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Australian Transport Safety Bureau

Landing gear failures involving a Gippsland Aeronautics GA8 Airvan, VH-BFS

Fraser Island, Queensland, 24 August 2019 and 31 October 2019

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Addendum

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Safety summary

What happened

In August and October 2019, a Gippsland Aeronautics GA8 Airvan (GA8) aircraft, registered VH-BFS and operated by Air Fraser Island, sustained failures of the right main landing gear, with both occurrences occurring during landings on beach aeroplane landing areas (ALAs) on Fraser Island. Both landings were described as normal with no excessive loads.

On 24 August 2019, during the landing roll, and just prior to reaching taxi speed, the right main landing gear collapsed, resulting in minor damage to the aircraft as it came to a stop. There were no reported injuries to the pilot or passengers on board. On 31 October 2019, during the landing roll the right main wheel and axle separated from the landing gear at slow speed, resulting in minor damage. There were no reported injuries to the pilot (the only occupant).

What the ATSB found

The ATSB found it was probable that a number of the eight mounting bolts securing the right main landing gear had loosened and wound out, placing excessive loads on the remaining bolts. The remaining bolts eventually sheared, resulting in the gear leg collapsing during landing on 24 August 2019. Although the bolts not being securely fastened would have been apparent during one or more periodic inspections, recent maintenance had not detected any problems.

The ATSB found that because of low weld penetration from manufacture at the right main landing gear axle attach sleeve, it was likely that a fatigue crack formed and propagated undetected, eventually resulting in the axle failure on 31 October 2019. It was likely the axle cracks were present, and detectable visually, when last inspected 27 flight hours before the occurrence. In addition, the axle inspection area had surface contamination and corrosion that indicated the requirement for cleaning prior to inspection had not been conducted for an extended period, thereby decreasing the likelihood of identifying cracks by visual means. Furthermore, the requirement for a magnetic particle inspection of the axles had not been carried out, and was about 470 flight hours overdue at the time of the 31 October 2019 axle failure.

The operator's aircraft experienced increased loads on the landing gear when routinely operating from beach ALAs up to 20–30 times daily, and they were subjected to a salt-laden and humid environment. With consideration of this context, the ATSB concluded that the operator did not place appropriate emphasis on ensuring the continuing airworthiness of the landing gear of its GA8 fleet.

What has been done as a result

Following the incidents, Air Fraser Island made changes to the control and conduct of maintenance on its aircraft. This included the appointment of a new head of aircraft airworthiness and maintenance control (HAAMC), the appointment of a quality assurance officer to audit the operator's maintenance system, and changes to the personnel conducting maintenance.

Safety message

Operators routinely conducting operations to beach landing areas should consider the options available for improving the resilience of their landing gear. In particular, they should ensure that they are conducting the required inspections in accordance with the manufacturer's maintenance schedule and procedures as a minimum standard. Improved and additional inspections should also be considered by operators when aircraft are frequently operated in challenging conditions.

Contents

The occurrences

Right main landing gear collapse (24 August 2019)

On 24 August 2019, a Gippsland Aeronautics GA8 Airvan (GA8), operated by Air Fraser Island and registered VH-BFS, conducted a local scenic flight over Fraser Island, Queensland. There was a pilot and five passengers on board.

On completion of the flight, the aircraft landed on a beach aeroplane landing area (ALA).[1] The landing was described as normal with no excessive loads. The pilot reported that, just prior to reaching taxi speed, the right main landing gear began to rotate towards the fuselage very slowly, and that the aircraft began to tilt to the right. This caused the aircraft to head toward the higher part of the beach before coming to a stop. The aircraft sustained minor damage and there were no reported injuries.

The operator's licenced aircraft maintenance engineer (LAME) reported that the right main landing gear was no longer secured at its mount fitting by eight mount bolts, allowing it to rotate aft and upwards to a position where it could no longer support the aircraft (Figure 1). The aircraft was repaired and returned to service.

Figure 1: VH-BFS where it came to rest on 24 August, showing the right landing gear collapsed

Source: Air Fraser Island, modified by the ATSB

[1] The Air Fraser Island operations manual specified that beach aircraft landing areas were to be established in accordance with Civil Aviation Advisory Publication (CAAP) 92-1(1) (*Guidelines for aeroplane landing areas*). The CAAP recommended minimum physical characteristics of landing areas applicable to daytime operation of the GA8.

Right main landing gear axle fracture (31 October 2019)

On 31 October 2019, VH-BFS was operated to Fraser Island to collect passengers returning to the mainland. The pilot[2] was the sole occupant.

The pilot reported that the landing was normal with no excessive loads. During the landing roll on the beach ALA, the right main landing gear wheel separated from the aircraft. There were no reported injuries. Following the flight, fuel was observed to be leaking from the right wing. Queensland Parks and Wildlife Service personnel were in attendance and attempted to manage the spill (Figure 2).

Figure 2: VH-BFS where it came to rest on 31 October, showing the right main wheel separated from the aircraft

Source: Queensland Police Service, modified by the ATSB

The operator's LAME established that the right main landing gear had fractured at the axle, which is the attachment point for the main wheel to the landing gear. Another main landing gear assembly from the operator's other GA8[3] was fitted to VH-BFS, and the nose wheel axle bolt was replaced. The aircraft was subsequently returned to service.

[2] VH-BFS was flown by different pilots on 24 August and 31 October 2019.

[3] The operator's other GA8, VH-BNX, was under maintenance at the time.

Context

Operations on Fraser Island

Air Fraser Island primarily conducted scenic charter flights over Fraser Island, Queensland. This involved positioning aircraft from the mainland to Fraser Island in the morning and making multiple scenic flights daily from beach ALAs. The operator utilised two GA8 Airvans, a Cessna 172, and a Cessna 206 for these flights.

Since October 2017, the operator's head of aircraft airworthiness and maintenance control (HAAMC) was a LAME who also maintained and certified their aircraft under a third party maintenance approval.

The operator's LAME advised that generally, each of their aircraft flew about 100 hours in a 7-week period and made 200–300 landings in that time. The operator's safety manager advised that, on a busy day, pilots would conduct 20–30 take-offs and landings.

The majority of take-offs and landings were on beach ALAs that typically were below the high tide mark on sand that had been compacted by the receding tide. The physical characteristics of beach ALAs regularly exposed the aircrafts' main landing gears to additional loads when compared to graded or sealed runways. The salt-laden and humid environment also increased the speed and severity of corrosion on the aircrafts' metal components.

Aircraft information

General

The Gippsland Aeronautics GA8 Airvan (GA8) is a high-wing, all-metal, unpressurised aeroplane with a fixed tricycle landing gear. It has a single, reciprocating piston engine driving a constant speed propeller. The aircraft type first entered service in December 2000 and 262 aircraft were produced.

VH-BFS was manufactured and first registered in Australia in 2003. The aircraft had been in service with Air Fraser Island since that time. VH-BFS was being maintained in accordance with the GA8 service manual and held a current maintenance release at the time of both occurrences. At the time of the second occurrence (31 October 2019), VH-BFS had accumulated about 10,492 flight hours total time in service (TTIS).

Main landing gear and mounting description

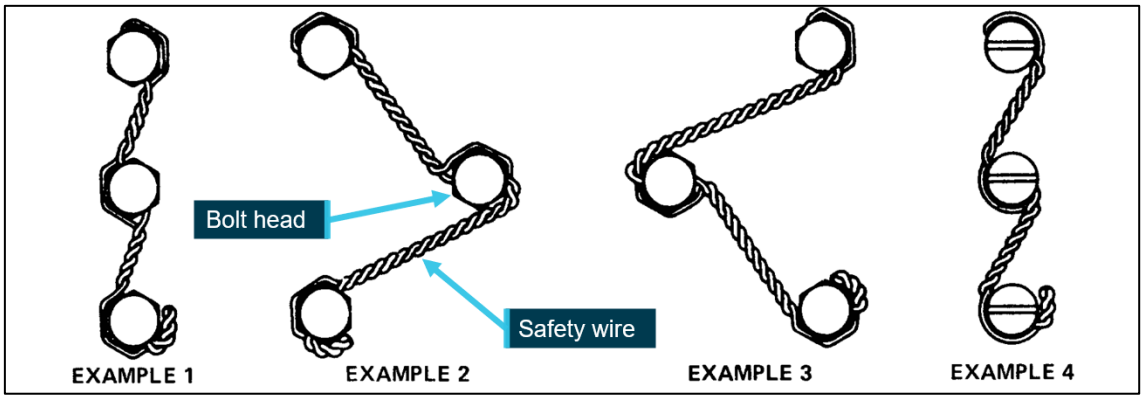
The GA8 main landing gear legs were manufactured from machined and heat-treated 5160 steel tube. They passed through fittings in the fuselage main landing gear carry-through structure and then into mount fittings that were bolted to the main keel members. The legs were fixed to these fittings by eight NAS6606-12 close-tolerance bolts per side. These mount bolts screwed into a special nut, with eight threaded holes, and the special nut was nested inside the landing gear tubing. The main landing gear tubing incorporated a waisted section that was designed to twist when subjected to excessive loads, such as a runway overrun, rather than transmitting those loads to the airframe via the mounting bolts.

The manufacturer, Gippsland Aeronautics, advised that the original design for fixing the main landing gear leg into the mount fitting was with four mount bolts per side. During testing with this arrangement, the bolts were found to shear off (in overstress) from the forces placed upon them. The design was subsequently modified to have eight bolts before the aircraft type first entered service. The manufacturer was not aware of any subsequent failures of the bolts after the aircraft type entered service.

At manufacture, the eight mount bolts fixing each main landing gear leg, after being tightened to the correct torque, were secured in place with safety wire.

Safety wiring is a means of securing hardware (such as bolts) to prevent them from loosening during operation. Safety wiring is not a means of maintaining the torque of a bolt, but rather to prevent their disengagement. Safety wire is most commonly stainless steel, and after being threaded through pre-drilled holes in bolt heads, is twisted together either by hand or by using special pliers (Figure 3).

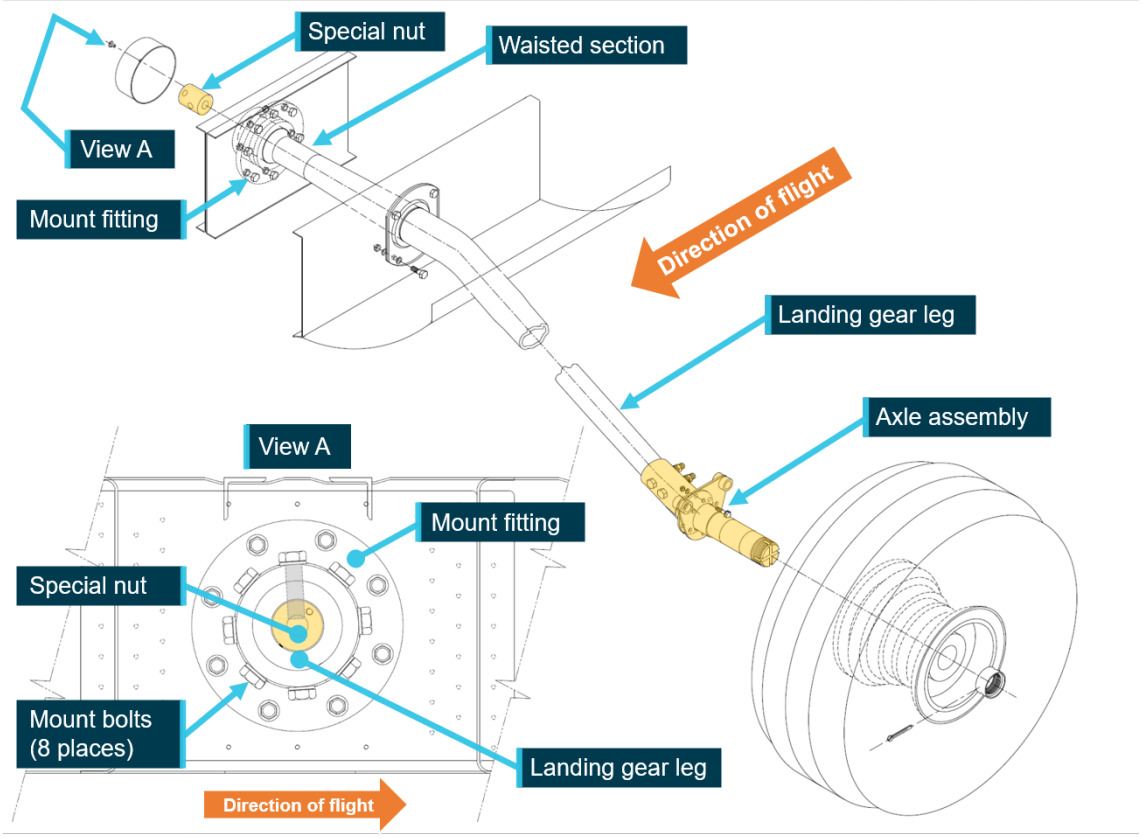
Figure 3: Examples of safety wiring of bolts



Source: US Federal Aviation Administration, modified by the ATSB

In-service experience showed that the GA8 landing gear mount bolts would loosen slightly due to the vertical and ratcheting forces on the main landing gear during take-off and landing. Access to the upper mounting bolts for removal, installation and safety wiring was limited by their proximity to the underside of the cabin floor (Figure 4).

Figure 4: GA8 main landing gear assembly showing the location of the mount fitting, mount bolts and axle



Source: Gippsland Aeronautics, modified by the ATSB

Soon after the GA8 entered service, the manufacturer made a design change so that a bolt retaining cap was installed over the mount fitting that covered the eight bolt heads. When installed, the cap ensured that the bolts could not wind out of the special nut and the bolt heads no longer needed to be safety wired. The design change was incorporated on the production line and could be incorporated as a non-mandatory modification to aircraft in service.

VH-BFS had not been fitted with the retaining caps on its landing gear at the time of the first occurrence (24 August 2019). Following the occurrence, when the aircraft was being repaired, the operator fitted a retaining cap on the left landing gear. No retaining cap was fitted to the right landing gear.

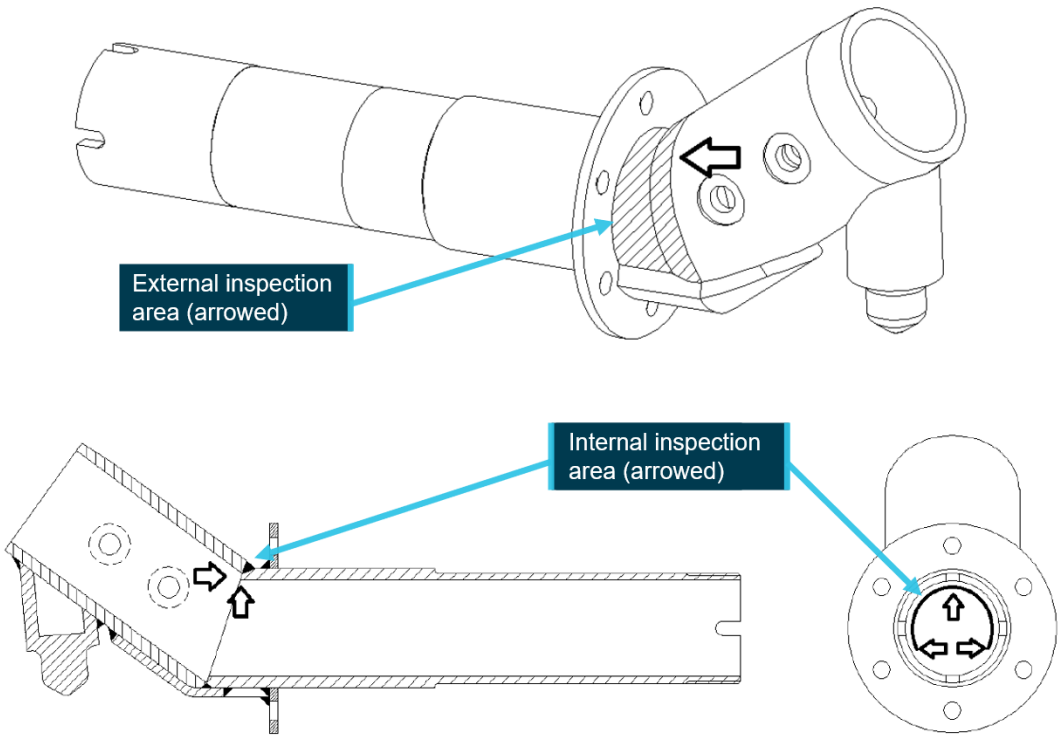
Main landing gear axle description

The main landing gear axles were manufactured from 4130 steel tube that was machined and welded. They were fixed to the main landing gear with two bolts (Figure 5). The axles incorporated a torque plate to attach the brake callipers.

The design specifications for the main landing gear axle assembly were progressively improved from the time the aircraft entered service. From October 2009 they included references to an internal Gippsland Aeronautics welding procedure that was intended to improve the integrity of the welded region between the axle and landing gear tube.

In response to a GA8 operator sustaining an in-service failure from fatigue cracking of a main landing gear axle, Gippsland Aeronautics issued service bulletin SB-GA8-2016-169 (*Inspection of the Main Undercarriage Axle Assembly*) in 2016. The associated issue was that cracks had been found to form on the upper side of the axle on the inboard side of the brake torque plate (Figure 5).

Figure 5: GA8 main landing gear axle assembly inspection areas



Source: Gippsland Aeronautics, modified by the ATSB

As a result of the initial service bulletin inspections identifying cracks in some instances, the service bulletin was re-issued to make it mandatory.[4] The service bulletin was issued for a third time on 11 November 2016 to give operators time to comply with the non-destructive inspection requirements. That inspection was to be conducted no later than 11 February 2017 if the axle had accumulated 2,000 hours TTIS.

The ongoing inspection requirements in the SB included:

- Part B - every 100 +/-10 flight hours, a detailed visual inspection of the external inspection area using at least 10x magnification and visual inspection internally
- Part C - from 2,000 flight (axle) hours, and every 1,000 +/-10 hours afterwards, a magnetic particle inspection.[5]

In both cases the main wheel, brake calliper and torque plate required removal and the inspection areas had to be cleaned with solvent to ensure they were free of contaminants and corrosion prior to commencing the inspection. The service bulletin also stipulated that the aircraft logbooks had to be certified showing the completion of the service bulletin.

Another requirement of service bulletin SB-GA8-2016-169 was to report the results of inspections by completing the included document compliance notice and returning it to the manufacturer. Gippsland Aeronautics advised that of the 262 production aircraft, 10 compliance notices had been received. None of those notices were for inspections conducted on VH-BFS or the operator's other GA8 aircraft (VH-BNX).

Recent scheduled maintenance

Periodic inspections of VH-BFS were certified as being carried out in accordance with the GA8 service manual at intervals of 100 +/- 10 hours or 12 months, whichever came first. They included the requirement to carry out a general inspection of the main landing gear attachment to the aircraft structure and, from 2016, a special inspection associated with SB-GA8-2016-169.

Recent periodic and special inspections were documented as being conducted on VH-BFS on:

- 2 August 2019 at 10,263.7 hours TTIS (22 days and 61.8 flight hours before the landing gear collapse occurrence)
- 15 September 2019 at 10,362.3 hours TTIS
- 21 October 2019 at 10,464.5 hours TTIS (10 days and 27.4 hours before the axle fracture occurrence).

Right main landing gear history

The right main landing gear involved in both of VH-BFS occurrences in 2019 was fitted to the aircraft following another occurrence in 2009 where the right wheel and brake calliper separated in flight due to a previous axle failure (see *Previous right main landing gear axle failure (21 June 2009)* in this report for further details). Based on the available evidence, the ATSB was unable to establish if the replaced landing gear was new or a part-life item at the time it was fitted in 2009.

The operator's LAME advised that they began carrying out maintenance on VH-BFS in October 2017 at 9,125.1 hours TTIS. They stated that the previous maintenance provider informed them that all the required inspections had been carried out. The LAME also reported that they expected the SB-GA8-2016-169 magnetic particle inspection (MPI) requirement to be due at 10,025.1 hours TTIS (900 flight hours after taking over the maintenance), but about that time experienced issues

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[4] As the operator was maintaining its GA8 aircraft in accordance with the manufacturer's maintenance schedule, it was required to comply with additional maintenance requirements, such as mandatory service bulletins.

[5] Magnetic particle inspection (MPI): a non-destructive inspection process for detecting flaws in ferrous metals. It requires specialist equipment and personnel who are trained and approved to carry out this work.

with their computer-based maintenance scheduling. That resulted in the most recent MPI of the main landing gear axle, as required by SB-GA8-2016-169, not being carried out.

At the time of the axle fracture occurrence (31 October 2019), VH-BFS was about 470 flight hours overdue for that inspection based on the statement from the operator's LAME. Further, the ATSB's examination of the aircraft maintenance documentation did not identify any previous occasion when the axle had an MPI conducted, including the initial inspection that was to be carried out no later than February 2017. MPI inspections were carried out on the operator's other GA8, VH-BNX, in July 2017.

Examination of recovered components

Main landing gear mounting hardware

Initial inspection by maintenance personnel

The worksheet completed for the recovery of the aircraft following the 24 August 2019 occurrence indicated that the bolts had sheared during landing and that an aircraft inspection was carried out. The LAME advised that:

- three bolt remnants consisting of bolt heads and part of their shanks were found in the keel of the aircraft, safety wired together
- the other five bolt heads with partial shanks were unable to be located, possibly lost during the repair activity
- the special nut used to secure the landing gear leg was lost during the repair activity.

Therefore, only three bolt heads with partial shanks were available for inspection.

Detailed examination of the remaining mounting hardware

The ATSB conducted a technical examination of the three main landing gear mount bolt remnants that were recovered (Figure 6). A summary of the examination is as follows:

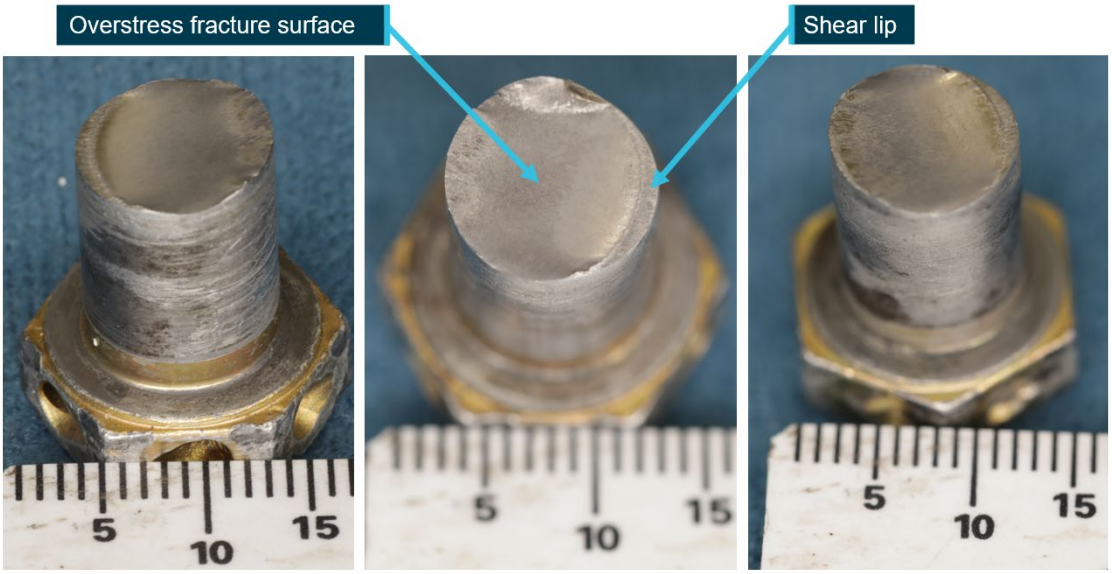
- Manufacturing stamps and measurements indicated the bolts were the right type and fit for purpose.
- There were no pre-existing defects with the bolts.
- There was no evidence of cracking, and there were shear lips present on all three bolts. Their fracture surfaces were consistent with shear overstress[6] from a single event.

Dimensional examination of the bolt remnants showed it was likely that all three bolts were correctly tightened, and that the fractures occurred at the interface between the landing gear leg and its mount fitting.

There was no physical evidence provided to determine if the five missing bolts had sheared in the same way as the three bolts recovered, or if they had wound out of the special nut so that the three bolts provided had supported the landing gear shear loads.

[6] Overstress failure: occurs when the loads applied to a component exceed the strength of its material. Shear overstress failures occur on a plain parallel to the direction of the applied loads.

Figure 6: The three recovered main landing gear mount bolt heads with partial shanks



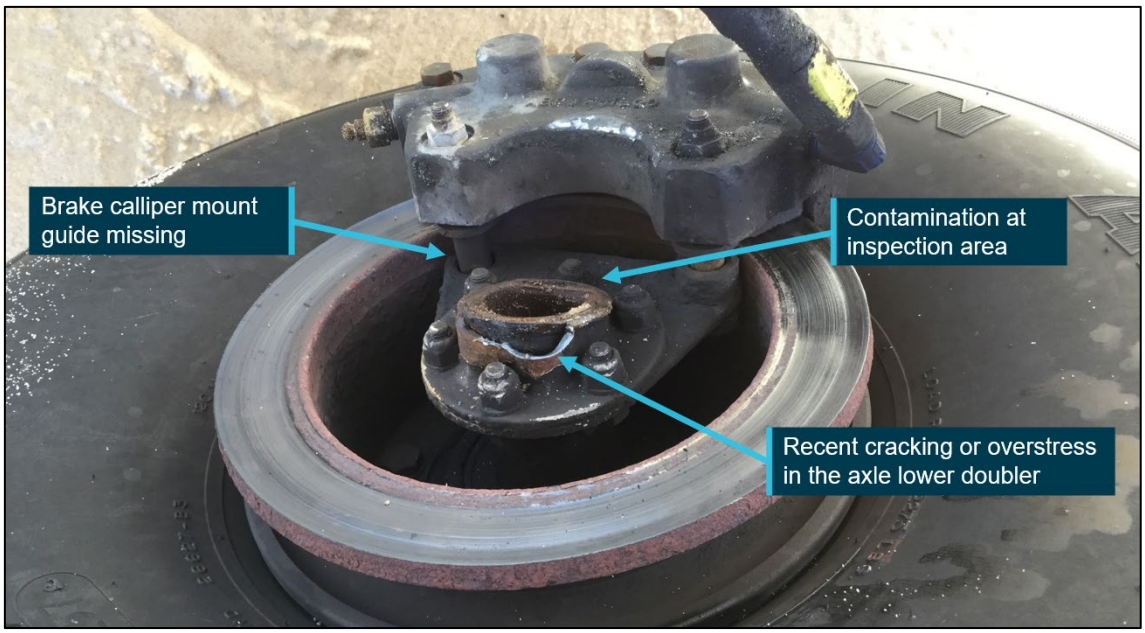
Source: ATSB

Main landing gear axle assembly

Examination of photographs

Examination of photographs taken immediately after the main landing gear axle fracture occurrence on 31 October 2019 showed that significant amounts of pre-existing contamination existed at the axle inspection area, and that one of the mount guides on the brake calliper torque plate had broken off at an unknown time prior to the occurrence (Figure 7).

Figure 7: VH-BFS right main wheel, brake and axle taken just after 31 October 2019 occurrence

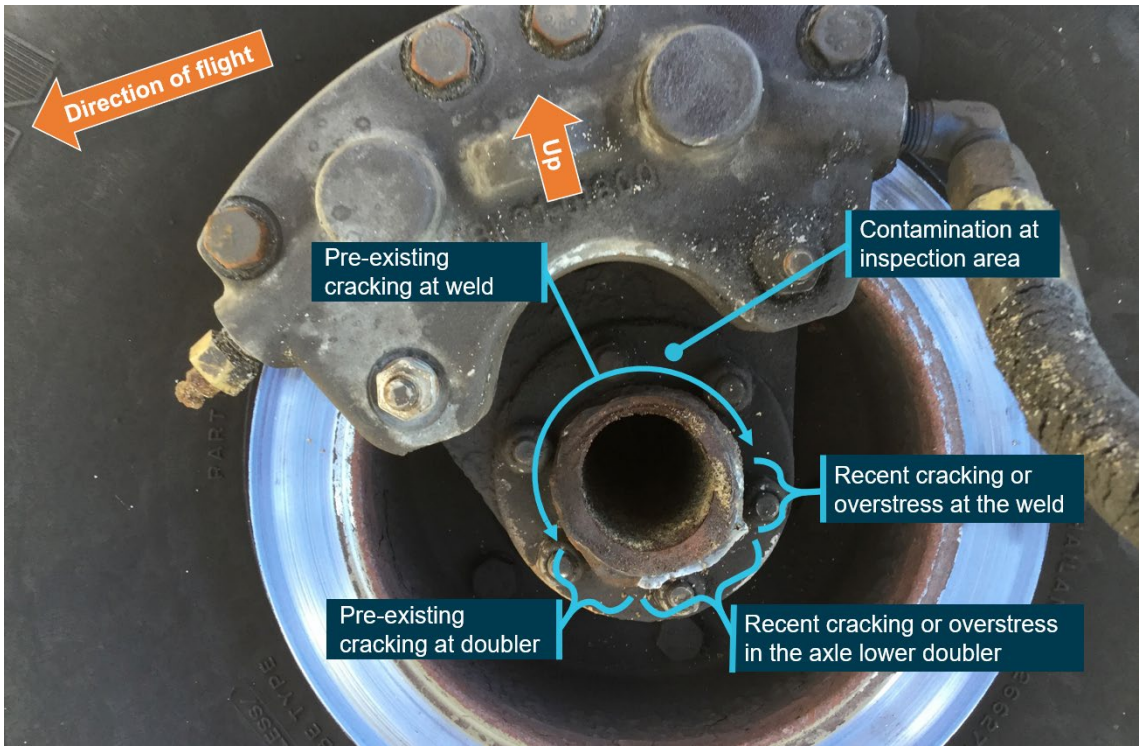


Source: Queensland Police Service, modified by the ATSB

Figure 8 shows dark and light areas across the axle fracture surface. Analysis of the photograph by materials failure specialists assessed the darkened areas as being pre-existing areas of fracture and the brighter areas, such as the area labelled as the ‘axle lower doubler’, were

overstress in nature. Based on that evidence, the axle weld was cracked around about two thirds of the circumference. The remaining structure failed in overstress during the landing occurrence.

Figure 8: VH-BFS right main landing gear axle failure taken just after 31 October 2019 occurrence



Source: Queensland Police Service, modified by the ATSB

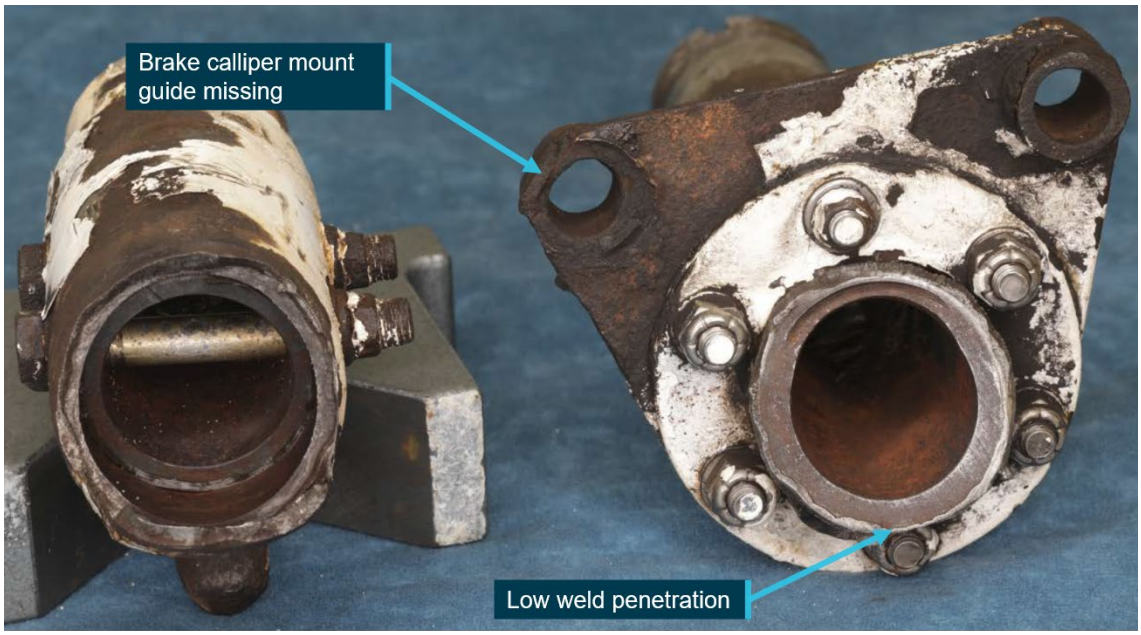
Detailed examination of the axle fracture

The right main landing gear leg and axle were provided to the ATSB for examination (Figure 9). A summary of that examination is as follows:

- There was low weld penetration (less than 1 mm) in some areas.
- The axle assembly was fractured in the area known to crack as described in SB-GA8-2016-169. However, smearing[7] and corrosion at the fracture surface prevented a determination on the degree of fatigue present prior to the occurrence.
- The axle assembly lower doubler had failed in overstress.
- There was paint missing on the leg and axle assembly with darker corrosion visible, likely present prior to the occurrence.
- Corrosion pitting was present on the fracture surface opposite the doubler, suggesting pre-existing damage.
- A secondary crack was found opposite the doubler, near the region of corrosion pitting.

[7] Deformation of the fracture surface that occurred as the axle failed.

Figure 9: VH-BFS right main landing gear axle after cleaning



Source: ATSB

Other noted defects

The ATSB identified that the right torque plate that located the brake calliper on the axle was significantly corroded and had a section of the brake calliper guide missing. The extent of the corrosion at the missing calliper guide indicated that it had been missing for an extended period.

Previous right main landing gear axle failure (21 June 2009)

On 21 June 2009, while travelling from Harvey Bay and during descent to Fraser Island, VH-BFS sustained a fracture of the right main landing gear axle assembly, resulting in separation of the wheel and brake calliper. The aircraft was diverted to Maryborough, Queensland, where it landed safely on the remaining portion of the axle.

To assist its investigation of the occurrence, the Civil Aviation Safety Authority (CASA) requested the assistance of the ATSB in the metallurgical examination of the fractured landing gear leg. The ATSB conducted that examination as an investigation under the *Transport Safety Investigation Act 2003* (see AE-2009-045 for details).

The ATSB examination concluded the following [emphasis added]:

> As a result of gross abrasion sustained during the aircraft landing, the amount of material lost from the leg attach fracture surfaces (including the doubler from the underside of the axle assembly) precluded an accurate determination of the failure mechanism.
>
> Considering the assembly design, the fillet weld would likely have been the region of highest stress in the axle assembly and therefore, in the absence of material or manufacturing defects, it is probable that the fracture would have originated and progressed through the weld along its full path.
>
> The onset of failure under low nominal stress conditions, that is, during flight, suggested a progressive or fatigue-type mechanism, rather than a gross transient overload event. However, there was no evidence of fatigue on the remaining fracture surface.
>
> **Future increased examination vigilance and possible enhanced inspections of the leg attach sleeve welds of other GA8 aircraft is suggested in view of the nature of the failure sustained.**

Safety analysis

Introduction

On two occasions in 2019, while conducting a landing on a beach aeroplane landing area (ALA), VH-BFS sustained failures of the right main landing gear. In the first occurrence, the right landing gear collapsed, and in the second the right main wheel separated from the aircraft due to an axle fracture. There were no reported injuries from either occurrence.

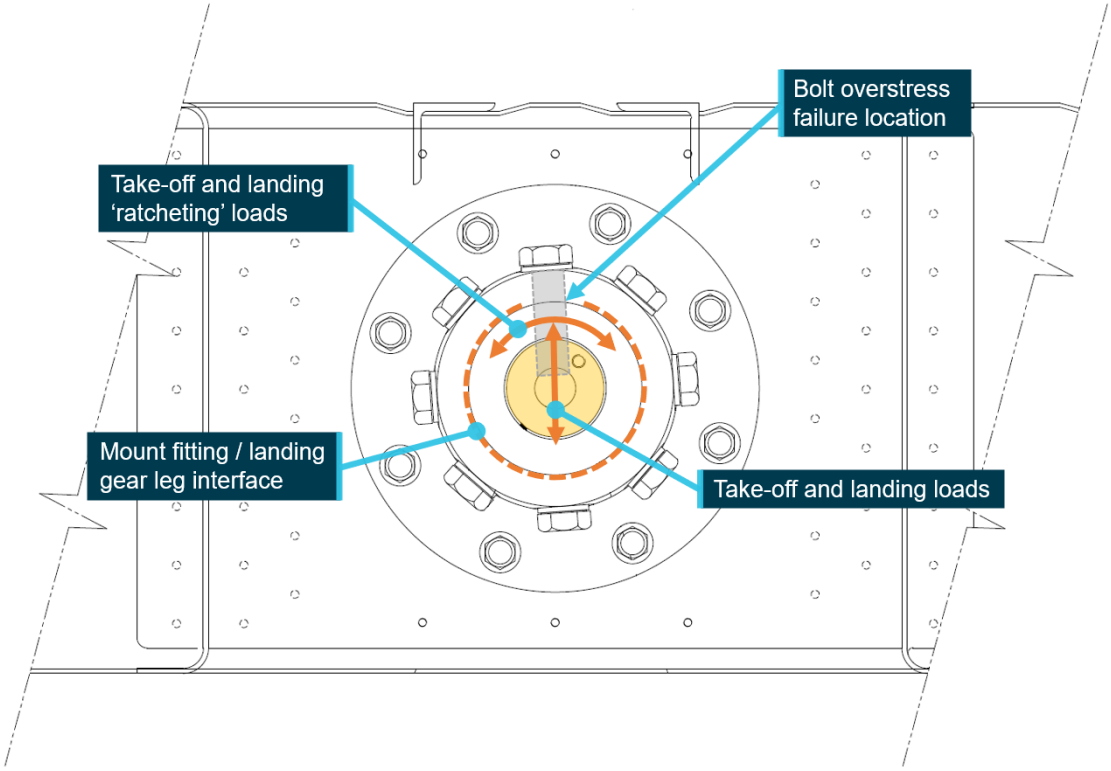
This analysis will discuss the likely failure modes involved in each occurrence and maintenance issues that were identified during the investigation.

Right main landing gear collapse (24 August 2019)

Landing gear mount bolt shear forces

Figure 10 shows an illustration of the eight mount bolts that are designed to secure the landing gear to the airframe structure. The bolts pass through the airframe fitting, into the landing gear leg and then they are retained by a special nut with eight threaded holes. The illustration also indicates the point of intersecting forces or loads applied by the airframe against forces applied by the landing gear. These forces are in shear and the point of intersection is the location where the three provided bolts sheared in overstress.

Figure 10: Main landing gear leg, mount fitting and special nut



Source: Gippsland Aeronautics, modified by the ATSB

Scenarios to explain the overstress failure of the recovered bolts

Technical analysis of the three provided landing gear mount bolt remnants were of the appropriate specification and they had no pre-existing defects. The fracture surfaces showed they had sustained an overstress failure due to shear loads.

The ATSB considered two possible scenarios with regards to the 24 August landing gear collapse:

- the shear overstress failure of all eight mount bolts due to significant landing loads
- the migration and release of five mount bolts that were not safety wired and the overstress failure of the three remaining bolts during normal landing loads.

Possible overstress failure of all eight bolts

The operator's LAME indicated that all eight mount bolts had failed in shear overstress during the landing. Apart from the three sheared bolt head remnants, the LAME was unable to provide any additional photographic or physical evidence to support that scenario; instead reporting that the five other sheared bolt remnants and the special nut were lost during repair activity. The LAME was unable to recall the circumstances regarding the removal of the eight bolt shanks and their threaded portions during the repair activity, and their subsequent whereabouts was not supplied.

In a scenario where all eight bolts fail in shear overstress, their shanks and threaded portion should retain the special nut in the landing gear leg, and the bolt heads should still be safety wired together, at least in pairs. Evidence such as the five missing bolts, the remaining threaded bolt shanks, and the special nut would have provided supporting evidence to show that all eight bolts were fitted and secure at the time of the 24 August occurrence. However, the only supporting evidence was the LAME's statement.

Possible migration of five unsecured bolts

Evidence to support the migration of five bolts that were not safety wired was as follows:

- The aircraft manufacturer reported that there have not been any taxi, take-off or landing incidents or accidents where all the landing gear bolts had sheared in overstress.
- The manufacturer designed the landing gear to twist and deform at a waisted section during hard landings before landing loads were significant enough to deform the airframe and shear the mount bolts. VH-BFS's landing gear was not twisted at the waisted section, and was refitted to the aircraft during the repair activity.
- The manufacturer reported that, during pre-production testing, the original installation of four mount bolts would shear in overstress rather than deform the landing gear leg. Therefore, an aircraft with four or less bolts fitted would likely shear those bolts.
- The landing was reported to have been normal with no excessive loads.
- There was no physical or photographic evidence available to show that the five bolts had sheared in overstress.
- The bolts examined were the correct type and fit for purpose.

ATSB analysis of the two scenarios

In the absence of a hard/abnormal landing, it would be unlikely for all eight mount bolts to fail in shear overstress provided they were all secured, the correct type, and fit for purpose. Further details about the recovery, repair and the replacement of parts requested by the ATSB was not forthcoming. Therefore, the ATSB could not assure itself that the LAME's account was entirely accurate.

The ATSB considered that, based on the available evidence, it was probable that the landing gear was not secured by all eight bolts prior to landing. It was also considered probable some bolts were not safety wired to ensure that they could not migrate out during numerous landing and take-off cycles. The replacement of the landing gear in 2009 due to the previous axle failure was at least one point in time where the bolts were removed and refitted with the possibility that they were not resecured by safety wire.

Access to the upper mounting bolts for safety wiring is limited by their proximity to the underside of the cabin floor. However, removal of this requirement could have been accomplished by retrofitting a main landing gear mount bolt retaining cap.

Each periodic (100 hourly) inspection required the examination of the landing gear securing points, which included the eight mount bolts. It was estimated that at least six periodic (100-hourly) inspections were conducted on VH-BFS every year. Each of those inspections provided an opportunity to identify an underlying issue with the security of the landing gear before it progressed to the point of failure.

Right main landing gear axle fracture

Landing gear axle examination

Technical analysis of axle fracture surfaces showed that a fatigue crack formed and propagated undetected around two thirds of the axle circumference along the weld and eventually failed in a weakened state during a normal beach landing. Examination of the weld points on the axle indicated that there was a low weld penetration at the axle attach sleeve. A combination of low weld penetration, operations on uneven beach ALAs and high landing cycles in a highly-corrosive environment may have increased the crack initiation and propagation rate. Corrosion pitting inside the fracture surfaces indicated that the crack had been present for a significant period of time.

The age of the right main landing gear from VH-BFS was not able to be established, however the low weld penetration at the axle attach sleeve suggests that it pre-dated the specification change in October 2009, when greater definition was added to the welding procedure by the aircraft manufacturer.

Maintenance aspects related to the axle failure

The ATSB's investigation into the axle failure of VH-BFS in 2009 recommended increased examination vigilance and possible enhanced inspections of the leg attach sleeve welds.

The manufacturer was aware of the possibility of fatigue cracks forming in axle attachment sleeves from the 2009 occurrence, and later in 2016 via in-service data gathered during the compilation of service bulletin SB-GA8-2016-169. The resulting mandatory requirements of this service bulletin were designed to identify fatigue cracks before they propagated to the point of failure. The fatigue cracking on the right axle of VH-BFS was located in the inspection area described in service bulletin SB-GA8-2016-169.

The service bulletin required detailed visual inspections in the area of the fatigue crack with a 10x magnifier every 100 hours, and a magnetic particle inspection (MPI) every 1,000 hours. The visual and MPI inspections required the removal of the main wheels, the brake callipers and torque plates for access, and the area had to be cleaned prior to inspection. Following each examination, a maintenance log entry was required to show that the examination was completed in accordance with the service bulletin and certified by appropriately licensed maintenance engineers.

Since February 2017, the aircraft had a periodic (100 hourly) inspection, which included the service bulletin, about every 7 weeks, with the last one being about 27 flight hours prior to the occurrence.

In accordance with the maintenance schedule, a calculation of aircraft hours and dates indicated that two MPIs should have been carried out on the aircraft since February 2017. The ATSB could not find any documented evidence to indicate that the initial MPI had been carried out, however an MPI was carried out on the operator's other GA8 in July 2017. The operator's LAME cited issues relating to maintenance scheduling software as a reason for the overrun of the second scheduled MPI.

Additionally, there was significant amount of pre-existing contamination at the axle inspection area. This indicated that required cleaning of the inspection area had not been conducted for an extended period, which reduced the likelihood of identifying cracks in the inspection area.

Each of the scheduled MPI and visual inspections represented an opportunity to identify a pre-existing crack in the axle area prior to failure. The ATSB concluded that a detectable crack would very likely have been present in the axle over numerous periodic inspection periods.

The operator was routinely operating from beach landing areas with increased loads on the landing gear, was aware of the axle failure of VH-BFS in 2009 and, later, the mandatory inspection requirements of SB-GA8-2016-169. However, it did not place appropriate emphasis on ensuring the continuing airworthiness of the landing gear of its GA8 fleet.

Landing gear maintenance procedures

Scheduled maintenance is designed to capture irregularities well before they can manifest into failures. More specifically, both issues that led to the landing gear failures involving VH-BFS were known to the aircraft manufacturer, and had been mitigated by scheduled and special inspections. The ATSB considered that the manufacturer's maintenance schedule, requirements and documentation, if followed correctly, were sufficient to identify the associated issues before they become incidents or accidents.

Operating aircraft on beach ALAs exposes them to increased loads on the landing gear, as well as also exposed the aircraft to sand and a salt-laden environment. Accordingly, operators conducting such operations on a routine basis should consider the options available for improving the resilience of their landing gear. In addition, they should ensure that all minimum maintenance inspections and requirements are being conducted at the specified frequency, and even consider whether to conduct them more frequently.

As a result of investigating these two occurrences, the ATSB identified that the relevant inspections of the landing gear did not appear to have been conducted at the inspection intervals required. More specifically:

- Each 100 hourly / periodic inspection required the examination of the landing gear securing points, which included the eight mount bolts. It was estimated that at least six periodic (100-hourly) inspections were conducted on VH-BFS every year. Each of those inspections represented provided an opportunity to identify an underlying issue with the security of the landing gear before it progressed to the point of failure (on 24 August 2019).
- Each of the scheduled visual and MPI inspections represented an opportunity to identify a pre-existing crack in the axle area prior to the failure (on 31 October 2019). However, the available evidence indicates two required MPIs since February 2017 were not conducted. In addition, a detectable crack would very likely have been present in the axle over numerous periodic inspection periods, and the amount of contamination in the axle inspection area meant that at least some of the visual inspections would not have been able to be effectively conducted.

The operator was aware of the previous axle failure involving its aircraft in 2009, and was aware of the service bulletin. Both occurrences involving VH-BFS highlight the importance of ensuring scheduled maintenance is carried out at the appropriate times and in accordance with the required maintenance data.

In summary, based on the available information, the ATSB concluded that the operator did not place appropriate emphasis on ensuring the continuing airworthiness of the landing gear of its GA8 fleet.

The manufacturer's ability to improve maintenance requirements relies partly on the provision of in-service data for analysis. SB-GA8-2016-169 incorporated an 'inspection result compliance notice' and, from 262 production aircraft, there have been only 10 responses. This represented a missed opportunity for the manufacturer and operators to obtain important ongoing airworthiness information.

Findings

ATSB investigation report findings focus on safety factors (that is, events and conditions that increase risk). Safety factors include 'contributing factors' and 'other factors that increased risk' (that is, factors that did not meet the definition of a contributing factor for this occurrence but were still considered important to include in the report for the purpose of increasing awareness and enhancing safety). In addition 'other findings' may be included to provide important information about topics other than safety factors.

Safety issues are highlighted in bold to emphasise their importance. A safety issue is a safety factor that (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.

These findings should not be read as apportioning blame or liability to any particular organisation or individual.

From the evidence available, the following findings are made with respect to the landing gear failures involving a GA8 Airvan, VH-BFS, on 24 August and 31 October 2019.

Contributing factors

- It is probable that a number of the eight right main landing gear mount bolts had migrated out of the special nut undetected and over an extended period. The three remaining bolts failed in overstress, resulting in the gear leg collapsing during a normal beach landing on 24 August 2019.
- Recent maintenance inspections specific to the security of the landing gear attachment had not detected issues related to the migration of the right main landing gear mount bolts. It is probable that the mount bolt migration would have been apparent during one or more inspections.
- There was low weld penetration at the right main landing gear axle attach sleeve, which likely resulted in a fatigue crack forming, then propagating undetected and eventually failing during a normal beach landing on 31 October 2019.
- It was likely the axle cracks were present, and detectable visually, when last inspected 27 flight hours before the 31 October 2019 occurrence.
- The axle inspection area had surface contamination and corrosion that indicated the requirement for cleaning prior to inspection had not been conducted for an extended period, thereby decreasing the likelihood of identifying cracks by visual means.
- The most recent mandatory service bulletin SB-GA8-2016-169 requirement for a magnetic particle inspection (MPI) of the axles had not been carried out, and was about 470 flight hours overdue at the time of the 31 October 2019 axle failure.
- **The operator did not place appropriate emphasis on ensuring the continuing airworthiness of the landing gear of its GA8 fleet, although being aware of:**
  - **the increased loads on the landing gear when routinely operating from beach landing areas up to 20–30 times daily, and being subjected to a salt-laden and humid environment**
  - **the axle failure of VH-BFS in 2009**
  - **the mandatory inspection requirements of service bulletin SB-GA8-2016-169.** (Safety issue)

Other factors that increased risk

- Although not mandatory, the operator had not retrofitted main landing gear mount bolt retaining caps on the landing gear of VH-BFS. Such retaining caps would have prevented the possible

scenario of the main landing gear mount bolts becoming loose and thereby reducing the integrity of the main gear leg.

- A requirement of service bulletin SB-GA8-2016-169 was to report the results of inspections by completing the document compliance notice and returning it to the manufacturer. Of the 262 production aircraft, 10 compliance notices had been received. This represented a missed opportunity for the manufacturer and operators to obtain important ongoing airworthiness information.

Safety issues and actions

Central to the ATSB's investigation of transport safety matters is the early identification of safety issues. The ATSB expects relevant organisations will address all safety issues an investigation identifies.

Depending on the level of risk of a safety issue, the extent of corrective action taken by the relevant organisation(s), or the desirability of directing a broad safety message to the aviation industry, the ATSB may issue a formal safety recommendation or safety advisory notice as part of the final report.

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 each safety issue relevant to their organisation.

The initial public version of these safety issues and actions are provided separately on the ATSB website, to facilitate monitoring by interested parties. Where relevant, the safety issues and actions will be updated on the ATSB website as further information about safety action comes to hand.

Maintenance processes for landing gear

Safety issue description

The operator did not place appropriate emphasis on ensuring the continuing airworthiness of the landing gear of its GA8 fleet, although being aware of:

- the increased loads on the landing gear when routinely operating from beach landing areas up to 20–30 times daily, and being subjected to a salt-laden and humid environment
- the axle failure of VH-BFS in 2009
- the mandatory inspection requirements of service bulletin SB-GA8-2016-169.

Issue number:	AO-2019-045-SI-01
Issue owner:	Air Fraser Island
Transport function:	Aviation: General aviation
Current issue status:	Closed - Adequately addressed
Issue status justification:	The ATSB acknowledges the operator's action regarding its changes to the control and conduct of maintenance on their aircraft. However, the ATSB notes that the prescribed maintenance program for any aircraft should be considered the minimum requirement, and when frequently operating in challenging environments such as a beach ALA additional activities or risk controls should also be considered. Nevertheless, the safety action taken by the operator has reduced the risk of this safety issue.

Proactive safety action taken by Air Fraser Island

Action number:	AO-2019-045-NSA-046
Action organisation:	Air Fraser Island
Action status:	Closed

In April 2021, the operator advised that it:

> …has overhauled its maintenance system which included a restructure of maintenance personnel, hiring and appointing a new experienced Head of Aircraft Airworthiness and Maintenance Control, contracting a new aircraft maintenance provider and appointing a Quality Assurance Officer to audit the companies maintenance system. These changes have collectively reduced external pressures and workload on the maintenance crew resulting in improvement in the quality of workmanship and increased operational standards throughout the company.

The operator further advised that it had:

> …started the process for all of our Ga8 gear legs to get NDT [non-destructive testing, in this case a magnetic particle inspection] so we have a new zero hour point to work off across the fleet.

General details

Occurrence details

Date and time:	24 August 2019 – 1315 EST	
Occurrence category:	Serious incident	
Primary occurrence type:	Landing gear failure	
Location:	Eurong, Queensland	
	Latitude: 25° 30.751' S	Longitude: 153° 7.148' E

Date and time:	31 October 2019 – 1434 EST	
Occurrence category:	Serious incident	
Primary occurrence type:	Landing gear failure	
Location:	Eurong, Queensland	
	Latitude: 25° 30.751' S	Longitude: 153° 7.148' E

Aircraft details

Manufacturer and model:	Gippsland Aeronautics	
Registration:	VH-BFS	
Operator:	Air Fraser Island	
Serial number:	GA8-03-035	
24 August 2019		
Type of operation:	Charter – Passenger	
Activity:	Commercial air transport – Non-scheduled (Joyflight/sightseeing charters)	
Departure:	Oaks, Queensland	
Destination:	Eurong, Queensland	
Persons on board:	Crew – 1	Passengers – 5
Injuries:	Crew – 0	Passengers – 5
Aircraft damage:	Minor	
31 October 2019		
Type of operation:	Charter – Test and ferry	
Activity:	General aviation/Recreational – Other general aviation flying (ferry flight)	
Departure:	Unknown	
Destination:	Eurong, Queensland	
Persons on board:	Crew – 1	Passengers – 0
Injuries:	Crew – 0	Passengers – 0
Aircraft damage:	Minor	

Sources and submissions

Sources of information

The sources of information during the investigation included the:

- pilot of the occurrence flight and another pilot who conducted flights for the operator
- chief pilot of Air Fraser Island
- Civil Aviation Safety Authority
- Queensland Police Service
- aircraft manufacturer
- maintenance organisation for VH-BFS at the time of the occurrences
- witnesses
- photographs taken on the day of the accident.

References

ATSB external investigation AE-2009-045, *Engineering examination into the fractured main landing gear axle Gippsland Aeronautics GA-8 Airvan, VH-BFS, 21 June 2009*, Australia.

Gippsland Aeronautics, *Model GA8 service manual amendment 12, 15 May 2018.*

Gippsland Aeronautics, Service Bulletin SB-GA8-2016-169 issue 3*, Inspection of the Main Undercarriage Axle Assembly.*

Federal Aviation Administration (1998), Advisory circular AC 43.43-1B, *Acceptable methods, techniques, and practices – aircraft inspection and repair*.

Submissions

Under section 26 of the *Transport Safety Investigation Act 2003*, the ATSB may provide a draft report, on a confidential basis, to any person whom the ATSB considers appropriate. That section 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 following directly involved parties:

- the pilots of the occurrence flights and another pilot who conducted flights for the operator
- the chief pilot and safety manager of Air Fraser Island
- the Civil Aviation Safety Authority
- the aircraft manufacturer
- the maintenance organisation for VH-BFS at the time of the occurrences.

The submissions were reviewed and, where considered appropriate, the text of the report was amended accordingly.

Australian Transport Safety Bureau

About the ATSB

The ATSB is an independent Commonwealth Government statutory agency. It is governed by a Commission and is entirely separate from transport regulators, policy makers and service providers.

The ATSB's purpose is to improve the safety of, and public confidence in, aviation, rail and marine transport through:

- 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, as well as participating in overseas investigations involving Australian-registered aircraft and ships. It prioritises investigations that have the potential to deliver the greatest public benefit through improvements to transport safety.

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

Purpose of safety investigations

The objective of a safety investigation is to enhance transport safety. This is done through:

- identifying safety issues and facilitating safety action to address those issues
- providing information about occurrences and their associated safety factors to facilitate learning within the transport industry.

It is not a function of the ATSB to apportion blame or provide a means for determining 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. The ATSB does not investigate for the purpose of taking administrative, regulatory or criminal action.

Terminology

An explanation of terminology used in ATSB investigation reports is available on the ATSB website. This includes terms such as occurrence, contributing factor, other factor that increased risk, and safety issue.