DATA SUMMARY

LOCATION

Date and time	**Thursday, 27 July 2006; 13:45 local time**
Site	**Valladolid Airport**

AIRCRAFT

Registration	**EC-FDE**
Type and model	**PIPER PA-34-200T**
Operator	**Aeromadrid**

Engines

Type and model	**CONTINENTAL TSIO-360-EB**
Number	**2**

CREW

Pilot in command

Age	**29 years old**
Licence	**Commercial airplane pilot**
Total flight hours	**3,200 h**
Flight hours on the type	**100 h**

INJURIES

	Fatal	Serious	Minor/None
Crew			**2**
Passengers			
Third persons			

DAMAGE

Aircraft	**Minor**
Third parties	**None**

FLIGHT DATA

Operation	**General aviation – Instruction – Dual control**
Phase of flight	**Landing**

REPORT

Date of approval	**19 November 2008**

1. FACTUAL INFORMATION

1.1. Description of event

The aircraft, a Piper PA-34, with an instructor and student onboard, had taken off from Cuatro Vientos Airport (Madrid) at 12:35 local time on an instruction flight to Valladolid.

After an hour and ten minutes of flight time, they landed on runway 23 at Valladolid airport.

As the main gear touched down, the crew noted that the airplane was veering slightly to the right. When they looked at the gear position lights they noted that though the two main landing gear green lights indicated the legs extended and locked, the position light for the nose gear was giving an intermittent signal. They decided to go around before the nose gear contacted the ground so as to check its operation before the definitive landing.

During the left hand visual pattern, they raised and lowered the landing gear and noted a correct indication with three green lights. After receiving clearance to land, they touched down once more and, after rolling some 300 m down the runway, they noted how the airplane, now at low speed, was tilting to the right.

As the airplane slowed, the propeller and right wing contacted the ground. The airplane came to a stop on the right part of the runway, resting on its right wing.

There was no fire and the occupants were uninjured. Airport emergency personnel responded to the scene immediately.

It was noted that the aircraft had lost its right wheel, wheel fork and axle, resulting in further damage to other components, including the brake assembly, propeller blade tips, flaps, and main landing gear door, all of them on the right side, and also to the step for entering the aircraft.

1.2. Personnel information

1.2.1. *Instructor*

The instructor had held a Commercial Airplane Pilot License since 20 May 1999, and the competency certificate was valid until 27 February 2008. He was rated for single- and multi-engine piston aircraft, instrument flight and airplane flight instructor. His flying experience, by his own account, was 3,200 total hours, around 100 of them on the type.

1.2.2. *Student pilot*

The student pilot was taking a complete Airline Transport Pilot License course, and his corresponding student pilot license was valid until March 2007.

1.3. Aircraft information

1.3.1. *Airworthiness certificate*

The aircraft had a normal airworthiness certificate valid until 9 May 2006, with an extension that prolonged its validity until 9 August 2006.

1.3.2. *Design of main landing gear leg*

The PIPER PA-34-200T aircraft has a retractable tricycle landing gear, consisting of a nose leg and two main legs.

Each main gear leg includes:

Trunnion
Piston
Fork
Wheel axle
Torque scissors
Wheel

The trunnion, or main body of the leg, has two pins or projections which allow the leg to turn or fold laterally under the wing when retracting by means of an electrically-operated hydraulic actuator.

The piston, along with the fork and the wheel axle, compose the sliding group that moves axially with respect to the trunnion. The transfer of the hydraulic liquid and the compression of the nitrogen gas contained in both cylinders provide the necessary shock absorption for the wheel.

The torque scissors prevent the wheel from pivoting and ensure it remains aligned with the aircraft.

The piston is a high strength steel tube with a chrome coating on the outside which reduces friction with the trunnion and provides increased wear resistance. It is housed in the fork and closed at the bottom by means of a plug and an O-ring which are fastened with a screw, nut and a non-turn washer. The plunger and the flow restrictors that provide the shock absorption are mounted on the head.

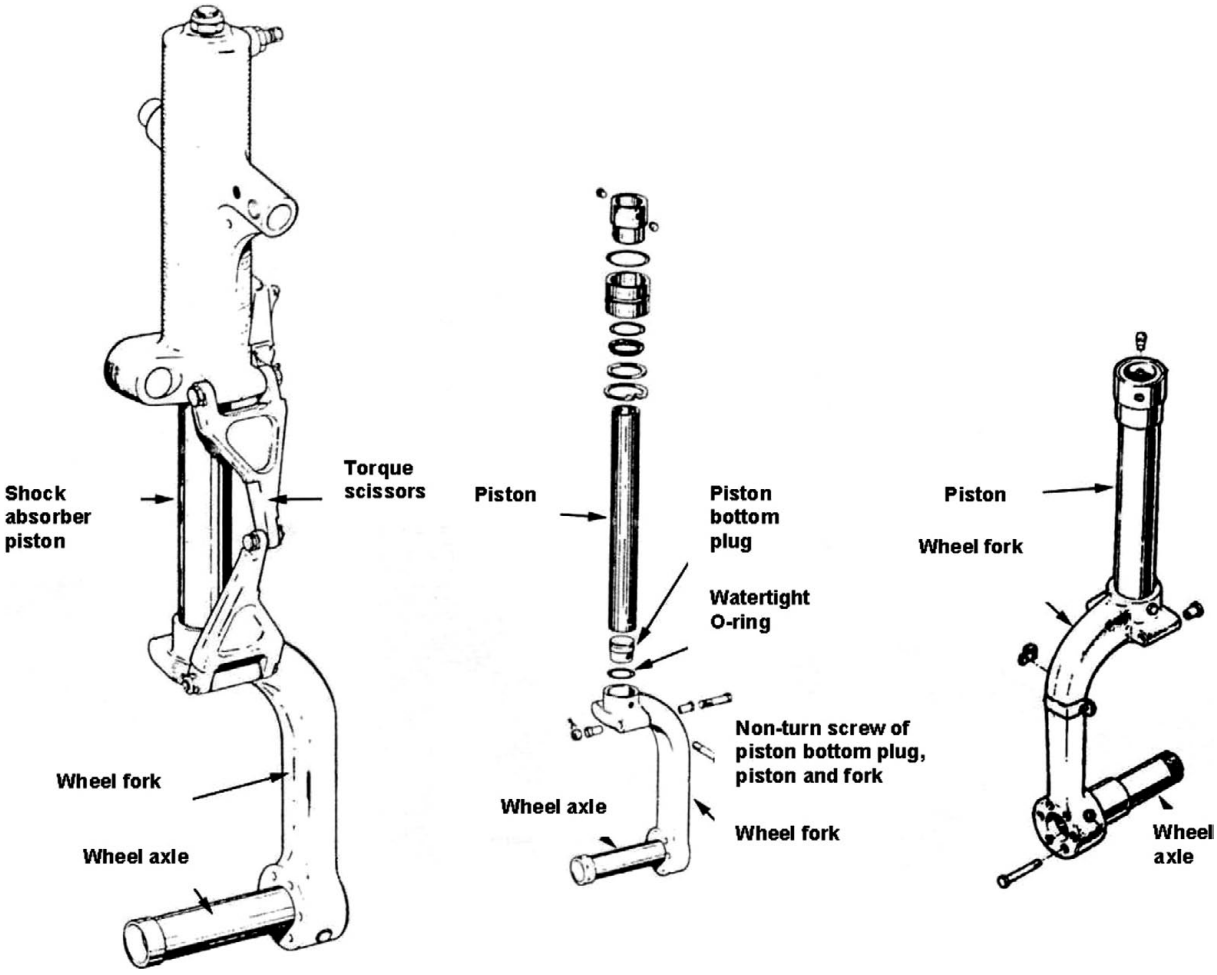

Figure 1. Diagram of main gear leg

A history of fatigue failure in some landing gear components prompted the FAA to issue Airworthiness Directive AD 94-13-11 on 27 June 1994, which required the trunnion on several Piper models, the PA 34 among them, to be inspected for cracks and, if found, for the trunnion to be replaced with a part of improved design, thus satisfying the requirements of the directive.

The Directive did not establish an operating time limit for the piston which moves inside the trunnion. The need to replace this piston is established on condition.

1.4. Aircraft inspection

The post-accident inspection of the aircraft revealed that the shock absorber piston had completely fractured. An analysis of the fracture indicated signs of fatigue failure.

The component was sent to a specialized laboratory for an in-depth analysis of the fracture. The study revealed an area of progressive fatigue crack growth on the broken

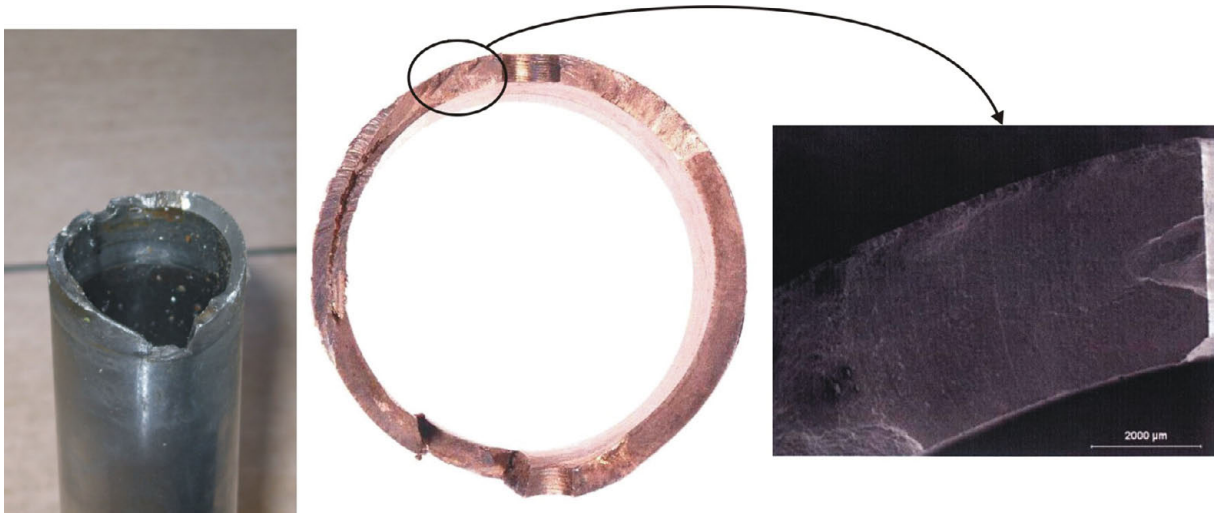

Figure 2. Fracture of the lower piston section. View of fractured area and macrofractographic detail of area indicated

piston zone, along with an area of brittle failure that developed as the wheel separated from the fork during the accident landing.

The crack developed on the surface of the lock screw for the plug found on the lower end of the piston. These screws have a rough surface finish, which induces the start of fatigue cracks. The part of the piston which cracked and eventually failed is located in an area where stress concentrates under normal landing loads.

1.5. Aircraft maintenance

According to the records, the aircraft had a total of 10528 flight hours. Its maintenance history notes the replacement of the trunnion on both legs on 18 June 1997 with 5144 hours, in fulfillment of the requirements of SB 787 C and of Directive 94-13-11.

There is no mention in the maintenance manual of the need to inspect the condition of the piston. The operator did indicate, however, that after a similar incident in 2005 involving an aircraft of the same type, an item was added to the 500-hour inspection to check the piston for possible defects. Given the difficulty posed by the chrome coating for performing a liquid penetrant test to check for cracks, the inspection uses a camera to check the inside of the piston.

The last 500-hour inspection had taken place on 21 May 2006 with 10,480 flight hours on the airplane. No defects requiring the piston or plunger to be replaced were detected at the time.

1.6. Similar events

There is an incident in the CIAIAC database dated 4 May 2005 which is similar to the one addressed here (see CIAIAC IN-16/2005). It also involved the shock absorber piston break, by fatigue failure, on a main landing gear leg, the left one in this case, on another Piper PA-34-200T aircraft.

The manufacturer has declared to be aware of another trunnion fracture, collected in the current Service Difficulty Report of the FAA (Federal Aviation Administration in the United States).

With this background the manufacturer has issued a Safety Risk Assessment based on the guidelines provided by the FAA. The assessment takes into account the effects on the safety caused by a main landing gear failure, the number of this type of aircraft manufactured (around 6,000), the type of operation it is usually assigned to and the frequency with which incidents with the trunnion have occurred. The results have indicated that it is not necessary to adopt measures on the design nor to change the maintenance instructions of this component.

2. ANALYSIS

During the initial landing attempt, which had proceeded normally, the crew performed a go around after receiving indications that the nose gear leg was malfunctioning. Once airborne, after the landing gear was retracted and lowered, the crew noted no further indications of a problem with the nose gear. Upon landing a second time, the right main gear leg collapsed. An inspection revealed that the trunnion on this leg had broken.

An inspection of the fractures and the laboratory tests determined that the failure was caused by a weakening of the trunnion resulting from a metal fatigue process. The fatigue crack had grown progressively until it exceeded its critical value, and the residual static resistance was exceeded by the landing load, which is estimated to have been normal.

The break occurred in a section where, due to the design of the component in question, stress can be expected to accumulate. The initiation of the fatigue cracks is further thought to have been aided by the presence of circular marks on the surface of the screws.

The school environment in which the airplane was operated could have furthered the fatigue problem in the landing gear piston since training landings can be somewhat harder than normal, and the maneuvers performed on taxi and takeoff also tend to be harsher that those carried out by more experienced pilots, such that the load spectrum

to which the gear is subjected can deviate from design without the load limits being exceeded. An additional factor is that instructional activities can also increase the number of cycles with respect to those considered during the design, resulting once more in a load spectrum in excess of design as a consequence of the larger number of load cycles to which the landing gear structure is subjected.

They are recorded 3 cases of a trunnion fracture during service. Another issue to consider is that this operator had already, of its own accord, established inspection requirements for the component, since it had already found an identical problem in another aircraft. As found in the course of this investigation, however, an inspection of the piston at the 10,480 flight hour mark, and which failed 48 flight hours later, had revealed no cracks, meaning either the method used to detect cracks was ineffective or the crack progressed from an undetectable level to fracture in just a few cycles.

There have also been fractures of the trunnion itself which led to design changes and to a service lifetime limitation before requiring its replacement. However, according to the risk evaluations on operational safety carried out by the manufacturer, it doesn't seem necessary by now to take additional actions in the trunnion design or maintenance.

3. CONCLUSIONS

- The incident resulted from the fracture of the shock absorber piston on the right landing gear leg of the aircraft.
- The piston fractured in a section that was weakened by a fatigue crack.
- The crack had not been detected during a maintenance inspection implemented by the operator and based on its own experience in its maintenance manual.
- The piston is not a limited lifetime component on this aircraft.
- There is no requirement to inspect the piston using any special crack detection or non-destructive testing techniques.
- There are known 3 previous cases of trunnion fracture during service in all the fleet of this aircraft model.
- There is no need for amendments in the trunnion design or maintenance derived from the risk evaluations on operational safety carried out according to the failures detected in this element.