**ACCIDENT**

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| **Aircraft Type and Registration:** | Piper PA-34-200T Seneca II, G-JDBC |
| **No & Type of Engines:** | 2 Continental Motors Corp LTSIO-360-E piston engines |
| **Year of Manufacture:** | 1975 |
| **Date & Time (UTC):** | 30 June 2008 at 1458 hrs |
| **Location:** | Runway 23L, Manchester International Airport, Greater Manchester |
| **Type of Flight:** | Training |
| **Persons on Board:** | Crew - 3 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Failed left main landing gear attachments, damage to left flap, aileron, propeller and pitot head and horizontal stabilser tip |
| **Commander's Licence:** | Commercial Pilot's Licence |
| **Commander's Age:** | 47 years |
| **Commander's Flying Experience:** | 1,975 hours (of which 302 were on type)<br>Last 90 days - 28 hours<br>Last 28 days - 4 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot and metallurgical examination of landing gear trunnion fitting |

**Synopsis**

During a training flight, three touch-and-go landings were conducted at Tatenhill Airfield. The next landing was to be a full stop. However, on touchdown the aircraft veered to the right; the instructor took control and flew the aircraft off the ground. When the landing gear was subsequently retracted, an 'unsafe' indication was obtained and it was later observed that, with the gear extended, the left wheel appeared to be at 90° to the airflow, with the leg deflected in an aft direction.

The decision was made to return to the operator's base at Manchester, where, immediately prior to touchdown, both engines were shut down and the propellers feathered. Subsequent examination of the aircraft showed that the left landing gear forward trunnion fitting had broken into several pieces, thus releasing the leg from its location. Metallurgical examination indicated that the fitting had failed from a combination of loose attachment bolts and fretting damage.

**History of the flight**

The first flight on the day of the accident was an instrument training detail from the operator's base

at Manchester to Blackpool Airport. Aboard were the instructor and two trainee pilots. The landing at Blackpool was uneventful and the aircraft subsequently departed to conduct an asymmetric power training detail. Some of this was carried out at high level, during which the landing gear was cycled six times. The aircraft then joined the circuit at Tatenhill, making three touch-and-go landings on Runway 26, with the purpose of conducting practice engine failures on departure. The surface wind was approximately 260° at 10 kt and the commander stated that the landings were smooth, with no lateral drift. The next landing was to be a full stop, in order to refuel before returning to Manchester. However, on touchdown the aircraft veered to the right and appeared likely to leave the paved surface. Accordingly, the instructor took control and flew the aircraft off the ground. When the gear was retracted the 'gear unsafe' light remained illuminated. The rear seat student then reported that he had heard a 'bang' during the touchdown.

The aircraft departed the circuit and the landing gear was cycled a number of times in attempt to clear the problem, but without success. When selected up, the gear unsafe light came on; when selected down, two greens (the nose and right main) illuminated. The emergency landing gear extension procedure was then conducted, at the appropriate speed of 84 kt, but the indications remained the same. During this time, the rear seat student observed that, with the gear extended, the left wheel appeared to be deflected at 90° to the airflow, with the leg bent rearwards. The commander then made his own visual inspection and agreed with the findings. The gear was cycled once more, whereupon, three green lights illuminated. By experimentation, it was found that the left wheel was fouling the left flap when set fully down.

It was by now clear that a normal landing could not be achieved, so it was decided to continue to Manchester where more comprehensive emergency services were available. Upon first radio contact with Manchester Approach, the commander explained the problem and the airport emergency services were placed on standby. The aircraft was held at a visual reference point (VRP) while preparations were made. During this time, the commander briefed the students as to what he expected from them and also debated whether to spend time burning off more fuel; approximately half the contents by now remained.

The commander took control of the aircraft and flew an off-set approach to Runway 23L; the surface wind was reported as 260° at 10 kt. He aimed to land on the right side of the runway in order to improve the chances of remaining on the paved surface in the event that the aircraft veered to the left. At approximately 250 ft agl and over the runway, the commander closed both throttles, feathered the propellers and selected the mixture controls to idle cut-off. Although the right propeller feathered quickly, the left continued to windmill. Only two stages of flap were selected in view of the fact that the left wheel fouled the flap at its full deflection. The commander held the aircraft off the ground for as long as possible, with the front seat student reporting the speed to be 60 kt on touchdown. Right aileron was applied to hold the left wing off the ground, with contact occurring at 40 kt. Right rudder and right brake were applied in order to keep the aircraft straight. As soon as it had halted the occupants vacated the aircraft; there were no injuries. The emergency services were in attendance almost immediately. The aircraft had sustained relatively little damage and there were no fuel or hydraulic fluid spillages.

**Examination of the aircraft**

The aircraft was recovered to the maintenance organisation's hangar, where an inspection revealed that the left landing gear forward trunnion fitting had broken into several pieces. Parts of the component were missing, although one piece was later recovered from the runway at Tatenhill. Figure 1 shows an illustration from the Illustrated Parts Catalogue, which shows details of the installation.

The fragments from the trunnion fitting were removed from the aircraft, Figure 2, and subjected to a metallurgical examination.

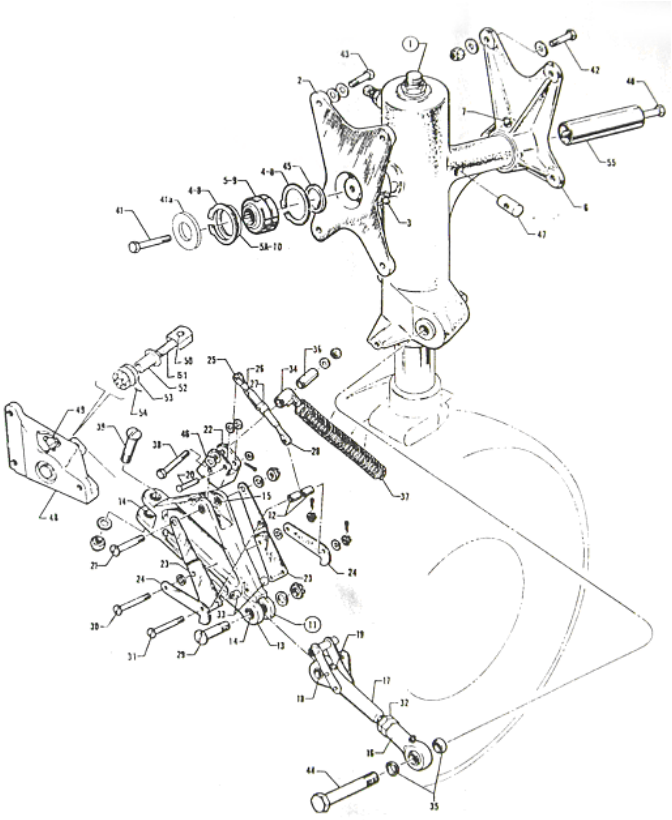

**Figure 1**

Drawing illustrating installation of the main landing gear trunnion fittings

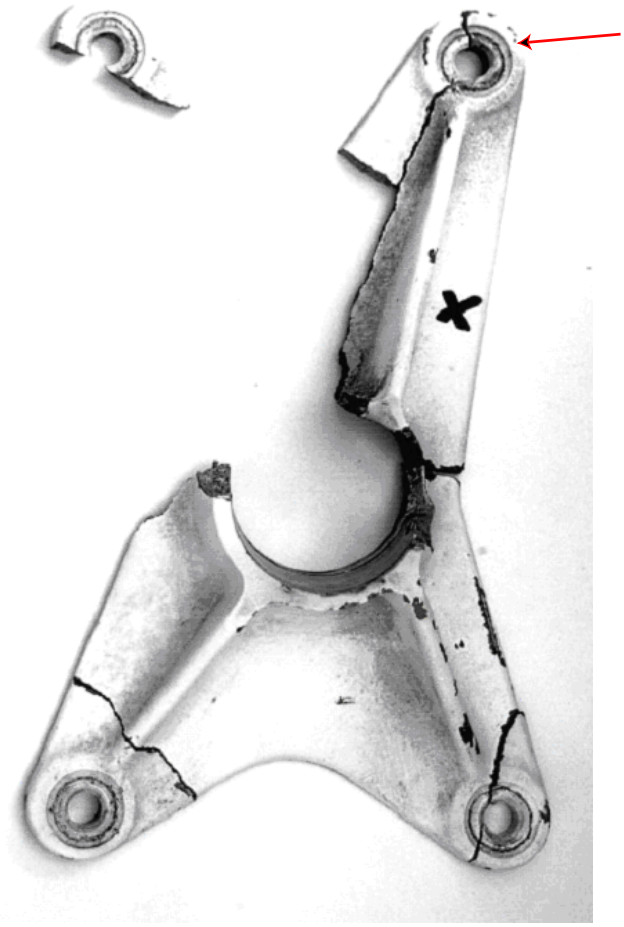

**Figure 2**

Recovered trunnion pieces. Fragment marked 'X' was found at Tatenhill. Note damage around bolt hole (arrowed)

**Metallurgical examination of the trunnion fitting**

There was evidence, in the form of polished areas on the rear face of the trunnion fitting, of fretting, ie, small amplitude relative movement between the fitting and the wing spar surface to which it was bolted, Figure 3. Fretting had also occurred between the attachment bolts, the bolt holes, and the washers under the bolt heads. Some of the fracture faces around the bolt holes bore evidence of very low cycle, high peak stress fatigue cracking. It is considered that this occurred during the later stages of the failure sequence, after the fretting damage. It was not possible to establish a timescale

for the failure process, but it is likely that it occurred over a number of landings, as opposed to progressing from initiation of the first crack to complete failure, on the day of the accident.

**Aircraft history**

Following an incident in Italy in 1995, the aircraft required a repair in which the right main landing gear forward and aft trunnion attachment fittings were replaced. There was no record of the left gear trunnion fittings having been replaced during the life of the aircraft.

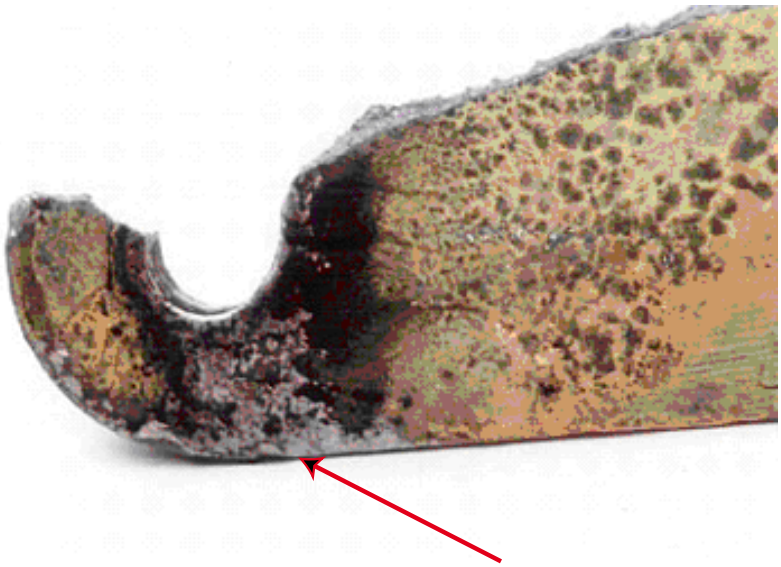

**Figure 3**

Fretting damage area on reverse side of fragment X (arrowed)

In March 1993, the aircraft manufacturer issued Service Bulletin (SB) No 956, which consisted of two parts. The purpose of the SB was to address the possibility of the trunnion fitting attachment bolts losing their assembly torque after prolonged service. The SB noted that:

> *'Left uncorrected, the bolt holes in the attach fittings and wing spar may become elongated, possibly resulting in damage to the wing structure or the failure of the landing gear.'*

Part 1 of the SB provided instructions for initial and repetitive (100 flight hour) inspections of the trunnion attachment fittings to determine if loosening had occurred. Part 2 provided larger diameter bolts, which strengthened the installation and removed the requirement for the repetitive inspections.

SB 956 Part 2 was embodied on G-JDBC on 11 August 2003, which thus removed the repetitive inspection requirement of Part 1. However, the maintenance organisation for this aircraft stated that they nevertheless continued to check the torque of the trunnion fitting bolts every 100 flight hours. The most recent such check was conducted on 6 June 2008, ie, 24 days before the accident.

The maintenance organisation stated that when the broken remains of the fitting were removed from the aircraft, it was noted that the bolts were "extremely tight". A subsequent inspection of the assembly torque on the attachment bolts on the trunnion fittings on the intact right landing gear showed that seven out of the eight bolts were at 140 lb.ins, with one at 80 lb.ins. (The specified value is 100-140 lb.ins). The torque on the left gear aft fitting attachment bolts could not be measured, as these were removed shortly after the accident.

**Discussion**

The metallurgical examination of the failed trunnion fitting determined that fretting had occurred, leading to a low cycle fatigue process in the material adjacent to the bolt holes. This culminated in the complete failure of the component, much as predicted in SB 956. In the absence of any additional evidence, it is likely that the fretting occurred due to the bolt torques slackening off in service.

The maintenance requirements remain the same regardless of whether an aircraft is used primarily in an air-taxi operation or, like G-JDBC, in a training role, in which the landing gear is subjected to many more cycles/landings per hour. The maintenance organisation appears to have recognised this, in that they continued to check the torque of the trunnion fitting attachment bolts every 100 flight hours, despite having complied with SB 956. It was not established why the trunnion fitting attachment bolts appeared to have slackened off prior to this failure.