
PO Box 967, Civic Square ACT 2608 Australia
www.atsb.gov.au

Reference No.

INFRA-08538

Abstract

On 7 December 2007, the pilot of an Air Tractor Inc. AT-802 aircraft, registered VH-LIS, was conducting a test flight at Lake Liddell, NSW. The purpose of the flight was to test an experimental in-flight water collection system using skis attached to the aircraft's main landing gear.

At about 0910 Eastern Daylight-saving Time, the pilot was conducting the second test run of the day. After the aircraft skis had been in contact with the surface of the lake for 36 seconds, witnesses observed the aircraft pitching nose down, about its right main landing gear while rotating to the right. The aircraft then overturned and sank. The aircraft was substantially damaged and the pilot was fatally injured.

The investigation concluded that the right experimental ski breached the surface of the water which caused a substantial amount of drag to act on the right side of the aircraft, as a consequence, the aircraft became uncontrollable. The circumstances of this accident highlight the need for due diligence and detailed risk assessments to be performed as part of experimental test programs.

As a result of this incident, the Civil Aviation Safety Authority (CASA) has proposed amendments to Advisory Circular 21-10 - *Experimental Certificates* to provide:

- updated guidance information to persons applying for the issue of experimental certificates
- advice on risk management for test pilots during experimental flight testing.

In addition, the Australian Transport Safety Bureau (ATSB) issued a safety recommendation to CASA in respect of the need to consider the safety of third parties, including on the ground or water, before issuing a Special Certificate of Airworthiness.

THE AUSTRALIAN TRANSPORT SAFETY BUREAU

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

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.

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 enhance safety. To reduce safety-related risk, ATSB investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not the object of an investigation to determine blame or liability. However, 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 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.

FACTUAL INFORMATION

History of the flight

On 7 December 2007, the pilot of an Air Tractor Inc. AT-802 aircraft, registered VH-LIS, departed Scone, NSW for a flight to Lake Liddell, located 40 km to the south-south-east. The aircraft was operated under the visual flight rules (VFR) and the pilot was the sole occupant.

The purpose of the flight was to test an experimental in-flight water collection system using skis attached to the aircraft's main landing gear (Figure 1). The testing involved the pilot descending the aircraft until the skis contacted the surface of the lake and then maintaining that contact while skimming across the water's surface. While skimming across the surface, water would be forced through a hole in the base of each ski and into the aircraft's hopper via attached pipes and hoses. When sufficient water was collected, the pilot would climb the aircraft, dump that load, and return for another test run.

Figure 1: A previous water collection test flight on 6 December 2007

At about 0910 Eastern Daylight-saving Time[1], the pilot was conducting the second test run of the day. Video evidence showed that after the aircraft had been in contact with the surface of the water for 36 seconds, and at the point where witnesses expected the pilot to commence climbing, the aircraft was observed to collide with the surface of the lake. The aircraft overturned and sank quickly to the bottom of the lake. The pilot was fatally injured.

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

Aircraft information

The Air Tractor Inc. AT-802 aircraft was of tail wheel, fixed landing gear design. The aircraft weight and balance documentation showed the aircraft had a specified maximum take-off weight of 7,257 kg. The capacity of the aircraft's hopper was documented by the aircraft manufacturer as 800 US gallons (3,028 litres). The aircraft was purpose built for use in firebombing operations and was factory fitted with a computer controlled fire-gate for the hopper.

Table 1: Aircraft details

Manufacturer	Air Tractor Inc.
Model	AT-802
Serial Number	802-0082
Registration	VH-LIS
Year of manufacture	1999
Certificate of airworthiness	Issue date 10/09/1999
Certificate of registration	Issue date 09/09/1999
Maintenance Release	Valid to hours/date 2,913.1hrs or 06/11/08
Total airframe hours	2,815.6hrs

The aircraft was powered by a single Pratt and Whitney Canada PT6A-67A turboprop engine. The engine had been fitted to the aircraft on 26 October 2005.

Table 2: Engine details

Manufacturer	Pratt and Whitney
Model	PT6A 67A
Type	Free Turbine (1200SHP)
Serial Number	PCE 105161
Time since overhaul	N/A (TBO 6,000hrs)
Total time in service	611.3hrs

The engine was fitted with a 5-bladed Hartzell constant speed propeller. The propeller was fitted to the engine on 26 October 2005.

Table 3: Propeller details

Manufacturer	Hartzell
Model	HC-B5MA-3D
Type	5 blade Constant speed
Hub Serial Number	HBA 1427
Time since overhaul	N/A (TBO 3000hrs)
Total time in service	611.3hrs

The aircraft was maintained by the operator in accordance with a Civil Aviation Safety Authority (CASA)-approved system of maintenance. At the time of the accident the aircraft had a current and valid maintenance release.

Pilot information

The pilot was the owner, managing director and chief pilot of the operating company. He held a Commercial Pilot (Aeroplane) Licence and had a valid Class 1 medical certificate. He held numerous aircraft endorsements, including the Air Tractor 802 aircraft and also held many operational approvals and appointments. The pilot had accrued over 29,800 total flying hours.

The pilot was reported to have been fit, healthy and well rested on the day of the accident flight. He had spent 90 minutes flight testing the skis on the day preceding the accident, and had stated to one of the company employees that he was very happy with the results from that testing.

The Air Tractor aircraft flight manual specified that an approved or military specification crash helmet must be worn when operating the aircraft. On the day of the accident, the pilot was not wearing a helmet, and it was later reported that due to a medical condition, the pilot never wore a helmet when flying. The pilot's doctor stated in a letter provided to the Australian Transport Safety Bureau (ATSB):

> This is to certify that I know [the pilot] well. He suffers from a minor muscular condition of the neck which is aggravated by wearing a heavy helmet while flying, making it hard to concentrate on the job at hand.
>
> I would recommend that he be allowed to fly without wearing a helmet as the discomfort could lead to lack of concentration.

Medical and pathological information

The results of the post mortem examination indicated that:

> The principal cause of death has been given as water immersion death (drowning secondary to incapacitation associated with a closed head injury and neck injury).

The toxicology report indicated that no alcohol or drugs were detected in the pilot's samples.

Meteorological information

Company employees on the lake on the day of the accident reported that they considered that there were no problems with the weather conditions, with only scattered[2] cloud and a light easterly wind present. While the surface of the lake was not considered to be flat or 'glassy', there were no waves and it was considered that the minor disturbance of the water's surface was a result of the light winds. This reported information was consistent with conditions observed on video recordings and photographs.

The 0900 weather observation at Jerrys Plains Post Office, 16 km south-south-west of the accident site, recorded the temperature as 24° C and the wind as a westerly at 3 kts. The 0900 weather observation at Singleton, 27 km south-east of the accident

2 Cloud amounts are reported in oktas. An okta is a unit of sky area equal to one-eighth of total sky visible to the celestial horizon. Few = 1 to 2 oktas, scattered = 3 to 4 oktas, broken = 5 to 7 oktas and overcast = 8 oktas.

site, recorded the temperature as 22° C and the wind as an easterly at 3 kts. At 0900, the Scone aerodrome automatic weather station recorded the wind as a south-south-easterly at 3 kts, gusting to 5 kts. At 1000, the wind at Scone was recorded as a south-westerly at 4 kts, gusting to 6 kts.

Aircraft ski design and testing process

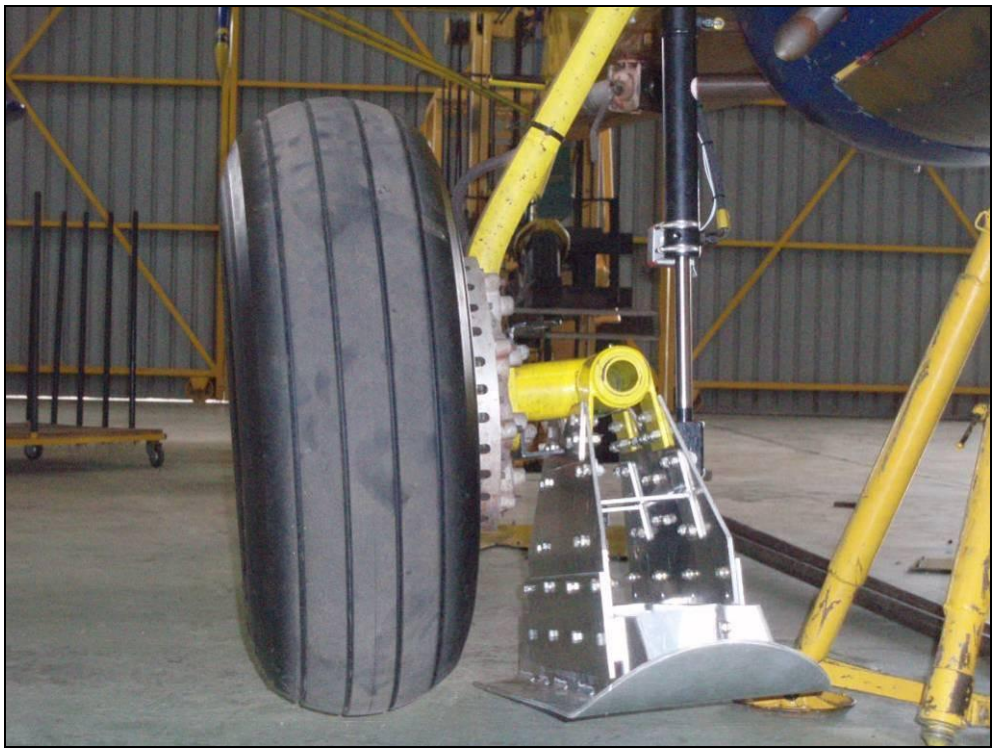
The pilot had conceived the idea for the skis as an alternative to existing aircraft systems such as the float equipped Air Tractor Fireboss. It was reported that there was significant interest in the skis for possible use overseas for fire-bombing contracts. It was also reported that the pilot was keen to have the design proven and approved for production before the next northern hemisphere fire-bombing season.

The initial design of the skis was completed within the company and a prototype set of skis was constructed from sheet metal. An aeronautical engineer, external to the operator's company, was consulted and he agreed to complete the engineering aspects. In February 2007, the engineer viewed the prototype and took some measurements in order to make some 'rough' calculations, from which he determined that the design was technically feasible. He calculated that the pitch (angle) of the skis should be about 14° nose up. He reported that he cautioned the pilot that the flight testing was a significantly risky operation and suggested that a less expensive aircraft should be used for testing. He stated that the pilot rejected that suggestion.

After presenting some preliminary drawings to the pilot, the engineer was instructed to stop any further work on the project. The operator, however, continued to work on the design and produced a working set of skis, complete with all the required plumbing, hydraulic and electrical components, without any further aeronautical engineering involvement evident. That set of skis was subsequently fitted to the accident aircraft, VH-LIS.

Before the skis were fitted to VH-LIS, they had been fitted to another company Air Tractor AT-802 aircraft, registered VH-LII (Figure 2). That aircraft was utilised to ground test the installation and the operation of the hydraulically-activated extension and retraction, of the skis.

Figure 2: Ski fitted to VH-LII in the extended position



A company employee reported that VH-LII was also used to flight test the skis to ensure that the aircraft could be safely operated and landed with the skis attached (Figure 3). The pilotwas reported to have advised a company employee that he considered that there was no change in the aircraft's performance or handling with the skis fitted, including no evidence of increased drag[3] or vibration.

In order to ascertain the correct angular pitch for the installation of the skis, the pilot had test flown the aircraft at the proposed water collection speed and marked the aircraft's pitch attitude on an inclinometer attached in the cockpit. The pitch angle was then used as a point of reference for the installation of the skis at a set angle. While the angle was not recorded, it was recalled by one staff member to be around 7° nose up. The pilot later asked for the skis to be lowered at the rear in an attempt to obtain a higher water collection rate.

A company employee also reported that on 23 October 2007, the pilot conducted ski test flights in VH-LII on the surface of Lake Liddell to test the adjustment of the skis. There had been no intention to collect water during those flights. As a result of that testing, the skis' fitment to the main landing gear legs was adjusted by lowering the skis, because the aircraft's wheels had been contacting the water rather than the skis.

Due to aircraft operational requirements, the skis were removed from VH-LII. Further modifications were made to the design and the skis were fitted to VH-LIS during the first week of December 2007.

3 Retarding force acting upon a body in relative motion through a fluid, parallel to direction of motion.

Figure 3: Initial flight testing in VH-LII

On 26 October, the aeronautical engineer was again contacted to view the fitted skis and associated hydraulic system, and was asked to prepare some drawings. The engineer completed a number of sketches in preparation for completing technical drawings. The engineer was also asked by the operator to submit a design advice to CASA, in order to obtain approval to commence test flights in VH-LIS.

On 12 November, the engineer submitted a design advice and, on 16 November, a Special Certificate of Airworthiness for VH-LIS was issued by CASA.

CASA issued the Special Certificate of Airworthiness for the aircraft under the experimental category. That allowed the operator to fit and flight test the skis on the aircraft under Civil Aviation Safety Regulations (CASRs) section 21.191(a) and (b) for the purpose of

a) Research and development: for example testing new aircraft design concepts, new aircraft equipment, new aircraft installations, new aircraft operating techniques or new uses for aircraft;

b) showing compliance with regulations: for example conducting flight tests and other operations to show compliance with the airworthiness regulations including flights to show compliance for issue of type and supplemental type certificates, flights to substantiate major design changes, and flights to show compliance with the function and reliability requirements of the regulations.

The certificate issued by CASA for VH-LIS also contained some conditions that, in part, indicated:

- The current certificate of airworthiness would be suspended at the time the skis were fitted to the aircraft. The special certificate would expire on 16 February 2008 or on the removal of the skis.

- A valid maintenance release was required to be in force and an entry made detailing that the aircraft was operating under the special certificate. The aircraft was not to be operated unless it was maintained in accordance with an approved system of maintenance.
- No person could operate the aircraft other than for the purpose of the flight test outlined in the operator's test schedule dated 16 November 2007. The aircraft was required to be operated in accordance with the aircraft flight manual limitations.
- Flight over built-up areas was to be avoided and the aircraft was to be operated under VFR, day only.
- Application was required to be made to CASA for any revision to these operating limitations.

On 29 November, CASA provided some guidance material to the engineer stating that:

> It may be useful to consider the following aspects prior to carrying out the [research and development] flights.
>
> A comprehensive risk analysis addressing, among others
>
> - crash survivability of the crew including escape under water, suitable rescue equipment and trained staff at flight test site
> - addressing of the local regulations related to flight over water bodies
> - regulations related to low level flight and the risks
> - adequacy of pilot skills to carry out the flight tests
> - potential risks to public and property
>
> A comprehensive risk analysis covering failure modes, among others,
>
> - asymmetrical deployment of the skis
> - failure to deploy and faulty indications
> - failure to retract the skis
> - catastrophic failure of the equipment

On 2 December, the engineer forwarded this advice to the company, together with a proposal to develop a test plan and suggestions for methods to measure loads, such as the fitment of pressure transducers on the skis and strain gauges on fittings. The pilot was reported to be unsupportive of those suggestions and indicated that as he had already received a permit to fly, he intended going ahead with the test flights.

On 16 November, the pilot submitted a one-page flight test schedule to CASA. That document indicated that the testing of the skis on VH-LIS would be carried out at Lake Liddell and would commence about 23 November. The schedule indicated the first flights would be carried out with the skis attached, but with the hoses disconnected from the hopper. The first approaches would be conducted at 85 kts and then subsequently increased to 95 kts to test for drag. During that initial period, the ski inlet would also be adjusted to suit the volume of water required.

Subsequent flight tests with the hoses connected to the hopper would commence with short runs of 100 m, increasing in length as the testing continued to determine the time and distance required to collect different volumes of water.

Other than the one-page flight test schedule, there was no documentary evidence of any:

- detailed schedule or formal test plan, including proposed aircraft speeds and configuration
- fitment of testing, monitoring or logging devices
- recording of test results or other data, other than some photographic and video images taken by company staff
- risk analysis or consideration of risk controls such as safety, rescue equipment and risk to third parties.

On the day preceding the accident, the pilot successfully conducted a series of 12 test runs on the surface of Lake Liddell. Those runs were observed and recorded by company staff who were located in a boat on the lake, using a hand-held digital camera[4] and by other staff in a company chase aircraft using a hand-held video camera.

The staff in the boat did not have any direct radio contact with the pilot, but did have contact with the pilot of the chase aircraft. The pilot of the chase aircraft had direct radio contact with the test pilot.

After the completion of that day's test flying, the pilot was reported to have said that while he was happy with the ski system, it was not collecting sufficient water. No records were kept of the amount of water collected during the runs. Staff later recalled the pilot saying that the maximum collection may have been about 250 gallons (946 L), while the aim was to collect 600 to 650 gallons (2,270 to 2,460 L). The pilot instructed maintenance engineers to remove previously-installed restricting devices from the openings on the base of the skis to allow a full flow of water into the hopper. Staff also reported that they had discussed some concerns with the pilot about both the size of the turn-up on the front of the ski and the angle of the ski in relation to the water. They stated that the pilot decided to continue the testing without any changes at that time.

It was also reported that some discussion took place with the pilot about holding the aircraft in contact with the surface of the water. It was considered that, as most of the aircraft's weight was supported by the lift from the wings, some additional forward pressure on the control column may have been required to hold or to 'pin' the skis to the water's surface.

Other separate discussions by the pilot, with both company staff and the aeronautical engineer, also considered the need to monitor the amount of water collected during a run. In the absence of any other indications, the pilot was required to look inside the cockpit at the fire retardant control system panel, or the markings on the rear of the translucent aircraft hopper, to see the amount of water collected in the hopper (Figure 4). Discussions relating to the possible fitment of an aural indication of the hopper content levels took place, but nothing had been installed or implemented at the time of the flight tests.

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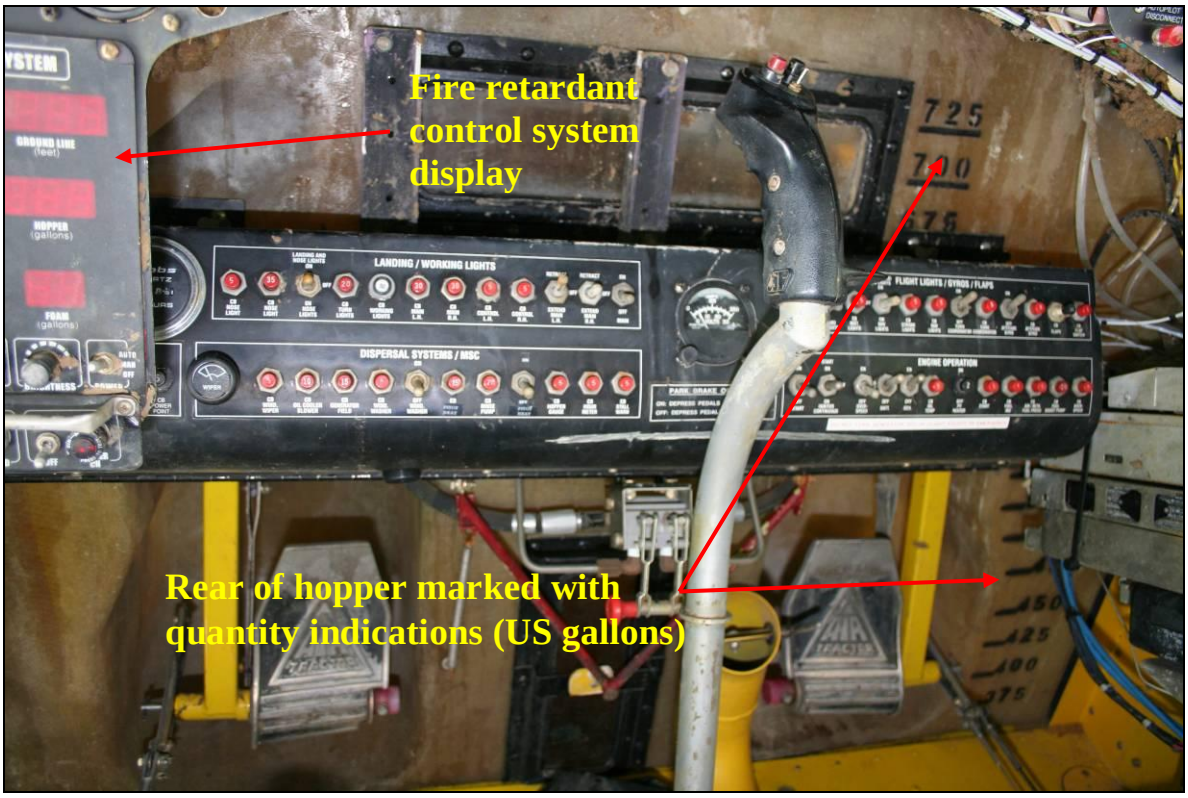
4 The camera had a video mode and was used in that mode to record the flight.

Figure 4: Cockpit of VH-LIS



The witnesses to the testing of the skis on the first day stated that, on the majority of occasions, the pilot had a tendency to fly with a slightly right-wing low attitude whilst the aircraft's skis were in contact with the water. One witness reported that he had mentioned that fact to the pilot following the first day's flying.

On 7 December, the pilot commenced the first test run of the day, prior to the arrival of the chase aircraft. However, the observers in the boat were in place and recorded some video footage on the hand-held digital camera.

That run was conducted in an approximately southerly direction, close to the eastern edge of the lake. The aircraft maintained contact with the surface of the lake for about 18 seconds, a shorter time than runs on the previous day. The observers had no direct radio contact with the pilot and did not know why the pilot did not complete a longer run. After climbing away, the pilot dumped the collected water, which the observers estimated to be about 150 gallons (567 L).

The second run was conducted in the same direction and position as the first run. The aircraft was observed to ski across the surface of the water for 36 seconds. During the run, the observers noted that the right wheel or ski appeared to be lower than the left, similar to the previous day. The right ski also appeared to be deeper in the water than that observed on previous runs. They also heard a flapping sound which was different to the noises heard during previous test runs. When the aircraft was about 300 m past the location of the boat, it was observed to pitch sharply nose down into the water and to make a large splash. Video footage of the event up to the initial point of impact was captured on a digital still camera. The video footage confirmed what had been observed by witnesses; that the right ski had been forced a considerable amount more into the water than the left ski during the accident run.

The pilot of the chase aircraft was still some distance from the lake at that time, but later reported also seeing the splash.

The staff in the boat immediately started the boat's engine and rushed to the aircraft, which was reported to have been inverted and quickly sinking nose-first, with only the tail section still out of the water as they arrived. Despite numerous attempts to dive down through fuel contaminated water, the boat occupants were unsuccessful in reaching the pilot in the cockpit. The aircraft came to rest on the bottom of the lake. The pilot's body was later recovered by New South Wales Police divers, who documented that the pilot was found fully restrained by a 4-point harness in the cockpit. The seatbelt straps were cut to release the pilot.

Witnesses on the day, together with police divers and other investigation staff during the following days, found no evidence of any floating or submerged hazards along the aircraft's path across the surface of the lake or in the vicinity of the accident site.

Experimental certificate process

CASA advised that they had no authority to prevent the issue of a Special Certificate of Airworthiness in the experimental category if there was no evidence of risk to other airspace users and persons on the ground or water.

Under CASR 21-193, anyone had the right to apply for experimental category approval without hindrance, provided the conditions of CASR 21-193 were met (refer to Appendix A for CASR 21- 193 extract). The investigation did not find any evidence that CASA had sought any information from the operator or engineer, in relation to establishing 'the safety of other airspace users and persons on the ground or water on land, sea or air', prior to issuing the Special Certificate of Airworthiness.

Wreckage and impact information

The aircraft was recovered from Lake Liddell with the assistance of New South Wales Police divers (Figure 5).

Examination of the aircraft by ATSB investigators showed crush damage to the leading edge of the entire left wing and the inboard section of the right wing. The damage was primarily on the upper surface of those sections. Substantial distortion and disruption of the engine cowling was observed. The lower surfaces had been forced to the left, with rippling observed on the upper cowls. The roof of the cockpit canopy had been torn away and the windscreen had been smashed. The investigation was unable to determine if the damage was the result of the impact sequence or of the recovery process.

Figure 5: Recovery of the aircraft wreckage

All five propeller blades displayed substantial bending, with damage to their pitch change collars and linkages observed. The engine reduction gearbox had cracked at the propeller flange and there was also rotational distortion of the engine's exhaust case.

Examination of the aircraft engine and propeller provided clear evidence that the engine had been delivering substantial power to the propeller at the time of the accident. That finding was consistent with the video evidence.

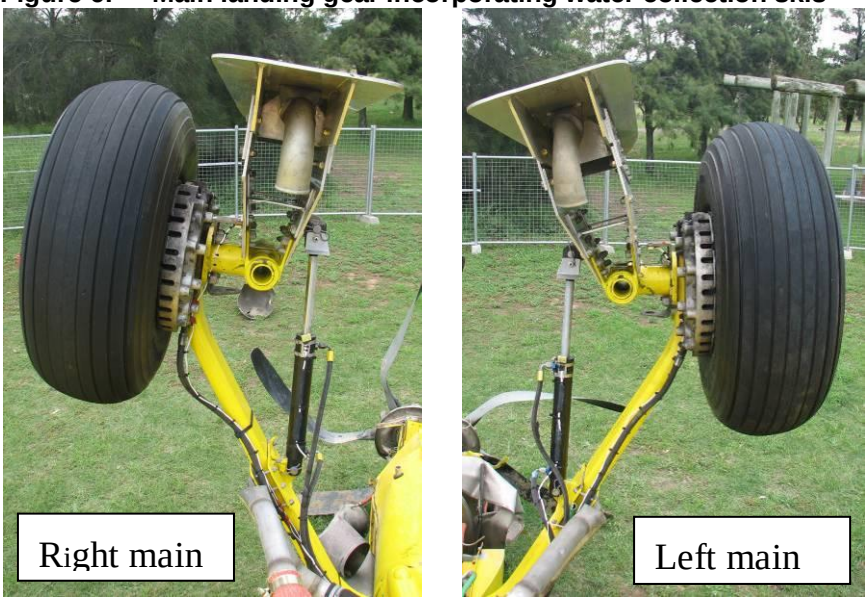
Continuity of all flight and engine controls was confirmed. There was no evidence of any pre-existing defects or faults found in any of the aircraft's systems. The aircraft's flaps were found in the fully extended position, although the video footage of the accident flight indicated that they were in approximately mid range seconds before the accident.

The impact damage observed on the wings and engine cowls, together with the directional movement of the skis, was consistent with the aircraft pitching sharply nose down about its right main landing gear while rotating to the right. Information gathered from the examination of the wreckage, together with witness statements, indicated that the aircraft most likely impacted the water with the propeller and nose cowling while pitching downwards, followed by the left and then right wings.

Water collection system

The main landing gear had been fitted with experimental skis for use in water collection. The skis were mounted on the inboard side of each main landing gear leg and were hydraulically operated between the vertical and horizontal planes by a single ram clamped to each leg (Figure 6).

Figure 6: Main landing gear incorporating water collection skis



The system used the forward motion of the skis on the water surface to force water through ducts in the base of each ski, into the aircraft's hopper. Each ski fed its side of the hopper through fixed pipes with flexible hoses at either end. The water was then contained in the hopper by check valves.

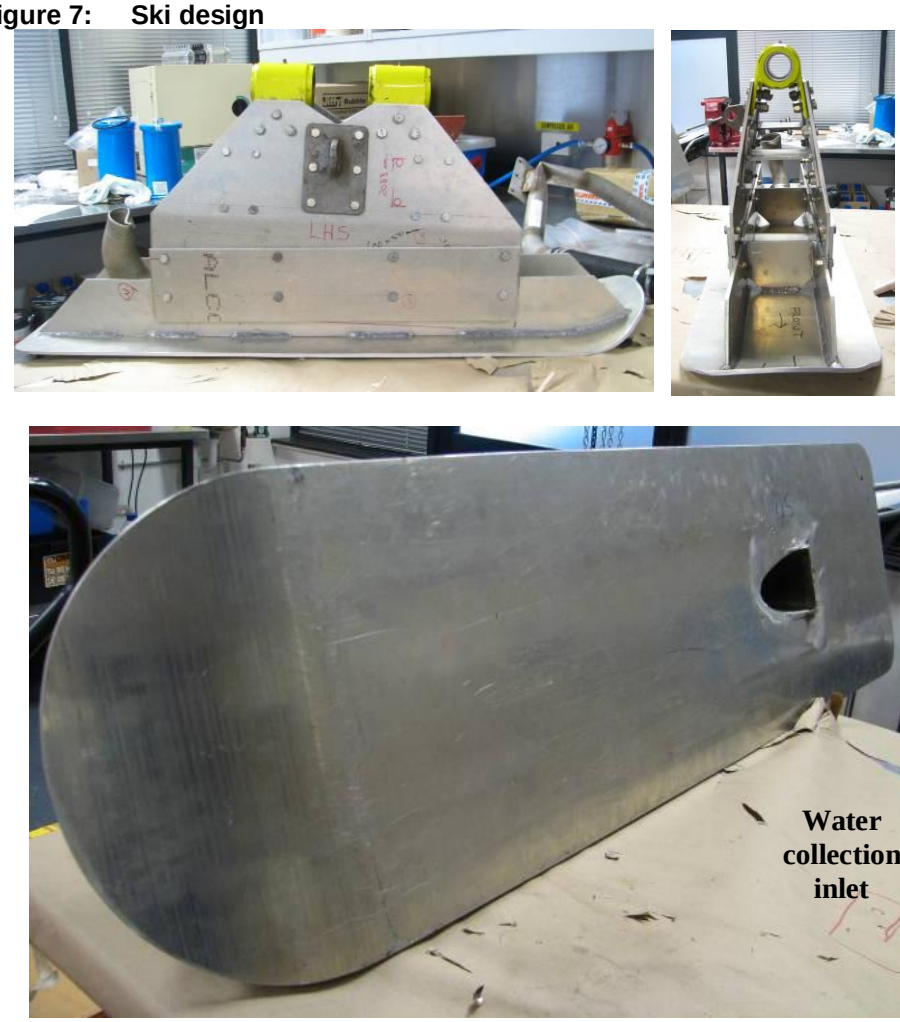
The hydraulically-actuated skis were found in the extended position with hydraulic locking confirmed. Witness marks on the landing gear legs indicated that both hydraulic rams had moved from their original fitted positions on their legs, with the left ram having moved upward and the right ram in an equal, downward direction.

The skis did not show any evidence of catastrophic or material failure. Connection of the water collection system between the rigid metal piping of the skis and the hopper inlet was made by use of lay-flat hose, similar to that used for fire-fighting purposes. Neither of the lay-flat hoses had remained connected to the skis. It was not possible to determine the volume of water the hopper contained at the time of the accident. The skis were removed and taken to the ATSB's technical facilities for closer examination.

Experimental ski examination

The skis were made from aircraft quality aluminium alloy in a box-type design and were approximately 1,060 mm x 300 mm x 450 mm. The ski base had a rolled nose with a water collection duct cut into its aft section (Figure 7).

Figure 7: Ski design



The skis attached inboard of modified main wheel axle assemblies. Their hydraulic rams attached to a lug mounted below the axle mount pivot point, allowing the skis to be rotated between the horizontal and vertical positions. The ski mounts were set at an angle, presumably to provide a nose-up attitude of the ski with the aircraft at a level attitude.

A comparison of the left and right skis (Figures 8 to 11) revealed significant differences between the skis. The main differences were:

- the overall heights of the skis were not the same
- there was a 1° difference in pitch angle between skis due to variations in the angular offset of the axle mount assemblies and hydraulic ram mounts
- the left ski hydraulic ram mount was positioned higher than the right ski
- the size and shape of the water collection inlets on the bottom surface of the skis varied in their diameters.

Figure 8: Left ski side view

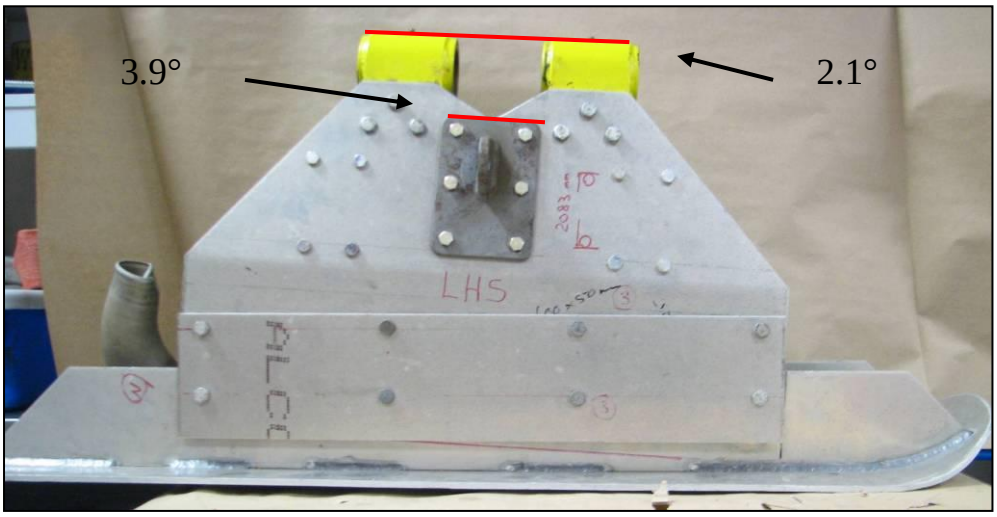


Figure 9: Right ski side view

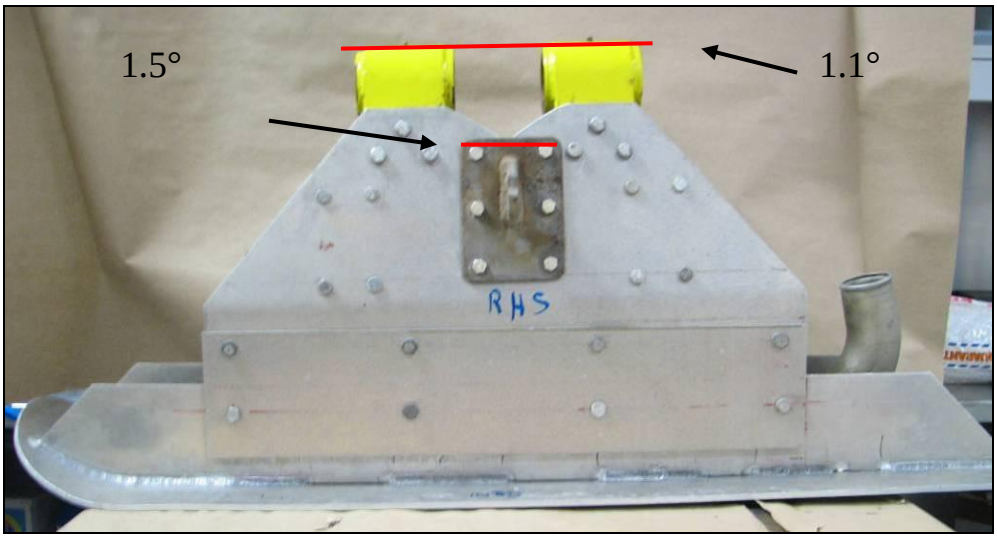


Figure 10: Water collection inlets

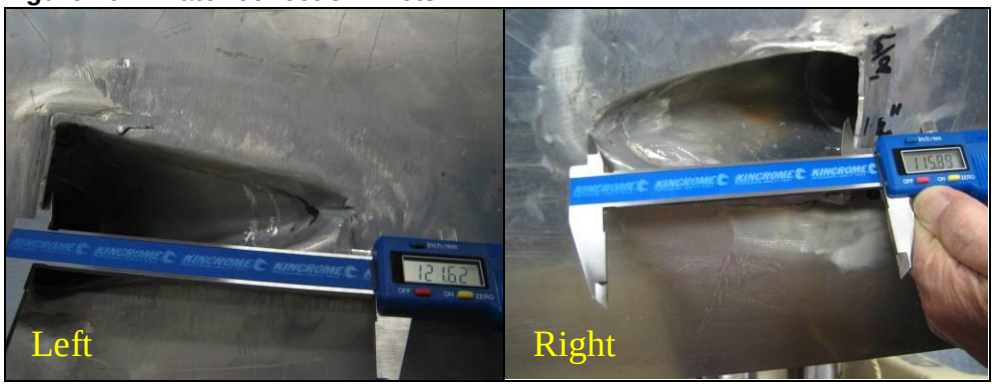
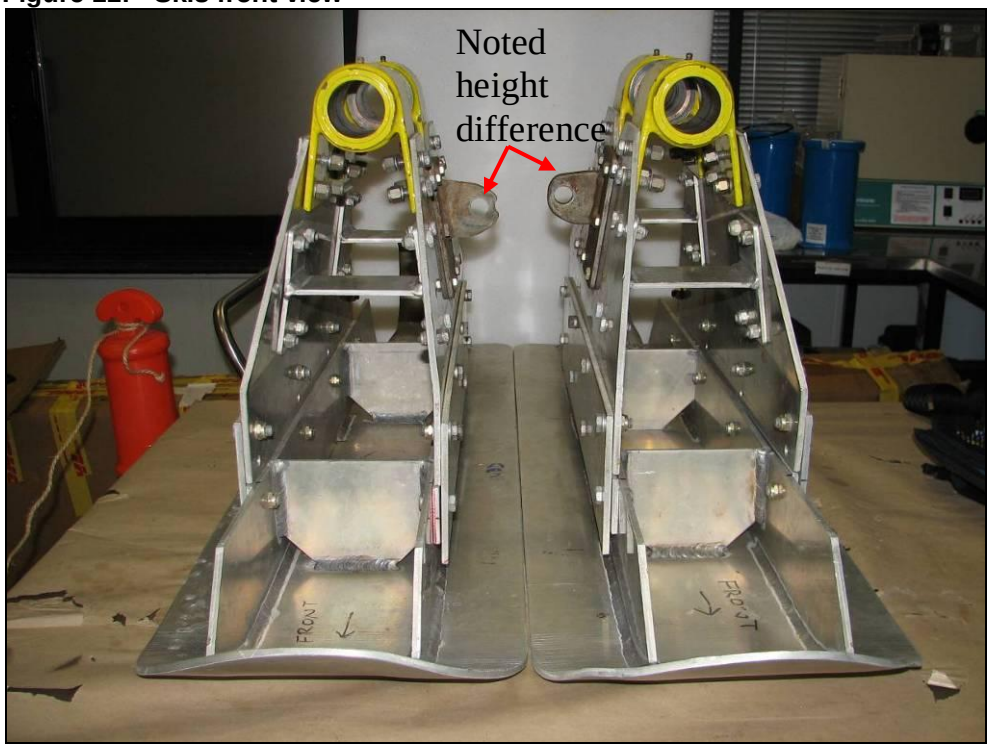


Figure 11: Skis front view



The company staff that built the skis stated that:

> The angular differences between left (2.1°) and right (1.1°) ski pivot centre line was to compensate for angular differences between the left and right axle attachment fitting on which the skis rotated during retraction and extension.
>
> The inclination angle of the left and right ski was set identical during system installation, confirmed by both digital inclinometer readings and vertical measurements taken from the ski toes and heels to the hanger floor with the aircraft on jacks, wings level and in the flying pitch attitude.

Recorded information

The aircraft was fitted with a number of components that were capable of recording aspects of aircraft performance and operational information. Those components included a digital data acquisition and analysis system (DAAM), a portable global positioning system (GPS) and a fire retardant control system. Each of those components was collected by the ATSB for examination and the possible retrieval of data.

The DAAM was unable to provide any information due to the results of immersion and subsequent corrosion of components before analysis. The portable GPS provided usable data. However, none of the data related to the accident or the test flights. The fire control system was unable to provide any information due to immersion in water.

ANALYSIS

Ski loading

Video and witness evidence indicated that the pilot had a tendency to fly the aircraft right-wing low on the majority of occasions whilst the aircraft skis were in contact with the water. The video footage of the last two flights, which included the accident flight, showed the right ski being forced into the water a considerable amount more than the left ski. That would have substantially increased the amount of drag acting on the right ski compared to the left ski.

There were no load measuring devices fitted to the aircraft's skis, therefore the pilot had no way of knowing how much force was being applied to each ski at any given time. The ingress of water into the hopper continued whilst the aircraft remained in contact with the lake for 36 seconds. That meant that the aircraft's weight, due to the water uptake, had increased substantially over a very short period of time. If suitable engine power and trim adjustments had not been made, there is the possibility that the additional weight would have increased the pressure being applied to the skis, forcing them further into the water.

The wreckage evidence was consistent with the accident sequence as described by the witnesses that the aircraft's right ski breached the surface of the water causing a substantial increase in drag acting on the right ski, the aircraft then became uncontrollable, rotating to the right about its right main landing gear and pitching nose down into the water.

Engineering aspects

The aircraft had been appropriately maintained in accordance with Civil Aviation Safety Authority (CASA) requirements. There were no pre-existing defects or faults found in the aircraft that may have contributed to the accident. Examination of the aircraft's engine and propeller provided clear evidence that the engine had been delivering power to the propeller at the time of the accident, which was consistent with the video footage recorded by company personnel at the time.

Design process

The pilot was the owner of the aircraft company and the driving force behind the concept, design, manufacture and testing of the experimental skis.

There was no evidence that a risk assessment into the design and testing of the skis was undertaken, even though CASA suggested that a detailed risk assessment be carried out. A detailed and methodical testing programme, as suggested by the aeronautical engineer, was also rejected by the pilot, together with the recommended use of a less expensive aircraft for the testing phase.

The pilot put in place an ad hoc testing programme, which listed only basic information and did not appear to follow any structured order. There was no evidence that the operator had considered the possible risks to third parties on land,

sea or air, including: recreational users of the lake, such as water skiers; or company staff who observed and recorded the test flights from a boat.

A number of dimensional inconsistencies were found between the left and right skis. A connection between the dimentional inconsistencies and the accident sequence could not be ruled out; however, there was insufficient evidence to draw any conclusions between the dimensional inconsistencies and the accident.

Issue of Special Certificate of Airworthiness

When considering the issue of a Special Certificate of Airworthiness in the experimental category, CASA was required to consider the conditions '...necessary for the safety of other airspace users and persons on the ground or water'. The investigation was unable to locate any evidence that the potential risk to third parties had been considered by the operator during the testing process, or that CASA sought or received such information or advice from the operator prior to issuing the certificate.

After the certificate was issued, CASA did suggest the analysis of a number of hazards that the operator should carry out in conjunction with the design and operational testing of the experimental skis. However, CASA was unable to mandate that risk analysis.

Had CASA sought a response from the operator in relation to the suggested analysis of those hazards before issuing the Special Certificate of Airworthiness, in the experimental category, it is likely that they would have had a better understanding of the potential for risks to third parties. That would have enabled them to make a more informed consideration of the application.

Perceived pilot work load

Operating the Air Tractor AT-802 aircraft safely in close proximity to land or water requires a high level of concentration, experience and manipulative skills, as it does for any aircraft used in agricultural applications. In addition, the pilot was exposed to a substantially increased work load when the aircraft's skis were in contact with the water.

To enable water to enter the hopper, the skis had to make contact with the water's surface, while the lift produced by the wings supported most of the aircraft's weight. As water entered the hopper, the weight of the aircraft increased and the centre of gravity changed. To compensate for these changes in aerodynamic forces, an increase in engine power and fine movements of the control stick were necessary. Keeping the wings level was also a precise action required of the pilot to maximise lift and to keep both skis equally in contact with the water. The pilot also had to look ahead of the aircraft for obstacles, such as floating debris, boats or other collision risks.

Throughout this maneuver, the pilot also needed to monitor the quantity of water entering the hopper by lowering his head slightly to see the translucent wall of the hopper. As the water colour was mostly clear, it would have been difficult to observe the water level against the graduated markings. To maintain a precise airspeed and level flight, while considerable weight, centre of gravity and power

changes were taking place, would have required a considerable level of concentration, experience and manipulative skills.

The high pilot work load during the water collection phase of the testing process was considered to be significant. A full situational awareness of every aspect of the water collection process under the given circumstances would have been difficult to achieve and maintain. The consequences of not achieving or maintaining full situational awareness during the critical phase of testing would have increased risk during that operation.

Survival aspects

The level of structural damage to the aircraft's cockpit area was relatively low, with only damage to the windscreen and roof area of the cockpit observed. The seat and seatbelt attachments were intact with the four point harness buckled. Survivability was dependant on the pilot being conscious and able to egress from the aircraft in an inverted, submerged environment. Specific training in this area had not been undertaken by the pilot. CASA suggested that the operator complete a risk assessment for the flight test; including of aspects such as the crash survivability of the pilot, escape under water, and the availability of suitable rescue equipment and trained staff at the flight test site.

However, there was no evidence that crash survivability was taken into consideration by the operator. The support staff had not been trained in water rescue techniques, and no equipment for removing the pilot from a submerged aircraft in the event of an accident was available. The flight test risk was further increased by the inability of the pilot to wear a helmet while flying. The post mortem results indicated that the pilot drowned after being incapacitated. Any actions taken to lessen the likelihood of the pilot being incapacitated or assisting the pilot to egress the cockpit would have improved survivability under the circumstances.

FINDINGS

Context

During the testing of an experimental water collection system, on 7 December 2007, the pilot of an Air Tractor Inc. AT-802 aircraft, registered VH-LIS, was fatally injured when the aircraft's right ski breached the surface of the water, causing the aircraft to become uncontrollable. The aircraft then rotated to the right about its right main landing gear, pitched nose down into the water, and subsequently sank.

From the evidence available, the following findings are made with respect to the accident involving VH-LIS, and should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing safety factors

- The pilot had a tendency to fly with a slightly right-wing low attitude whilst the aircraft's skis were in contact with the water, which meant the right ski was forced a considerable amount more into the water than the left ski, increasing the drag acting on the right ski.
- There was no emergency equipment or procedures in place in the event of an accident during the testing of the water collection system.
- The pilot was not wearing a helmet at the time of the accident.

Other safety factors

- No risk analysis was carried out on the concept, design or testing of the water recovery system despite the inherent risks involved. The pilot ignored several suggestions and warnings made by the Civil Aviation Safety Authority (CASA), his own staff and the design engineer with regard to the design and testing of the experimental water collection system.
- There were several dimensional inconsistencies between the two skis.
- The nature of the experimental design was such that work load on the pilot was very high during the water collection phase of testing.
- CASA did not seek information to establish whether conditions '...necessary for the safety of other airspace users and persons on the ground or water' were required prior to issuing the Special Certificate of Airworthiness. *[Safety issue]*
- CASA had no regulatory power to mandate its suggested risk analysis prior to the conduct of the test of the experimental water collection system.

SAFETY ACTION

The safety issues identified during this investigation are listed in the Findings and Safety Actions sections of this report. The Australian Transport Safety Bureau (ATSB) expects that all safety issues identified by the investigation should be addressed by the relevant organisation(s). In addressing those issues, the ATSB prefers to encourage relevant organisation(s) to proactively initiate safety action, rather than to issue formal safety recommendations or safety advisory notices.

All of the responsible organisations for the safety issues identified during this investigation were given a draft report and invited to provide submissions. As part of that process, each organisation was asked to communicate what safety actions, if any, they had carried out or were planning to carry out in relation to each safety issue relevant to their organisation.

Civil Aviation Safety Authority

Issue of Special Certificate of Airworthiness

During the investigation, a safety issue was identified and was included in the draft transport safety report. As part of the directly involved party process (see above), the Civil Aviation Safety Authority (CASA) was invited to make a submission as to the factual accuracy of the draft report, and in relation to the draft safety issue.

The following discussion outlines the progress of that safety issue, which has culminated in the issue by the ATSB of a safety recommendation.

Draft safety issue

CASA did not mandate suggested risk management actions made to the operator before issuing the Special Certificate of Airworthiness.

Action taken by CASA in response to the draft safety issue

In its response to the draft transport safety report, CASA advised that:

> By its very nature, experimental flight testing of aircraft with a new unproven design is inherently and in certain cases, unavoidably risky. For this reason special experimental certificates of airworthiness authorising flight testing may, and generally do, carry conditions necessary for the safety of other airspace users and persons on the ground or water. See subregulation 21.195A(2) of the Civil Aviation Safety Regulations 1998.
>
> CASA has agreed that it will provide further advisory information and education to the industry on risk management for test pilots during experimental flight testing.
>
> CASA has initiated Project CS 08/22 - Amendments to Advisory Circular 21-10 *Experimental Certificates* to provide updated guidance information to persons applying for the issue of experimental certificates, and advice on risk management for test pilots during experimental flight testing.

ATSB assessment of response

The ATSB acknowledges the safety action taken, or planned by CASA, elements of which appear to address parts of the draft safety issue.

However, the ATSB considered that aspects of the safety issue remained unaddressed. That was, by not requiring the completion of the subsequently-suggested risk analysis before issuing the Special Certificate of Airworthiness, CASA was unable to assure itself that the operator had considered the potential risks to third parties prior to commencing testing.

On that basis, the following safety issue was identified and provided to CASA for additional consideration and comment before the ATSB finalised any proposal for safety action.

Safety issue

CASA did not seek information to establish whether conditions '...necessary for the safety of other airspace users and persons on the ground or water' were required prior to issuing the Special Certificate of Airworthiness. *[Safety issue]*

Action taken by CASA

In its response to this safety issue, CASA provided the following reponse to the ATSB on 1 June 2009:

> I refer to your email dated 15 May 2009 regarding a further draft of Transport Safety Report AO-2007-066.
>
> I understand CASA has already provided comments on the safety management issue for the pilot. However, the current draft of the report appears to have broadened this issue to include other persons *ie "CASA did not seek information to establish whether conditions '...necessary for the safety of other airspace users and persons on the ground or water*'" were required prior to issuing the Special Certificate of Airworthiness.
>
> In CASA's view the new safety issue is irrelevant to the accident because no other airspace users and persons on the ground and water were affected. The person who was fatally injured was the pilot, a participant and fully aware of the risk. CASA did not seek information *'...necessary for the safety of other airspace users and persons on the ground or water' were required prior to issuing the Special Certificate of Airworthiness,* because it based the safety determination on the information submitted by the applicant initially as part of the application and subsequent flight test plan. This information and the conditions set out on the Special Certificate of Airworthiness and other required operational approvals (low level flight over water) are intended to ensure the safety of other airspace users and persons on the ground or water.
>
> In those cases where such inquiries are or might be relevant, CASA will not hesitate to make them and formulate and impose such additional conditions (if any) as may be necessary in the interest of safety, on that basis.

ATSB assessment of response

The potential for risk to other parties in relation to the experimental flight test was identified by CASA in its advice to the engineer of 29 November. If there had been

due consideration of that potential risk in the operator's application for a Special Certificate of Airworthiness and 'subsequent flight test plan', then the additional advice to the engineer, which was provided after the issue of the certificate, would not have been warranted.

When considering the issue of future Special Certificates of Airworthiness in the experimental category, CASA needs to be able to assure itself that adequate information is gathered to enable an informed decision on the conditions '...necessary for the safety of other airspace users and persons on the ground or water'.

ATSB safety recommendation SR-081

The ATSB recommends that CASA address this safety issue.

APPENDIX A: CASR 21.93

Experimental certificates: general

An applicant for an experimental certificate is entitled to the certificate if the applicant gives CASA or an authorised person the following:

(a) a statement, in a form and manner acceptable to CASA or the authorised person, setting forth the purpose for which the aircraft is to be used;

(b) enough data (such as photographs) to identify the aircraft ;

(c) upon inspection of the aircraft, any information reasonably needed by CASA or the authorised person to enable it to impose any conditions or operational limitations necessary in the interests of the safety of other airspace users and persons on the ground or water;

(d) if the experimental certificate is to be issued for a purpose mentioned in paragraph 21.191 (a) (research and development) or paragraph 21.191 (b) (showing compliance with the regulations):

(i) a description of the experimental purposes for which the certificate is sought; and

(ii) a statement setting out the estimated time or number of flights required for the purpose; and

(iii) a description of the areas over which the experiment will be conducted; and

(iv) except for aircraft converted from a previously certificated type without appreciable change in the external configuration — three-view drawings or three-view dimensioned photographs of the aircraft.

(e) if the experimental certificate is to be issued for a purpose mentioned in paragraph 21.191 (j) (operating certain light sport aircraft):

(i) written information that shows that a special certificate of airworthiness for light sport aircraft covered by regulation 21.186, or another document of similar effect under a law of a Contracting State, has been issued for a production aircraft of the same make and model; and

(ii) a statement of compliance, issued by the manufacturer of the kit from which the aircraft was assembled, that includes the statements and information required by subregulation 21.186 (2), in so far as the statements and information relate to the manufacture of such kits; and

(iii) copies of the aircraft assembly and operating instructions, aircraft maintenance and inspection procedures, and aircraft flight training supplement, issued for the aircraft by the manufacturer.

APPENDIX B: CASR 21.195A

Issue of experimental certificates

(1) CASA or an authorised person must issue an experimental certificate to an applicant for the certificate if the applicant:

(a) is eligible, under regulation 21.192, to apply for the certificate; and

(b) applies for the certificate in accordance with this Subpart; and

(c) is entitled, under this Subpart, to the certificate; and

(d) otherwise complies with this Part.

(2) CASA or an authorised person must issue the certificate subject to the conditions (if any) that CASA or the authorised person considers necessary for the safety of other airspace users and persons on the ground or water.

(3) A condition imposed under subregulation (2) may include operational limitations.

(4) Any conditions imposed under this regulation must be in writing and set out in, or attached to, the experimental certificate.

(5) A person must not engage in conduct that results in a breach of a condition of an experimental certificate.

Penalty: 50 penalty units.

(6) An offence against subregulation (5) is an offence of strict liability.

Note For ***strict liability***, see section 6.1 of the *Criminal Code*.

APPENDIX C: SOURCES AND SUBMISSIONS

Sources of information

The sources of information for this investigation included:

- the operator/owner of VH-LIS
- the aeronautical engineer that was consulted by the operator/owner of VH-LIS
- the Civil Aviation Safety Authority (CASA)
- a number of Licensed Aircraft Maintenance Engineers (LAMEs) who had worked on the aircraft or skis modification
- a number of witnesses to the accident
- the New South Wales Police Service
- the New South Wales Coroner
- the Bureau of Meteorology (BoM).

Submissions

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

A draft of this report was provided to the operator/owner of VH-LIS, the aeronautical engineer, CASA, the LAMEs, the New South Wales Coroner and the BoM.

Submissions were received from the operator/owner of VH-LIS, CASA and a number of the LAMEs. The submissions were reviewed and where considered appropriate, the text of the report was amended accordingly.