

SERIOUS INCIDENT

Aircraft Type and Registration:	Piper PA-31, G-UKCS
No & Type of Engines:	2 Lycoming TIO-540-A2C piston engines
Year of Manufacture:	1974 (Serial no: 31-7400984)
Date & Time (UTC):	23 July 2021 at 0933 hrs
Location:	Doncaster Sheffield Airport
Type of Flight:	Aerial survey
Persons on Board:	Crew - 1 Passengers - 2
Injuries:	Crew - None Passengers - None
Nature of Damage:	Lower cabin door damaged
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	26 years
Commander's Flying Experience:	1,513 hours (of which 66 were on type) Last 90 days - 37 hours Last 28 days - 15 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB

Synopsis

The aircraft's lower cabin door came open in flight when a screw forming part of the door's forward latching mechanism fractured. The aircraft landed safely and the investigation determined that the cabin door's rear latch was probably not locked when the cabin door was closed, allowing the door to open when the screw fractured. The screw had not been securely fastened and was loose, which contributed to a fatigue failure of the screw. The operator has taken a number of safety actions intended to detect unsafe conditions of the cabin doors on its PA-31 fleet.

History of the flight

The aircraft was operating an aerial survey flight, with a crew of one pilot and two systems operators onboard. The lead systems operator confirmed that prior to departure the cabin doors had been closed without difficulty, with the cabin door ajar warning light extinguished and the cabin door indicator showing SAFE. The doors were confirmed closed and locked by the application of gentle physical pressure to the doors, which is part of the normal pre-departure checklist.

After departing from Doncaster Sheffield Airport at 0920 hrs, the aircraft routed towards Hull at an altitude of 2,000 ft in IMC when, at 0933 hrs, the crew heard a 'loud bang' as the lower cabin door opened. The commander transmitted a PAN call to Humberside Radar informing them that the cabin door had come open and requesting radar vectors to the

Runway 02 ILS at Doncaster Sheffield Airport. The pilot informed the systems operators that he would fly a faster than normal approach, using full flap, to minimise the aircraft's pitch attitude during approach and landing.

The aircraft was transferred to Doncaster Radar who vectored the aircraft for the Runway 20 ILS, as this was a more direct return route and the surface wind was light. The aircraft landed uneventfully at 1000 hrs.

Aircraft information

The main cabin door is a clamshell design (Figure 1) with upper and lower outward-opening doors. The lower door is fitted with two folding steps and when open is supported by two cable-stays.

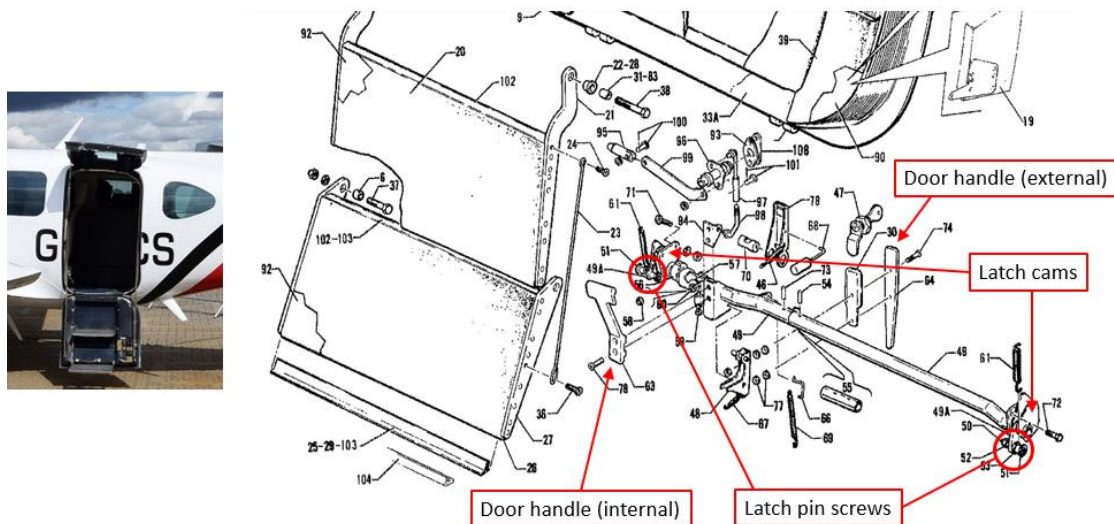


Figure 1

PA-31 cabin door and latching mechanism (illustration courtesy of Piper)

The upper door is held closed by overlap with the lower door when it is closed and locked. On G-UKCS the upper door is also fitted with an internal sliding latch¹, to additionally secure the cabin upper door.

The lower door is locked by means of two cams, mounted at either end of a rotating torque tube that is operated by movement of either the internal or external door handles. Latch pins, composed of a bushing sleeved over a latch screw that rotates with the latch cam, engage in hook lock plates fixed to the cabin door frame when the lower door is locked closed (Figure 2).

Footnote

¹ Embodied in accordance with Piper Service Letter 739.

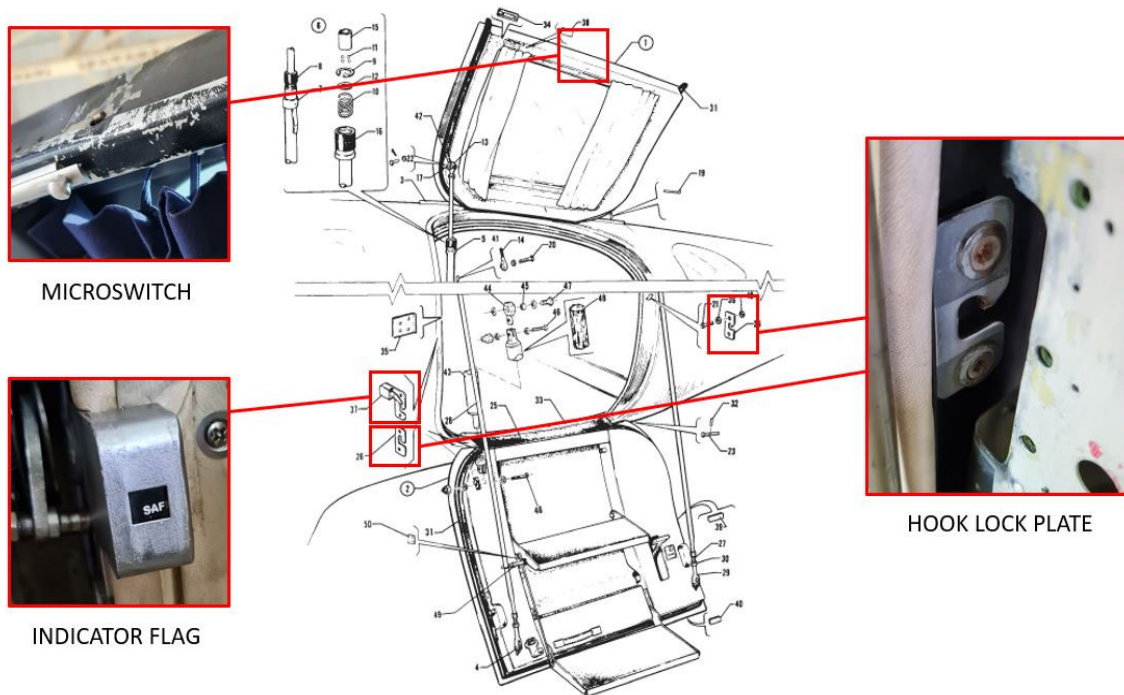


Figure 2

PA-31 cabin door components (illustration courtesy of Piper)

In addition to the two cam assemblies, G-UKCS also has a visual indicator flag incorporated into the cabin door forward latch assembly, which displays the word SAFE when the forward latch is engaged. This feature was introduced by the manufacturer to prevent inadvertent opening of the cabin door in flight and was mandated by a FAA Airworthiness Directive².

A single microswitch is fitted to the upper cabin door that contacts a striker plate in the lower cabin door when the doors are closed. Closure of the microswitch causes a door ajar warning light on the upper console of the flight deck instrument panel to extinguish.

Aircraft examination

The aircraft's upper and lower cabin doors remained attached to the aircraft, however the forward cable-stay had broken at its attachment point to the lower door and the rear cable-stay mounting structure was damaged.

The cabin door latch mechanism was disassembled, revealing that the forward door latch pin screw had broken (Figure 3), and the door latch return spring was bent, with one end fractured.

Footnote

² Piper Service Letter 803A and FAA AD 78-05-05, effective 8 March 1978.

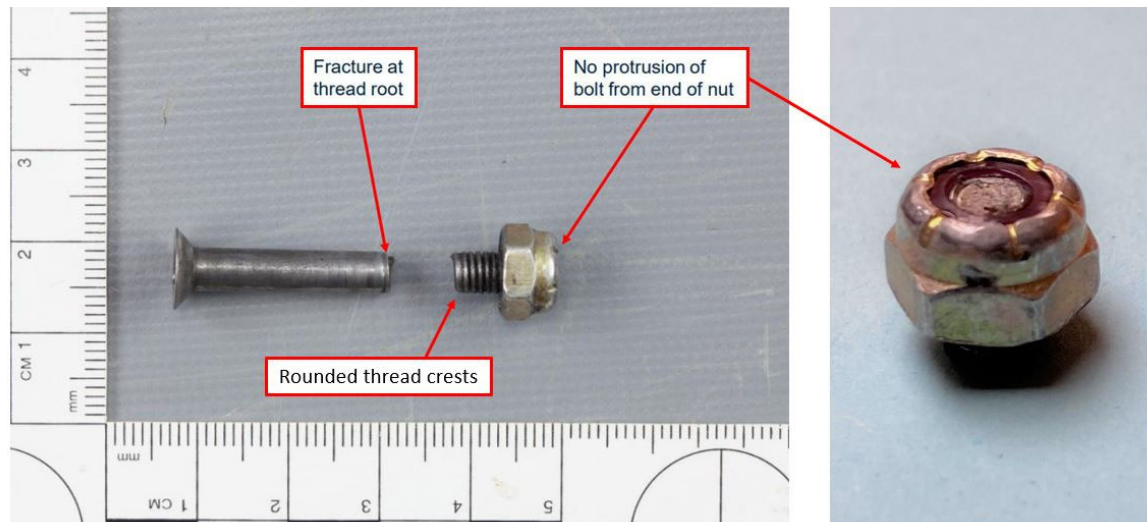


Figure 3

Fractured door latch pin screw (image courtesy of QinetiQ)

The latch pin screw had fractured at the thread root, close to the shank of the screw, and the thread crests in this area were rounded and worn around the circumference. The self-locking nut was observed to be insufficiently engaged on the screw threads, with no projection of the screw thread beyond the end of the nut. The screw was measured and confirmed, with reference to the aircraft's Illustrated Parts Catalogue, to be the correct screw for the latch assembly³.

The screw's fracture surface exhibited fatigue beachmarks around the circumference of the fracture surrounding a smaller area of relatively rough, dull fracture characteristic of overload (Figure 4). A number of ratchet marks⁴ were also visible within the fatigue region of the fracture surface, which encompassed approximately 60% of the screw's cross-section.

The propagation of fatigue cracking around the periphery of the screw thread root, surrounding the overload region, is characteristic of the screw being loose in the door latch assembly and rotating between load cycles. The worn and rounded thread crests at the fracture location on the screw also indicate a similar wear mechanism.

Operator's testing

The operator conducted testing of the cabin door following the incident and noted that when closing the doors from the inside, the rear latch pin was observed to not always fully engage in its latch hook when the door handle was in the closed position. This condition could only be seen from inside the cabin when conducting a visual inspection using a torch and would not be immediately visible or apparent to the crew members.

Footnote

³ Part number MS24694-S63 (#10-32 UNF-3A thread, 7/8" grip).

⁴ Ratchet marks are lines on a fatigue fracture surface that result from the intersection and connection of fatigue fractures propagating from multiple origins.

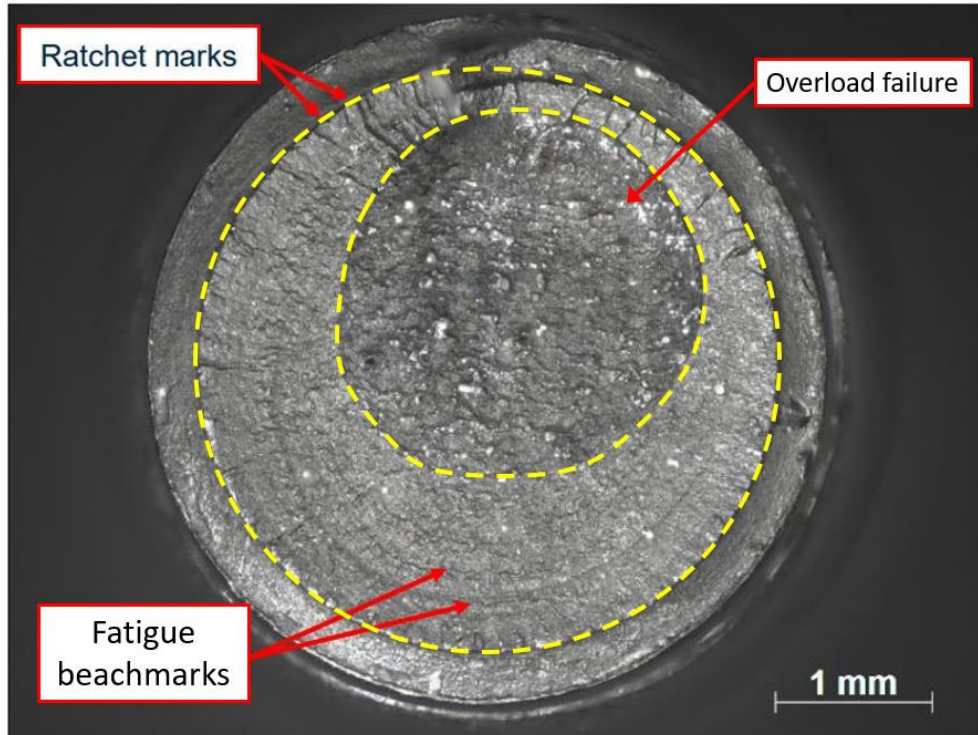


Figure 4

End view of screw fracture surface showing regions of fatigue and overload crack propagation (image courtesy of QinetiQ)

The forward latch pin screw was replaced and the testing was repeated. Whilst the repaired forward latch locked reliably, the unlocked condition of the rear latch could be reproduced. In this condition the door ajar cockpit indication extinguished and the lower door appeared to be flush but both the internal and external door handles were not in their fully closed positions, with the external handle protruding outwards (Figure 5).



Figure 5

Protruding state of the lower cabin door handle observed during testing (image courtesy of 2Excel)

Other information

The aircraft manufacturer stated that no similar occurrences of a broken latch pin screw were listed in the FAA's Service Difficulty Reporting System database.

The operator checked the aircraft's maintenance records and could not identify when the forward latch pin screw had last been disturbed. They stated that the screw had not been subject to any maintenance input since they had acquired the aircraft in June 2016.

Analysis

It is probable that when the cabin doors were closed and locked by the lead systems operator, the rear latch pin did not fully engage in its hook lock plate whilst the forward latch pin did, and that the door therefore appeared to be securely locked closed. The visual presentation of SAFE on the forward latch indicator, combined with the extinguishing of the door ajar cockpit warning light and the apparent security of the cabin door when pressure was applied to it would have all contributed to confirmation that the cabin door was properly closed and locked. The contrary indications of the internal door handle not being fully in the closed position and the rear latch pin not being safely engaged in its hook plate were not sufficiently prominent to have caused the crew to question the security of the cabin door prior to departure.

The forward latch pin screw fractured during flight due to propagation of a fatigue crack, through the threaded portion of the screw, which reached sufficient length that the remaining section of the screw could no longer withstand the loads applied to it. The screw was loose within the latch pin assembly because its self-locking nut had not been tightened at an unidentified previous maintenance event. The looseness of the screw contributed to the propagation of the fatigue crack as the screw had been subject to bending loads in service and rotation of the screw had caused fatigue to propagate from multiple initiation sites around the screw thread root.

The investigation did not determine whether the loose forward latch pin screw possibly contributed to the lack of engagement of the rear latch pin in its hook plate.

The upper cabin door remained closed when the lower door opened, due to its separate sliding latch, which contributed to the safe outcome of the event.

Safety action

The operator plans to conduct a fleet check on its PA-31 aircraft to ensure that the latch pin screws are not loose and are correctly mechanically fastened. It also plans to issue the following amplification statements:

- In its PA-31 Aircraft Maintenance Programme daily inspection instructions to ensure that the internal and external door handles are flush when the door is in the locked closed.

- In its PA-31 Check 1 (50-hour) inspection to include specific visual inspections for correct engagement of the cabin door latch pins and hook plates when the door is locked closed, and also that the latch pin screws are correctly mechanically fastened. Correct rigging of the internal and external cabin door handles is also to be highlighted in the Check 1 instructions.
- In its PA-31 Operations Manual pre-flight checklist to include a specific visual inspection to ensure that the cabin door internal handle is flush to the door inner skin when the door is locked closed.

The operator also plans to disseminate its internal occurrence report for this event to its engineers and flight crews and will include related safety information in recurrent continuation training.