

Low oil pressure on one engine in cruise, diversion, dual hydraulic failure during landing roll

Aircraft	Airbus A320 registered CS-TKP
Date and time	25 April 2014 at 07 h 45 ⁽¹⁾
Operator	Thomas Cook
Place	Toulouse Blagnac Airport (31, France)
Type of flight	Public transport
Persons on board	Captain (PF), co-pilot (PM), 5 cabin crew members, 179 passengers
Consequences and damage	None

This is a courtesy translation by the BEA of the Final Report on the Safety Investigation. As accurate as the translation may be, the original text in French is the work of reference.

1 - HISTORY OF THE FLIGHT

The crew took off at 3 h 43 from Brussels (Belgium) bound for Tenerife (Spain). From 4 h 22 onwards, they were informed by the ECAM⁽²⁾ of an oil level problem on engine no.1. The auto-thrust disconnected two minutes later. The PF made an input on the engine no.1 thrust control. As it responded normally to these inputs, the crew re-engaged the auto-thrust. At 4 h 48, a Master Warning sounded, associated with low oil pressure on engine no.1. The crew immediately reduced the thrust to idle and then shut down the engine⁽³⁾. The aeroplane was then above the Atlantic Ocean, 116 NM west of Bordeaux. The crew took the decision to divert to Bordeaux-Mérignac aerodrome (33), after issuing a pan pan message and then a distress message to the ATC. They also informed the operator via an ACARS message about their engine problem.

At 4 h 57, while the crew was preparing for a single-engine arrival at Bordeaux-Mérignac Airport, the ECAM yellow system low hydraulic level page was displayed with, at the same time, the Master Caution alert. The crew started to deal with this hydraulic failure, following the associated ECAM page, but then interrupted the procedure after receiving an ACARS message from the operator asking them to fly to Toulouse Blagnac Airport.

At 5 h 03, the crew told the Bordeaux approach controller that they wished to divert to Toulouse-Blagnac Airport. During this diversion the pressure values of the three hydraulic systems remained close to 3,000 Psi (nominal pressure).

At 5 h 34, on the approach to Toulouse-Blagnac aerodrome, the crew switched the aeroplane to configuration 1 (leading edge slats and flaps). The pressures on the yellow and green systems dropped considerably (from 3,000 to 2,200 Psi)

⁽¹⁾Unless otherwise specified, the times in this report are local.

⁽²⁾ECAM : Electronic Centralized Aircraft Monitoring.

⁽³⁾In accordance with the scheduled "abnormal" procedure displayed on the ECAM.

At 5 h 36, a Master Warning alarm was triggered associated with an ECAM green system low pressure page. The crew then requested and made a delaying 360° turn on the axis. The combination of low hydraulic pressure on the yellow and green systems lengthened the time required to extend the flight control surfaces.

Nine minutes later, before extending the landing gear, the pressures on the yellow and green hydraulic systems climbed to 3,000 Psi. The landing gear slowly extended and locked. The aeroplane was on the ILS axis.

At 5 h 46 the aeroplane landed. Hydraulic demand climbed to a high level when the flight control surfaces and the engine 2 thrust reverser were used. The aeroplane stopped on the runway with a dual hydraulic failure. The nose gear steering system was inactive and some flight control surfaces remained extended (spoilers, slats, flaps, engine 2 thrust reverser).

On the ground a hydraulic fluid leak was found and a connection on the yellow system was found to be loose.

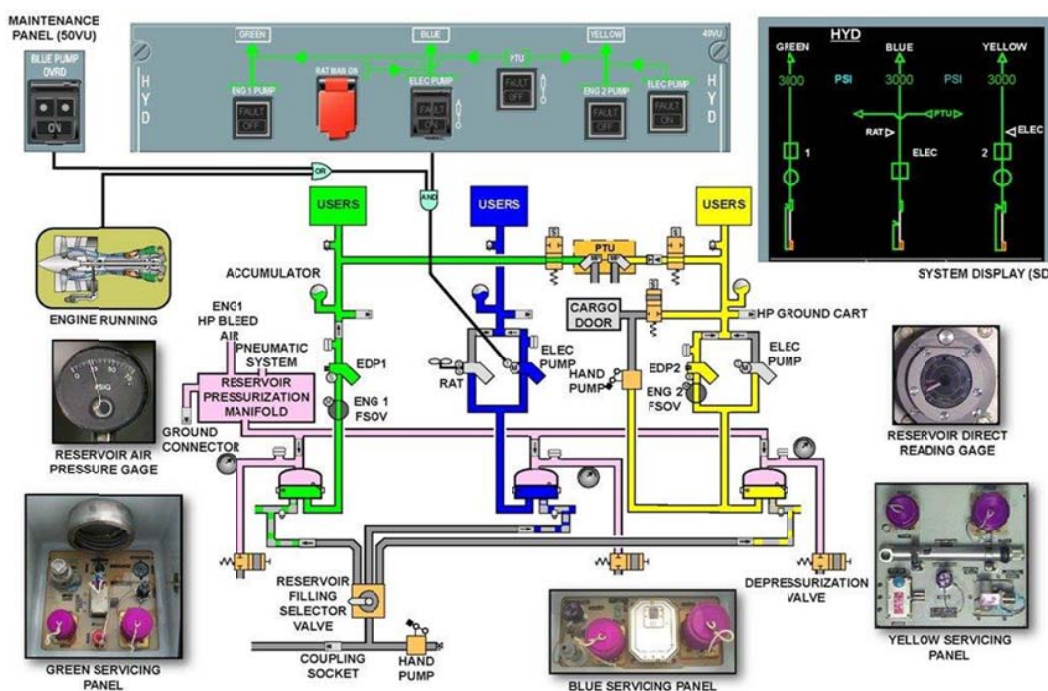
2 - ADDITIONAL INFORMATION

2.1 Description of the hydraulic systems

The hydraulic system of the A320 has three circuits, defined by a colour code:

- ☐ a "green" system, pressurized by a pump⁽⁴⁾ (EDP 1,) driven by engine no.1;
- ☐ a "blue" system pressurized by an electric pump that can be supplied by a Ram Air Turbine in case of failure;
- ☐ a "yellow" system pressurized by a pump (EDP 2) driven by engine no.2. An electric pump and a manual pump can operate the yellow system.

⁽⁴⁾Engine Driven Pump.



A Power Transfer Unit (PTU) also allows one of the systems (yellow or green) to increase the pressure of the other (green or yellow) when a pressure differential of 500 Psi is detected between the two systems. This system works without exchanging any fluid.

The ECAM page for a low level in the yellow system reservoir shows:

- ☐ PTU.....OFF
- ☐ YELLOW ENG 2 PUMP.....OFF
- ☐ YELLOW ELEC PUMP.....OFF
- ☐ BRK Y ACCU PR MONITOR

When an engine is shut down, windmilling of the engine no longer delivering power can nevertheless power the hydraulic system associated with it.

2.2 Examination made at the ramp

Hydraulic fluid was found at the level of the hydraulic connection at the junction between the pylon and engine no.2. The sealing ring for this connector was found to be outside its housing. It corresponded to specifications and had no signs of damage. Only an error in tightening could cause the seal to come out of its housing with no damage, and consequently explain the leak.

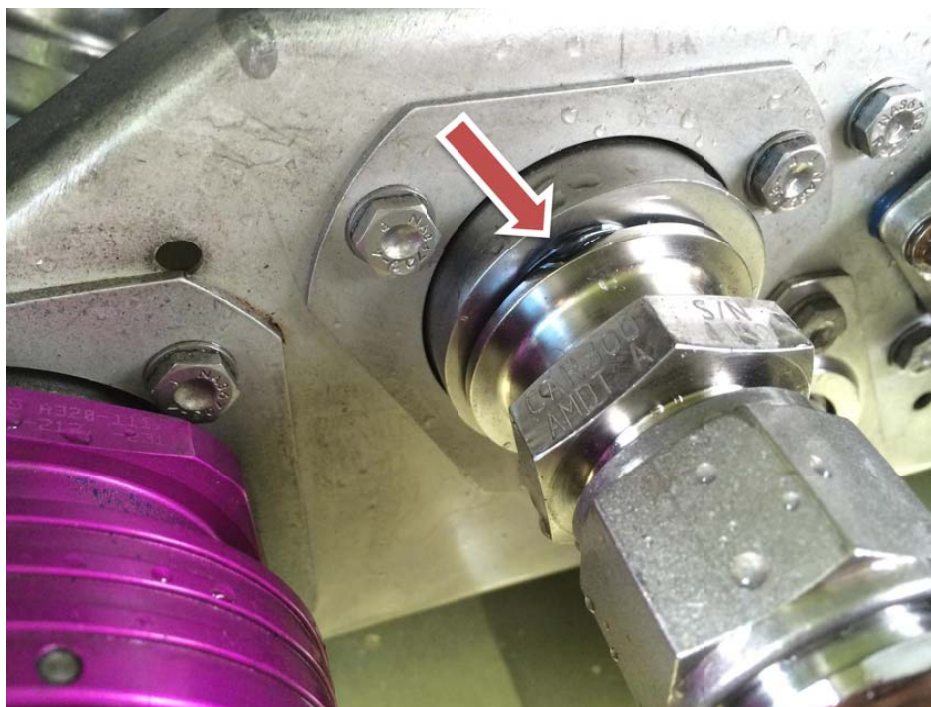


Figure 2: engine no.2 yellow system

2.3 History of maintenance operations

On 22 April, the hydraulic fluid on the yellow system (engine no.2) was changed.

On 25 April at Brussels airport, before the first flight of the day, the EDP 1 (green system) was changed. It is possible that during this operation, the O-ring on the pump drive shaft was incorrectly positioned or damaged. It is also possible that there may have been an internal failure in the magnetic seal after long-term deterioration. The BEA was unable to analyse these parts.

⁽⁵⁾PM:
Pilot Monitoring.

⁽⁶⁾PTU: Power
Transmission Unit.

Either of these hypotheses may explain the oil leak and the drop in oil pressure on engine no.1.

2.4 Handling of the yellow system hydraulic low level failure

When the Master Caution alert associated with the ECAM yellow system hydraulic low level page was displayed, the crew were preparing for the arrival in Bordeaux. The PM⁽⁵⁾ began the ECAM procedure approximately one minute after the warning by disabling the PTU⁽⁶⁾ (PTU OFF). He interrupted the procedure although it required the following additional actions:

- ☐ YELLOW ENG 2 PUMP.....OFF
- ☐ YELLOW ELEC PUMP.....OFF
- ☐ BRK Y ACCU PR MONITOR

The DFDR indicated that the PTU had been reactivated (PTU ON).

The crew indicated that they had limited the application of the ECAM procedure (and therefore did not cut the yellow system hydraulic pumps) in order not to be confronted with a dual hydraulic failure.

Also, fearing a dual hydraulic failure on the yellow and green systems, the captain asked the PM to prepare for the procedure associated with this situation (SUMMARY readout) during the diversion to Toulouse Blagnac Airport.

2.5 Handling of the final approach

The crew members said they were surprised by the hydraulic pressure on the green system, which remained close to the nominal values, although engine no.1 had been shut down.

The captain added that he chose configuration three before extending the landing gear, contrary to the procedure in a normal situation, to anticipate a total hydraulic loss, it being possible to apply the emergency landing gear extension procedure later.

3 - LESSONS LEARNED AND CONCLUSION

The investigation was unable to determine whether there was a common link between maintenance operations on the no.1 engine and the yellow hydraulic system. The failure of the yellow hydraulic system was caused by an incorrectly performed maintenance operation. The oil leak on engine no.1 can be attributed either to a maintenance operation or to a deterioration of the magnetic seal.

By fully applying the *“yellow system low hydraulic level”* procedure, the crew would have had to deal with a dual hydraulic failure. Although this situation may seem uncomfortable, it is included in the procedures and training.

Since the *“yellow system low hydraulic”* procedure had not been fully applied, the flight continued with a malfunctioning yellow system and a green system pressurized by windmilling. In such a case, it is not possible to predict the behaviour of hydraulic devices, and a dual hydraulic failure can occur at any time, especially during a critical phase of flight (short final, flare or landing roll as happened on the day of the incident).

Its occurrence had, however, been anticipated by the captain, who asked the co-pilot to prepare the associated procedure.