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ATSB TRANSPORT SAFETY REPORT
Aviation Occurrence Investigation AO-2010-025
Final

Total power loss, VH-MTC
Hobart, Tasmania
4 April 2010

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Abstract

On 4 April 2010, the pilot of a Victa Airtourer 115 aircraft, registered VH-MTC was conducting a private visual rules return flight from Cambridge Aerodrome, Tasmania. The flight consisted of some aerobatics, followed by some sight-seeing over Hobart.

At about 1020, after the pilot commenced the return to Cambridge, the engine suddenly lost all power. The pilot conducted a forced landing onto a nearby road, seriously damaging the aircraft. The pilot, who was the sole occupant, was uninjured.

The investigation found that the power loss was due to exhaustion of the aircraft's fuel supply.

A number of safety issues were identified concerning the measurement of the quantity of fuel on board, and consumed before and during the flight. Those issues contributed to the pilot's belief that there was more fuel on board the aircraft than was actually the case.

As a result of this accident the aircraft's type certificate holder, aircraft owner's association and the aircraft's operator have undertaken a number of safety actions. Those actions include a number of pilot education initiatives and the amendment of the operator's maintenance processes to ensure compliance with all airworthiness directives.

In addition, the aircraft's type certificate holder is undertaking a number of enhancements in response to an unrelated Civil Aviation Safety Authority-initiated review of aspects of the aircraft's fuel system and concerns about the aircraft's original fuel system certification process.

FACTUAL INFORMATION

History of the flight

On Sunday 4 April 2010 at about 0920 Eastern Standard Time[1], the pilot arrived at Cambridge Aerodrome near Hobart, Tasmania in preparation for a flight in a Victa Airtourer 115 aircraft, registered VH-MTC (MTC). The pilot planned to conduct solo aerobatic flight manoeuvres in the local Ralph's Bay flying training area, about 9 NM (17 km) to the south of the aerodrome, followed by a scenic flight overhead Hobart.

The pilot reported that prior to the flight, he measured the fuel quantity on board with the aircraft's fuel dipstick as 14 to 15 imperial gallons (gal)[2] (64 to 68 L). The pilot stated that he crosschecked that reading with the indicated fuel gauge quantity.

The flight departed Cambridge at about 0950 for the Ralph's Bay training area. The pilot reported carrying out a series of aerobatic manoeuvres between 3,000 and 6,000 ft above mean sea

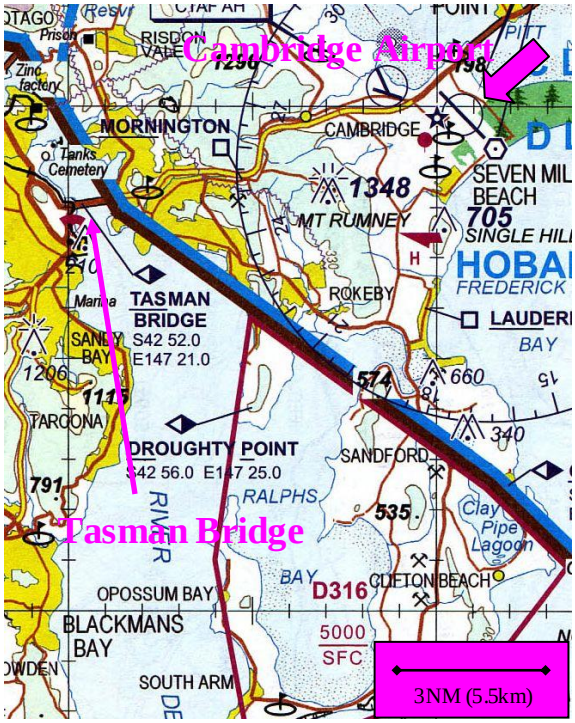
1 The 24-hour clock is used in this report to describe the local time of day, Eastern Standard Time (EST), as particular events occurred. Eastern Standard Time was Coordinated Universal Time (UTC) +10 hours.

2 The aircraft was designed and built in Australia in 1965. At that time, the use of British imperial gallons was standard in Australia for fuel volume measurement. One imperial gallon equals 4.546 L.

level (AMSL) in that area for about 10 to 15 minutes. The fuel gauge was reported to indicate about 13 gal (59 L) at the completion of the aerobatics.

The pilot then descended to about 1,500 ft and departed the training area for the scenic flight over Hobart. The pilot recalled that when adjacent to Cornelian Bay, near the Tasman Bridge visual flight rules reporting point and at about 1,600 ft, the engine suddenly lost all power (Figure 1).

Figure 1: Section from Airservices Visual Terminal Chart for Hobart, Tasmania



The pilot reported that he climbed the aircraft to about 1,800 ft by converting forward speed to height, while conducting his engine failure checks. The pilot was able to re-start the engine at low power momentarily, before it failed completely. The pilot stated the fuel quantity gauge indicated about 12 gal (55 L) at that time.

The pilot declared a MAYDAY[3] to air traffic control advising of the complete loss of engine power and indicating that he was undertaking a forced landing onto nearby sports grounds. As the pilot manoeuvred in preparation for the landing, he decided against that location due to the number of people in the vicinity, choosing instead to conduct a flapless landing in a southerly direction onto the Brooker Highway. The pilot observed that at that time, there was little traffic on the highway's southbound lane.

During the approach the aircraft lost altitude quicker than expected, and the pilot was forced to approach beneath the Lower Domain Highway overpass. The pilot reported that immediately prior to touchdown, the aircraft's right wing contacted a concrete barrier resulting in the aircraft moving left and clipping a gutter. The aircraft then contacted a pole and some trees before coming to rest. During those impacts, the aircraft's left mainwheel and most of the left wing were torn from the aircraft (Figure 2).

The aircraft was seriously damaged and the pilot uninjured.

The aircraft operator was authorised by the Australian Transport Safety Bureau (ATSB) to move the aircraft wreckage to secure storage for later examination.

Figure 2: Aircraft wreckage on Brooker Highway

Personnel information

The pilot held a student pilot licence (aeroplane) and a valid Class 2 medical certificate with no restrictions. He commenced flying training on 1 January 2007 and passed a general flying progress test (GFPT) on 1 May 2008. The GFPT allowed the pilot to fly single-engine aircraft below 5,700 kg. He underwent aerobatic instruction in the Victa Airtourer aircraft and was endorsed to conduct specified aerobatic manoeuvres.

At the time of the accident, the pilot had a total aeronautical experience of 129.6 hours, of which 24.7 were in MTC.

3 A MAYDAY transmission is made in the case of a distress condition and where the flight crew requires immediate assistance.

Aircraft information

The aircraft was a Victa Airtourer 115 type, serial number 112/A1. It was manufactured in Australia in 1965 as a side-by-side, two-seat aerobatic basic training and touring aircraft. The aircraft was originally fitted with a 115 hp Lycoming O-235 engine, and was subsequently upgraded to the 115/A1 type in September 1974. That upgrade included some structural modifications to the aircraft and the installation of a more powerful, 150 hp Lycoming O-320 engine with a different propeller. An associated approved flight manual supplement listed a number of changes to the aircraft's limitations, performance and handling that resulted from the changed engine installation.

Wreckage examination

An examination of the aircraft wreckage did not identify any failure of the engine or of the associated airframe systems that would have contributed to the loss of power.

Examination of the fuel tanks and supply confirmed system continuity, and that it was capable of supplying fuel for normal engine operation. Despite the aircraft's fuel quantity gauge indicating just over 12 gal (55 L) when battery power was applied post accident, less than 100 ml of fuel was able to be collected from the system. That gauge indication was consistent with the pilot's account of the gauge reading at the time of the power loss.

Emergency personnel and the operator's recovery team reported that no fluid (such as fuel) had leaked from the aircraft following the accident, or at any time during the transit and storage of the wreckage.

The investigation identified that it was not possible to fully insert the aircraft's Victa Airtourer-type dipstick into the fuel tank opening. Examination of the tank's rubber bladder showed that it had partially detached from its fuselage mounts and was wrinkled on the tank's upper and lower surfaces. That wrinkling partially blocked the fuel filler opening. The wrinkling on the tank's lower surface did not to appear to be interfering with the position of the fuel quantity transmitter float valve; however a definitive examination of the tank's lower surface proved difficult to carry out.

One of the aircraft's owners advised that the position of the fuel tank's rubber bladder could become temporarily disturbed during aerobatic flight, and that it would normally settle down again following refuelling.

Testing of the float-operated fuel quantity transmitter unit did not reveal any faults with the unit. Testing was not conducted on any other aircraft fuel quantity system components.

Fuel and fuel management information

Fuelling of the aircraft

The pilot pre-arranged to fly the aircraft over the weekend and was the only pilot to fly the aircraft during that time. The pilot reported that prior to flying on Saturday; he ascertained the fuel on board the aircraft as 68 L by dipping the tank using the dipstick provided. He crosschecked that reading with the fuel gauge in the cockpit and added 59 L of fuel to take the tank to full.

During the weekend, the pilot flew the aircraft on four occasions on Saturday and once on Sunday, the occurrence flight, without further refuelling.

The pilot had recorded an estimation of the fuel quantity remaining after each flight on the aircraft's flight and fuel log that was kept in the aircraft.

Fuel usage rates and the aircraft flight manual

The operator provided pilots with fuel usage rate information for the aircraft on a Victa Airtourer checklist. That checklist listed a typical fuel consumption rate for the O-320 engine of 32 L/hour.

There was no supplement for the O-320 engine in the aircraft flight manual (AFM) as required by the relevant regulations.[4] All of the fuel usage rate information in the aircraft's AFM was related to the O-235 engine.

The O-320 engine supplement indicated a typical fuel usage for the O-320 engine of 35.9 L/hour at

4 CASA Regulations: Civil Aviation Regulation 1988, 2(1), 54, 55, 138, 139, 322 and 323. Also detailed in Civil Aviation Advisory Publication, CAAP 54-1(2).

'full rich'[5] mixture setting in cruise flight or 34 L/hour in cruise in the 'leaned'[6] condition. Climb at full throttle was listed at 53.4 L/hour.

No fuel consumption planning figures were stipulated for aerobatic flight in the O-320-engined aircraft; however it was reported by one of the aircraft's owners to be about 45 L/hour. The operator's flight instructor advised that this information was passed on to pilots during their aerobatic training.

The pilot reported that during the flights, he calculated fuel usage for the aircraft using a fuel consumption rate of about 30 L/hour.

ATSB fuel calculations

The ATSB reviewed the aircraft's maintenance release, flight and fuel log and the fuelling tanker/trailer's refuelling sheets for the period from 27 January 2010 to the date of the accident. Using that data, the fuel on board was estimated at the commencement of flying operations for each day. The estimation was based on a fuel consumption figure of 32 L/hour and an allowance of 1 L for each recorded takeoff. The estimated fuel on board figures indicated that fuel exhaustion would have occurred during the accident flight.

Dipstick description and use

The aircraft's fuel dipstick was a standard, right-angled dipstick as supplied by the manufacturer of the aircraft when new. It comprised a right-angled tubular construction, with a spring-loaded activating button at the upper end, and a series of six collapsible vertical segments at the lower end that were marked in imperial gallons (Figure 3). Those segments were held rigidly together under tension by an internal cord when the activating button was released.

Use of the dipstick entailed depressing the activating button, which allowed the segments to articulate on entry to the aircraft's right-angled fuel tank filler neck. Once inserted into the filler neck, the spring-loaded activating button was released and the now-rigid dipstick was pressed firmly against the lower surface of the tank bladder several times to ensure a correct reading. The dipstick was then withdrawn quickly from the filler neck without pressing the button and the tank quantity read off against the marked increments on the segments.

Figure 3: Airtourer fuel dipstick

Some pilots reported that the dipstick could be difficult to use and could give variable fuel quantity readings. The pilot of the aircraft reported that he had experienced difficulty with the dipstick when he first started using it.

Information from sources engaged in commercial Airtourer operations, confirmed that there were differences in the use of the dipstick. Some pilots reported that they pushed the button to remove the dipstick from the tank, while others, including those pilots trained on the aircraft soon after it entered service in the 1960s, reported that they were instructed to remove the dipstick in the rigid condition. The latter technique was reported to prevent the segments from falling further into the tank, causing the dipstick to over read.

Examination of the aircraft's dipstick

The aircraft's dipstick was examined following the occurrence. It was noted that the dipstick had been modified and that the cord holding the six segments together had been replaced at some time. The cord extended beyond the lower end of the dipstick, with two knots securing the bottom segment with a metal washer (Figure 4).

5 Having an excess of fuel for a given flow of air or other oxidant.

6 A fuel/air mixture that lacks fuel.

Figure 4: Aircraft's dipstick, showing knots at the lower end

The dipstick activation button extended beyond the upper end of the tube by about 37 mm (Figure 5). Fully depressing the aircraft's dipstick button allowed the collapsible segments to extend by a further 27 mm, or about one 5-gal segment (Figure 6). The segments of the dipstick were marked in litres and imperial gallons.

Figure 5: Dipstick button extension

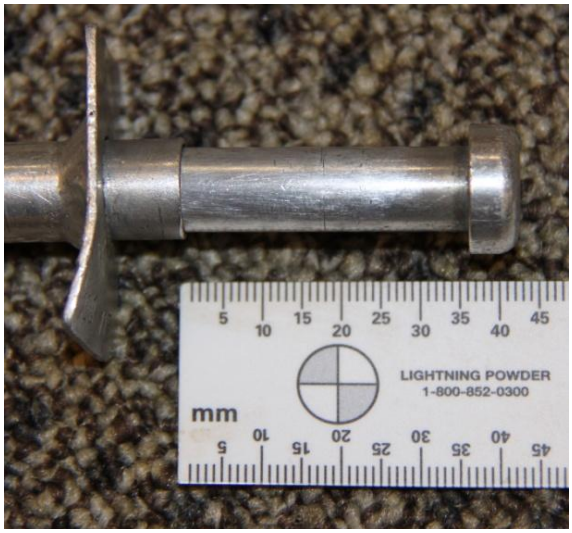
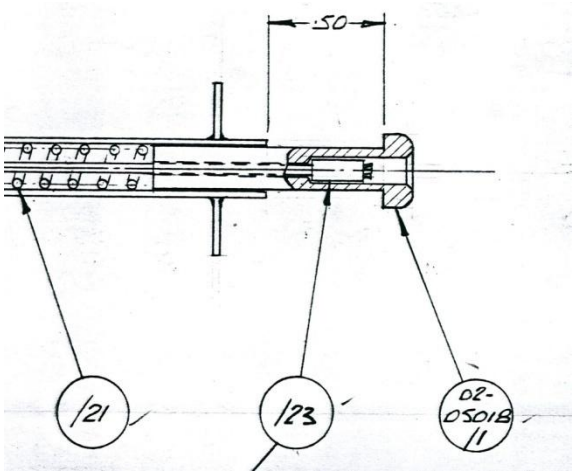


Figure 6: Extended dipstick cord - extension button fully depressed

Manufacturer's information

The manufacturer's drawing for the dipstick specified a 0.5 in. (12.5 mm) extension when the extension button was activated (Figure 7). The drawing showed that the dipstick's internal cord was to be terminated at each end with a copper swage fitting. Both swaged ends remained fully recessed within each end of the dipstick once fitted.

Figure 7: Manufacturer-specified dipstick drawing



Maintenance issues

An examination of the aircraft's logbook showed that all maintenance was up to date with the exception of Civil Aviation Safety Authority (CASA) Airworthiness Directive AD/Inst/8.[7] That AD was required to be carried out on the aircraft on a 3-yearly basis, and required amongst other related maintenance, that the fuel quantity gauge was checked for integrity and accuracy. AD/Inst/8 was last due for completion on 20 Oct 2008, over 17 months prior to the occurrence. Information from the maintenance venue for the aircraft indicated that the AD had not been carried out.

There was also an entry in the logbook relating to maintenance carried out on 11 April 2007 to remove wrinkles from the fuel tank bladder.

Organisational and management information

CASA detailed the responsibilities[8] for ensuring that maintenance such as ADs was complied with and that supporting records were kept up to date. Those responsibilities rested with the Registered Operator. In this case, the operator understood that the authorised maintenance facility had ensured compliance, and was unaware of the operator responsibility in that regard.

ANALYSIS

The action by the pilot to depress the dipstick extension button before removing the dipstick from the tank may have combined with the non-standard modifications to the dipstick to allow the collapsible segments to fall further into the fuel tank. That would have immersed a larger number of segments into the fuel in the tank and resulted in an erroneous fuel level indication.

The aircraft's fuel quantity gauge was probably not indicating correctly at the time of the total power loss and may also have been over reading at the commencement of the flight. The reason for the inaccurate fuel gauge indication could not be conclusively determined but, it may have been related to the wrinkles on the bottom of the fuel tank. The effect of any wrinkles on the capacity of the fuel tank prior to the accident could not be determined, as the orientation of the tank bladder may have changed as a result of impact forces.

The investigation could not discount that if Airworthiness Directive AD/Inst/8 had been carried out when required, any malfunction of the quantity measuring system may have been identified, and been corrected prior to the occurrence.

The pilot's fuel calculations were based on consumption figures less than those published and reported as typical for the aircraft/engine combination. Those calculations also did not take into consideration the increased fuel consumption at different stages of the flight, such as at takeoff and during aerobatics. Application of the appropriate fuel consumption rates to the pilot's flights over the week end showed that there was insufficient fuel on board for the occurrence flight.

The investigation concluded that the total loss of power was a consequence of fuel exhaustion.

FINDINGS

From the evidence available, the following findings are made with respect to the total loss of power that occurred in Hobart, Tasmania on 4 April 2010 and involved Victa Airtourer 115 aircraft, registered VH-MTC. They should not be read as apportioning blame or liability to any particular organisation of individual.

Contributing safety factors

- The aircraft's engine lost all power due to fuel exhaustion.
- A number of issues were identified with the aircraft's fuel system and operation that led the pilot to believe that there was more fuel on board the aircraft than was actually the case.
- The aircraft's fuel gauge probably indicated a tank quantity of about 12 imperial gallons (55 L) at the time of the total loss of engine power.
- The fuel dipstick had been modified and would possibly over read if used incorrectly.

7 CASA AD/Inst/8 Amdt 4, *Instruments in VFR Aircraft*, issued 26 June 2003.

8 See Civil Aviation Safety Regulations (CASR) 1998, Part 39. In addition, guidance information on these regulations is provided in Advisory Circular AC 39-01(4), issued in May 2010.

- There was the potential for the incorrect use of the dipstick to result in the over-reading of the fuel quantity. *[Minor safety issue]*

Other safety factors

- At the time of the accident, Civil Aviation Safety Authority Airworthiness Directive AD/INST/8 was overdue for completion.
- The Registered Operator's maintenance control practices did not ensure compliance with all Airworthiness Directives. *[Minor safety issue]*
- Information contained in the aircraft flight manual and pilot's operating handbook was not applicable to the engine that was fitted to the aircraft. *[Minor safety issue]*

SAFETY ACTION

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

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

Incorrect use of the fuel quantity dipstick

Minor safety issue

There was the potential for the incorrect use of the dipstick to result in the over-reading of the fuel quantity.

Action taken by the aircraft owner's association[9]

The aircraft owner's association has produced an article for their newsletter highlighting the correct method of fuel dipstick use to aircraft owners. That article can be accessed through the association's website at www.airtourer.asn.au

ATSB assessment of action

The ATSB is satisfied that the action taken by the aircraft owner's association adequately addresses the safety issue.

Action taken by the aircraft type certificate holder

The aircraft's type certificate holder has devised an Operations Bulletin for issue to owners of the aircraft type that will detail the correct method for the use of the dipstick. At the time of the release of this report, the bulletin was undergoing review by the type certificate holder.

ATSB assessment of action

The ATSB is satisfied that the action being taken by the aircraft type certificate holder will, when complete, adequately address the safety issue.

Aircraft owner's association

Inappropriate engine information

Minor safety Issue

Information contained in the aircraft flight manual and pilot's operating handbook was not applicable to the engine that was fitted to the aircraft.

Action taken by the aircraft owner's association

The aircraft owner's association has updated a previously-written article on this risk and an article on the importance of reviewing Flight Manual Supplements has been placed on the Airtourer Association website. The article was also published in the association's November 2010 Newsletter.

9 The Airtourer Association is a group of enthusiasts for the Australian-designed Airtourer aircraft. A related but separate organisation is the Airtourer Co-operative, which owns the intellectual property for the Airtourer (type certificate) and is responsible for its ongoing airworthiness. The Airtourer Association has the support of the Airtourer Co-Operative.

The association has also drafted an Operations Bulletin advising certificate of registration holders and pilots of the possibility of aircraft flight manual (AFM) data being amended by a supplement. That document is currently undergoing the association's document review process.

The association also intends to hold an 'AFM Workshop' at one of their upcoming aircraft 'fly-ins' to provide registered owners with the knowledge to allow them to assess their own aircraft's AFMs for all required supplements.

ATSB assessment of action

The ATSB is satisfied that the action being taken by the aircraft owner's association will, when complete, adequately address the safety issue.

Aircraft operator

Compliance with Airworthiness Directives

Minor safety Issue

The Registered Operator's maintenance control practices did not ensure compliance with all Airworthiness Directives.

Action taken by the aircraft operator

The aircraft operator has created an ongoing list of the required airworthiness directives affecting each aircraft to facilitate compliance monitoring.

ATSB assessment of action

The ATSB is satisfied that the safety action taken by the aircraft operator adequately addresses the safety issue.

Civil Aviation Safety Authority

Although there were no safety issues identified for which the Civil Aviation Safety Authority (CASA) had direct ownership, CASA has advised of the following proactive safety actions in response to this accident.

Usable fuel quantity in the Victa Airtourer

Separate to this investigation, CASA undertook a review of aspects of the Victa Airtourer aircraft type's usable fuel quantity. A number of anomalies with the original certification tests conducted for both the usable fuel quantity and the fuel quantity indicating system were identified by that review.

The CASA action was instigated partly as a result of a previous fuel exhaustion accident investigation, involving Victa Airtourer aircraft registered VH-MVP.[10]

Following consultation by CASA with the aircraft's type certificate holder, the type certificate holder has indicated that the following actions will be carried out to address CASA's concerns:

1. Distribution of a temporary flight manual amendment increasing the amount of unusable fuel by about 4 gallons[Imperial] [That amendment was approved by CASA on 8 July 2010 and subsequently placed on the Association's website and distributed to all Airtourer Co-Operative members],
2. Development of a modification to incorporate a more contemporary and accurate fuel indicator gauge and/or sender unit, particularly intended to improve indication accuracy at lower fuel levels (initial specification and design complete),
3. Conduct unusable fuel flight testing to satisfy the appropriate FAR/ANO 101.1.4 Par 3.3.1, and
4. Future cancellation of the temporary flight manual amendment after the intent of subparagraphs 2 and 3 can be both satisfied.

CASA regulatory actions in relation to AD/Inst/8

In respect of the requirements of AD/Inst/8 and AD/Inst/9, CASA has advised that:

> CASA is actively reviewing the requirements of AD/INST/8 and AD/INST 9 with a view to cancelling these directives and transferring the requirements to a Civil Aviation Order (CAO) in a simplified form. CAO 108.56 is subject to the same review, and the specific tests described for the various systems (airspeed indicators, pitot-static, fuel quantity systems etc) are being looked at for transfer to CAO 100.5.

SOURCES AND SUBMISSIONS

Sources of Information

The sources of information during the investigation included the:

10 Available at http://www.atsb.gov.au/publications/investigation_reports/2003/aair/aair200303633.aspx

- aircraft's registered operator and owner
- aircraft maintenance venue
- aircraft type certificate holder
- Civil Aviation Safety Authority (CASA)
- aircraft type association.

Submissions

Under Part 4, Division 2 (Investigation Reports), Section 26 of the *Transport Safety Investigation Act 2003*, 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 pilot, the aircraft operator and owner, the aircraft maintenance provider, the aircraft type certificate holder and CASA.

Submissions were received from the pilot, the aircraft maintenance provider, the aircraft type certificate holder and CASA. The submissions were reviewed and, where considered appropriate, the text of the draft report was amended accordingly.