# DATA SUMMARY

## LOCATION

| | |
|---|---|
| Date and time | **4 September 2008; 15:38 UTC**[1] |
| Site | **Seville Airport** |

## AIRCRAFT

| | |
|---|---|
| Registration | **F-GLEC** |
| Type and model | **AEROSPATIALE SN-601 Corvette S/N: 30** |
| Operator | **Airbus** |

### Engines

| | |
|---|---|
| Type and model | **PRATT & WHITNEY JT15D-4** |
| Number | **2** |

## CREW

| | Captain | Copilot |
|---|---|---|
| Age | **55 years old** | **44 years old** |
| Licence | **ATPL(A)** | **ATPL(A)** |
| Total flight hours | **4,700 h** | **1,200 h** |
| Flight hours on the type | **3,100 h** | **750 h** |

## INJURIES

| | Fatal | Serious | Minor/None |
|---|---|---|---|
| Crew | | **2** | |
| Passengers | | **8** | |
| Third persons | | | |

## DAMAGE

| | |
|---|---|
| Aircraft | **Minor damage to left landing gear leg, fuselage and left wing** |
| Third parties | **None** |

## FLIGHT DATA

| | |
|---|---|
| Operation | **General Aviation – Business (corporate operations)** |
| Phase of flight | **Takeoff** |

## REPORT

| | |
|---|---|
| Date of approval | **26 September 2011** |

[1] All times in this report are in UTC unless otherwise specified.

# 1. FACTUAL INFORMATION

## 1.1. History of the flight

The aircraft had flown from Toulouse to Seville on the morning of 4 September, landing without incident at the Seville Airport at 06:45.

The return flight to Toulouse was scheduled for 15:35. The aircraft, flown by the same crew as on the flight to Seville, requested engine start-up at 15:16. There were eight passengers on board.

After a normal taxi phase, the aircraft started its takeoff run at 15:26. Once airborne, the crew braked the tires, as specified in the normal procedures, and then attempted to actuate the gear retraction lever, though they were unable to do so as it was locked in place.

They kept climbing and at 15:29, ATC informed them that they were not receiving a signal from the SSR transponder on their screen. The crew replied that they would check the equipment.

At 15:30 the controller insisted on the need to have a functioning SSR transponder to fly in that airspace. After requesting information on their position, he instructed them to return immediately. The crew reported their position and turned back.

They were cleared to land at 15:37.


**Figure 1.** Condition of aircraft on runway

After touching down at 15:39:30, during the last part of the landing run the left wing gradually descended until it made contact with the runway surface, sliding along it over the course of some 50 m until the aircraft came to a stop within the paved area (Figure 1).

There was no fire. An emergency evacuation was conducted. There were no injuries to either the passengers or crew.

At 15:42, emergency services reported to the scene. They detected a fuel leak in the left wingtip tank and cooled the surfaces in contact with the runway by spraying them with foam.

## 1.2. Damage to aircraft

There was damage to the left landing gear leg, the left wing flaps and the left wingtip fuel tank.

The shock absorber on the left leg lost its integrity as a result of the outer cylinder separating from the piston, though neither component evidenced any signs of impact or deformations (Figure 2).

**Figure 2.** Left main landing gear leg

## 1.3. Personnel information

Both members of the flight crew were rated to fly on the SN-601. They also had instrument ratings (IR/ME). The captain was also rated as a flight instructor on the aircraft type (TRIA SN-601).

The crew of the incident aircraft was the same that had flown in from Toulouse a few hours earlier. During the incident flight, the pilot flying was the captain.

## 1.4. Aircraft information

### 1.4.1. *General*

The aircraft was a Corvette SN-601, manufactured by Aerospatiale. It is a twin-engine low-wing design with a maximum takeoff weight of 7,000 kg. This unit was manufactured in 1976 and had serial number 30. The takeoff weight reported for the incident flight was 6,800 kg.

It was equipped with two Pratt&Whitney JT15D-4 turbofan engines, which were mounted at the rear of the fuselage.

According to the aircraft's log, it had 14,341 flight hours and 11,137 operating cycles.

It had an Airworthiness Review Certificate (ARC), which had been issued on 26/03/2007 and first extended on 19/02/2008. It was valid until 09/05/2009.

Airbus, the Corvette SN-601 aircraft Type Certificate holder, has informed that this Type Certificate, issued by French DGAC on 29 May 1974 has been renewed on date 24 February 2011 upon a request placed by Airbus on 23 April 2010.

### 1.4.2. *Landing gear*

The landing gear is a tricycle retractable design with a single wheel on each leg (Figure 3).

The main gear legs are hinged. Shock absorption is achieved by means of oil-pneumatic struts outfitted on each leg.

The gear is lowered and raised by means of a hydraulic actuator. In its full down position, the actuator activates a micro-switch that provides the "gear down and locked" signal. The "gear up and locked" signal is provided by another micro-switch that is engaged by the mechanical locking mechanism that is activated when the leg is housed in its compartment under the wing.

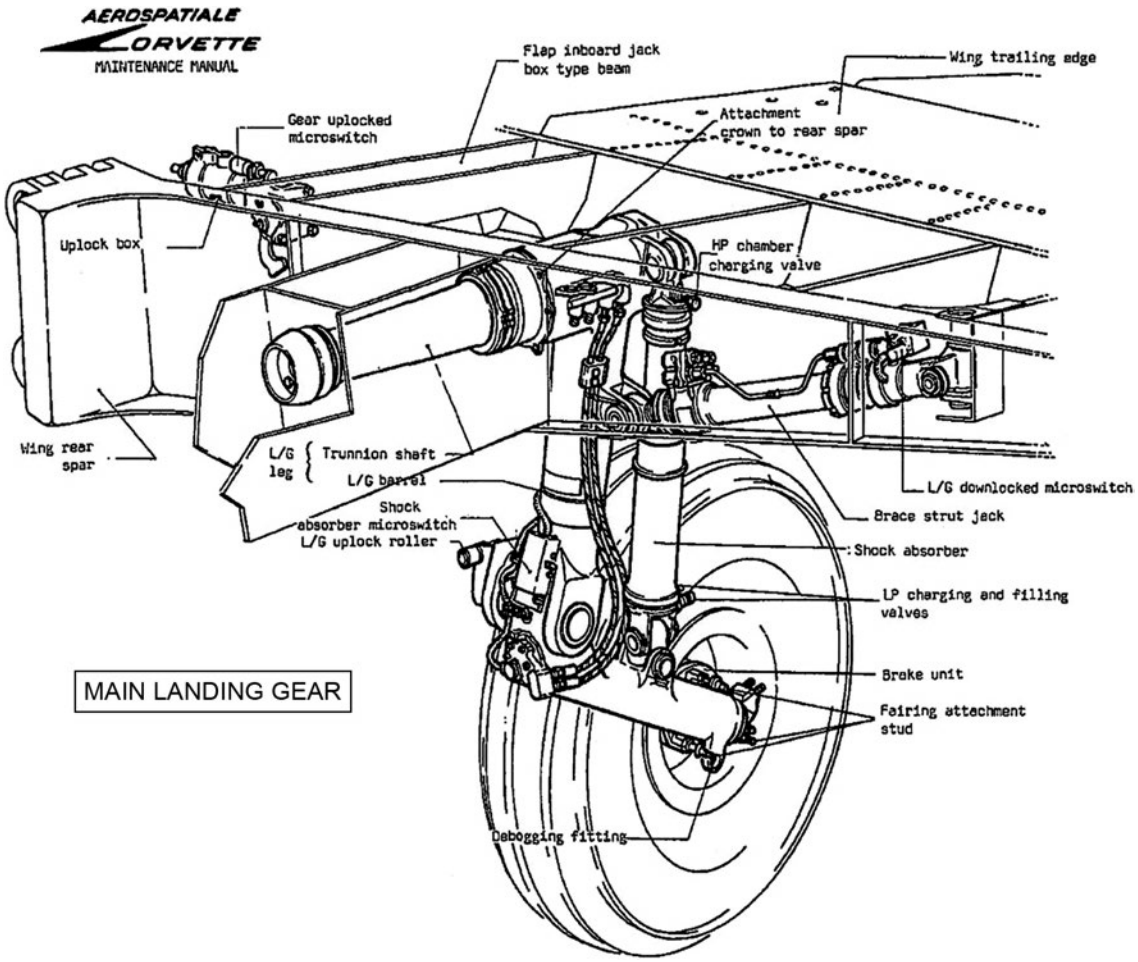


**Figure 3.** Diagram of main landing gear

The main gear leg fairings consist of three doors, two of which move in unison with the leg without any type of mechanism. The third is operated through actuating rods.

The gear is both electrically and hydraulically actuated. The electrical signal generated when the gear lever is moved goes to an electrohydraulic distributor that transmits the pressure to the actuators either to extend (DOWN position on lever) or retract (UP position on the lever) the gear. There is a manually actuated backup distributor in the cockpit for extending the gear in the event of an electrical fault in the primary system. If hydraulic pressure is lost, the gear can be lowered by means of a manual pump.

### 1.4.3. *Main gear shock absorber*

#### 1.4.3.1. Description

Landing gear loads are absorbed through the use of oil-pneumatic shock absorbers. The upper end of each strut is attached to the segment that connects the leg to the wing

spar by means of a simple hinge, while the lower end is attached to the bar on the leg where the tire is housed by means of a dual-axis hinge (Figure 3).

The shock absorbers (Figure 4) consist of an outer cylinder and a hollow piston, or inner cylinder, that moves inside the outer cylinder (items no. 2 and no. 1). The inside of the piston is in turn divided into two chambers separated by an intermediate piston (item no. 31). The upper chamber is at high pressure (212-bar load pressure), and the lower chamber is at low pressure (41-bar load pressure).

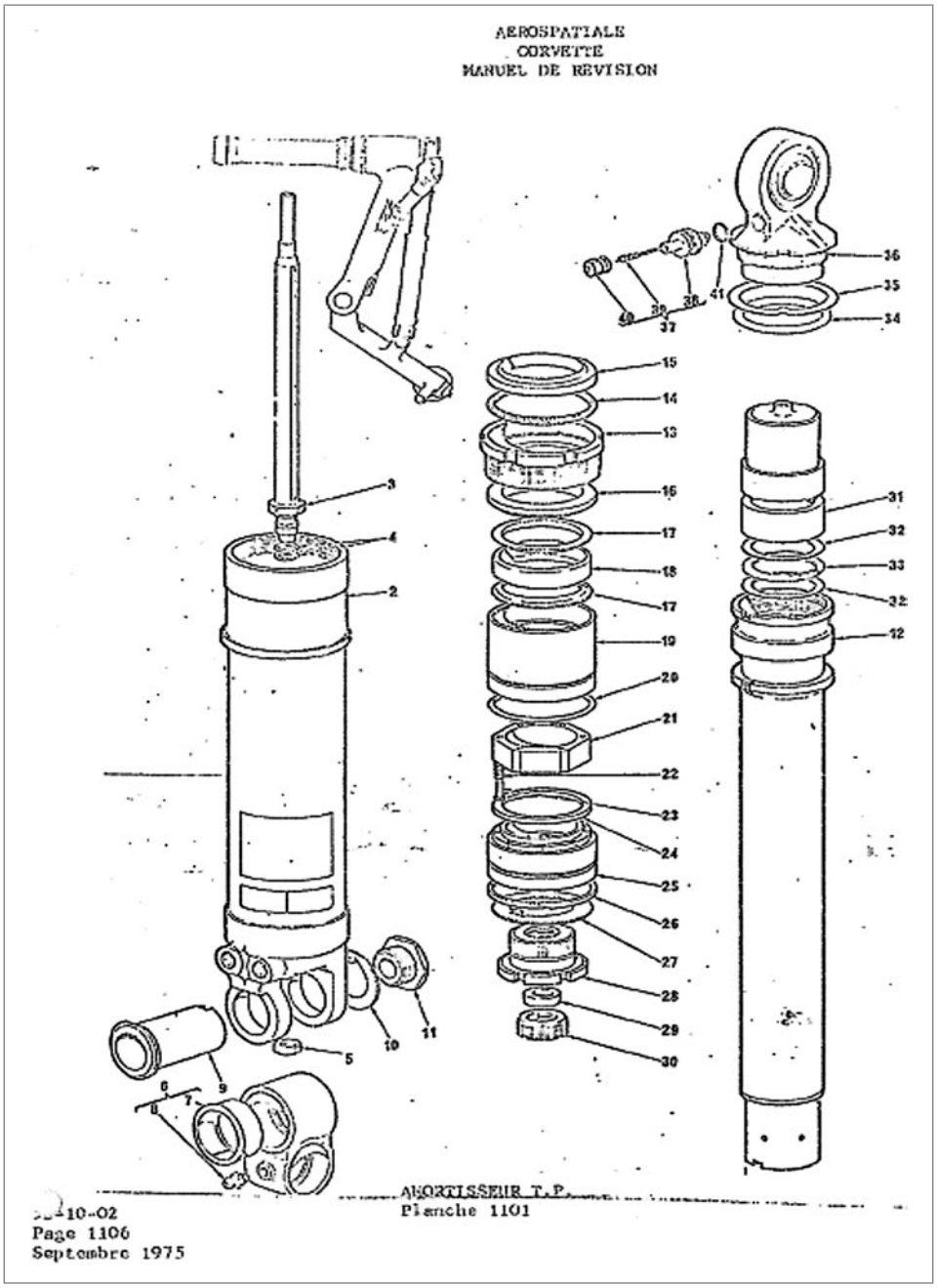


**Figure 4.** Parts of main gear shock absorber

The low-pressure chamber is in contact with the outer cylinder to allow the transfer of hydraulic fluid.

The sealing mechanism between the cylinder and piston consists of two sets of seals, bearings and segments. One is attached to the inside of the plunger and the other to the outside of the piston. The upper set rests on a narrow portion inside the plunger and is fastened to the upper edge of the plunger by means of a nut threaded to the plunger body (item no. 13). The lower set is firmly attached to the thinnest part of the piston, at its bottom end, by means of another nut threaded into the body of the piston (item no. 28). This nut is locked by means of a washer (item no. 27) that has a tab on its upper face that is inserted into a key machined into the edge of the piston.

When the shock absorber extends, the coming together of these two assemblies acts as a stop to limit the upper movement of the piston and keep it from traveling outside the outer cylinder.

The compression or extension of the shock absorbers is used to provide information to different systems whose operating logic depends on the status of the airplane (air or ground). Two micro-switches located in the leg hinges close a ground contact when the shock absorbers are compressed (airplane on ground), energizing various systems (ground air conditioning fan, opening of the outflow valve, test circuit for the angle of attack alarm, horizontal stabilizer position alarm, energy to the stick pusher and erasure of the CVR).

The signal from these micro-switches is also used to lock the gear actuating lever in the "Down" position when any of the shock absorbers is compressed, thus preventing the gear from being retracted while the airplane on the ground.

The micro-switch in the left leg (called 2GD) also supplies a ground/air signal to a relay (called 3GD) that provides energy to the system that controls the secondary surveillance radar (SSR) transponder.

### 1.4.3.2. Maintenance history

The record for the affected shock absorber on the left leg (P/N 15330001A) showed that it had been in service for 1,737 flight hours and 1,545 cycles since its last overhaul (TSO), which had been performed in September 2006. It was repaired in January 2008 to correct a loss of hydraulic fluid in the high-pressure chamber, after which it had flown 224 h, completing 140 cycles.

Its counterpart on the right main gear leg had been installed on another aircraft of the same type and whose service history is unknown. It was last inspected in June 2007 and had flown 451 cycles and completed 280 cycles since.

The Aircraft Maintenance Manual specifies that the shock absorber must undergo a detailed visual inspection and the hydraulic fluid replaced every six years. The compression of the shock absorber is also checked as part of the daily inspection.

## 1.5. Communications

At 15:16:33, the aircraft initiated communications with ramp control at Seville Airport to request start-up. ATC authorized the start-up and provided information on QNH, departure route, initial flight level, squawk code (which was 4616) and control tower frequency. The crew acknowledged all of this information.

At 15:22:03, the crew tuned in to the control tower frequency and reported they were ready to taxi. They were instructed by the tower to proceed to the runway 27 hold point.

At 15:25:40, the control tower cleared them to line up and hold on the runway.

At 15:26:42, the control tower cleared them to takeoff, and reported wind from 210° at 15 kt.

At 15:28:32, the controller in the tower requested confirmation of the SSR transponder code, to which the crew replied giving the assigned code (4616).

At 15:29:05, the controller reported that he was not receiving a signal on the radar screen. The crew replied that they would check the SSR.

At 15:30:06, the controller insisted on the need to have a working SSR transponder in that airspace. The crew indicated its knowledge of this fact and that it was checking the transponder.

At 15:31:09, the controller requested a position report. The crew replied by giving the radial they were on with respect to the airport (303). They did not provide altitude information.

At 15:31:25, the controller requested that the airplane return, clearing them to enter the runway 27 downwind leg. The crew confirmed the request and acknowledged the circuit information.

At 15:33:05, the controller requested a position report. The crew reported that they were on the runway 27 downwind leg at 1,500 ft.

At 15:34:53, the controller informed them that they were number two to land behind other traffic. The crew reported the traffic in sight and that they would follow it.

At 15:37:49, the controller cleared them to land and reported the wind from 210° at 18 kt.

At 15:39:46, the crew reported a problem and the controller informed them that he saw something unusual in the left wing.

At 15:41:54, the crew reported they were blocking the runway and that the passengers were fine.

At 15:42:19, the controller informed the crew that he would send a vehicle for the passengers.

Finally, at 15:42:42 the crew reported that the left gear had not lowered.

## 1.6. Tests and research

A test of the aircraft indicated that the shock absorber piston on the left leg had detached from the plunger.

The sealing assembly (seals, bearings and segments) attached to the outer cylinder was mounted in its correct position and held in place by the proper nut (item no. 13). The corresponding components on the inner piston, however, held by nut no. 28, had come loose and detached from the piston, falling to the bottom of the outer cylinder.

### 1.6.1. *Inspection of shock absorber*

The shock absorber (P/N 15330001A, S/N 83) on the left main gear leg was inspected at the facilities of Hydrep in France in October 2008. The resulting report was issued by the manufacturer, Messier-Dowty. It was thoroughly disassembled and cleaned.

All of its components appeared to be in good condition, with only a few wear marks consistent with normal operations. There were no significant defects on the outer or inner surfaces of either cylinder.

The nut used to hold the set of seals, bearings and segments firmly in place inside the inner cylinder (item no. 28) did not exhibit any marks or damage, either to the body or threads.

The bend in this nut's retaining washer (item no. 27) was apparently within the limits for being housed inside the slot on the nut and stop the movement of the assembly (Figures 5 and 6). It also had circular friction marks halfway along its circumference (Figure 5).

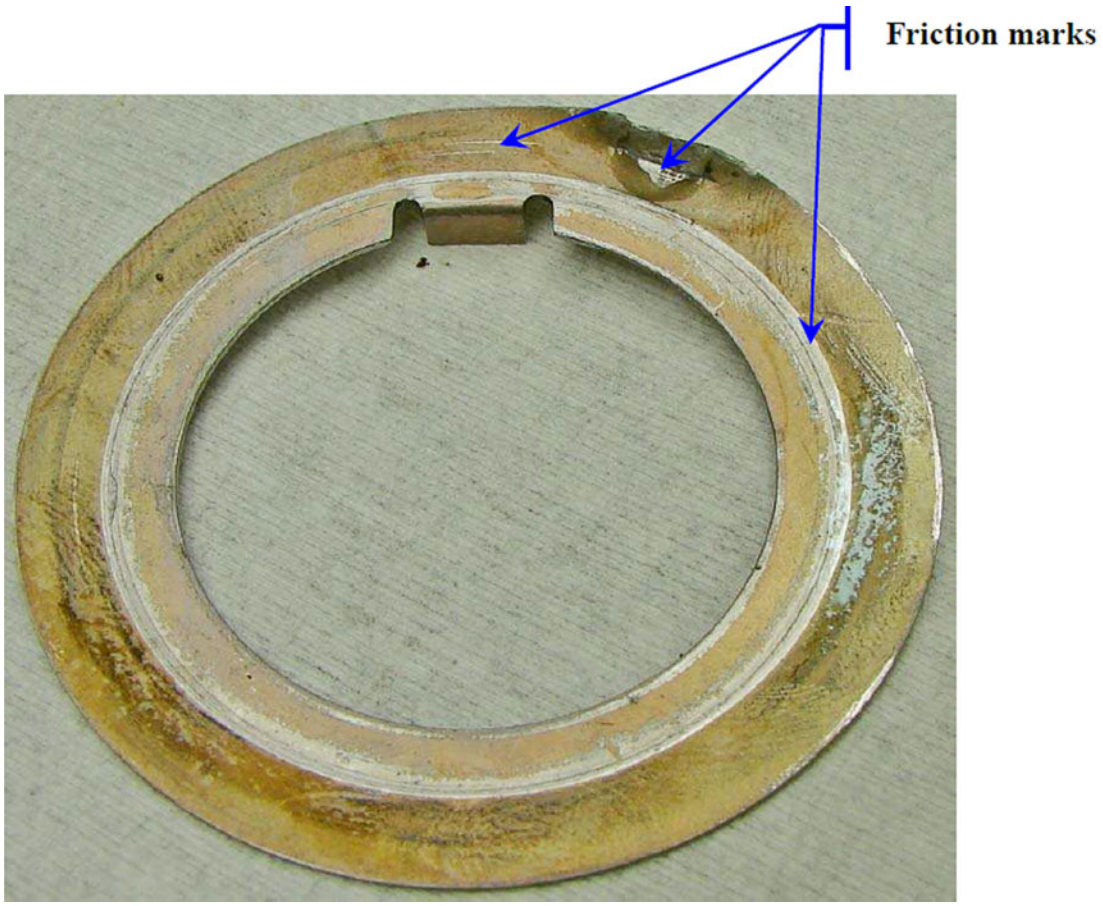


Figure 5. As-found condition of retaining washer

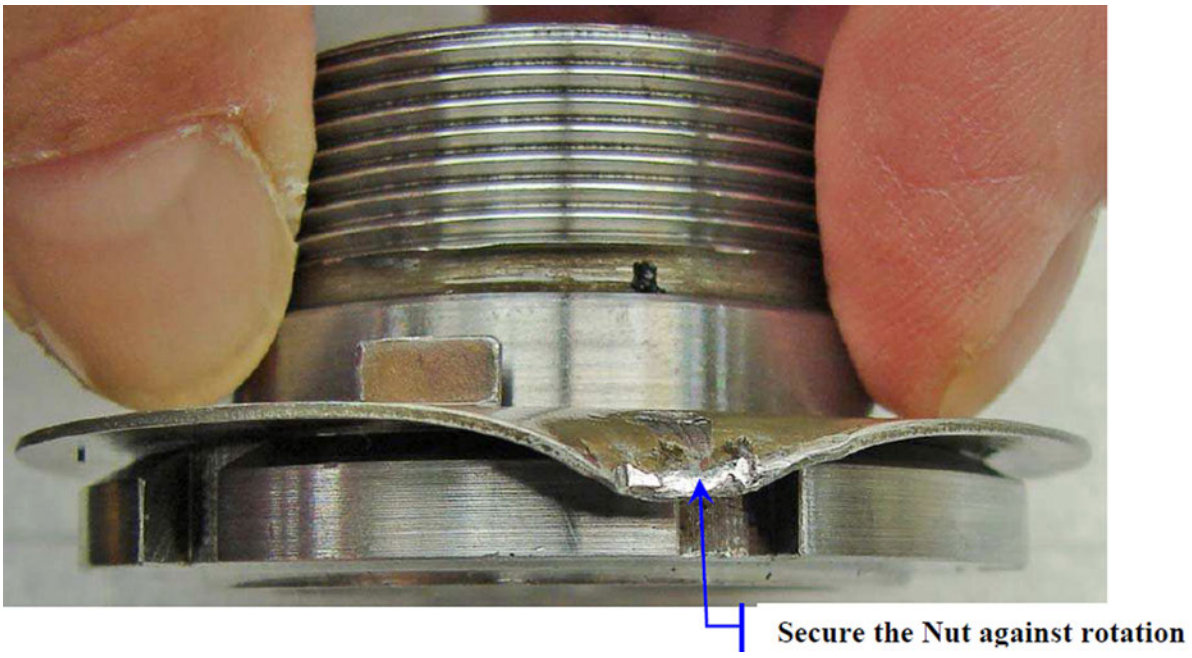


Figure 6. Nut and washer as assembled

### 1.7. Additional information, previous failures in this shock absorber type

Information was obtained regarding two similar incidents also caused by a failure of the shock absorber:

1. In August 1988, at the airport of Le Bourget (France). The gear could not be retracted after takeoff and the left leg collapsed during the subsequent landing. The upper and lower cylinders separated. An analysis of the shock absorber revealed that the nut, item no. 28, was not tight and that the retaining washer (item no. 27) was not properly bent to prevent rotation of the nut. The shock absorber had undergone 69 cycles since the last overhaul.
2. An event similar to the above took place in March 1989 at the Saint Yan Airport (France). The post-incident investigation revealed that the nut (item no. 28) was loose and the washer (item no. 27) was insufficiently bent to prevent the nut from rotating. The shock absorber had undergone 81 cycles since the last overhaul.

As a result of these events, Airbus issued a new revision to the Component Maintenance Manual (CMM ERAM), reference 32.10-02, dated November 1989.

## 2. ANALYSIS AND CONCLUSIONS

### 2.1. Failure of gear to retract and in SSR transponder

After an uneventful taxi and takeoff, the crew of the aircraft was unable to retract the gear due to the associated lever being locked in the "Down" position. Under normal conditions, the compression of the shock absorbers is interpreted by the micro-switch as being indicative of an "airplane on ground" condition. This results in the gear lever being locked so as to prevent its accidental actuation while the airplane is on the ground.

Upon taking off, the loss of integrity of the left shock absorber very likely led to the abnormal and sudden extension of the leg, damaging the left-side micro-switch (2GD). As a consequence of this, the gear's electrical control circuit did not receive the "air" signal, which locked the lever and prevented the gear from being retracted.

Shortly after takeoff, ATC contacted the crew to inform them that they were not receiving a signal from their secondary radar transponder.

The aircraft's ATC system is designed to relay the signal from the SSR transponder only when the aircraft is in flight. To do this, it relies on the same signal that locks the gear lever in place, that is, the signal from the micro-switch. After takeoff, the micro-switch in the left leg (called 2GD) provides a signal to a relay (called 3GD), which in turn

supplies electrical energy to the system that control the SSR transponder. Since said micro-switch was damaged on takeoff, the relay was not energized and the airplane's radar transponder did not activate.

At no time did the crew declare an emergency. Though they were unable to retract the gear, the cockpit readings indicated that the gear was down and locked, which they interpreted to mean that it was safe to conduct a landing.

Only after the airplane was already traveling on the runway during the landing run did they identify the presence of a problem, as they noted the airplane deviate left and the subsequent slump of the left wing. These two effects began as the airplane reduced speed, which caused a loss of aerodynamic lift and increased loading on the landing gear. The left gear, which lacked the support of the shock absorber, yielded under the weight causing the wingtip to contact the ground.

Once the airplane stopped, the crew erroneously reported that the left gear was retracted. At no time following the takeoff had the gear been retracted.

## 2.2. Failure of main gear shock absorber

In flights prior to the incident flight there had been no indications of a fault or of any abnormalities involving the landing gear. The fault occurred suddenly when the left leg shock absorber over-extended as the aircraft became airborne and the compression loads on the gear disappeared.

The internal failure of the shock absorber resulted from the complete loosening of the locking nut on the upper cylinder or piston which holds the sealing assembly in place. Neither the nut nor the shock absorber components displayed any damage that would indicate that the fault took place as a result of unusual conditions different from those present during normal operations.

The washer that is used to prevent the nut from rotating is designed to have a dual rotating effect, provided in part by the 90° angled tab on its inside, which is inserted into the key machined into the piston, and that keeps it from rotating with respect to the piston, and partly by a bend in its outer diameter that is produced ad hoc, once the nut is tightened so that this bent area can be inserted into a slot on the nut. It was noted that the washer in the incident airplane featured the lip and appeared to have been bent in accordance with the maintenance procedures.

A check of the friction marks on the washer revealed that it was able to keep the piston from rotating but not the nut, which turned gradually over the course of an indeterminate number of cycles, until it became completely loose.

## 2.3. Findings

The incident took place as a result of the separation of the two cylinders that comprise the shock absorber on the left main gear leg, and which, in addition, led to the transmission failure of the SSR transponder.

Investigations into previous similar incidents concluded that they had likely resulted from maintenance errors, as a consequence of which the aircraft manufacturer, with the aid of the shock absorber manufacturer, modified its Component Maintenance Instructions (CMM) to reduce the risk of deficient maintenance practices causing the catastrophic failure of the shock absorber.

An analysis of the circumstances involved in this incident does not provide clear evidences as to point to deficient maintenance in violation of airworthiness instructions or to an extreme condition caused by the abnormal operation of the aircraft. As a result, a safety recommendation is issued whose goal is to reduce the risk of a failure in the piston closing and locking mechanism.

# 3. SAFETY RECOMMENDATIONS

**REC 48/11.** It is recommended that Messier-Dowty, the manufacturer of the shock absorber with P/N 15330001A, revise the anti-rotation system for the nut on the piston sealing assembly (P/N 15381), either by modifying the design or the continuous airworthiness instructions, so as to ensure that the system remains operable throughout the useful lifetime of the shock absorber.