



Australian Government

Australian Transport Safety Bureau

In-flight break-up involving de Havilland DH82A Tiger Moth, VH-TSG

300m east of South Stradbroke Island, Queensland, 16 December 2013

ATSB Transport Safety Report

Aviation Investigation

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Addendum

Page	Change	Date

Contents

Summary.....	1
The occurrence.....	2
Context.....	4
Pilot information	4
Aircraft details	4
General information	4
VH-TSG details	4
Wing structure description	5
Fuselage to wing attachment description	6
Recorded information	8
Video cameras	8
Video footage	9
Wreckage examination	9
Aircraft recovery	9
Wreckage examination	10
Preliminary examination of recovered components	12
Lateral tie rod history and maintenance requirements	13
General history	13
JRA-776-1 tie rods	14
Previous ATSB Tiger Moth investigations	15
VH-TMK	15
VH-AJG	15
Previous accidents involving VH-TSG	15
Safety analysis.....	16
Finding	17
Preliminary finding	17
Safety issues and actions	18
Unidentified fuselage lateral tie rod fatigue cracks	18
Safety issue description:	18
Continuing investigation	20
General details	21
Occurrence details	21
Aircraft details	21
Sources and submissions	22
Sources of information	22
Submissions	22
Australian Transport Safety Bureau	23
Purpose of safety investigations	23
Developing safety action	23

Summary

On 16 December 2013, at approximately 1215 Eastern Standard Time, a de Havilland DH82A (Tiger Moth) aircraft, registered VH-TSG, took off from the operator's airstrip at Pimpama, Queensland with a pilot and passenger on board. The purpose of the flight was to conduct a commercial joy flight in the Gold Coast area. At about 1224, 1 minute after the pilot commenced aerobatics, the left wings failed and the aircraft descended steeply; impacting the water about 300m from the eastern shoreline of South Stradbroke island. The aircraft was destroyed and the two occupants were fatally injured.

Preliminary examination indicated that both of the aircraft's fuselage lateral tie rods, which join the lower wings to the fuselage, had fractured at areas of significant, pre-existing fatigue cracking in the threaded section near the join with the left wing. These tie rods, part number JRA-776-1, were manufactured under an Australian Parts Manufacturing Approval.

The ATSB has not, at this preliminary stage of its investigation, determined whether the failure of the fuselage lateral tie rods, or another mode of wing structural failure, was the initiator of the left wing separations. However, this Preliminary Report includes a safety issue that advises of the JRA-776-1 tie rod fatigue cracking and includes a Safety Advisory Notice to Tiger Moth operators about this safety issue.

The investigation is continuing and a final report is expected by December 2014.

The occurrence

The information contained in this preliminary report is released in accordance with section 25 of the Transport Safety Investigation Act 2003 and is derived from the initial investigation of the occurrence. Readers are cautioned that new evidence will become available as the investigation progresses that will enhance the ATSB's understanding of the accident as outlined in this Preliminary report.

On 16 December 2013, at approximately 1215 Eastern Standard Time (EST),¹ a de Havilland DH82A (Tiger Moth) aircraft, registered VH-TSG, took off from the operator's airstrip at Pimpama, Queensland with a pilot and passenger on board. The purpose of the flight was to conduct a commercial joy flight in the Gold Coast area. The operator reported that, as part of such joy flights, aerobatics were conducted above the South Stradbroke Island area at about 3,500 ft above mean sea level.

A review of Airservices Australia recorded radar data showed primary radar returns² for an aircraft appear near the Pimpama airstrip at 1217:40 and disappear near South Stradbroke Island at 1223:25. The aircraft did not appear on secondary radar as its transponder was not operating. The operator reported that it was common practice not to turn on the aircraft's transponder for this type of flight outside of controlled airspace.

Video footage obtained from a fixed, on-board camera (see Recorded information) showed that about 8 minutes after take-off, the aircraft commenced aerobatic manoeuvres. About 1 minute later, during an aerobatic manoeuvre, the left wings failed.

Two witnesses observed the final moments before the aircraft impacted the water about 300 m to the east of South Stradbroke Island. Neither witness observed the prior operations of the aircraft. One witness was working at Sovereign Waters, about 4.5 km south-south-west of the accident site, and was on a mobile telephone when he observed the aircraft descending straight down at high speed before losing site of the aircraft behind trees. The witness's telephone recorded the time of the call as 1224.

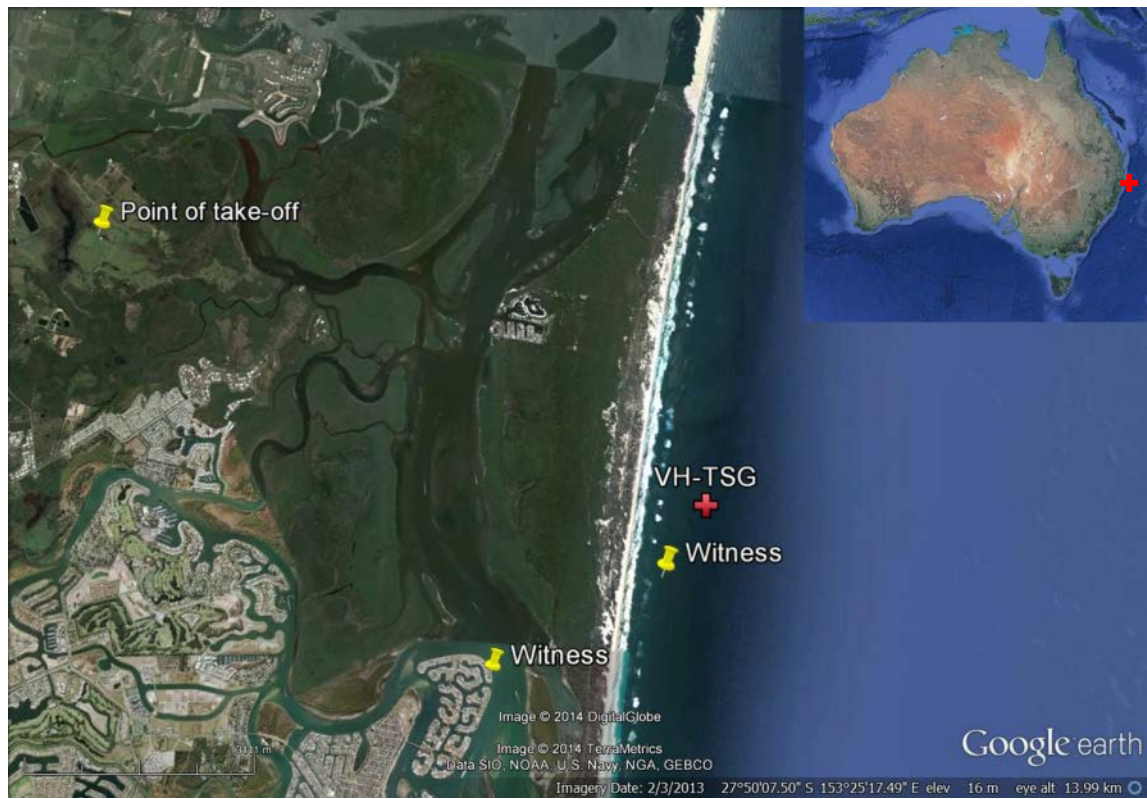
The other witness was a surf lifesaver who was conducting a beach patrol in the local area on a jet ski, just to the south of the aircraft. He was in company with another surf lifesaver who was also on a jet ski. Upon observing the aircraft impact the water, the surf lifesaver informed his companion and they arrived at the site of the accident as the tail of the aircraft submerged below the surface of the water. The lifesavers notified emergency services and remained on-site to assist the police with locating the wreckage.

The aircraft was destroyed and the two occupants were fatally injured. Figure 1 shows the aircraft's point of take-off, the location of the witnesses and the location of the aircraft when it impacted the water.

¹ Eastern Standard Time (EST) was Coordinated Universal Time (UTC) + 10 hours.

² Primary radar returns are produced by radar transmissions that are passively reflected from an aircraft and received by the radar antenna. The received signal is relatively weak and provides only position information. Secondary radar returns are dependent on a transponder in the aircraft replying to an interrogation from the ground. An aircraft with its transponder operating can be more easily and reliably detected by radar and, depending on the mode selected by the pilot, the aircraft's pressure altitude is also received.

Figure 1: Location overview



Source: Google earth, modified by the ATSB

Context

Pilot information

The pilot held a Commercial Pilot (Aeroplane) Licence that was issued on 12 February 2010. The pilot's logbook indicated that he obtained a spin endorsement on 1 December 2008 and an aerobatics endorsement on 2 March 2009. The aerobatics endorsement authorised the pilot to conduct loops, barrel rolls, 'humpty bumps', stall turns, and spins, all at altitudes not below 3,000 ft above ground level (AGL).

During a series of flights to gain initial experience on Tiger Moth aircraft, the pilot demonstrated competence in spins, barrel rolls, loops and wingovers, and his logbook was appropriately endorsed on 19 July 2013.

The pilot's logbook, when integrated with the operator's pilot duty hours summary,³ showed that he had a total flying experience of 1,189.2 hours as of 15 December 2013. His total experience on the Tiger Moth was 188.2 hours. In the previous 90 days, the pilot had flown 59.1 hours on type, and in the previous 30 days he had flown 19.4 hours on type.

The pilot held a valid Class 1 Medical Certificate with no restrictions. His last medical examination was conducted on 8 July 2013.

Aircraft details

General information

The de Havilland DH82A Tiger Moth aircraft was a two-seat tandem biplane with fixed undercarriage comprising two main wheels and a tail skid or tail wheel. The aircraft was fitted with a four-cylinder piston engine driving a two-bladed, fixed-pitch propeller (Figure 2). The aircraft's structure was primarily fabric-covered metal and timber.

The aircraft type first flew in 1931 and was predominantly used for air force ab initio flight training. Thousands of Tiger Moth aircraft were built, mainly in the United Kingdom, Australia and Canada. At the time of the accident, there were 210 Tiger Moth aircraft registered in Australia.

VH-TSG details

According to the aircraft maintenance documentation, VH-TSG (Figure 2) was built in 1939 and allocated serial number DHC78. The aircraft operated in the visual flight rules (VFR)⁴ day charter category and was used for commercial joy flight operations. It had a current maintenance release, certificate of registration and certificate of airworthiness. The maintenance release indicated that before the accident flight, the aircraft's total time in service was 4,982.3 flight hours. There were no outstanding defects endorsed on the maintenance release. The aircraft was not fitted with wing slats.⁵

³ The last entry in the pilot's logbook was on 2 November 2013. The operator's pilot duty hours records were used to determine the additional hours after that date.

⁴ Visual flight rules (VFR) are a set of regulations which allow a pilot to only operate an aircraft in weather conditions generally clear enough to allow the pilot to see where the aircraft is going.

⁵ Wing slats are automatic lift augmentation devices that were able to be fitted to the outboard end of the upper wing leading edges. The slats, when deployed, reduced the aircraft's stall speed by about 2 kt.

Figure 2: VH-TSG



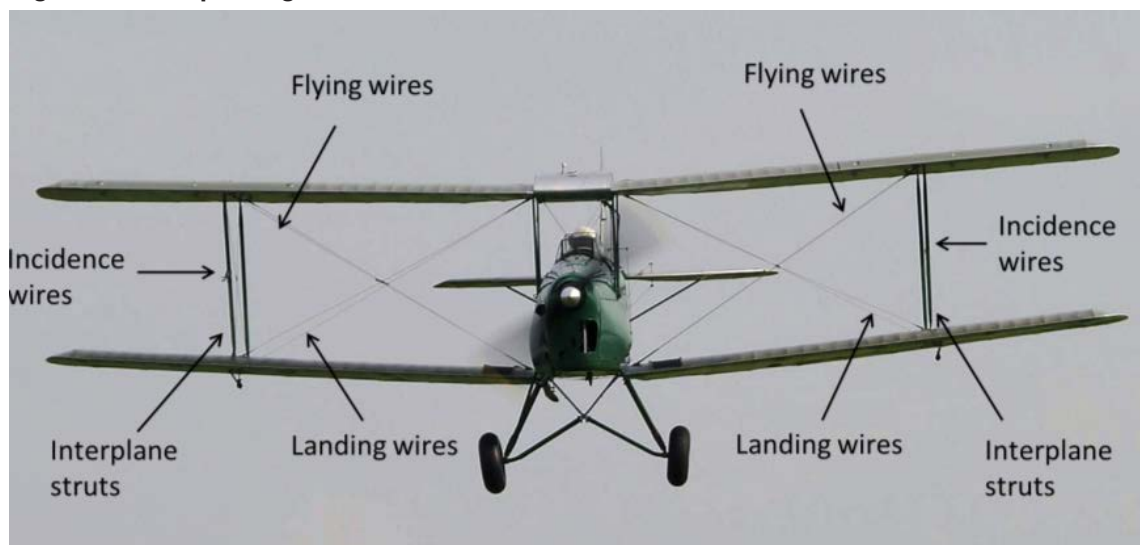
Source: Air-Britain Photographic Images Collection
Photo: David Welch

Wing structure description

The wings were predominantly made of timber with a fabric covering. They were externally braced against each other and the fuselage using a series of flying wires, landing wires, interplane struts and incidence wires. The aircraft type did not have wing flaps fitted and only the lower wings had ailerons.

The wings were attached to the fuselage using two attachment points per wing. The left and right lower wing forward attachment points (Joint H) were also attachment points for the undercarriage. The flying wires were attached to the inboard end of the front spar, immediately adjacent to the respective Joint H (Figure 3).

Figure 3: Exemplar Tiger Moth DH82A

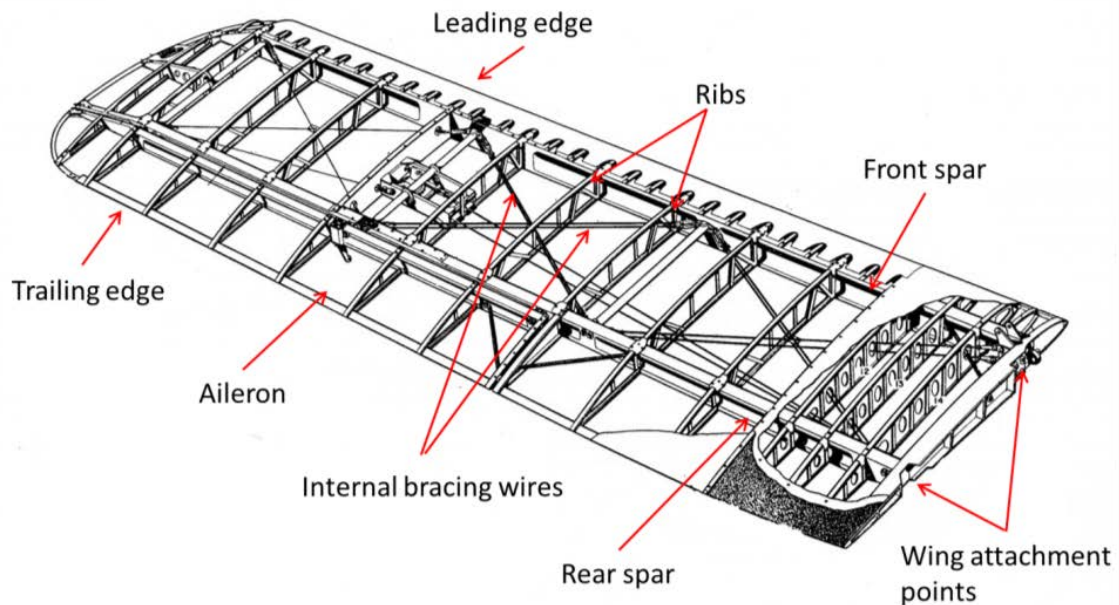


Source: de Havilland Support Ltd

Wing structure

Each lower wing structure comprised either two solid timber or alternatively two laminated timber spars, two wing-to-fuselage attachment points, three sets of internal bracing wires with corresponding steel tube supports and numerous timber ribs. Figure 4 shows a lower wing structure; the upper wing structures are similar but the upper wings do not have ailerons.

Figure 4: Left lower wing structure⁶



Source: de Havilland data used with permission

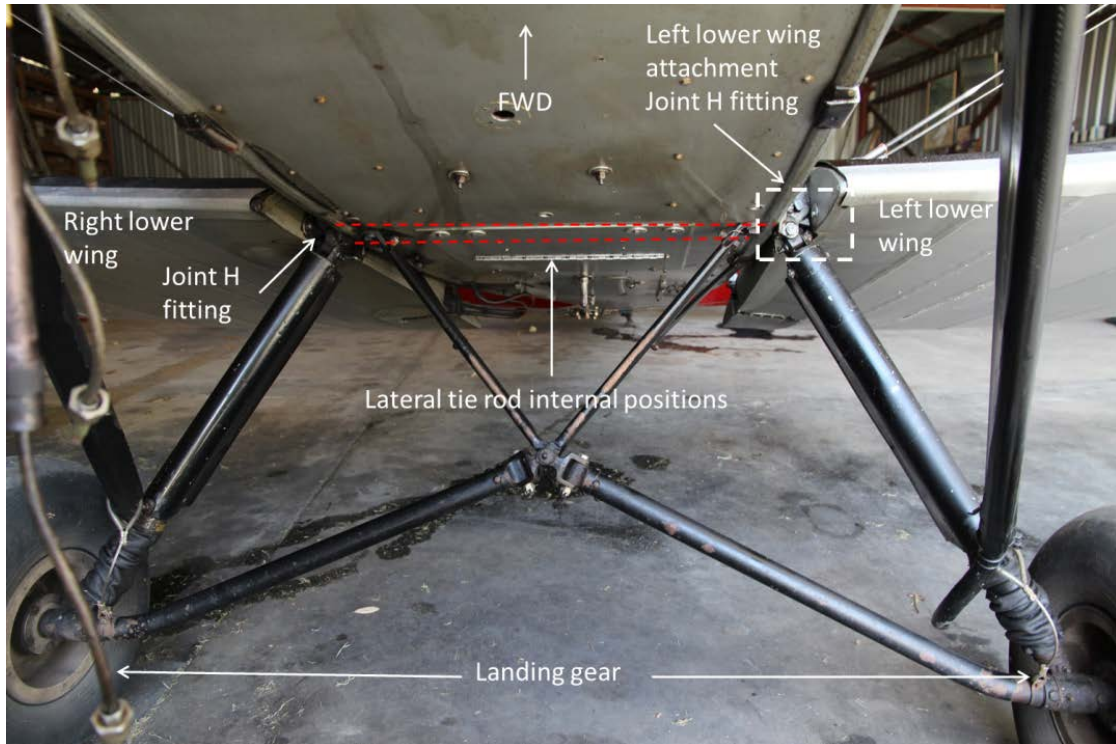
Fuselage to wing attachment description

Both lower wing forward attachment point Joint H fittings were secured to the fuselage by two bolts and two fuselage lateral tie rods (tie rods), which were located fore and aft. The tie rods passed through the lower fuselage structure and were secured and held in tension by nuts against the Joint H fittings at both ends.

Figure 5 is an exemplar picture showing the Tiger Moth lower wing forward attachment points at the Joint H fittings and the landing gear attachment. The tie rods cannot be seen as they are internal to the fuselage; their position is depicted by the dashed red lines.

⁶ Figure 4 is a drawing of a de Havilland DH-82C wing structure; the internal structure is very similar to that of the DH-82A wing.

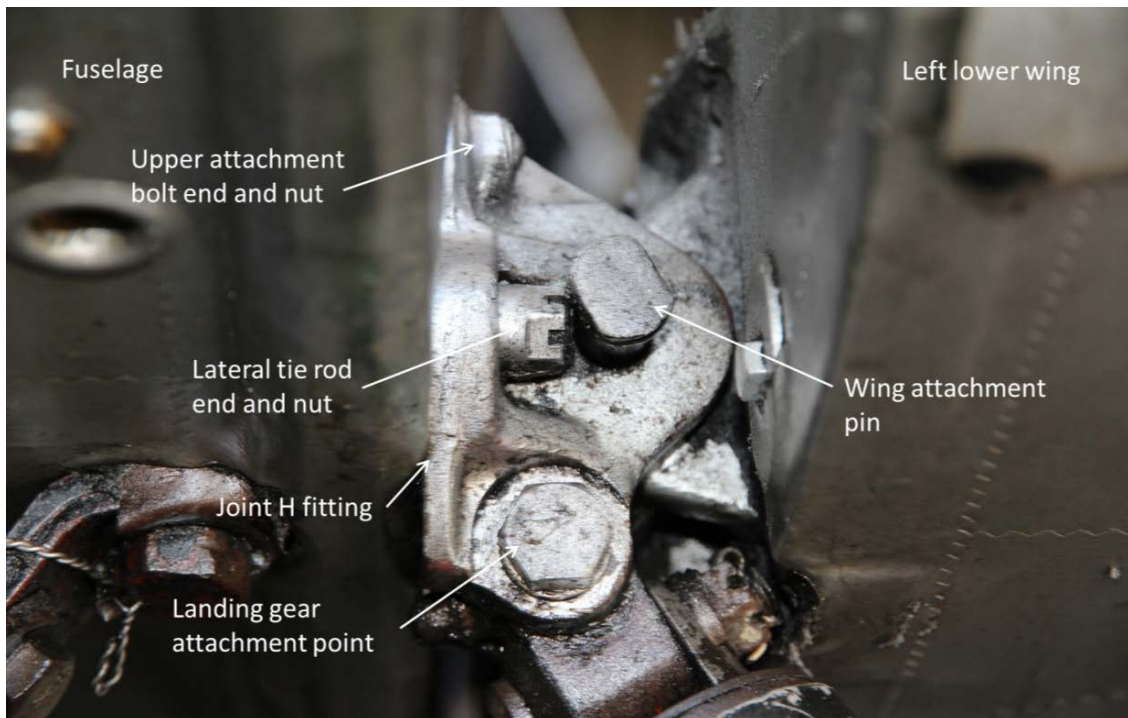
Figure 5: Exemplar aircraft showing lower wing attachment points (Joint H fittings)



Source: ATSB

Figure 6 shows an exemplar view of the left lower wing forward attachment point Joint H fitting (viewed from the front), with the forward lateral tie rod end and nut, upper attachment bolt end and nut, wing attachment pin and landing gear attachment point annotated.

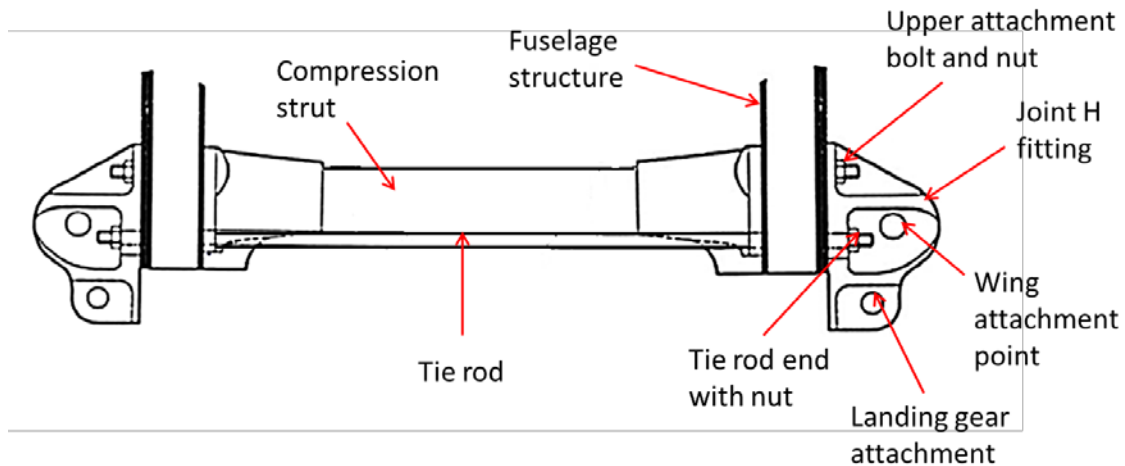
Figure 6: Exemplar left lower wing attachment point (Joint H fitting)



Source: ATSB

The tie rods held the two lower wings together in tension and transferred the majority of the lift loads (flight loads) from the wings to the fuselage (Figure 7). Any failure or loss of tie rod integrity would allow the outward movement of the Joint H fitting(s) - overloading the fitting upper attachment bolts and leading to an in-flight separation of the wings. A compression strut that ran parallel to the tie rods provided support to the fuselage for landing, ground and inverted loads.

Figure 7: Lateral tie rod position



Source: de Havilland data, modified by the ATSB

Recorded information

Video cameras

The aircraft was fitted with two cameras to record the joy flight activities. One camera was mounted on the right wing rear interplane support strut, facing towards the fuselage and was programmed to take photographs at 2-second intervals. That camera was not located at or recovered from the accident site.

The second camera, which was mounted in the front cockpit position facing rearwards (Figure 8), was set to record video in high definition at 60 frames per second. That camera was recovered from the accident site. Full video and audio was recovered from the camera's memory card except for about the last 10 seconds of data. The premature termination of full recording was attributed to water ingress and subsequent power supply disconnection, rather than a normal unit shut down.

Figure 8: Mounting position of the recovered camera



Source: Witness

Video footage

The video footage showed a rearward view, predominantly in line with the fuselage. A small portion of the rear of each lower wing, including the inboard sections of the left and right ailerons, was in view.

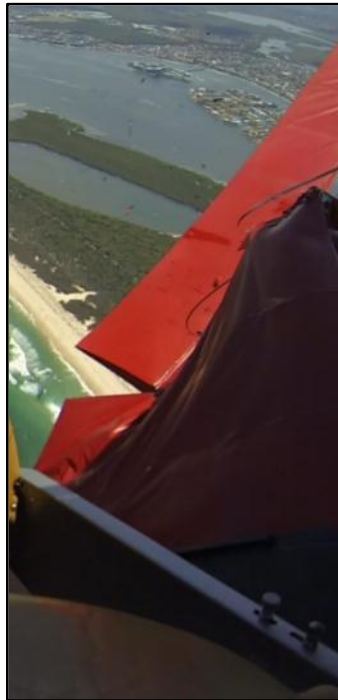
The video indicated that, after 1 minute of aerobatic manoeuvres and while pulling out at the bottom of a loop, the left lower wing appeared to fail in an area forward and outside of the camera's view. The initiation point of the failure was in an area that was either part of the wing's forward spar structure or at its attachment point to the fuselage. A very short time later, the upper left wing failed and both left wings folded backwards towards the fuselage. The time between normal operations to complete failure of the lower and upper left wings was less than 1 second.

Figure 9 is a cropped selection of video frames displaying the progression of the left lower wing failure, from a slight ripple on the left lower wing fabric covering to complete failure.

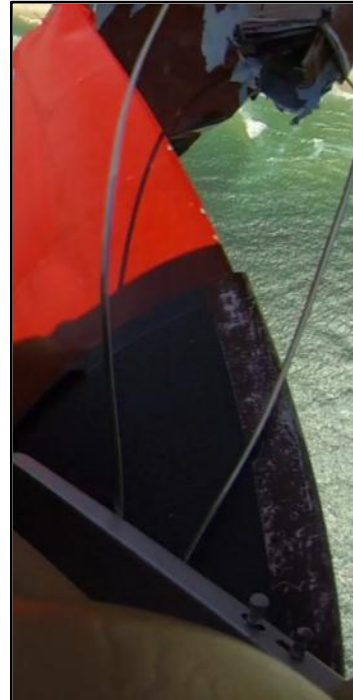
Figure 9: Cropped view of 3 separate frames of video showing wing failure progression



Frame 1: Failure Initiation



Frame 2: 0.15 of a second



Frame 3: 0.35 of a second

Wreckage examination

Aircraft recovery

The aircraft was located in about 15 m of water on the ocean side of South Stradbroke Island. The Queensland Police Service floated and recovered the main wreckage 2 days after the accident (Figure 10), in conditions including rough seas, high winds and reduced underwater visibility. One of the two video cameras fitted to the aircraft was located on the ocean floor, having separated from the aircraft during the accident sequence. The other video camera was not on its mounting point and was not located after an extensive search. Other items of wreckage were collected floating on the ocean surface or washed up on South Stradbroke Island.

Figure 10: Aircraft recovery



Source: ATSB

Wreckage examination

General

The aircraft was significantly damaged, consistent with the impact with the water. Though the fuselage was relatively intact, the wing structures were severely disrupted, having broken into numerous pieces, some of which were recovered as flotsam. The engine had separated from the fuselage during the impact sequence and the propeller had fragmented. However, the majority of the propeller hub remained attached to the engine's attachment flange.

The fuselage structure and flight control systems were inspected with no pre-impact defects identified. The fuselage and wings were reconstructed to assist with determining the aircraft break-up sequence (Figure 11).

Figure 11: Wreckage reconstruction



Source: ATSB

Wing inspections

The wings were reconstructed with about 95 per cent of the main spar structures accounted for. The left wing flying wires and landing wires were still attached to their corresponding attachment points. The internal wing bracing wires were also intact. Figure 12 shows the partially reconstructed left lower wing.

Figure 12: Left lower wing looking at the upper surface

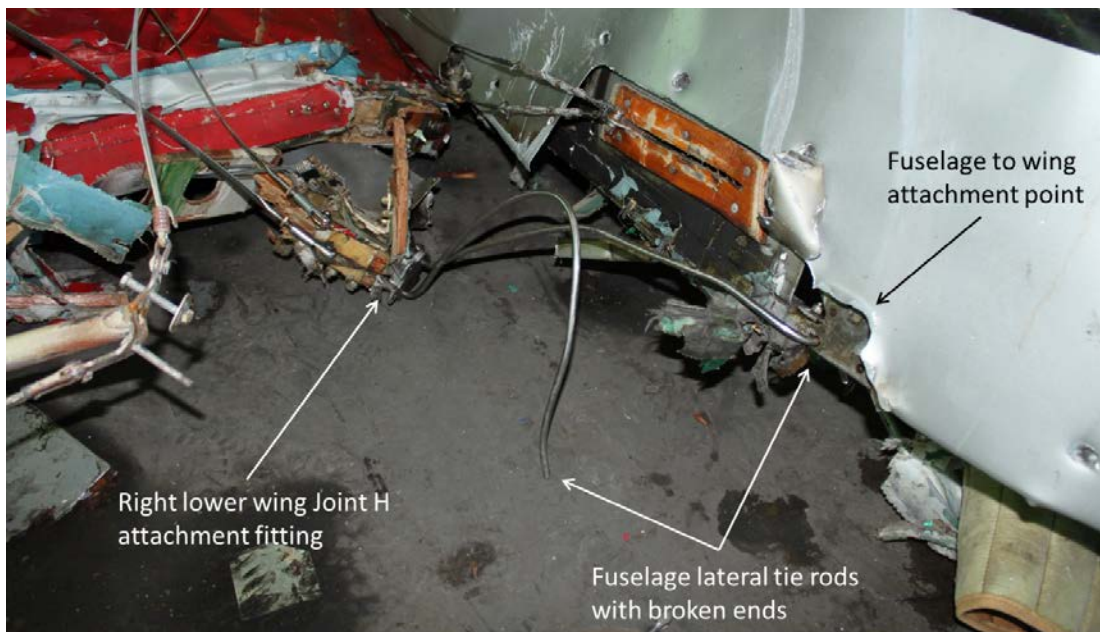


Source: ATSB

Wing attachment points

The lower wing attachment point Joint H fittings were still attached to the wings, but had separated from the fuselage (Figure 13). Both lateral tie rod ends were fractured through the threaded section at the left wing attachment point. The remaining part of the threaded section and nut for each tie rod were not recovered.

Figure 13: Right wing-to-fuselage attachment point



Source: ATSB

Further examination

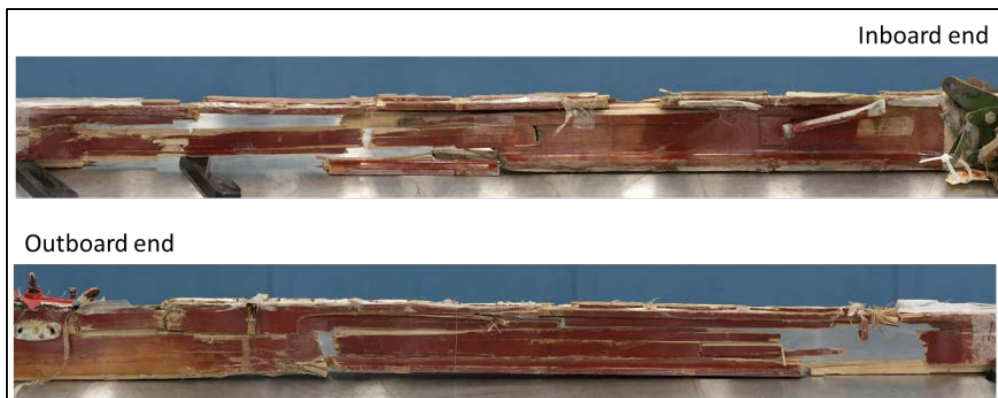
The inboard two thirds of the left lower wing main spar and the lateral tie rods were taken to the ATSB's technical facilities in Canberra, Australian Capital Territory for further detailed examination.

Preliminary examination of recovered components

Left lower wing main spar

Examination of the inboard end of the left lower wing main spar identified an inscription indicating that it was manufactured in 1943. The spar was constructed from one piece of timber (not of laminated construction) and was severely fragmented with numerous fracture surfaces requiring inspection (Figure 14). The inspection of the main spar is ongoing.

Figure 14: Inboard two thirds of the left lower wing main spar viewed from the rear

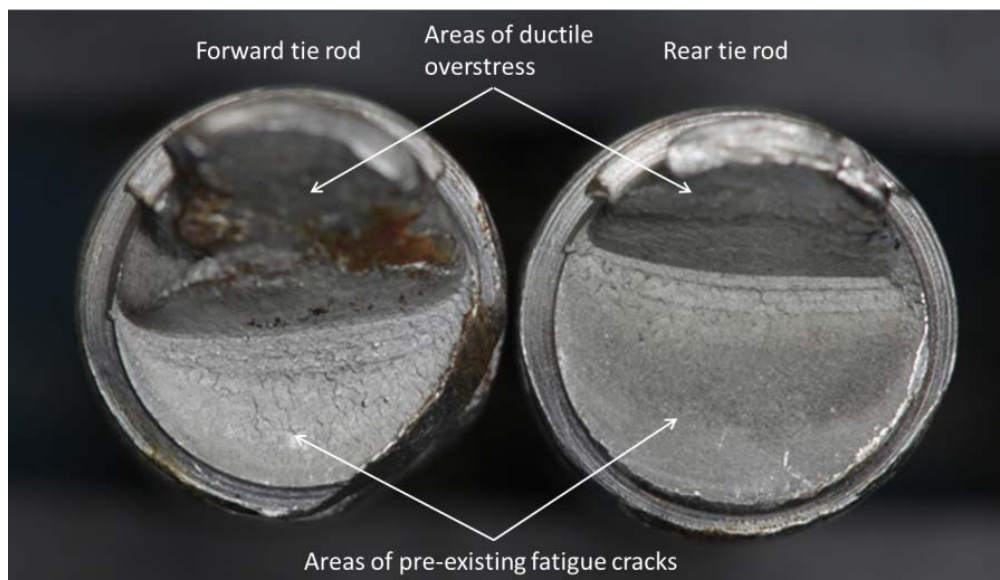


Source: ATSB

Fuselage lateral tie rods

Both lateral tie rods fractured at an area of pre-existing fatigue cracking within the threaded section (Figure 15). The rear tie rod cracking extended across approximately 70 per cent of the total rod cross-sectional area and the forward rod cracking extended across approximately 50 per cent. The remainder of the fractures on both rods was consistent with ductile overstress. No significant corrosion was evident at or surrounding the points of fracture.

Figure 15: Fuselage lateral tie rod fracture surfaces showing the left side thread ends



Source: ATSB

Pre-existing fatigue cracking was also evident in the threaded section of the right end of the forward lateral tie rod. The crack had propagated in the same thread-root area as the left side, although the rod had not completely fractured in that area (Figure 16). The crack extended across about 40 per cent of the cross-sectional area.

Figure 16: Forward fuselage lateral tie rod showing right side thread



Source: ATSB

Lateral tie rod history and maintenance requirements

General history

Up until 1997, there were no requirements for inspecting or replacing lateral tie rods in Tiger Moth aircraft. However, in July 1996, during a routine maintenance activity in the UK on a UK-registered DH82A aircraft, it was found that a lateral tie rod had fractured at the thread root. Subsequent examination found that there was significant pre-existing fatigue cracking at the point of failure.

Based on that finding, the type certificate holder for the aircraft type issued Technical News Sheet (TNS) CT (Moth) No 29. The current version of the TNS (issue 3) was released in March 1999⁷ and stated:

Reason

During routine maintenance on a DH 82 aircraft it was found that the lateral Fuselage Tie Rod at the aft position had sheared at its location with the spar attachment fitting. Subsequent investigation found the failure was the result of fatigue cracking in the thread root. In addition the forward Tie Rod (which had not fractured) was distorted and found to have been manufactured from material of incorrect specification with a lower tensile strength.

Description

This Technical News Sheet (TNS) CT (MOTH) No 29 Issue 3 calls for both lateral Fuselage Tie Rods to become “lifed items” restricted to a service life of 2000 flying hours or 18 years (whichever is

⁷ TNS CT 29 issue 2 was issued in March 1998 and had similar requirements. Issue 3 introduced additional inspection requirements following heavy landings.

sooner) and introduces a procedure for the examination of the aircraft structure following a heavy landing, following undercarriage trauma and at annual inspection. Undercarriage trauma is defined as hitting an obstacle or deep rut in the landing or taxi area, distortion, buckling or other impact damage to undercarriage, including collapse.

The inspection requirements detailed in the TNS involved inspecting the aircraft structure and various wing fittings in situ. It also required removing the front seat pan and checking the 'integrity and condition of the tie rods and tie rod nuts for displacement and damage'.

The UK Civil Aviation Authority (CAA) mandated the requirements of TNS 29 in Airworthiness Directive CAA AD 006-10-97. The Australian Civil Aviation Safety Authority (CASA) subsequently issued AD/DH 82/10 Amendment 1 in June 1999 that reflected the requirements of the UK CAA directive.

The type certificate holder advised that the age of the tie rods fitted to the UK-registered aircraft was not known, but they could have been on the aircraft from its initial manufacture in 1939. The tie rods were made by the original equipment manufacturer (OEM) and had the part number H37869A. At the time of the failure, the aircraft had accrued 7,556 hours in service.

The type certificate holder also advised that, during the inspection of those tie rods in 1996, a level of fatigue cracking was also found in the threaded section of both ends of the forward tie rod (which had not fractured). However, it advised that it was not aware of any reports of fatigue cracking associated with Tiger Moth OEM tie rods prior to or subsequent to the 1996 event. There was no requirement for owners and operators to use the OEM tie rods, as long as the rods being used conformed to the same design standards and were approved by the relevant (local) airworthiness authority.

JRA-776-1 tie rods

According to the maintenance documentation, the tie rods fitted to VH-TSG had the part number JRA-776-1. Tie rods with this part number were manufactured in Australia under an Australian Parts Manufacturing Approval (APMA). According to the Engineering Order associated with the parts, they could be manufactured using alloy steel with cadmium plating (as per the OEM parts and the aircraft manufacturer's design standard) or stainless steel to the equivalent strength, which would give improved corrosion resistance.

The tie rods fitted to VH-TSG were about 7 years old and had accrued about 1,300 flight hours. Chemical analysis of the tie rod material was consistent with the American Iron and Steel Institute 431 stainless steel alloy specified in the Engineering Order for JRA-776-1 parts, and that their hardness was consistent with the required strength level. The method of thread production was not specified in the Engineering Order; however, the thread profile and appearance was consistent with production by machining/cutting, as opposed to a profile rolling process. The threads on OEM tie rods were also manufactured with machining/cutting production. The threads on the two rods recovered from VH-TSG appeared to be cut to a lesser quality than a sample of other JRA-776-1 tie rods and OEM tie rods inspected by the ATSB.

The manufacturer of the JRA-776-1 tie rods provided documentation indicating that 234 of these tie rods were manufactured and supplied to Tiger Moth owners, operators and maintainers between September 1998 and October 2012, with most supplied in 1998–1999. The vast majority of the tie rods were supplied to Australian organisations, with about 20 per cent also being sent to New Zealand. The manufacturer indicated that the tie rods were no longer being produced and they had no more JRA-776-1 tie rods in stock.

Previous ATSB Tiger Moth investigations

VH-TMK

A review of the ATSB's occurrence database found one previous known case of an in-flight break-up involving Tiger Moth aircraft in Australia between 1969 and 2013. That accident involved aircraft VH-TMK on 28 February 1998, when the aircraft was being used to conduct aerobatics.⁸ Witness evidence and wreckage disposition indicated that the right upper wing failed while the pilot was pulling out from a loop. The wing failed in the area of the right upper wing spar where the inter-plane strut was attached. Evidence indicated that the upper right wing spar was significantly weakened around the inter-plane strut attachment point by the effects of fungal decay and a partially de-bonded doubler.

Following that investigation, guidance on the inspection of Tiger Moth aircraft wooden structures was enhanced with the release by the type certificate holder of TNS CT (Moth) No. 32, now at issue 3. Unless mandated by National Airworthiness authorities by the issue of an AD, TNS CT (Moth) No. 32 issue 3 is a non-mandatory series of inspections done at the discretion of the aircraft operator and maintainer. There is no AD to mandate TNS 32 in Australia.

VH-AJG

In another accident on 16 February 2002, VH-AJG was reported seen by some witnesses with the wings folding during straight-and-level flight. However, a wreckage examination did not conclude that an in-flight break-up had occurred.⁹

Neither of these accidents involved tie rod failures. The circumstances of both accidents, and any other similar accidents the ATSB identifies worldwide, will be reviewed to determine their relevance, if any, to the current investigation relating to VH-TSG.

Previous accidents involving VH-TSG

The ATSB is aware of two previous accidents where VH-TSG was substantially damaged.¹⁰ The first accident was on 27 February 1994. While conducting a joy flight over Surfers Paradise, Queensland, the engine power reduced to idle. The pilot carried out a forced landing on the beach. The aircraft came to rest in shallow water after manoeuvring to avoid people on the beach. The aircraft was substantially damaged and the occupants were uninjured.

The second accident occurred on 21 November 2001. It was reported that the aircraft experienced a reduction in power after take-off and during the subsequent forced landing the aircraft collided with trees. The aircraft was substantially damaged and one of the two occupants was seriously injured. Following this accident, the wings were replaced with parts from other aircraft.

The aircraft had an extended period of inactivity after the 2001 accident. In 2004 the aircraft restoration began and it was completed towards the end of 2006, at which point the aircraft returned to commercial joy flight operations. During the restoration, the wings were replaced with parts from other aircraft. The maintenance documentation indicated that new JRA-776-1 tie rods were also installed at that time.

⁸ Investigation 199800648 - http://www.atsb.gov.au/publications/investigation_reports/1998/air/air199800648.aspx

⁹ Investigation 200200377 - http://www.atsb.gov.au/publications/investigation_reports/2002/air/air200200377.aspx

¹⁰ The ATSB or its predecessor the Bureau of Aviation Safety Investigation (BASl) did not investigate these accidents.

Safety analysis

The circumstances of the accident involving VH-TSG on 16 December 2013 are still being investigated. This analysis focuses only on the fatigue cracks identified on the fuselage lateral tie rods that were fitted to VH-TSG at the time of the accident.

The fuselage lateral tie rods on a Tiger Moth are a safety-critical component. It is likely that the in-flight failure of both tie rods would lead to a loss of control and in-flight structural break-up of the airframe. At this preliminary stage of the investigation, the ATSB cannot determine whether the failure of the tie rods, or another mode of wing structural failure was the initiator of the left wing separations. However, the extent of the pre-existing fatigue cracking meant that such a wing failure was likely to occur at some stage.

The factors contributing to the tie rod fatigue cracking are still to be established. Both rods were Australian-manufactured JRA-776-1 parts, which have some different characteristics to the original equipment manufacturer (OEM) parts. The OEM parts have been more widely used and used for longer periods in the past, with only one known reported fatigue cracking problem. Since the introduction of a retirement life for OEM tie rods in 1997, no other fatigue cracks have been identified in OEM tie rods. JRA-776-1 tie rods were a commonly used part in Australia and New Zealand, and the significant fatigue cracking of both tie rods from VH-TSG is a major cause for concern.

Tiger Moth tie rods currently have a retirement life of 2,000 flight hours or 18 years, whichever comes first. The tie rods fitted to VH-TSG were fitted as newly-manufactured items in 2006 and had accumulated 1,300 hours in service at the time of the accident, giving them 700 hours or 11 years of service life remaining.

In addition to design and manufacturing aspects, the initiation and propagation of tie rod fatigue cracking can be strongly influenced by aircraft utilisation and operational events that generate elevated rod loads. Aerobatic flight, flight in turbulent or adverse weather or heavy/rough landings could all prove contributory. VH-TSG was frequently used for aerobatic activities since the JRA-776-1 tie rods were fitted.

The type certificate holder advised that the fuselage lateral tie rods retirement life of 2,000 hours was developed for tie rods that met the design standard, and it was not known whether the same safe life assumptions would apply to tie rods made from a different material and manufactured in a different way (as was possible with JRA-776-1 parts). The extent to which the retirement life for tie rods was applicable to aircraft being frequently utilised for aerobatic activities is being considered in the ATSB investigation.

Although there is an in-situ repetitive schedule inspection requirement for the fuselage lateral tie rods, there are no currently-prescribed tie rod maintenance inspections that would be capable of identifying fatigue cracking in the threaded sections. Even if the tie rods are removed, visual or magnetic particle/dye penetrant inspections of the threaded areas are subject to significant limitations and would likely be of limited effectiveness in detecting fatigue cracking. More detailed inspections would probably be more costly than replacing the tie rods.

In summary, given the criticality of the of the fuselage lateral tie rods, the ATSB believes that the identification of significant pre-existing fatigue cracking within the JRA-776-1 tie rods on VH-TSG, which were within the stipulated retirement life, coupled with the current lack of an effective inspection to detect such cracking, presents a safety issue that requires action.

Finding

From the evidence available to date, the following finding is made with respect to the in-flight break-up involving de Havilland DH82A aircraft, registered VH-TSG, near South Stradbroke Island, Queensland on 16 December 2013. It should not be read as apportioning blame or liability to any particular organisation or individual.

Safety issues, or system problems, are highlighted in bold to emphasise their importance.

A safety issue is an event or condition that increases safety risk and (a) can reasonably be regarded as having the potential to adversely affect the safety of future operations, and (b) is a characteristic of an organisation or a system, rather than a characteristic of a specific individual, or characteristic of an operating environment at a specific point in time.

Preliminary finding

- The two JRA-776-1 fuselage lateral tie rods fitted to de Havilland DH82A Tiger Moth, registered VH-TSG, had significant, pre-existing fatigue cracks in the threaded sections. The parts' service life was significantly less than the published retirement life for DH82A tie rods of 2,000 flight hours or 18 years. [Safety Issue]

Safety issues and actions

The safety issue identified so far during this investigation is listed in the Findings and Safety issues and 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 directly involved parties were provided with 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 the safety issue if it were relevant to their organisation.

Unidentified fuselage lateral tie rod fatigue cracks

Number:	AO-2013-226-SI-01
Issue owner:	Civil Aviation Safety Authority
Operation affected:	Aviation: General aviation

Safety issue description:

The two JRA-776-1 fuselage lateral tie rods fitted to de Havilland DH82A Tiger Moth, registered VH-TSG, had significant, pre-existing fatigue cracks in the threaded sections. The parts' service life was significantly less than the published retirement life for DH82A tie rods of 2,000 flight hours or 18 years).

Initial advice of the safety issue

After determining the nature and significance of the fatigue cracking on the tie rods from VH-TSG, the ATSB advised the following organisations of the safety issue during the period 3-6 February 2014: the Australian Civil Aviation Safety Authority (CASA), the Australian manufacturer of the lateral tie rods, the operator and current maintainer of VH-TSG, the UK Air Accidents Investigation Branch (AAIB), the type certificate holder for Tiger Moth aircraft and the United Kingdom Civil Aviation Authority (UK CAA). Subsequently the Transport Accident Investigation Commission of New Zealand (TAIC) and the Civil Aviation Authority of New Zealand (CAANZ) were also informed.

Proactive safety action taken by: The Civil Aviation Safety Authority

On 19 February 2014, CASA advised:

CASA is considering two separate Airworthiness Directives. One Airworthiness Directive related to the inspection of the wing spar and one related to the tie rods. At this stage we are in the process of gathering information from the State of Design (UKCAA) and the Australian manufacturer of the tie rods.

We have also issued a letter to all Tiger Moth operators requesting detailed information regarding the affected lateral tie rods. We will then carry out risk assessments before taking any further action.

ATSB comment/action in response:

Although CASA and other organisations are considering additional requirements in respect of the fuselage lateral tie rods in Tiger Moth aircraft, the ATSB is issuing the following safety advisory notice to ensure that all operators and owners of Tiger Moth aircraft are aware of the safety issue as soon as possible.

ATSB safety advisory notice to Tiger Moth (DH82 and DH82A) owners and operators:

Action number: AO-2013-226-SAN-01

The Australian Transport Safety Bureau advises all owners and operators of de Havilland DH82 and DH82A (Tiger Moth) aircraft to consider the safety implications of the initial findings of this investigation regarding the fatigue cracking on both lateral tie rods and take action where considered appropriate. The safety issue has particular relevance to aircraft fitted with JRA-776-1 tie rods, aircraft that have been used for aerobatics, aircraft that have experienced heavy landings, and/or aircraft with lateral tie rods that have accrued longer periods in service.

Continuing investigation

The investigation is continuing and will include examination of the:

- video data
- aircraft's lateral tie rods, lower left wing structure and related components
- history of the aircraft's operations and maintenance
- component history and traceability
- previous tie rod failures and reported defects
- Tiger Moth maintenance requirements
- applicability of the 2,000-hour/18-year tie rods retirement life to aircraft being frequently utilised for aerobatic activities
- design specifications and manufacturing processes for lateral tie rods
- circumstances of other similar Tiger Moth accidents.

Should any other significant safety issues emerge in the course of the investigation, the ATSB will immediately bring those issues to the attention of the relevant authorities or organisations and publish them as required.

General details

Occurrence details

Date and time:	16 December 2013 – 12:24 EST	
Occurrence category:	Accident	
Primary occurrence type:	In-flight break-up	
Location:	300 m east of South Stradbroke Island, Queensland	
	Latitude: 27° 50.765' S	Longitude: 153° 25.995' E

Aircraft details

Manufacturer and model:	De Havilland DH82A Tiger Moth	
Registration:	VH-TSG	
Operator:	Tiger Moth Joy Rides	
Serial number:	DHC78	
Type of operation:	Charter	
Persons on board:	Crew – 1	Passengers – 1
Injuries:	Crew – fatal	Passengers – fatal
Damage:	Destroyed	

Sources and submissions

Sources of information

The sources of information during the investigation to date include:

- the type certificate holder
- the UK Air Accidents Investigation Branch (AAIB)
- the Civil Aviation Safety Authority (CASA)
- Airservices Australia
- the Queensland Police Service
- the aircraft operator
- the aircraft's maintainers
- the manufacturer of JRA-776-1 fuselage lateral tie rods
- various aircraft type experts.

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 CASA, the aircraft operator, the manufacturer of JRA-776-1 fuselage lateral tie rods, the AAIB, the type certificate holder and the UK Civil Aviation Authority.

Submissions were received from CASA, the type certificate holder and the UK AAIB. The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

The Australian Transport Safety Bureau (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 fare-paying passenger operations.

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

Purpose of safety investigations

The object of a safety investigation is to 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.