Australian Government
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**ATSB TRANSPORT SAFETY INVESTIGATION REPORT**
Aviation Occurrence Investigation – AO-2007-066
Preliminary

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

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ISBN and formal report title: see 'Document retrieval information' on page iii.

# DOCUMENT RETRIEVAL INFORMATION


| Report No. | Publication date | No. of pages | ISBN |
|---|---|---|---|
| AO-2007-066 | 19 February 2008 | 16 | 978-1-921165-88-7 |

**Publication title**

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

**Prepared by**

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www.atsb.gov.au

**Reference No.**

Feb2008/Infrastructure 08049



**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 that 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 had been in contact with the surface of the lake for about 36 seconds, witnesses observed the aircraft collide with the surface of the lake. The aircraft overturned and sank in about 9 metres of water. The pilot was fatally injured.

Examination of the aircraft wreckage showed impact damage consistent with the aircraft pitching nose down, about its right main landing gear while rotating to the right.

The investigation is continuing.

# 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

*The information contained in this preliminary report is derived from initial investigation of the occurrence. Readers are cautioned that there is the possibility that new evidence may become available that alters the circumstances as depicted in the report.*

## 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. 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 (Figure 1). While skimming across the surface, water would be forced through a hole in the base of each ski and via attached pipes and hoses into the aircraft's hopper. When sufficient water was collected, the pilot would climb the aircraft, dump that load, and return for another test run.

At about 0910 Eastern Daylight-saving time[1], the pilot was conducting a test run. That run was the second run of the day. After the aircraft had been in contact with the surface of the water for about 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 quickly sank in about 9 metres of water. 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, as particular events occurred. Eastern Daylight-saving Time was Coordinated Universal Time (UTC) + 11 hours.

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


## Aircraft information

The Air Tractor Inc. AT-802 aircraft, serial number 802-0082, was manufactured in the US. It was purchased new by the operator and was first registered in Australia on 9 September 1999. It was powered by a single Pratt and Whitney Canada PT6A-67A turboprop engine, fitted with a 5-bladed Hartzell propeller.

The aircraft was of tailwheel, fixed landing gear design. It had a specified maximum take-off weight of 7,257 kg. The capacity of the aircraft's hopper was documented by the manufacturer as 820 US gallons (3,075 litres). The aircraft had been factory fitted for use in a fire-bombing role and had a computer controlled fire-gate for the hopper.

The aircraft had been 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.

The Civil Aviation Safety Authority had issued a Special Certificate of Airworthiness for the aircraft under the experimental category on 16 November 2007. This allowed the operator to fit and flight test the skis on the aircraft under Civil Aviation Safety Regulations section 21.191 (b) for the purpose of

> 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

## 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 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 he never wore a helmet.

## Meteorological information

Witnesses 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 and photograph recordings.

The 0900 weather observation at Jerrys Plains Post Office, 16 km south-south-west of the accident site, recorded the temperature as 24 degrees Celsius, and the wind as a westerly at 3 kts. The 0900 weather observation at Singleton, 27 km south-east, recorded the temperature as 22 degrees Celsius, 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 was recorded as a south-westerly at 4 kts, gusting to 6 kts.

## Aircraft ski design and testing

The pilot had conceived the idea for the skis after considering and rejecting existing aircraft systems such as the float equipped Air Tractor Fireboss. It was reported that there had been significant interest in the skis for possible use in other countries for fire-bombing contracts. It was also reported that the pilot had been keen to get the design proven and in use, 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 were 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

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.

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 degrees 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. However, the operator continued to work on the design and produced a working set of skis complete with 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 those skis were fitted to VH-LIS, they were fitted to another company Air Tractor AT-802 aircraft, registered VH-LII (Figure 2). That aircraft was used 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**

It was 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 pilot had reported that he considered that there was no change in the aircraft’s performance with the skis fitted, including no evidence of increased drag or vibration.

**Figure 3: Initial flight testing in VH-LII**

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. This was then used to install the skis. While the angle was not recorded, it was recalled by one staff member to be around 7 degrees nose up. The pilot had later asked for the skis to be lowered at the back in an attempt to obtain a higher water collection rate.

It was also reported that on 23 October, the pilot had 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 had been adjusted by lowering the skis as 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 and after further modifications, were fitted to VH-LIS in the first week of December 2007.

On 26 October, the aeronautical engineer was contacted to view the fitted skis and associated hydraulic system and asked to prepare some drawings. The engineer completed a number of sketches in preparation for completing technical drawings. The engineer had also been 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, a few days later, the special certificate of airworthiness for VH-LIS was issued. CASA staff later 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

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 any of the suggestions and indicated that as he had already received a permit to fly, he was going to test fly the aircraft regardless of the CASA and engineer's advice.

On 16 November, the pilot submitted a short 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 without the hoses connected to 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 that 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 and rescue equipment.

The special certificate of airworthiness issued by CASA for VH-LIS also contained some conditions relating to that certificate. In part it indicated:

- The current certificate of airworthiness was suspended at the time the skis were fitted to the aircraft. The special certificate expired 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 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 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 located in a boat on the lake using a hand-held digital camera and by other staff in a company chase aircraft using a hand-held video camera.

It was reported that 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.

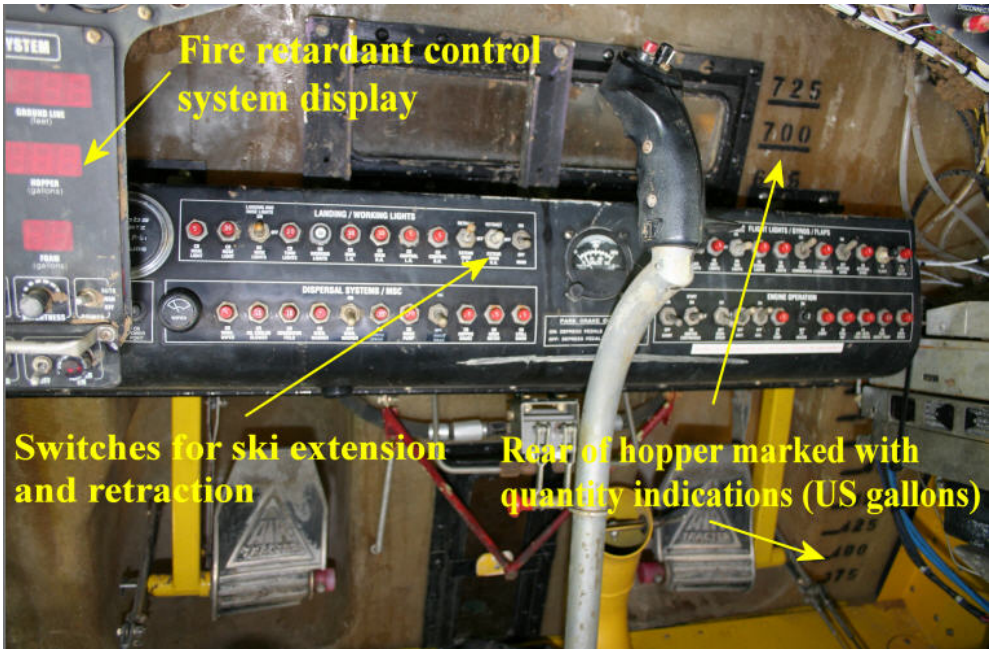
After the completion of that day's test flying, the pilot is reported to have said that while he was happy with the ski system, it was not collecting sufficient water. No records were kept of the amount of water collected during the runs. Staff later recalled the pilot saying that the maximum collection may have been about 250 gallons (946 l), while the aim was to collect 600 gallons (2,272 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. It had also been noted and mentioned to the pilot that in previous flights the pilot had a tendency to fly with a slightly right wing low attitude, both in normal flying duties and while conducted the ski flight testing.

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 an aural indication of the

hopper content levels took place, but nothing had been installed or implemented at the time of the flight testing.

**Figure 4: Cockpit of VH- LIS**




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 a 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 (568 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 about 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. 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 swim and dive down through fuel contaminated water, the staff 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 police divers, who documented that the pilot was found fully restrained by a 4-point harness in the cockpit.

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.

## 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 Australian Transport Safety Bureau (ATSB) investigators showed crush damage to the leading edges 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 cockpit canopy had been torn away and the windscreen had been smashed. It was not able to be determined if those were as a result of the impact sequence or the recovery process. The cockpit was partially filled with clay from the lake bed.

**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 exhaust case.

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

Continuity of all flight and engine controls was confirmed. There was no evidence of any pre-existing defects or faults found to any of the aircraft's systems. The aircraft's flaps were found in the fully extended position.

The experimental skis were fitted to the main landing gear. The skis were hydraulically actuated and 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, with the left ram having moved upward and the right ram moved, in an equal, downward direction.

The skis did not show any evidence of catastrophic or material failure. There were numerous inconsistencies in the manufacture and fitment between the left and right skis. 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 ski end of the water collection system. It was not possible to determine how much water the hopper contained.

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 wing and then the right wing.

## Recorded information

The aircraft was fitted with some components 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 testing flights. The fire control system is subject to further examination.

The accident flight, together with a number of the preceding test flights, had been recorded by company staff by means of a hand-held digital camera and/or video camera. Those images, while not of a high quality, may provide information relating to the operation and performance of the aircraft and the attached skis.

## Investigation continuing

The investigation is continuing and will include further investigation in relation to

- the photographic and videotape recordings
- analysis of any information available from the computerised fire retardant control panel
- some aspects of the construction and installation of the water collection system
- the water collection flight test program

- the process by which the water collection system and flight test program was approved
- the aircraft’s weight and balance
- risk assessment and management processes, including crashworthiness and survivability considerations
- the pilot’s medical records and post-mortem results.