Australian Government

Australian Transport Safety Bureau

Collision with terrain involving Air Tractor AT-502, VH-LIK

50 km east of Walgett Airport, NSW | 5 November 2016

Investigation

ATSB Transport Safety Report

Aviation Occurrence Investigation

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Cover photo: AirTractor

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Addendum

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Safety summary

What happened

On 5 November 2016, the pilot of an Air Tractor AT-502 aircraft, registered VH-LIK, was conducting aerial spraying operations from an airstrip at Cryon, New South Wales. After completing six spray loads, the pilot loaded liquid chemical into the aircraft's hopper and refuelled the aircraft. At 0953 Eastern Daylight-saving Time,[1] the pilot commenced a take-off to the north.

About 44 seconds after commencing the take-off, the aircraft collided with trees and the ground before coming to rest inverted. The pilot was fatally injured and the aircraft was destroyed by impact forces and a fuel-fed fire.

What the ATSB found

The flaps were retracted at some point during the take-off, which significantly degraded the take-off and climb performance. This effect was compounded by the estimated weight of the aircraft, the local temperature and wind conditions at the time of the flight. The combined effect probably resulted in the aircraft having insufficient take-off performance. The reason the flaps were retracted was not able to be determined.

The aircraft reached a height above the ground where the reduced benefit of ground effect further degraded the aircraft's performance. The low height and airspeed precluded the pilot from turning the aircraft towards a clear area and the aircraft descended into trees.

Recorded data from the aircraft indicated that the pilot attempted to dump the hopper contents after becoming airborne, which would have achieved significant gains in climb performance, however a complete dump was not achieved. The reason for this could not be determined.

What has been done as a result

The aircraft manufacturer is updating the maintenance section of the aircraft owner's manual to specify that the gatebox and emergency dump controls are to be inspected periodically for condition, function and adjustment.

Safety message

Acknowledging that the pilot was unable to dump the load on this occasion, the performance benefits in quickly and significantly reducing the aircraft weight means that the requirement to dump the hopper load, when the aircraft performance is not as expected, should be at the forefront of the minds of agricultural pilots. As with all emergency procedures, it is essential that pilots have a well-rehearsed plan, appropriate training and recent practice in conducting an emergency hopper load dump in the aircraft they are operating.

Proper functioning of the emergency jettison system is vital as pilots rely on it in case performance is inadequate, particularly when taking off with a heavy load. Therefore, registered operators should ensure adequate ongoing maintenance and regular checks to maintain serviceability of the system.

Pilots are reminded to monitor weather conditions like temperature and wind and anticipate the potential adverse effects of local conditions on aircraft performance. Where performance data is available for an aircraft, pilots should make active use of it to have the best opportunity to assess the expected performance of the aircraft for the given weight and environmental conditions before take-off.

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

The occurrence

On 5 November 2016, at about 0641 Eastern Daylight-saving Time,[2] the pilot of an Air Tractor AT-502 aircraft, registered VH-LIK (LIK), commenced a flight from Wee Waa Airport, New South Wales, to position the aircraft at an agricultural airstrip near Cryon, about 20 minutes flying time away. The aircraft was carrying full fuel (794 L) but the hopper, which had the capacity to carry about 1,892 L of liquid, was empty.

The aircraft landed at Cryon at about 0700 in preparation for aerial spraying of a crop about 5 km north of the airstrip. A loader[3] filled the aircraft's hopper with between 1,650 L and 1,670 L of liquid chemical, which was a solution of fungicide and insecticide in water.

At about 0721, the pilot commenced the first of seven planned loads of aerial spraying. After the aircraft landed from spraying the fifth load, the loader loaded the aircraft's hopper for the sixth load. The loader reported that a similar quantity of chemical was loaded on each of those flights.

Following completion of the seventh flight, the intention was to reposition to a property about 50 km away and continue spraying activities. In order to avoid delaying commencement of the next job, the loader mixed the seventh batch of liquid chemical and arranged for the pilot to load the hopper and refuel the aircraft himself. At about 0907, the loader observed the aircraft take off on the sixth load and then left the airstrip to drive to the next property.

Data recorded by the aircraft's GPS showed that the aircraft landed after completing the sixth load at 0930. About 24 minutes later, the aircraft commenced a take-off run to the north, consistent with previous departures. The last recorded aircraft position was 44 seconds later, 2 km north of the runway threshold.

The aircraft clipped the top of a fence 1,300 m beyond the start of the runway, struck multiple trees about 700 m beyond the fence and subsequently collided with terrain. The aircraft flipped over and came to rest inverted.

The pilot sustained fatal injuries and the aircraft was destroyed by the impact with terrain and a subsequent fuel-fed fire.

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

3 The loader/mixer is a ground support person whose functions include assisting with mixing chemicals and loading and dispatching the aircraft.

Pilot experience

The pilot held a commercial aeroplane pilot licence, was appropriately endorsed for the aircraft, and held aerial application and low-level ratings applicable to operation of the accident flight. At the start of the accident day, the pilot had logged a total of 9,896.8 flying hours. Over 8,000 hours of that time were low-level flying, including survey, fire bombing and about 2,500 hours of aerial agricultural operations. The pilot had accrued over 4,600 hours in turbine-engine aircraft and had about 450 hours on AT-502 aircraft.

The pilot had successfully completed a flight review and agricultural flight proficiency check on 7 June 2016.

Medical and pathological information

The pilot held a current Class 1 medical certificate without restriction that was valid to 22 December 2016. The pilot had also passed medical testing for entry into the Australian Defence Force as a military pilot within the previous two months.

The post-mortem examination did not identify any conditions that could have contributed to the accident. Toxicology results were negative for alcohol and commonly-tested drugs.

Aircraft

LIK was an Air Tractor Incorporated AT-502 single-seat agricultural aircraft manufactured in 1990 in the United States (US), (serial number 502-0115). It was powered by a Pratt & Whitney PT6A-15AG turboprop engine that drove a Hartzell HC-B3TN-3D three-bladed constant speed, reversible pitch propeller.

The aircraft was fitted with a fuel tank in each wing and had a total capacity of 817 L, of which 794 L was useable. The aircraft was also fitted with dispersal equipment for spraying and spreading, and a system that allowed the hopper contents to be dumped if required.

Maintenance

The aircraft was maintained under a Civil Aviation Safety Authority (CASA)-approved system of maintenance (SOM) by a CASA-approved maintenance organisation. The last scheduled 75-hourly was on 16 August 2016 at which time the aircraft had 13,000.4 hours total time in service (TTIS) and 150- and 300-hourly inspections were carried out on 15 October 2016 at 13,150.6 TTIS. The aircraft had flown about 40 hours since the last inspection.

Previous recent maintenance

- 30 November 2015: the maintenance records stated that a ‘flap system fault caused a take-off accident.’ The flap system was found to be intermittent and a new flap motor was installed and the ‘up’ relay was replaced.
- 8 April 2016: the flap actuator pivot bearing and right flap middle attachment bracket were identified as unserviceable and replaced.
- 16 August 2016: the flap motor was replaced in accordance with the operator’s requirement to replace it every 450 hours. The motor had accumulated about 150 hours of operation at the time of the accident.
- 15 October 2016: the hopper dump door boot was found unserviceable and was replaced.

The SOM specified that the daily pre-flight walk-around inspection was to be conducted in accordance with the AT-502 flight manual. The manual identified various checks relating to the dispersal equipment, however there was no reference to checking the integrity or operation of the hopper dump system.

The SOM specified that the airframe, electrical and instrument categories were to be maintained in accordance with the latest revision of the AT-502 owner’s manual, inspection section.

Additionally, agricultural role equipment was to be maintained to the applicable manufacturer's schedule when installed on aircraft. As with the daily inspection, the Air Tractor inspection information specified a number of checks relating to the dispersal equipment, but no specific reference to maintenance and operation of the hopper dump mechanism.

Registration holders of class B aeroplanes may optionally use the CASA Maintenance Schedule to maintain their aircraft. In contrast to LIK's SOM, the CASA Maintenance Schedule *Daily Inspection* included the following items specific to agricultural aeroplanes:

1. Check that the agricultural equipment (e.g. hopper, hopper lid and fasteners, spray tanks, spray pump and lines, booms and boom supports, dump doors, fan and fan brake) is secure.
2. Check that the dump and fan brake mechanisms are free from obstructions and operate correctly.

The CASA Maintenance Schedule for *Periodic Inspection – The Airframe* specified additional items for agricultural aeroplanes:

1. Inspect the hopper, hopper lid and fasteners, baffles and internal braces.
2. Inspect the spreader, spreader gate and controls.
3. Inspect the spray pump fan, fan mount, fan brake, spray pump lines booms and boom supports.
4. Inspect the emergency dump doors and dump controls.

Agricultural operations

The AT-502 is a specialised aircraft designed for agricultural operations. Liquid or granular chemical for aerial spraying or spreading can be carried in the aircraft's hopper. With a load in the hopper, a pilot can use the performance benefits of flying the aircraft close to the ground (in ground effect)[4] while it accelerates to a safe airspeed prior to climbing. If the pilot assesses the aircraft's performance is inadequate, particularly during the take-off, a jettison system enables them to dump the load, which quickly reduces the aircraft's weight and increases performance.

Regulations

The US Federal Aviation Administration (FAA)-approved Airplane Flight Manual (AFM) for the AT-502 specified an original maximum agricultural gross take-off weight of 3,296 kg. However, the AFM for LIK had revised weight and balance data, specifying a maximum agricultural gross take-off weight of 8,000 lb (3,629 kg). Additionally, the AT-502, like most agricultural aircraft, had provision in its Type Certificate Data Sheet (TCDS)[5] for operators to approve a higher maximum (gross take-off) weight. The TCDS applicable to LIK stated that the aircraft type and model had demonstrated satisfactory operation, at a maximum (gross take-off) weight of 9,200 lb (4,173 kg) under the following conditions:

- 1,300 ft altitude
- 32 °C outside air temperature
- a stall speed of 77 kt calibrated airspeed (CAS) and maximum speed 122 kt (CAS).

Australian Civil Aviation Regulations 1988 (CAR) 138 requires that the pilot must comply with the aircraft's flight manual. CAR 235(4) prohibits taking off in an aircraft if its gross weight exceeds its maximum take-off weight. However, to facilitate overweight operations in Australia, CASA has issued exemptions against the requirements of CAR 138 and 235. The exemption current at the time of the accident was EX217/15, which allowed operations up to weights where jettisoning the

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[4] After lift-off and before the aircraft reaches the best rate of climb speed, induced drag is nearly all of the total drag. Remaining in ground effect significantly reduces the induced drag. The pilot can then hold the aircraft in ground effect as it accelerates until the airspeed approaches the best rate of climb speed, which is the speed where the aircraft has the most excess power.

[5] TCDS was issued by the US FAA and described an aircraft, its engine and propeller. A TCDS lists the limitations and information required for type certification including an aircraft's airspeed and weight limits, thrust limitations, and so on.

hopper load would reduce the gross weight to below the maximum take-off weight. However, the gross weight at take-off was not permitted to exceed the highest of the weights shown on:

- the aircraft TCDS
- a placard (with a weight certified by CASA)
- the approved flight manual.

Under the exemption, LIK was permitted to operate at the maximum demonstrated weight of 9,200 lb (4,173 kg) specified in the TCDS.

The aircraft operator reported that although the aircraft had capacity to carry 800 L of fuel and 1,800 L of liquid in the hopper, they carried a maximum of 600 L and 1,600 L respectively, in accordance with regulatory requirements. However, they also advised that LIK had successfully operated at its maximum capacity of about 400 kg higher than the demonstrated maximum take-off weight, with the same engine and propeller combination, for many years under an earlier exemption that did not specify a gross weight limit.

Effect of increased weight

An increase in aircraft weight reduces aircraft performance. In the take-off phase, increased weight for the same power setting:

- increases induced drag and rolling resistance
- slows acceleration
- lengthens the ground run.

An increase in weight also increases the stalling speed and means that the aircraft has to reach a higher groundspeed (for the same configuration and wind conditions) before it can safely fly. That in turn also increases the length of the required ground run.

Induced drag is proportional to the weight of the aircraft squared, so an increase in weight of 10 per cent increases induced drag (in all flight conditions) by about 20 per cent and the power required to overcome that drag increases similarly.

Flaps

To increase lift and aid in overcoming the increased induced drag, the aircraft was fitted with large Fowler-type flaps, interconnected to the ailerons. Fowler flaps extend rearwards before extending downwards, increasing the wing surface area and then the camber. The initial rearwards extension means in the partially extended or take-off position, the flaps increase lift without significantly increasing the drag. That flap design particularly assists agricultural aircraft operating at high weights, close to the ground and for short take-off performance. The flaps are operated electrically and may be stopped at any position from 0° to the maximum of 26° of travel. The flaps had external markings visible from the cockpit at 10° and 20° of travel.

For take-off with a load or for short-field take-offs, 10 to 20° flap was used. Up to 10° of flap was also used during turns. The AFM stated that for take-off with a full hopper load, ‘lower flaps to 10° position…after breaking ground do not retract the flaps until at least 91 kt indicated airspeed is reached.’ This was consistent with the manual’s stated best rate of climb speed[6] for a heavy load, which was between 86 kt and 91 kt indicated airspeed.

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6 The best rate of climb speed is the speed where the aircraft has the most excess power (power available minus the power required).

When fully extended (to 26°), the flaps significantly increased drag. Following reports of pilots attempting to use full flap on take-off, the aircraft manufacturer added the following warning to the AFM:

> Full flaps should not be used during the takeoff sequence. The use of full flaps creates large amounts of drag and will lengthen the ground roll and impair climb performance.

Flap switch position

The AT-502 aircraft are fitted at manufacture with a flap switch near the throttle quadrant. The pilot presses the electric switch and holds it until the desired amount of extension or retraction is achieved. The pilot can verify the amount of flap extended based on two markings on the flap.

In Australia, it is common to fit an additional flap switch in accordance with an engineering order. The setup comprises either a rocker switch or, in the case of LIK, two buttons on the control stick (Figure 1). This allows the flaps to be operated with the pilot's right hand, leaving the left hand free to operate the throttle and/or dump lever.

Figure 1: Flap stick switch

Source: Aircraft operator

The aircraft manufacturer advised that, although the additional flap switch position was convenient, very few US operators placed one on the control stick due to safety concerns associated with this setup. Specifically, it was reported that during high stress, high workload events, pilots had squeezed the control grip tightly and unintentionally actuated the switch and raised or lowered the flap.

The ATSB received notification in September 2017 of inadvertent flap retraction during take-off, using the flap stick switch, which resulted in the aircraft descending and colliding with terrain (see also ATSB investigation 199800640 in *Similar occurrences*).

Operations

The day's planned operation

The task for the pilot was to spray a combination of insecticide and fungicide over an area of 390 hectares, at a volume rate of 30 L per hectare. Seven loads were programmed, with each load area 55.7 hectares and each load volume 1,671 L.

The loader reported loading 1,650–1,670 L of water-based chemical into the hopper for each spray run. In preparation for the seventh spray load, the loader had mixed 400 L of chemical, which the pilot was to load into the hopper along with water to make up the total volume. The exact volume loaded was not witnessed but there was no reason for it to have varied from the quantity loaded on the previous runs.

Fuel

The pilot refuelled the aircraft and refilled the hopper after the loader had left and therefore the amount of fuel and chemical on board at the time of the accident was estimated, based on the available evidence.

The aircraft fuel tanks were full (794 L usable fuel) at the start of the first flight that day. Based on a planned fuel consumption of 225 L per hour, the usable fuel remaining after the sixth spray load would have been 160 L. This was a conservatively high consumption figure used for fuel planning so the fuel remaining may have been greater.

The aircraft operator had a supply fuel tank with a capacity of 14,000 L situated at the airstrip. On 26 October 2016, 12,940 L of Jet A1 fuel was delivered to fill the supply tank. Two days prior to the accident, the job record obtained for a company aircraft showed that 594 L of fuel was taken from the tank to refuel that aircraft. There was no other known refuelling from the supply tank prior to the day of the accident.

After the accident, the supply tank contained about 13,000 L. This indicates that the pilot likely added approximately 400 L of fuel to LIK. In consideration of the conservatively low estimated fuel remaining value (160 L), and the reported normal procedure of filling to a visible indicator, it was therefore estimated that the pilot filled aircraft to between 560-600 L at the start of the seventh take-off.

Weight and balance

Using the estimated fuel and chemical load at the start of the seventh take-off run, the aircraft take-off weight was probably between 4,214-4,246 kg (Table 1). This weight was about 41-73 kg above the TCDS weight of 4,173 kg. At the estimated weight, the aircraft's centre of gravity would have been within the fore and aft limits.

The stalling speed at the TCDS demonstrated weight was 77 kt CAS (equivalent to 75 kt indicated airspeed).[7]

Table 1: Estimated take-off weight range

Source	Weight (kg)
Basic empty weight	2,007
Pilot	95
Hopper load	1,670
Fuel (using specific gravity of 0.79 for jet A1 fuel at 29 °C)	442-474
Estimated likely take-off weight	**4,214-4,246**

Meteorological conditions

As part of the investigation, the ATSB obtained weather data for 5 November 2016 recorded at 10-minute intervals at:

- Cryon Station, which was about 7 km south-west of the accident airstrip
- Burren Junction (40 km east)
- Rowena (40 km north-northeast).

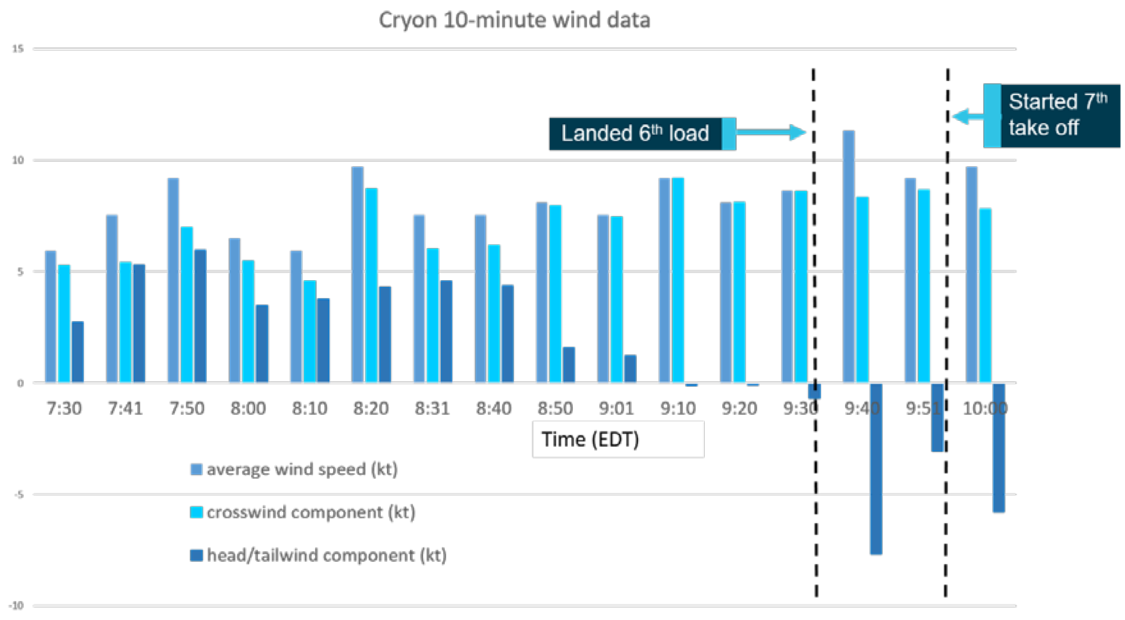
Recorded 1-minute interval data was also obtained for Walgett Airport (50 km west of the accident airstrip).

The weather recorded between 0720 and 1000 at those locations showed the temperature increased from 19 °C to 29 °C and the wind changed from north-westerly, through westerly to south-westerly. As the wind changed direction, it became gustier and the wind speed increased.

The average wind speed and direction for each 10-minute period was recorded at Cryon Station, about 7 km south-west of the accident airstrip. Figure 2 shows the recorded 10-minute data divided into the crosswind and tailwind components for the runway heading 017° True. During the 24 minutes the pilot was on the ground between the sixth and seventh loads, the average wind speed increased to about 11 kt and changed direction so that there was a tailwind of about 6 kt and a crosswind of about 8 kt for the final take-off. Shortly after take-off, the aircraft turned to track in a more north-easterly direction (Figure 6), which would have increased the tailwind component by about 1.5 kt.

[7] The TCDS demonstrated stalling speed was at an elevation of 1,300 ft and temperature 32 °C, or a density altitude of about 3,580 ft. The density altitude at Cryon at the time of the accident was about 2,315 ft, so the stalling speed may have been lower than 77 kt, but there was no performance data with which to make the adjustment.

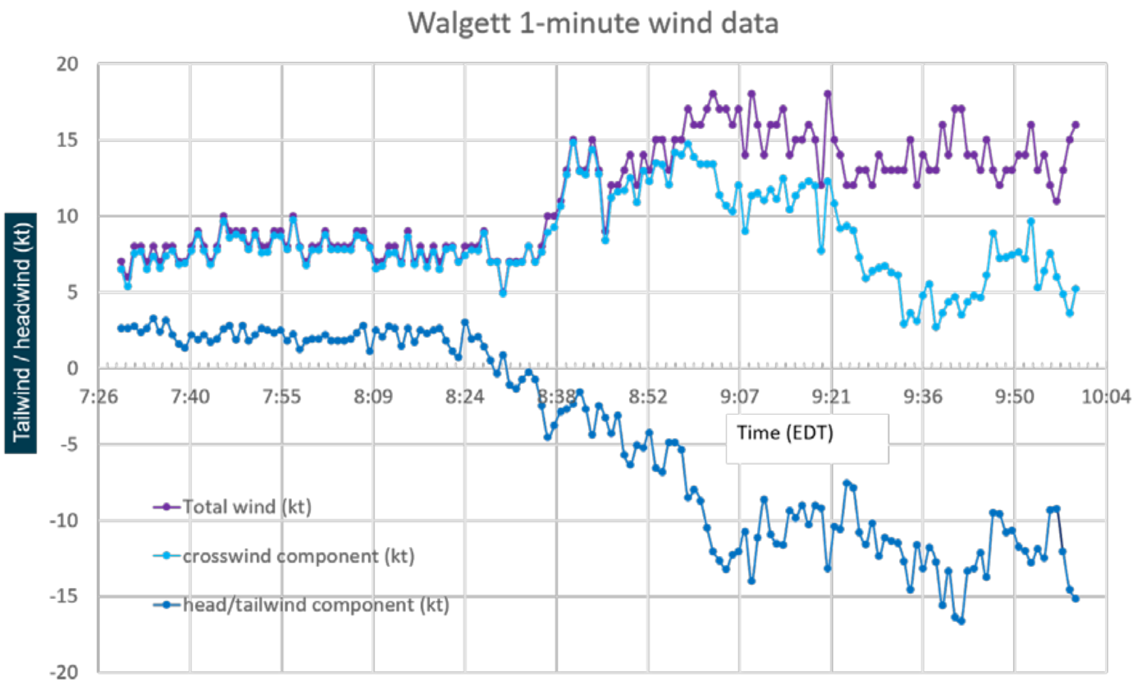
Figure 2: Recorded wind data at Cryon showing headwind and crosswind components for a runway heading 017° T



Source: Delta Ag – analysed by ATSB

South-westerly winds at Walgett were at 14 kt, gusting to 20 kt between 0930 and 1000. Figure 3 shows the crosswind and tailwind components for the runway heading 017° True if the wind at the accident site was similar to that recorded at Walgett Airport.

Figure 3: Recorded wind data at Walgett Airport showing tailwind and crosswind components for runway heading 017° T



Source: Bureau of Meteorology – analysed by ATSB

A pilot who was operating about 11 km east-south-east of the accident site reported that the wind changed suddenly at the time of the accident, and that he had just ceased spraying operations for the day because of the strong wind. He estimated the wind was gusting about 30 to 35 km per hour (16–19 kt) and potentially over 40 km per hour (22 kt).

Based on the pilot's assessment and the recorded 1-minute wind data at Walgett, the aircraft may have encountered wind gusts stronger than the 10-minute average recorded at Cryon during take-off for the seventh run.

Density altitude

Density altitude is pressure altitude corrected for non-standard temperature. As density altitude increases, aircraft and engine performance decrease. The pressure altitude decreased by 30 ft during the morning's flights from 575 to 545 ft, and the density altitude increased due to an increase in temperature.

The temperature at the time of the accident was 29 °C and the density altitude for the airstrip (elevation 485 ft above mean sea level) was 2,405 ft above mean sea level. The 10 °C increase in temperature and slight decrease in pressure altitude since the first spray run of the day increased the density altitude by 1,170 ft (from 1,235 ft). AT-502B performance data indicated (no performance data was available for the AT-502) that this would have increased the length of the take-off ground run by about 15% and the distance to clear a 50 ft obstacle by about 17%. As the performance of the AT-502 and 502B is comparable, the required ground run and obstacle clearance distance for LIK would have been similarly affected.

Recorded information

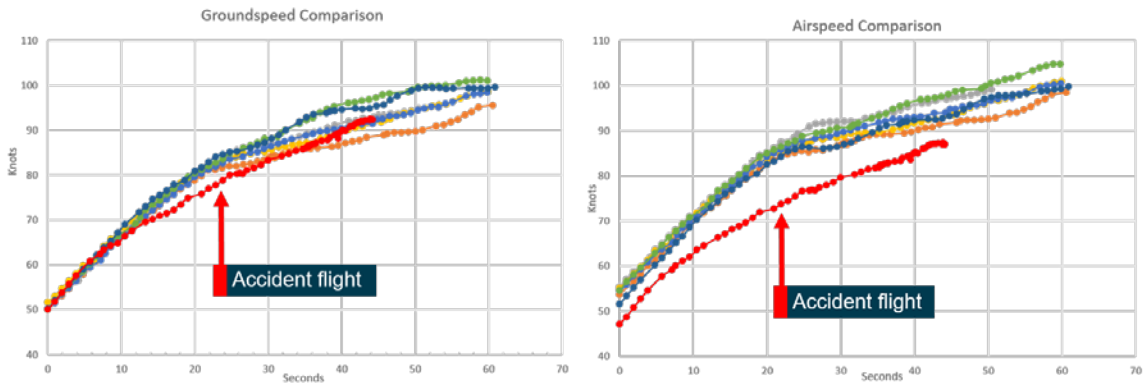
The aircraft was equipped with a satellite navigation system that provided tracking guidance to the pilot to facilitate accurate spray coverage of the crop. The system recorded in-flight data to a compact flash (CF) memory card that included the time and the aircraft's position, speed, track and altitude.

Data from the seven flights (loads) that day were recovered from the device and the accident flight was compared with the first minute of the six previous flights (Figure 4). On each flight, the system started recording when the aircraft reached 50 kt on the take-off run and stopped when the aircraft decelerated below 50 kt during the landing roll.

The aircraft's recorded groundspeed on the accident take-off was comparable to the six previous flights, except that the acceleration was slower — between about 70 and 80 kt. The ATSB combined the recorded 10-minute wind data at Cryon with the system data to derive the approximate airspeed for all of the day's flights. The accident flight showed significantly reduced airspeed and slower acceleration between about 60 and 80 kt airspeed. The previous six flights had similar profiles to each other. Fuel consumption reduced the aircraft's weight over the six flights, which would have offset the decreasing headwind component to some extent during the morning's operation.

Based on the recorded groundspeed and 10-minute average wind data at Cryon, the aircraft's maximum airspeed on the accident flight was about 87 kt (and 80 kt based on the Walgett 1-minute data) immediately before impact.

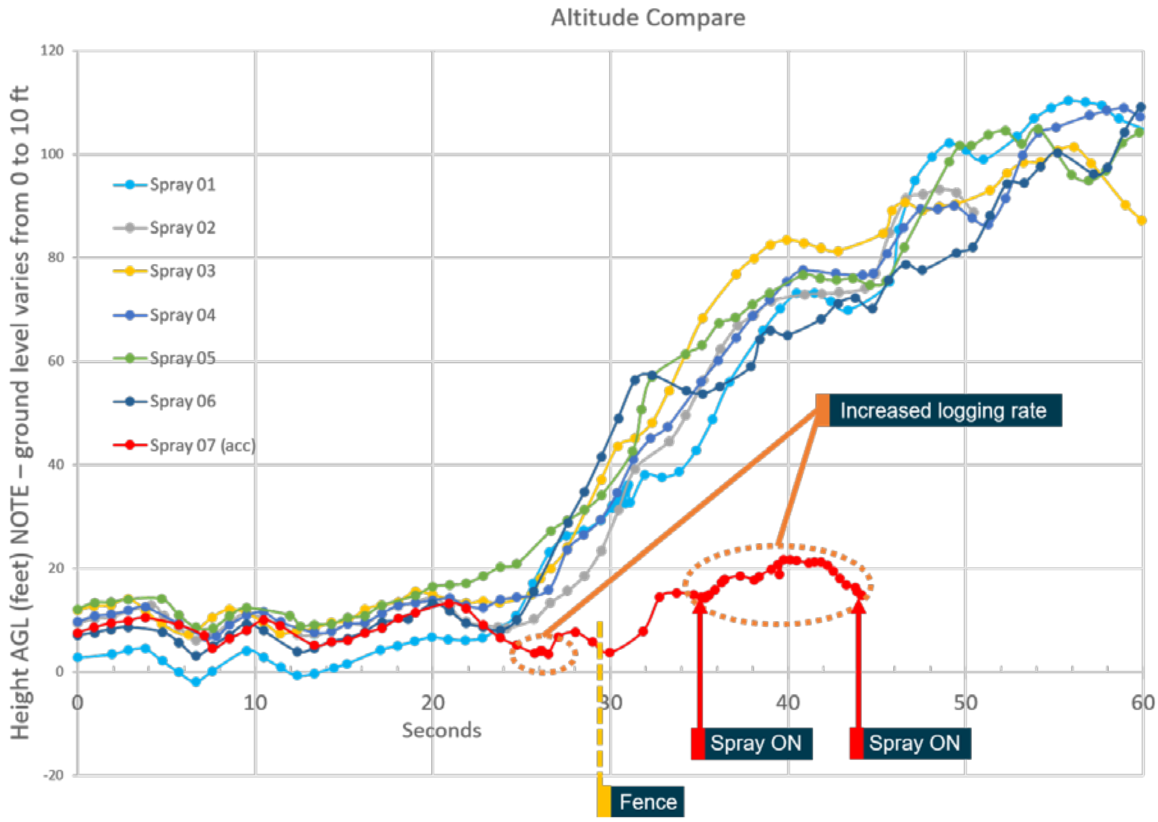
Figure 4: Comparison of LIK's seven flights from the day of the accident – groundspeed (left) and airspeed (right) calculated from recorded groundspeed and adjusted for recorded wind



Source: ATSB analysis of VH-LIK navigation system data

Altitude data from the day's flights revealed that the aircraft did not climb more than 20 ft above the ground on the final take-off. The data does not depict the exact flight profile and height due to data accuracy limitations (the 'ground level' for the accident take-off varies between about 5 and 10 ft), but provides a reliable comparison of the flights (Figure 5).

Figure 5: Navigation system recorded data comparing the aircraft's recorded height above ground on the day's flights



Source: ATSB analysis of VH-LIK navigation system data

The data contained a discrete recorded spray on/off parameter. The spray ON is actuated through a pressure switch on the spray boom, as well as a micro-switch at the bottom of the dump handle (for spreading granular chemical or jettisoning the hopper load). The normal data recording rate was about one record per second. However, if the system was actively spraying or spreading, the data recorded at a higher rate of 4 to 5 times per second.

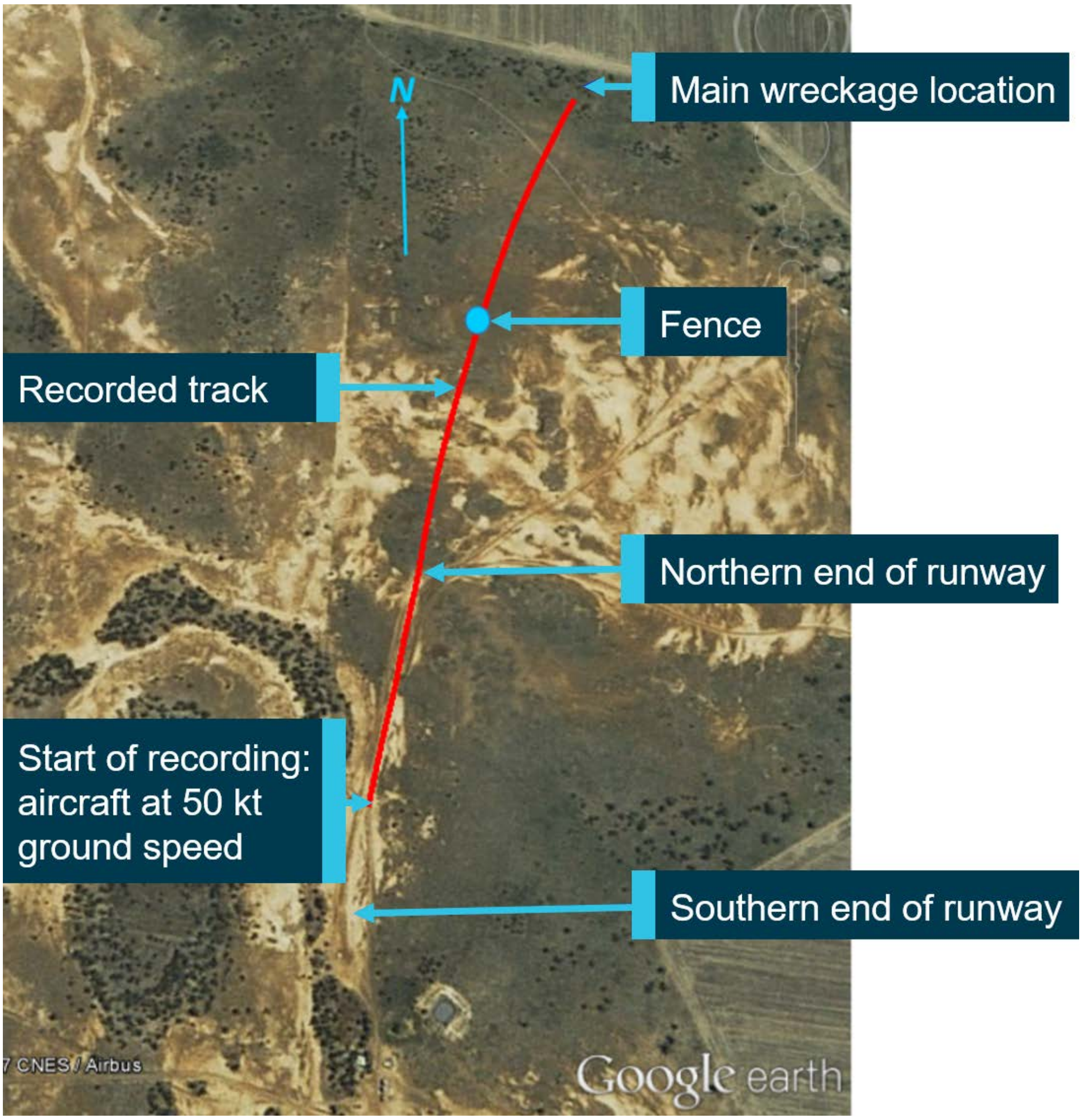
During the first six flights, the spray ON parameter remained on during the spray runs, and then OFF as the aircraft turned for the next run or was taking off and landing. Consistent with the spray ON activating, the data logging rate was higher than once per second.

At 0954:19 on the final take-off, 26 seconds into the recording the system briefly recorded at a higher rate without the spray discrete parameter activating (Figure 5). This occurred just before the aircraft reached a one-metre high fence, about 1.3 km beyond the start of the runway.

Nine seconds later, at 0954:28, the system again recorded at a higher rate, and the spray discrete parameter activated ON once only and then immediately returned to OFF. The discrete parameter activated once more (for one data record) at 0954:37, and the recording ended 0.25 seconds later.

The aircraft's recorded flight path on the accident flight showed the aircraft's take-off and a turn gradually to the right, consistent with previous flights and in the direction of the target area to be sprayed on that load (Figure 6).

Figure 6: Recorded aircraft track for accident flight



Source: ATSB

Site and wreckage information

Witness information

A pilot who was conducting aerial spraying about 11 km east-southeast of Cryon saw black smoke and flew towards it. He found LIK inverted and on fire, and radioed for assistance.

The pilot landed his aircraft at the Cryon airstrip and met a farm worker with a vehicle and they travelled together to the accident site. He reported that he could not see any evidence that the pilot had dumped the load.

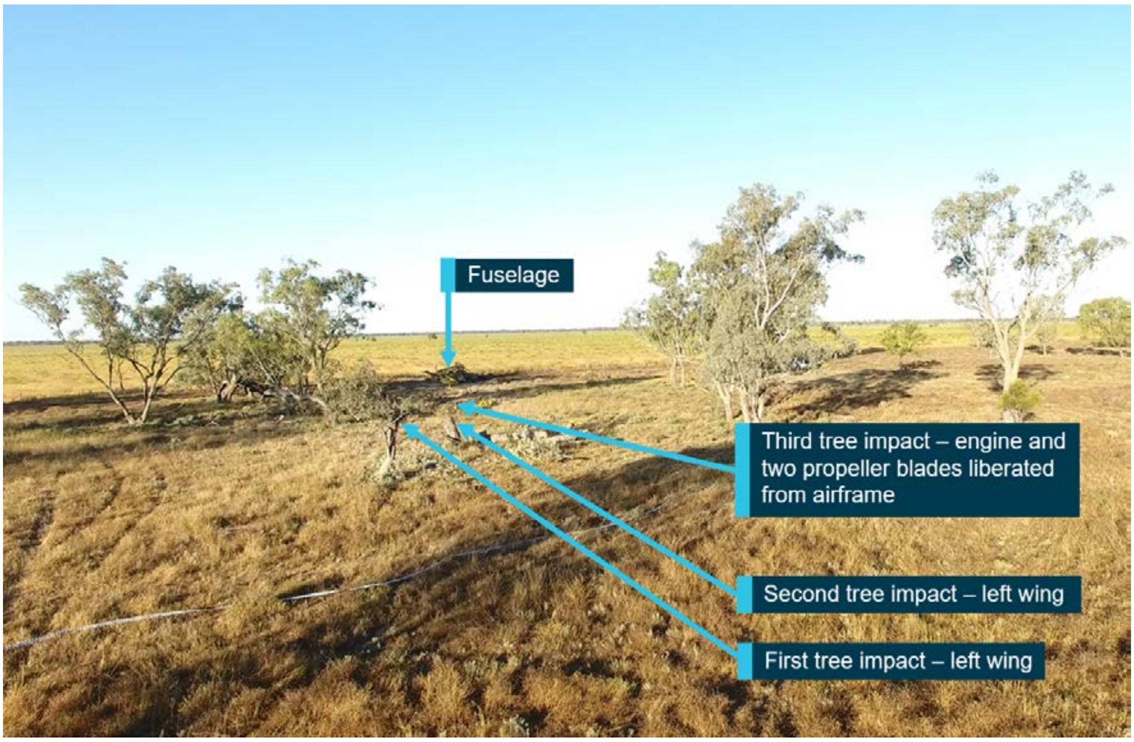
Wreckage information

The accident site was about 2 km north of the southern end of the runway and the general spread of wreckage indicated the aircraft had been tracking to the north-northeast. Examination of the accident site determined that the aircraft's left wing struck a tree about 9 ft above the ground, then a second tree about 6 ft above the ground (Figure 7). The right wingtip struck the ground and the aircraft then collided with a third tree dislodging the propeller and engine. The main landing gear struck the ground and separated from the airframe, and the fuselage then collided with the ground nose first, flipped over and came to rest inverted. The debris trail extended about 80 m from the first tree impact to the fuselage. A fuel-fed, post-impact fire destroyed most of the aircraft.

About 1.3 km from the start of the runway, a 1.2 m high wire fence ran across the flight path. The top two fence wires were broken in line with the aircraft's flight path, suggesting contact with part of the aircraft. The fence was noted to have been undamaged about a week prior to the accident.

The impact forces and post-impact fire destroyed many of the aircraft components, however all major components of the aircraft were identified.

Figure 7: Accident site showing tree impacts



Source: ATSB

Engine and propeller

Examination of the engine outer combustion case identified evidence of twisting associated with engine torque. Additionally, the compressor blades at the engine inlet were bent opposite to the direction of rotation and the power turbine blades were fractured around the entire circumference of the disc. All of those indications were consistent with the engine rotating at the time of the accident.

The propeller separated from the engine upon striking a tree, with only one of the blades remaining within the hub. One of the two detached propeller blades was located at a right angle to the aircraft's flight path, approximately 90 m from the tree strike. The significant distance of travel by the ejected blade required significant energy, which was only likely to occur under conditions of high engine power/torque.

That blade had fractured at the blade tip and displayed rearward bending that was indicative of a ground or tree strike while rotating. There was a hand file mark along the edge of the blade but no indication of pre-existing cracking or other defects.

All of the propeller blades exhibited a general level of bending, twist and leading edge impact damage that was consistent with the propeller being driven with significant torque at the time of impact.

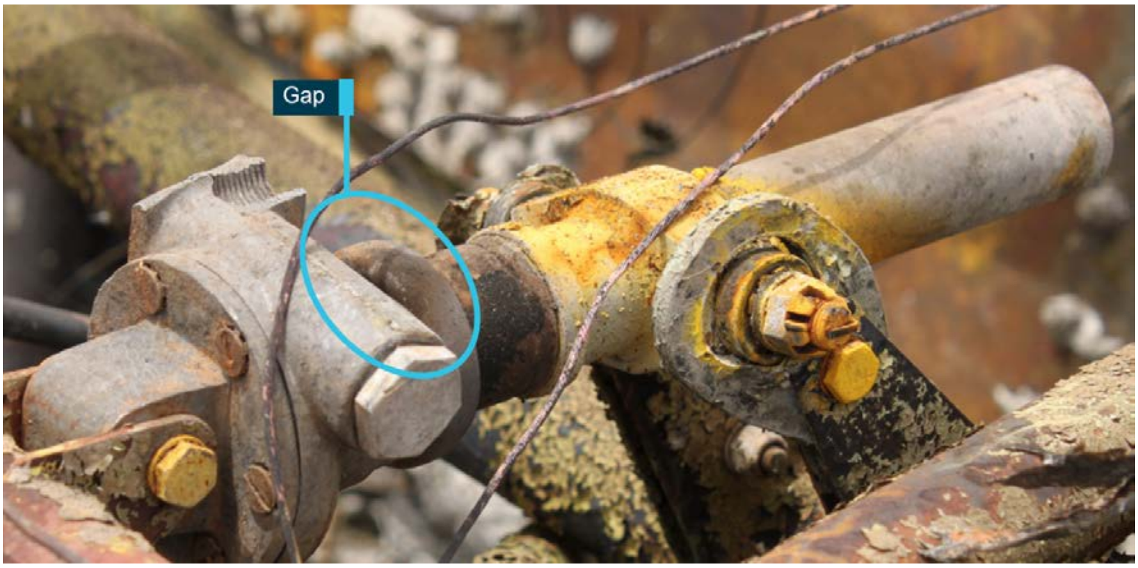
Flight controls

Examination of the aircraft's flight controls verified that they were continuous prior to the collision. The flaps were found in the retracted position. The flap controls were heavily damaged by impact forces and fire, but the remaining identifiable parts appeared to be in place. The flap micro-switches and relays had melted, so their positions could not be verified.

Flap actuator

The flap actuator was in the fully retracted position (Figure 8) and the flap actuator motor had broken free from the gearbox.

Figure 8: Flap actuator



Source: ATSB

When fully retracted, the manufacturer specified that there should be a gap of 1/16" to 1/8" (1.6-3.2 mm) between the striker and the end of the up travel. If the flap micro-switch is not set correctly, and the gap is insufficient, the flap motor may stop the 'up' travel. If this occurs, it can jam the actuator and prevent the flaps from extending. An appropriate gap was identified on the occurrence actuator. The aircraft's maintenance records indicate that the aircraft had flown 150 hours without any related issues since the flap micro-switch was set.

Air Tractor Service Letter 260 reported a case of the rubber coupling between the flap actuator motor and gearbox tearing. This occurred during take-off with the flaps extended and allowed the actuator to back-drive, which resulted in an uncommanded flap retraction. The service letter recommended that the coupling be replaced upon condition and inspected every 400 hours to prevent a similar event occurring. Due to the extent of damage, the condition of the rubber coupling prior to the impact could not be assessed.

Hopper

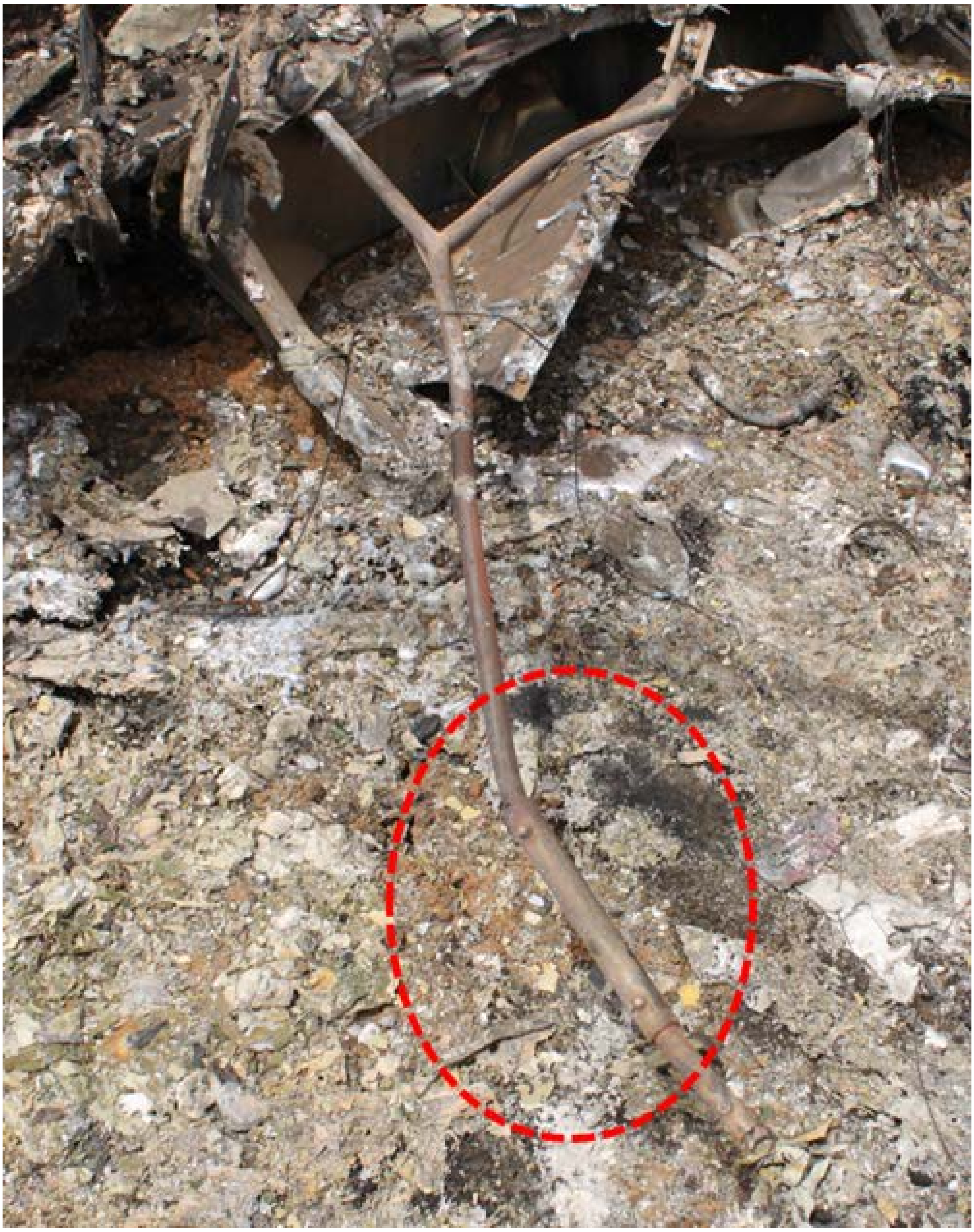
The emergency hopper dump mechanism appeared to be continuous except for a rod end fracture, consistent with impact damage. The dump lever (handle) was found in the closed position, but was not locked and was free to move. Its pre-impact position could not be determined. The over-centre latch of the hopper gate box was in the unlocked and fully-open position; however, it was not clear whether it had moved to that position during the impact sequence.

A modification, involving a sleeve bolted to the hopper gate box push rod, was identified during the wreckage examination (Figure 9). No documentation for the modification was available and therefore an assessment of its suitability could not be made. However, the operator advised that the modification had been made to extend the rod, and that the aircraft had flown over 10,000 hours since, without any issue relating to the dump mechanism. The push rod was bent at the sleeve modification but it had not fractured. It was likely that the damage was a result of the accident impact. The hopper gate mechanism had been used in this configuration during spreading operations and cleaning.

Examination also identified that a bolt was missing from one of two gate box push rod attachments (Figures 10 and 11). The bolt was not recovered and therefore the failure mode could not be assessed. The aircraft manufacturer advised that those bolts and clamps were known to separate from the torque tube during the majority of impact sequences. In any event, testing showed that failure or absence of one of the bolts would not prevent the transfer of sufficient force to open the hopper door, providing the associated clamp was tightened securely.

At the time of writing, the aircraft manufacturer reported that there were no known failures of the hopper dump mechanism.

Figure 9: Gate box push rod showing modification

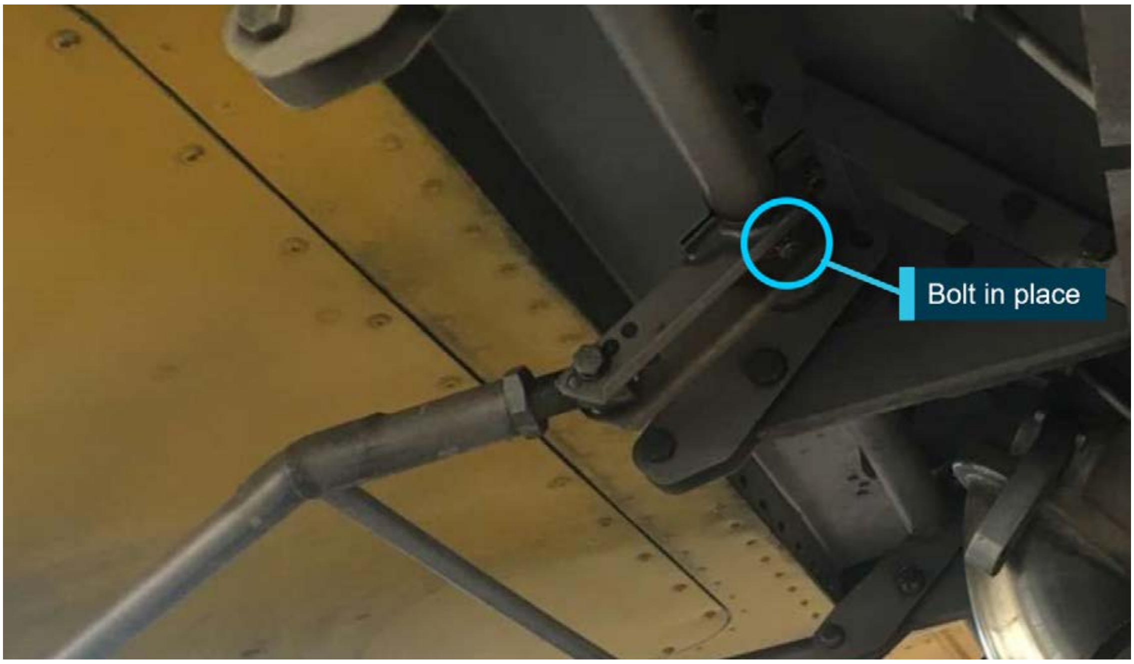


Source: ATSB

Figure 10: Gate box wreckage showing hole in gate box torque tube where bolt was missing

Source: ATSB

Figure 11: Image of gate box torque tube bolt in place



Source: ATSB

Survivability

The webbing of the seat harness was entirely destroyed in the post-impact fire. Despite this level of damage, various buckle and harness adjust mechanisms were identified. The lap-belt harness buckle was found in the secured, or closed position. The pilot's helmet was located in the wreckage and seriously damaged by fire. The loader reported that the pilot was wearing the helmet throughout the morning's flights, and it was therefore very likely he was wearing it at the time of the accident. The cockpit survivable space was relatively intact but severely burnt.

Previous occurrences

Occurrence involving VH-LIK

On 16 November 2015, the pilot of VH-LIK was conducting the ninth load of a spray job. There was 1,500 L of chemical in the hopper, and 400 L of fuel on board (about half fuel capacity). The pilot reported that the start of the take-off roll was normal – the first performance check point was reached with the tail wheel off the ground at approximately 400 m, the second check point at 600 m was achieved. At the 800 m mark, the pilot selected additional flap to try to get the aircraft to climb out of ground effect (break ground) and applied back pressure on the control stick. The aircraft failed to break ground so the pilot selected the dump lever and jettisoned the chemical load. The pilot descended onto the remaining airstrip and attempted to land, but the aircraft collided with a fence.

The operator reported that aircraft likely encountered windshear during the take-off run and once airborne. An engineering inspection found a faulty relay on the flap system such that the flaps could be raised but not lowered. In response to that accident, the operator implemented a periodic inspection for the flap relay to be replaced every 1,000 hours. Prior to that, the flap motors were routinely replaced at 450 hours but the relays were not routinely replaced, nor were they required to be.

Similar occurrences

199800640 Air Tractor AT-802, VH-ODL

On 1 March 1998, the pilot of VH-ODL was conducting a fire-fighting demonstration at an air show. The pilot started the drop run and at a height of about 40 ft, the load release commenced at, or close to, the maximum rate. During the load release, the nose of the aircraft pitched up and the aircraft entered a climb. On completion of the load release, the aircraft nose continued to pitch up and the climb angle increased. The aircraft climbed straight ahead for a short distance before commencing to yaw and roll to the left. The bank angle increased to a maximum of about 90 degrees, while the nose attitude dropped to almost horizontal. At about 450 ft and a very low airspeed, the aircraft rolled inverted and entered the incipient stages of an inverted spin. Recovery to controlled flight was not achieved and the aircraft impacted the ground inverted. The pilot sustained fatal injuries and impact forces and the ensuing fire destroyed the aircraft.

Among other findings, the investigation found that the flaps were fully extended (to 30 degrees), which could be selected by the pilot using either a switch mounted just below the throttle quadrant, or by a toggle switch mounted on the control stick. Experienced AT-802A pilots reported that it was possible to inadvertently extend the flaps by unintentionally activating the control stick switch. Extending the wing flaps resulted in a nose-up pitching moment.

200600851 Aircraft loss of control – 20 km SSW of Cootamundra, NSW, 16 February 2006, VH-FVF PZL M-18A, Dromader

The pilot was fatally injured when the aircraft stalled and impacted terrain during fire-bombing operations. The pilot was an experienced agricultural pilot with previous fire-bombing experience, but had limited familiarity with the handling characteristics of the modified and heavily-loaded aircraft. The pilot had not jettisoned the load of retardant when the aircraft stalled. The ensuing loss of control occurred at a height that did not permit recovery before the aircraft collided with the ground.

Review of occurrence data

For the period September 2000 to September 2018, the ATSB identified 26 take-off accidents involving aircraft in agricultural operations, where inadequate aircraft performance was a factor. These included stalling shortly after take-off, tailwind conditions, and several occurrences where the pilot dumped or attempted to dump part or all of the hopper load. Three of the accidents resulted in serious injuries and another three in minor injuries.

Of the accident aircraft, at least 18 had take-off performance data available. Five involved AT-502 aircraft, which did not have published take-off performance data. Given that the majority of the accidents occurred in aircraft with performance data available, this suggests that a lack of performance data is not associated with an increased likelihood of take-off accidents. However, a lack of reference to performance data may have contributed to these accidents.

Safety analysis

Having failed to gain any significant altitude, the aircraft clipped the top of a fence about 1,300 m beyond the start of the runway. The aircraft subsequently descended and collided with trees and the ground a further 700 m along the flightpath. Despite the impact and fire damage to the aircraft, there was no evidence of failure of the engine, or structural failure of the aircraft that may have contributed to the accident. The pilot was suitably qualified and experienced in low-level and agricultural operations and the investigation did not identify any preconditions with the pilot that may have contributed to the accident.

The investigation identified some operational factors that would have contributed to decreased aircraft performance during the accident flight. These included high outside air temperature and aircraft weight, tailwind conditions, combined with the flaps being retracted at some point prior to the impact. Apparently unable to maintain height, the aircraft descended into the trees. Although it is evident that the pilot attempted to dump the hopper load, which would have significantly improved the aircraft's performance, no significant dump of the contents occurred. These factors are explored in detail below.

Aircraft performance

Aircraft weight

After refuelling, the estimated weight of the aircraft at the start of the accident flight take-off run was likely at, or about 70 kg above, the aircraft's maximum demonstrated weight and within the aircraft's centre of gravity fore and aft limits. The additional weight of the aircraft, due to refuelling after the previous load, would have comparatively lengthened the ground run, slowed acceleration, increased the stalling speed and reduced the rate and angle of climb. However, the aircraft had reportedly been operated at that airstrip previously at the same weight and in similar conditions and therefore the weight alone was not considered to have affected the performance sufficiently to have resulted in the accident.

Environmental conditions

Similar to the effect of aircraft weight, the 10 °C increase in temperature across the day's operations would have resulted in a significant reduction the aircraft's performance, including a 15 per cent increase in the length of the ground roll, for an equivalent weight, over that time.

The take-off distance and climb gradient would have been further increased by the effect of the probable tailwind. The aircraft was on the ground for 24 minutes before the start of the accident take-off. The pilot may not have been aware of the wind change as he was refuelling and refilling the aircraft and there was no fabric on the windsock frame. A gusty tailwind can cause sudden reductions in airspeed and increase the pilot's workload to control the aircraft. There would have been an increase of 16 per cent in the take-off distance for a tailwind of 6 kt based on the wind conditions measured at Cryon, and a greater effect if the wind conditions were similar to those recorded at Walgett Airport and reported by a nearby witness.

Effect of retracted flap

The combined effect of the likely weight and local environmental conditions was considered in terms of overall effect on aircraft performance. There was no performance data available for the 502 aircraft. However, based on performance data for the 502B aircraft with the same engine model, there was sufficient runway distance available for the aircraft to take off with the estimated weight, temperature and density altitude, with the flaps extended 20 degrees. When the effect of the recorded average tailwind component was considered, there was still likely sufficient runway distance available for the take-off. Although if the aircraft encountered the witnessed stronger wind gusts during the take-off, this may have resulted in the ground roll extending to the fence.

The distance required to climb to a height of 50 ft above ground level was sufficient even at the highest likely aircraft weight, in nil wind, with the flaps extended to 20 degrees. However, with a tailwind of 6 kt (or more), the aircraft may not have achieved 50 ft by 2,000 m beyond the start of the runway – the distance at which the aircraft struck a tree. The recorded data identified that the aircraft was not climbing at that time, and that it struck the tree about 9 ft above the ground while descending.

In summary, the aircraft had reportedly taken off successfully at that airstrip on previous occasions, with similar weight and environmental conditions, with the flaps extended in the take-off position of between 10 and 20 degrees. However, with the flaps retracted, as found at the accident site, the aircraft would likely have had insufficient take-off performance in the distance available.

While the evidence from the engine and propeller damage at the accident site indicated the engine was making significant power at the time of impact, a partial power loss that may have reduced the aircraft performance could not be ruled out.

Reduction of ground effect

According to the recorded data, the aircraft descended in the last 3–4 seconds while continuing to accelerate. This likely occurred as a result of diminishing ground effect.

After lift-off and before the aircraft reaches the best rate of climb speed, induced drag is nearly all of the total drag. Remaining in ground effect significantly reduces the induced drag. The normal take-off technique for heavily loaded agricultural aircraft is to hold the aircraft in ground effect as it accelerates until the airspeed approaches the best rate of climb speed, which is the speed where the aircraft has the most excess power.

The best rate of climb speed for the likely weight of the aircraft was 91 kt indicated airspeed. The highest recorded groundspeed of about 93 kt was the last recorded interval on the accident flight. Assuming a 6 kt tailwind, the aircraft's highest airspeed was about 87 kt immediately prior to impact, so it never reached the best rate of climb speed, and therefore the best available performance was not achieved.

As the aircraft approached trees, it effectively climbed gradually as the ground sloped away. This height above the ground resulted in the aircraft losing some of the benefit of ground effect – less than half the reduction in induced drag of that achieved near the ground. As the induced drag increased, the aircraft performance would have reduced, further reducing the excess power available to climb.

In discussing ground effect on take-off, the United States Federal Aviation Administration Airplane Fling Handbook (section 5-9 page 107) stated:

> Due to the reduced drag in ground effect, the airplane may seem to be able to take off below the recommended airspeed. However, as the airplane climbs out of ground effect below the recommended climb speed, initial climb performance will be much less than at [best rate of climb speed] Vy or even [best angle of climb speed] Vx. Under conditions of high-density altitude, high temperature, and/or maximum gross weight, the airplane may be able to lift off but will be unable to climb out of ground effect. Consequently, the airplane may not be able to clear obstructions. Lift off before attaining recommended flight airspeed incurs more drag, which requires more power to overcome. Since the initial takeoff and climb is based on maximum power, reducing drag is the only option. To reduce drag, pitch must be reduced which means losing altitude. Pilots must remember that many airplanes cannot safely take off at maximum gross weight at certain altitudes and temperatures, due to lack of performance.

With insufficient performance available to climb or maintain altitude, despite accelerating, the aircraft descended. The small margin above the stalling speed and low height above ground would have precluded any turn away from the trees ahead in the flight path, as an increase in bank angle would have increased the load factor and further reduced the margin.

Retracted flaps

With the flaps retracted, the stalling speed would have increased by about 10 kt. Retracting the flaps would also have increased the angle of attack to achieve the same lift coefficient. If the pilot was not aware the flaps were retracted, the higher nose attitude may have led the pilot to perceive the aircraft was climbing and would out-climb the trees. Several scenarios for when and how the flaps were retracted were considered.

The pilot may have omitted to extend the flaps prior to take-off due to oversight. Normal pre-take-off checks included that the pilot looks out to a mark on the left flap and checks the 10 degrees of extension prior to commencing take-off. However, some highly experienced pilots reported that they extend the flaps based on feel and, rather than looking outside to check, extend (or retract) small amounts of flap and assess how the aircraft responds.

Based on interviews with a number of pilots of Air Tractor aircraft, the ATSB assessed that the experienced pilot would have been well aware of the importance of flap for take-off with a heavily-loaded aircraft. Therefore, he was unlikely to have commenced the take-off run if he knew that the flaps were retracted or would have quickly assessed that the weight was excessive for the conditions (and no flap) and dumped the hopper load.

The flaps may have been extended at the start of the take-off run but then retracted at some point during the flight. It was considered unlikely that the pilot would have deliberately retracted the flaps during the take-off, given his experience and knowledge of performance degradation that would have ensued. Previous occurrences have shown that it was possible to inadvertently retract the flaps using the flap stick switch however, there was insufficient evidence to determine if that occurred.

It was possible that the flaps may have suffered a technical failure. Failure of a flap relay or the flap motor, or jamming of the flap actuator would result in the flaps being stuck in whatever position they were in at the time of failure. The likelihood of this was reduced by the fact that the flap relay had been replaced after failing 12 months earlier and the flap motor had been replaced on schedule, 150 flying hours prior to the accident flight.

There was one known means for the flaps to retract uncommanded. That is, if the rubber coupling in the flap actuator perished (as per Air Tractor Service Letter 260), which should be inspected for during scheduled maintenance. The condition of the coupling prior to the accident was unable to be assessed, however, based on previous occurrences, the likelihood of this occurring was considered low.

Ultimately, there was no conclusive evidence to determine how and when the flaps were retracted. In any event, if the pilot was aware that the flaps were retracted, based on his experience he is very likely to have recognised the adverse effect on the take-off and climb performance, and dumped the chemical load.

Emergency hopper dump

If the aircraft is not achieving the required performance for take-off, particularly to clear obstacles in the flight path, the pilot can dump all or a portion of the hopper load and/or abort the take-off. When the pilot pushes the dump handle forward and the hopper door opens fully, the entire liquid load should jettison in about 8 seconds. Dumping the hopper load will significantly, and almost immediately, reduce the aircraft's weight and increase performance. In the context that agricultural aircraft are often operated near their maximum capability, pilots should be prepared to dump the load if the expected performance is not realised during take-off.

About 26 seconds after the start of the recorded data (50 kt groundspeed) there was an increased logging rate, but no activation of the spray ON discrete parameter. For this to occur, it was possible that the pilot moved the spray lever down, but not enough to activate the spray pressure switch or that the pilot moved the dump lever forwards slightly very briefly and then returned it to closed. Normal procedure was to take-off with the spray pump off, so activation of the spray lever would not result in any liquid dispersal. The ATSB analysed data from a test flight where the spray lever was activated with the pump off, and no Spray ON or increased logging rate occurred in the data. This indicated that the accident data was not consistent with the pilot inadvertently pushing the spray lever instead of the dump lever.

About 9 seconds before the recording ceased, the spray ON discrete parameter activated and the logging rate increased. The operator conducted a flight test by setting the unit to liquid (spraying) and then pushing the dump lever forwards to jettison the contents of the hopper during the take-off run and again in level flight. The data from the test flight exhibited the same characteristics of the accident flight. The Satloc manufacturer advised that the accident and test dump data is consistent with the pilot pushing the dump lever forward far enough to activate the micro-switch. The data was therefore consistent with one positive dump handle micro-switch activation during the accident flight.

This indicated that the pilot pushed the dump handle forward far enough to activate the micro-switch, in an attempt to jettison at least a portion of the hopper load. However, the recorded data did not show any significant aircraft performance improvement at the time the micro-switch activated (or at any time during the flight), and the airspeed and groundspeed continued to increase at a comparable rate to the previous six flights. In addition, there was no evidence of chemical residue other than at the main wreckage site. Based on those factors, it was determined that, at most, only a small amount of liquid was jettisoned.

The ATSB considered the following potential factors contributing to why that may have occurred.

Timing of the micro-switch activation

The micro-switch activation consistent with the pilot initiating a jettison of the hopper contents occurred 35 seconds after the data started recording and about 5 seconds after the aircraft clipped the fence. The delay in the pilot's initiation of the dump may have been due to the pilot experiencing high workload controlling the aircraft in gusty conditions.

The pilot may also have expected that the aircraft would fly when it accelerated to 80 kt. About 40 seconds into the recorded data, the derived airspeed (based on a tailwind of 6 kt) reached 85 kt, and although the speed continued to increase, the aircraft then started to descend. A number of AT-502 pilots reported that once the airspeed reached 80 kt (with the take-off flaps extended) the aircraft would normally climb away and this may have also been the pilot's expectation, particularly if he was unaware that the flaps were retracted.

Hopper door malfunction

The aircraft manufacturer advised that there was no known malfunction of the dump lever that would have prevented a successful dump and that the mechanical jettison system had never been known to fail. Despite this, the data indicated that the pilot pushed the lever far enough forward to activate the micro-switch, which would ordinarily effect a hopper dump. Therefore, while a detailed examination of the dump system functionality was not possible due to accident damage, a technical failure or malfunction could not be ruled out. The effect, if any, that the apparently unapproved modification of the dump mechanism had on the ability to jettison the chemical could not be determined.

Hopper dump mechanism checks

Civil Aviation Advisory Publication (CAAP) 42B-1(1.1), January 2016, stated that the manufacturer's maintenance schedule is generally more appropriate than the alternative Civil Aviation Safety Authority (CASA) maintenance schedule. However, in this instance, the aircraft's system of maintenance (in referencing the aircraft flight manual and owner's manual) was less specific than the CASA alternative in relation to required daily or scheduled inspection of the dump mechanism and controls.

The reason for the unsuccessful hopper dump was unknown, as was the extent of any pre-flight or periodic inspections leading up to the accident. Therefore, the potential influence of dedicated checks of the dump system in this occurrence could not be established. Nevertheless, daily and scheduled inspections do provide an established and effective means of providing improved assurance around component and system integrity. Additionally, the majority of aeroplanes used in agricultural operations rely on operation of the dump mechanism to reduce weight if there is insufficient available performance.

Take-off performance

Successive approvals to operate the AT-502 aircraft at weights higher than that originally certified indicate that the aircraft is often operated at the upper end of its load capacity. That situation increases the risk that the aircraft may not have adequate take-off performance for certain weight/operating conditions. This has been partially recognised by publication of a revised stall speed associated with the Type Certificate Data Sheet that demonstrated safe operation of the aircraft at weights 877 kg (27 percent) higher than the originally-approved limit. However, and although not required, that approval was not accompanied by access to performance data to assess the runway length required to take off for given aircraft weights/environmental conditions.

A review of performance-related accidents involving agricultural aircraft identified that performance data was available for the overwhelming majority of the involved aircraft. While that indicated that the absence of performance data for the AT-502 was not itself a safety issue, it did indicate that this important source of planning information may not be widely used during agricultural operations.

The majority of agricultural aircraft have the advantage of a dump mechanism to rapidly reduce weight if the pilot assesses that there is insufficient available performance during the take-off. While this does provide some mitigation, pilots may still be exposed to degraded performance situations, with the associated risk that control of the aircraft may be lost before the load can be jettisoned. Past performance-related accidents have demonstrated this does occur. All of the aircraft involved in the 26 accidents reviewed by the ATSB had the capacity to jettison the load however, in all cases this either did not commence or the dump was unable to prevent the accident.

As environmental conditions change throughout the day, take-off performance can change significantly. In addition, variations in runway surfaces used in agricultural operations can also significantly affect the required runway distance required. For those reasons, pilots need to monitor changes in operating conditions and use all means to assess the effect on the aircraft's performance. These include the use of experience, local knowledge and published take-off data (including documented take-off configuration).

The Australian Aerial Application Association's Aerial Application Pilots Manual advises pilots that:

> if you are operating off an unfamiliar strip, always take a light load first time and then build up gradually to a load that is heavier but still safe.

Further, the manual reminds pilots that environmental conditions will change throughout the day and the pilot must constantly monitor these.

Findings

From the evidence available, the following findings are made with respect to the collision with terrain involving an Air Tractor AT-502 aircraft, registered VH-LIK, which occurred at an agricultural airstrip 50 km east of Walgett Airport, New South Wales, on 5 November 2016. These findings should not be read as apportioning blame or liability to any particular organisation or individual.

Contributing factors

- The flaps were either never extended, or were retracted at some point during the take-off sequence. This probably resulted in insufficient take-off performance when combined with the high aircraft weight and environmental conditions. The ATSB could not determine at what point during the take-off the flaps were retracted.
- The pilot attempted to jettison the hopper contents but no significant dump of the chemical occurred and therefore the associated performance gains were not realised. It could not be determined why the load did not dump.
- The aircraft reached a height above the ground where the reduced benefit of ground effect further reduced the aircraft's performance, at a height and airspeed which precluded the pilot from turning the aircraft towards a clear area. This probably resulted in the aircraft descending into trees.

Other factors that increased risk

- There was no evidence of appropriate approvals for the modification to the hopper gate box push rod**.**
- There was no performance data available for the AT-502 aircraft to calculate the required departure runway length.
- The aircraft was operated under a Civil Aviation Safety Authority-approved system of maintenance that did not explicitly require a daily or periodic inspection of the hopper dump system.

Safety issues and actions

The ATSB did not identify any organisational or systemic issues that might adversely affect the future safety of aircraft operations. However, relevant organisations may proactively initiate safety action in order to reduce their safety risk. The ATSB has been advised of the following safety action in response to this occurrence.

Air Tractor

As a result of this occurrence, Air Tractor advised the ATSB that the following inspection will be added to the maintenance section of the owner's manual, to be completed every 100 hours:

> Check gatebox controls and emergency dump controls for proper function and adjustment. Check all components and hardware for condition, wear, and/or cracking.

This requirement will apply to all three types of emergency dump system that can be fitted to Air Tractor aircraft.

General details

Occurrence details

Date and time:	5 November 2016 – 0954 EDT	
Occurrence category:	Accident	
Primary occurrence type:	Collision with terrain	
Location:	50 km E of Walgett Airport, New South Wales	
	Latitude: 29° 56.37' S	Longitude: 148° 39.19' E

Pilot details

Licence details:	Commercial pilot (aeroplane) licence issued 24 February 2015 (first issued 4 September 1990)
Relevant ratings and endorsements:	**Aircraft ratings and endorsements:** Class ratings: single and multi-engine aeroplane Design feature endorsements: gas turbine engine, tailwheel undercarriage **Operational ratings and endorsements:** Aerial application rating aeroplane (day and night) Low level rating
Medical certificate:	Class 1 valid to 22 December 2016; Restrictions: none
Aeronautical experience:	9896.8 hours at the start of the accident day
Last flight review:	7 June 2016

Aircraft details

Manufacturer and model:	Air Tractor Incorporated AT-502	
Year of manufacture:	1990	
Registration:	VH-LIK	
Serial number:	502-0115	
Total Time In Service	13150.6 (at last inspection 15 October 2016)	
Type of operation:	Aerial work – Aerial agriculture	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 1 Fatal	Passengers – N/A
Damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation included:

- recorded meteorological information
- the Civil Aviation Safety Authority
- Satloc US
- Air Tractor US
- the aircraft operator and operator records
- a number of Air Tractor pilots
- the aircraft maintainer and maintenance records
- the pilot's medical records and logbook.

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 aircraft operator, aircraft maintainer, Civil Aviation Safety Authority, Air Tractor via the United States National Transportation Safety Board, Bureau of Meteorology, and a number of Air Tractor pilots.

Submissions were received from the aircraft operator, the Civil Aviation Safety Authority and the aircraft manufacturer. The submissions were reviewed and where considered appropriate, the text of 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.

Australian Transport Safety Bureau

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Investigation

ATSB Transport Safety Report
Aviation Occurrence Investigation

Collision with terrain involving Air Tractor AT-502, VH-LIK, 50 km east of Walgett Airport, NSW on 5 November 2016

AO-2016-146

Final – 20 November 2018