RNSA

Rannsóknarnefnd samgönguslysa

Final report on aircraft serious incident

Case no.: **18-199F035**

Date: **1. November 2018**

Location: **69 NM west of Keflavik Airport at FL200**

Description: **In-flight shutdown of Engine no. 2 due to loss of oil pressure**

1. FACTUAL INFORMATION

Location and time	
Location:	69 NM west of Keflavik Airport at FL200
Date:	1. November 2018
Time[1]:	16:01

Aircraft	
Type:	Airbus 321
Registration:	TF-WIN
Year of manufacture:	2017
Serial number:	7650
CoA:	Valid
Engines:	Two CFM56-5B3/P

Other information	
Type of flight:	Commercial flight
Persons on board:	193 (7 crew and 186 passengers)
Injury:	None
Damage:	None
Short description:	In-flight shutdown of Engine no. 2 due to loss of oil pressure

Commander	
Age:	45 years
Certificate:	ATPL/A
Ratings:	A320/321
Medical Certificate:	Class 1, valid

Experience:

Total flight hours:	~8500 hours
Total flight hours as Commander	4314 hours
Flight hours as Commander on type:	~1300 hours
Total flight hours on type:	~1300 hours
Last 90 days on type:	244 hours
Last 24 hours on type:	0 hours

[1] All times in the report are Icelandic local times (UTC+0), unless otherwise stated

Co-pilot	
Age:	43 years
Certificate:	FCL.A
Ratings:	A320/321
Medical Certificate:	Class 1, valid
Experience:	Total flight hours: 2537 hours Total flight hours on type: 1892 hours Last 90 days on type: 178 hours Last 24 hours on type: 0 hours

Technician 1	
Age:	29 years
Certificate:	Part-66 license with CAT B1 authorization
Ratings:	• Airbus A318/A319/A320/A321 (IAE V2500) • Airbus A318/A319/A320/A321 (CFM56) • Airbus A330 (GE CF6, PW4000, RB Trent 700) • Airbus A340 (CFM56, RB211 Trent 500)
Company Authorizations:	CAT B1 BMQT & LMVT for Airbus A318/319/320/321: • V2500 and CFM56 engines • Preflight Technical Assistance • CRS - Line Maintenance • Work signing • Duplicate inspections
Experience:	• 2008 - EASA Part 66 Technician Course • 2010 to 2013 – Worked as Aircraft Mechanic on C & D checks on Airbus 319/320/321 and Bombardier CRJ 200/700/900 • 2013 to 2018 – Worked as Aircraft Mechanic and Avionic on C & D checks on Airbus 320 family, A330 and A340 • 2015 – Internal Level 2 authorization as Mechanic and Avionic • 2017 – Licensed B1 Aircraft Engineer on Airbus 320 family, A330 and A340

Technician 2	
Age:	41 years
Certificate:	Part-66 license with CAT B1 authorization
Ratings:	• Airbus A318/A319/A320/A321 (IAE V2500) • Bombardier CL-600-2B19 (GE CF34) • Airbus A318/A319/A320/A321 (CFM56) • Bombardier CL600-2C10/2D15/2D24/2H25 (GECF34)
Company Authorizations:	CAT B1 BMQT: • Work signing A318/319/320/321 limitations
Experience:	• 2013 – EASA Part 66 Technician Course • 2013 to 2015 – Worked as Aircraft Mechanic on C & D checks on Airbus 319/320/321 and Bombardier CL600 • 2015 – Licensed B1 Aircraft Engineer on Bombardier CL-600 • 2016 – Licensed B1 Aircraft Engineer on Airbus 320 family

Technician 3	
Age:	31 years
Certificate:	Part-66 license with CAT B1 authorization
Ratings:	• Airbus A318/A319/A320/A321 (IAE V2500) • Airbus A318/A319/A320/A321 (CFM56) • Boeing 737-600/700/800/900 (CFM56) • Airbus A330 (GE CF6, PW4000, RB Trent 700) • Airbus A340 (CFM56, RB211Trent 500)
Company Authorizations:	B1 BMQT & LMVT for Airbus A318/319/320/321: • V2500 and CFM56 engines • Preflight Technical Assistance • CRS - Line Maintenance • Work signing • Duplicate inspections
Experience:	• 2016 – Category A Line Maintenance Certifying Mechanic • 2017 – Licensed B1 Aircraft Engineer on Boeing 737NG • 2017 – Licensed B1 Aircraft Engineer on Airbus 320 family, A330 and A340

1.1. History of the flight

Flight WOW117 was a scheduled flight from Keflavik Airport (BIKF) to Baltimore (KBWI) with ETD[2] at 15:30. The preflight inspection was performed by the Commander, who did not notice anything abnormal during the inspection.

Flight WOW117 took off from RWY 28 at Keflavik Airport (BIKF) at 15:48, to Baltimore (KBWI). The takeoff was normal, and the Co-pilot was the Pilot Flying (PF).

The wind was 230°/6 knots during the takeoff and the QNH was 1003 Hpa. The runway was wet, as it had been raining.

According to the FDR[3], at 15:51:42 during the climb, when passing through 7040 feet MSL[4], the flight crew received the following ECAM[5] advisory message:

- OIL QTY

The flight crew consulted the ECAM, which showed the oil quantity for Engine no. 2 (right engine) had dropped to 3 quarts. According to the flight crew, both engines had around 18.5 quarts of oil before the flight.

The flight crew continued the climb as they consulted the QRH[6]. According to the QRH, the oil pressure and the oil temperature should be monitored. According to the FDR, at 15:51:42 Engine no. 2 oil pressure was 46 psi and its oil temperature was 63.5°C.

According to the FDR, at 15:54:58 when the airplane passed through 10,916 feet MSL, the oil quantity for Engine no. 2 had dropped to zero. Simultaneously on the ECAM, the oil quantity for Engine no. 2 was replaced by “XX”. The flight crew initially considered if there was a malfunction with a sensor, as the oil pressure and temperature seemed unchanged.

Then about 30 seconds later Engine no. 2 oil pressure started dropping and the flight crew concluded that they had an engine oil leak.

[2] Estimated Time of Departure
[3] Flight Data Recorder
[4] All altitudes in this report are above Mean Sea Level (MSL) unless otherwise stated
[5] Electronic Centralized Aircraft Monitor
[6] Quick Reference Handbook

The flight crew took a picture of the engine display at 15:57 (see Figure 1
), showing the “XX” for Engine no. 2 oil quantity as well as Engine no. 2 oil pressure had dropped to 24 psi.

The drop in Engine no. 2 oil pressure led to an ECAM LOW PRESS warning at 16:00:15. The flight crew analyzed the fault according to the QRH, which required Engine no. 2 to be shutdown.

The flight crew notified ATC[7] of technical problems and received a clearance back to Keflavik Airport.

The flight crew performed Engine no. 2 shutdown according to the QRH at 16:01 and turned around to Keflavik Airport.

At 16:05, during the approach, the Commander took over as Pilot Flying.

Figure 1: Photo of the ECAM after the “XX” appeared

The Commander declared PAN-PAN at 16:06 and notified ATC that they had shut down Engine no. 2.

The flight crew briefed the senior cabin attendant of the situation and informed the passengers that they were returning to Keflavik Airport due to technical reasons.

During the descent the flight crew performed the approach checklist, referred to QRH 25.07A Overweight Landing checklist and performed landing performance calculations for RWY 19[8] at Keflavik Airport.

The Commander landed the aircraft on RWY 19 at Keflavik Airport at 16:23.

[7] Air Traffic Control
[8] Since the takeoff from Keflavik Airport RWY 28, the active RWY had been changed to RWY 19

After the landing the aircraft was parked at the terminal and an inspection was performed on Engine no. 2. The inside of the Engine no. 2 cowling was found wet with oil. The oil drain plug on the main oil supply filter on Engine no. 2 was found loose along with a loose safety wire.

Figure 2: Engine no. 2 - The inside of cowling wet with oil

Figure 3: Engine no. 2 - Leaking oil drain plug on oil supply filter

During further inspections of the oil leak, by the flight operator, on the evening of November 1st, a general inspection of Engine no. 1 (left engine) was also performed. During this inspection, an oil leak was also discovered on the inside of Engine no. 1 cowling and the same oil drain plug on the main oil supply filter for Engine no. 1 was found to be loose along with a loose safety wire.

Figure 4: Engine no. 1 - The inside of the cowling was wet with oil

2. ANALYSIS AND CONCLUSION

2.1. Engines 1 and 2 – Loss of oil quantity and oil pressure

According to the flight crew, both engines had around 18.5 quarts of oil before the flight. The OFF-BLOCK time for the flight recorded in the Aircraft Journey and Technical Log was 15:30.

According to the FDR, the oil quantity for Engine no. 1 was 17.5 quarts and for Engine no. 2 it was 15.75 quarts at 15:34:31.

Both Engine no. 1 and Engine no. 2 incurred a sudden drop in the oil reservoir around 15:47:30 (see Figure 5). About 5 quarts of the sudden oil drop (for both engines) occurred because of oil gulping during takeoff. This happened as the high-power selection required additional volume of oil for the engine operation, which is taken from the oil reservoir.

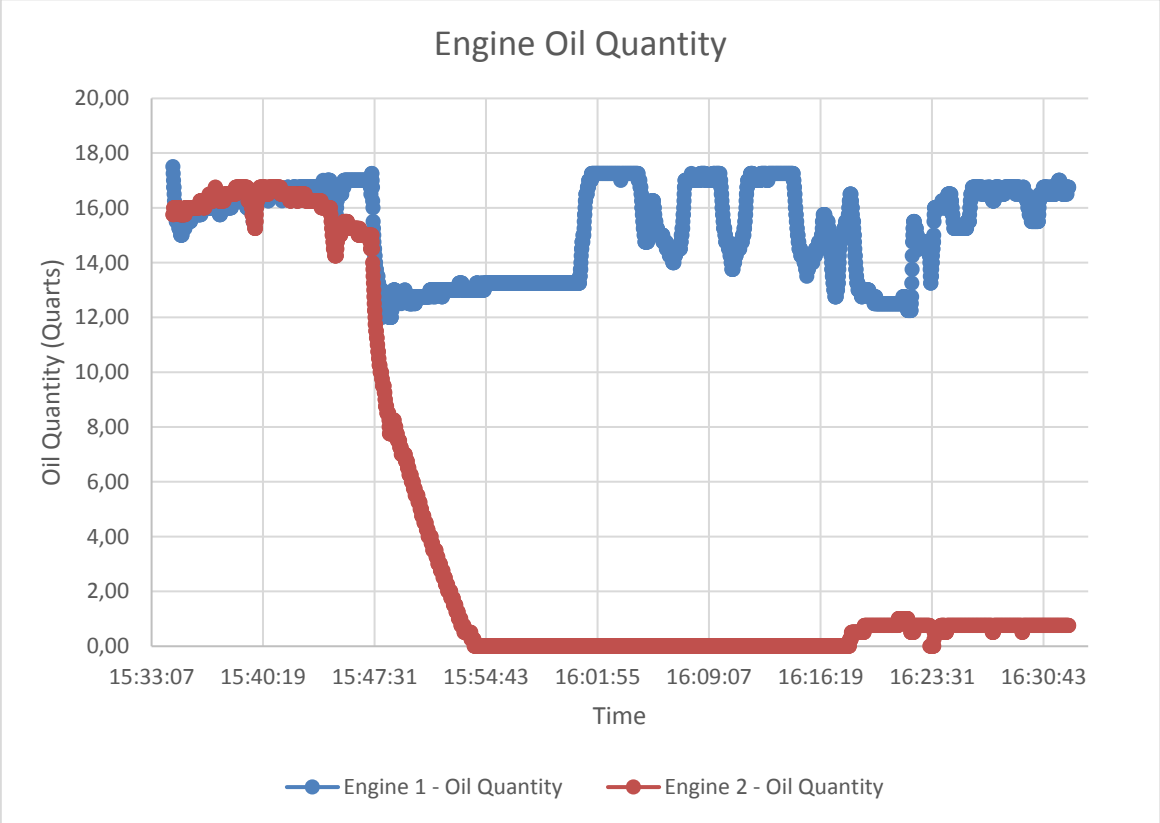


Figure 5: Loss of oil quantity

For Engine no. 1, the drop in oil quantity stabilized at about 13 quarts at 15:47:54. This was at the same time as the aircraft nose pitched up at the end of the takeoff roll, when the aircraft was about to take off from Keflavik Airport.

For Engine no. 2 the oil quantity continued to drop during the climb and reached 0 quarts at 15:53:58, when the aircraft had reached 10,900 feet altitude.

As some of the drop in quantity (for both engines) was because of oil gulping as a result of the engine running at higher power, the actual oil quantity loss can be found by comparing the oil in the oil reservoir during taxi before the flight, to the oil in the oil reservoir during taxi after the flight.

For Engine no. 1, during taxi before the flight at 15:34:31, the engine oil quantity was 17.5 quarts. After the flight, during taxi at 16:28:29, the engine oil quantity was 16.75 quarts.

Engine no. 1 had therefore lost just below 1 quart of its oil during the flight, when comparing the taxi FDR values. Considering that the original oil quantity on both engines was about 18.5 quarts before the flight, as stated by the flight crew, Engine no. 1 lost a little less than 2 quarts of its oil.

The engine oil quantity of Engine no. 2 was 15.75 quarts at 15:34:31, during taxi before the flight. After the flight, during taxi at 16:28:29, the engine oil quantity was 0.75 quarts.

Engine no. 2 had therefore lost almost all its oil during the flight. Comparison of the FDR taxi values for the oil quantity before and after the flight revealed a loss of 15 quarts of oil. Considering that the original oil quantity on both engines was about 18.5 quarts before the flight, as stated by the flight crew, Engine no. 2 lost a little less than 18 quarts of its oil.

The oil loss on Engine no. 2 therefore also included most of the extra oil that was required by the engine from the oil reservoir during its high-power operation during takeoff and initial climb.

From the data derived from Figure 6 it is apparent that the engine oil pressure for both engines increased between 15:47:10 and 15:47:22, which coincides with the selection of takeoff power in the beginning of the takeoff roll of the aircraft at RWY 28 at Keflavik Airport.

The rapid drop in the oil quantity for both Engine no. 1 and Engine no. 2 at 15:47:30 occurred during the takeoff roll, about 8 seconds after both engines had reached their maximum engine oil pressure (after the takeoff power was selected). This is normal as at high power selection the engines require additional oil.

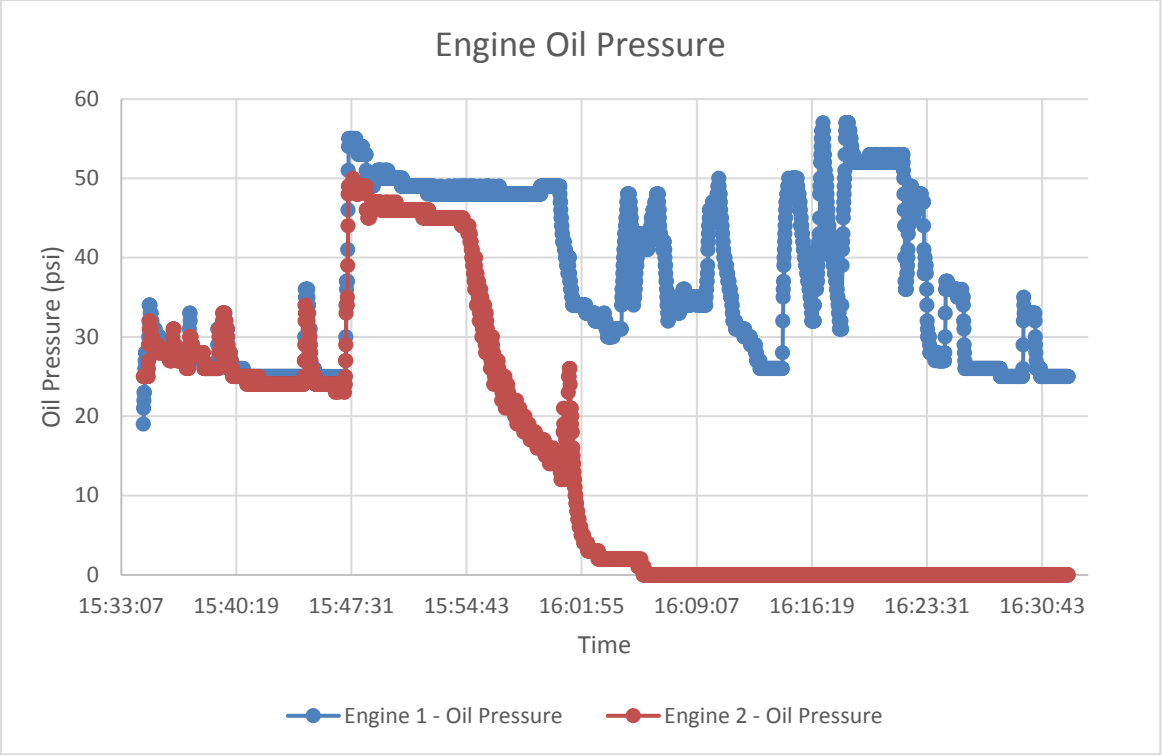


Figure 6: Loss of oil pressure

The initial ECAM warning for low oil pressure for Engine no. 2 occurred at 16:00:15. From the data behind Figure 6 it is however apparent that the Engine no. 2 oil pressure started to drop around 15:54:30, or 32 seconds after the oil quantity for Engine no. 2 had reached zero.

The ITSB noted that the oil pressure value for Engine no. 1 oscillated between an upper value around 50-55 psi and a lower value around 25-35 psi after Engine no. 2 lost its oil pressure.

Comparison of the engine pressure (Figure 6), the engine displayed value (Figure 7) and the engine throttle value (Figure 8) parameters, revealed that Engine no. 1 did not operate continuously at high-power after Engine no. 2 shutdown.

According to the engine manufacturer, this was because the Auto thrust was engaged with N1 regulated without any action on throttle by the flight crew. In this mode, aircraft gives data to EEC[9] to drive the engine with specific N1. The Auto thrust was engaged between 15:48:29 and 16:23:19.

[9] Electronic Engine Controller

When the flight crew shut down Engine no. 2 and turned around to Keflavik Airport at 16:01, the aircraft was located 69 NM from the threshold of RWY 19 and at FL200[10].

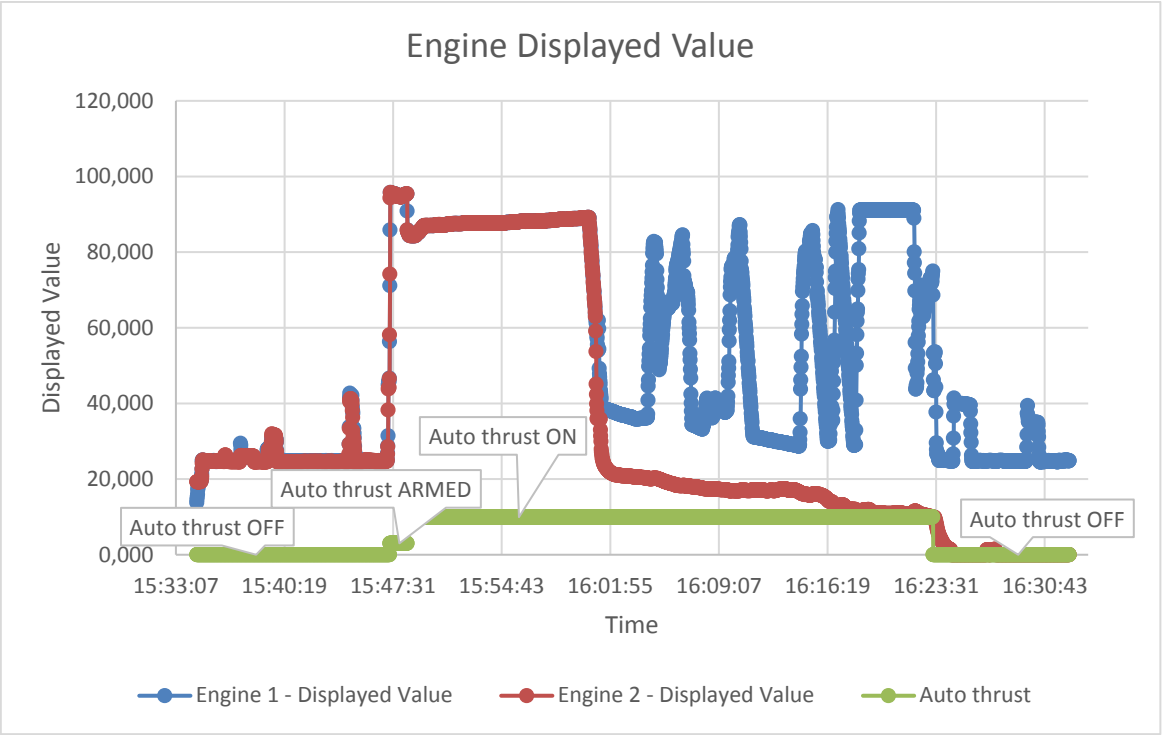


Figure 7: Engine displayed value

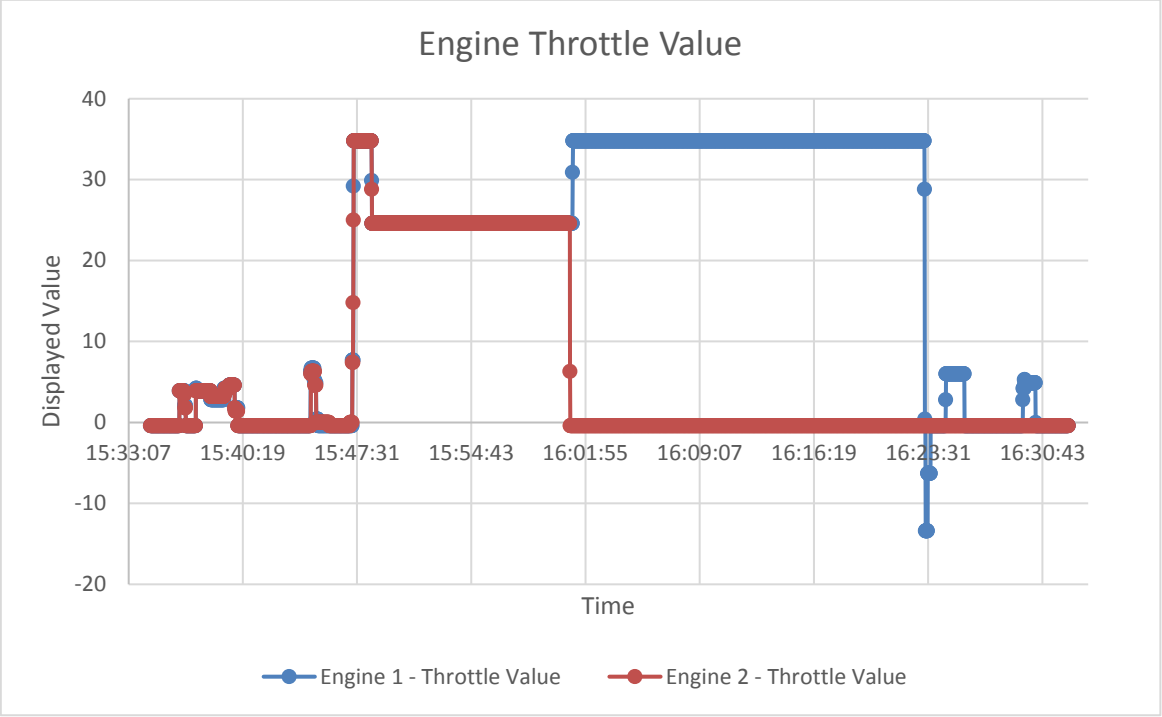


Figure 8: Engine throttle value

[10] Altitude of 20,300 feet

2.2. Maintenance

Aircraft TF-WIN underwent a C-check inspection at Adria Tehnika at Ljubljana Airport in Slovenia between October 15th and October 28th, 2018. Adria Tehnika operated under EASA Part 145 certificate SI.145.100 at the time of the C-check.

At the time of the C-check TF-WIN had accumulated a total of 7036:43 flight hours and 1698 flight cycles[11].

The aircraft was released out of the C-check at 12:00 UTC on October 28th, 2018, 4 days prior to the serious incident. The aircraft flew 13 flight legs after the C-check and until the serious incident flight, or a total of 56 hours and 25 minutes[12].

During the period between the C-check and the incident flight, the following engine oil had been added to the engines of aircraft TF-WIN:

28. October:

- Engine no. 1 and Engine no. 2 fan cowlings opened, and 3 quarts of engine oil added to each engine (oil consumption rate 0.25 quarts/hour)

29. October:

- Engine no. 1 and Engine no. 2 fan cowlings opened. Added 4 quarts of engine oil added to Engine no. 1 (oil consumption rate 0.36 quarts/hour). Added 3 quarts of engine oil added to Engine no. 1 (oil consumption rate 0.27 quarts/hour)

30. October:

- Engine no. 1 and Engine no. 2 fan cowlings opened, and 3 quarts of engine oil added to each engine (oil consumption rate 0.53 quarts/hour)

31. October:

- Engine no. 1 and Engine no. 2 fan cowlings opened, and 3 quarts of engine oil added to each engine (oil consumption rate 0.27 quarts/hour)
- Engine no. 1 and Engine no. 2 fan cowlings opened, and 1 quart of engine oil added to each engine (oil consumption rate 0.20 quarts/hour)

[11] One flight cycle incorporates all the phases of a a single flight
[12] BLOCK HOURS

1. November:

- Engine no. 1 and Engine no. 2 fan cowlings opened, and 1 quart of engine oil added to each engine (oil consumption rate 0.18 quarts/hour)

According to Airbus Aircraft Maintenance Manual[13] (AMM), normal oil consumption is not expected to exceed 0.60 quarts/hour. The oil consumption never exceeded this limit until the serious incident flight.

During the C-check at Adria Tehnika the main oil supply filters for both Engine no. 1 and Engine no. 2 were replaced.

[13] A318/A319/A320/A321 AMM, revision dated May 01 2018, task 72-00-00-200-008-A – Inspection/Check after the Engine has Exceeded the Operational Limits, page 12 of 16, part (3) Oil Consumption, subpart (a)

2.3. Engine Oil Supply Filter

Inspections after the flight revealed that oil had leaked from the drain plug on the main oil supply filters for both Engine no. 1 and Engine no. 2. The drain plugs were found loose as well as their safety wires (see Figure 9).

The drain plugs could easily be turned by hand and did not meet the torque values stated in AMM task 79-21-10-920-002 [subtask 79-21-10-420-060-A].

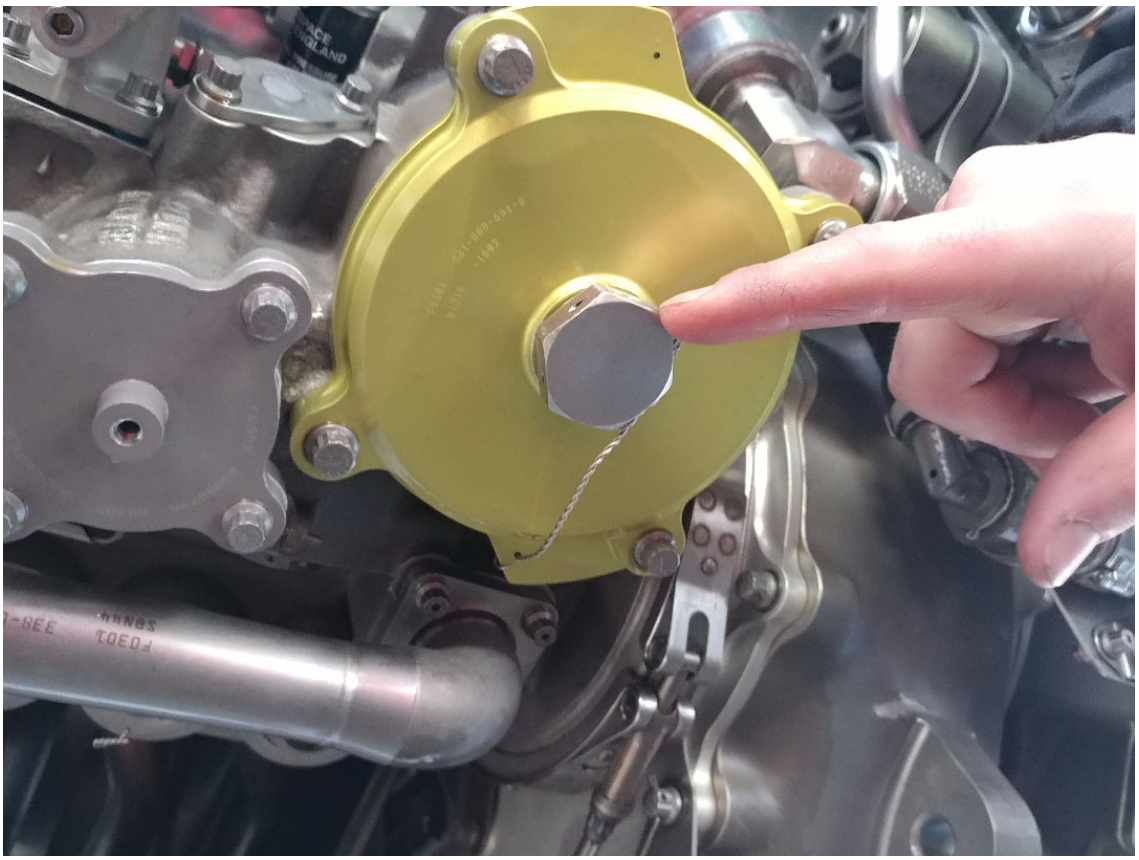


Figure 9: Main Oil Supply Filter – Oil leak indication and loose safety wire

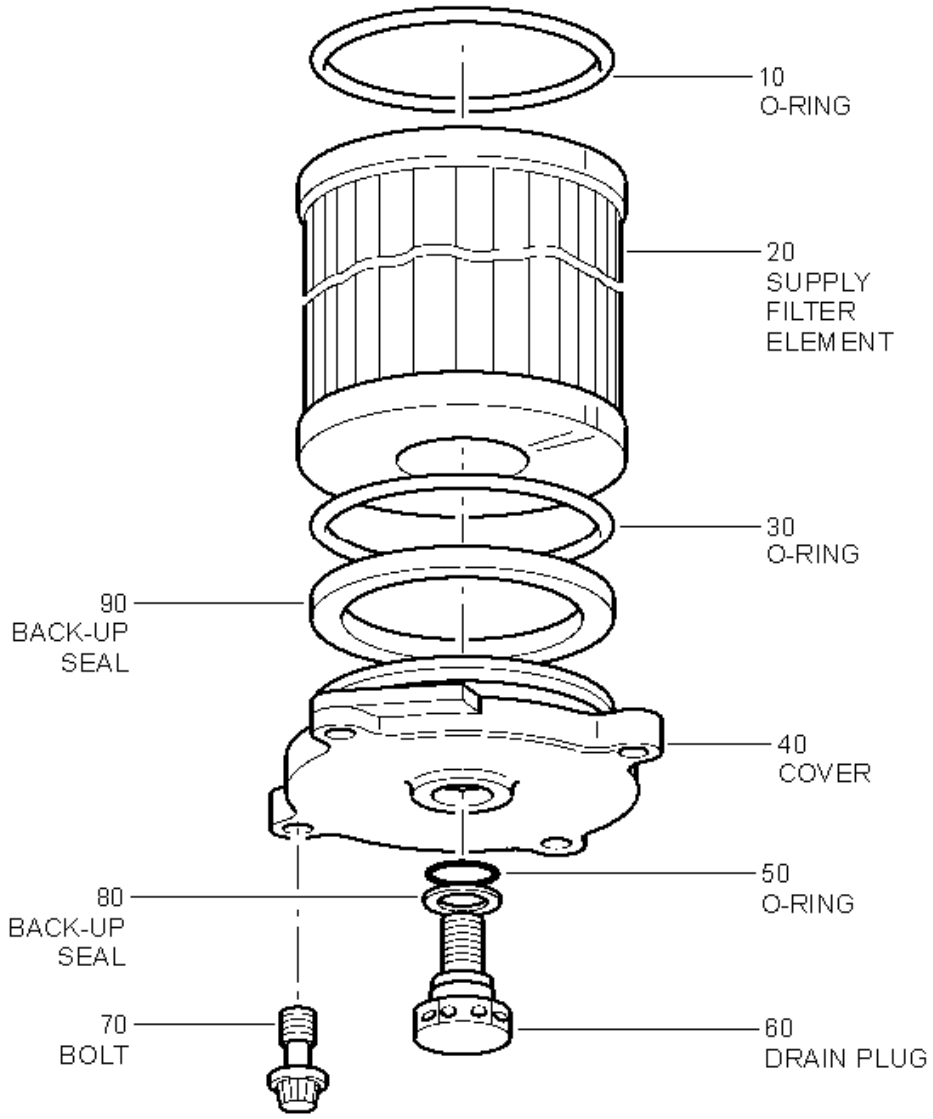


Figure 10: Main Oil Supply Filter

The method used for the installation of the Main Oil Supply Filter is provided in AMM subtask 79-21-10-420-060-A, as seen in Figure 11 and Figure 12.

The replacement of the main oil filter requires a duplicate inspection from an authorized staff.

Technician 1 performed the main oil supply filter replacement on Engine no. 2 and performed the duplicate inspection for Engine no. 1. He was authorized for both tasks.

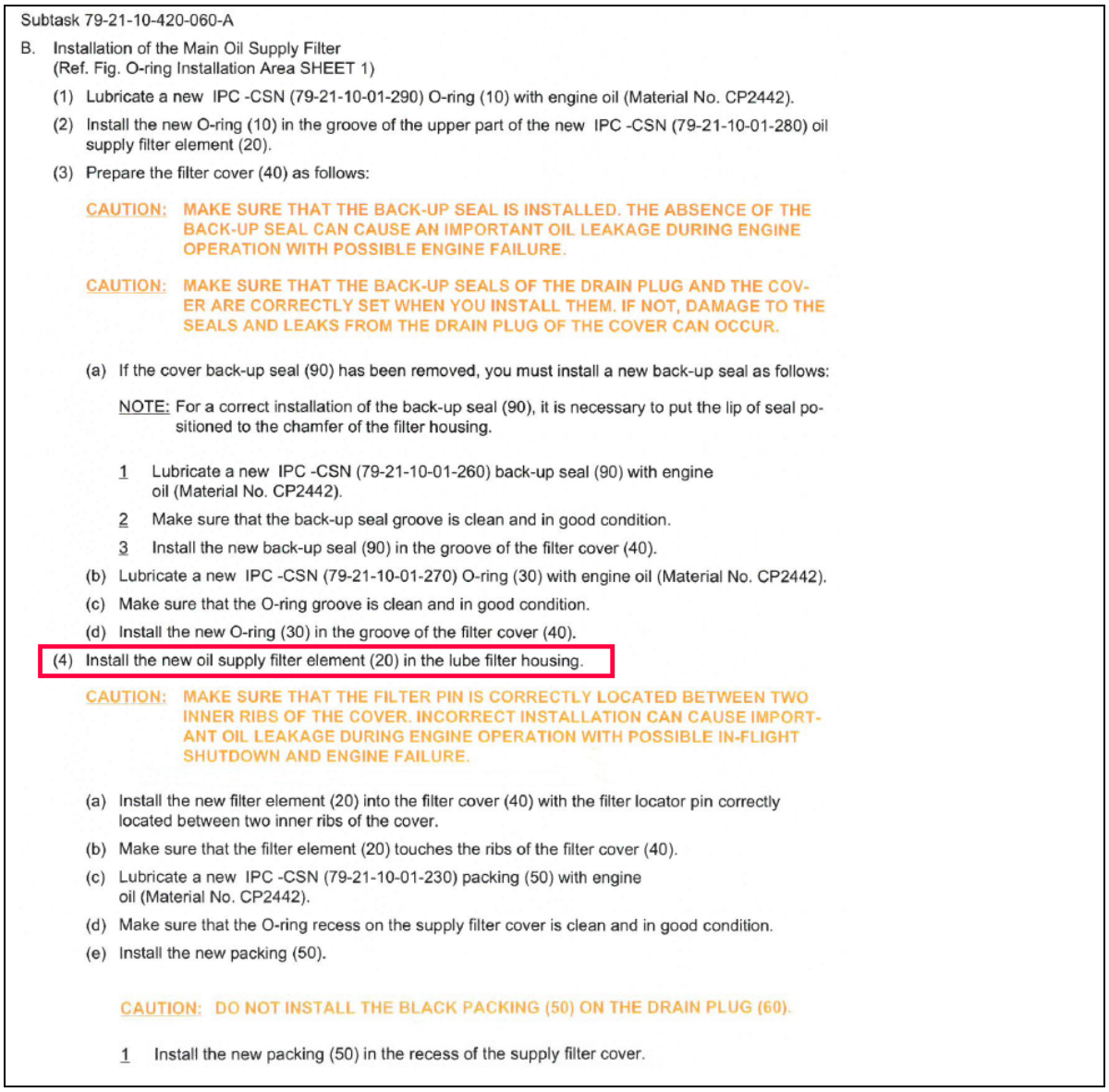
Technician 2 performed the main oil supply filter replacement on Engine no. 1. He was authorized for this task.

Technician 3 performed the duplicate inspection for Engine no. 2. He was authorized for this task.

In Airbus AMM subtask 79-21-10-420-060-A, part (4) the top line (header) reads:

(4) Install the oil supply filter element (20) in the lube filter housing.

Nevertheless the underlying instructions (a)-(e) in part (4) are only instructions to attach the filter (item 20 in Figure 10) to the filter cover (item 40 in Figure 10), to lubricate packings (item 40 in Figure 10) and to install O-ring packing packings (item 40 in Figure 10). See Figure 11 for details.



Subtask 79-21-10-420-060-A

B. Installation of the Main Oil Supply Filter
(Ref. Fig. O-ring Installation Area SHEET 1)

(1) Lubricate a new IPC -CSN (79-21-10-01-290) O-ring (10) with engine oil (Material No. CP2442).

(2) Install the new O-ring (10) in the groove of the upper part of the new IPC -CSN (79-21-10-01-280) oil supply filter element (20).

(3) Prepare the filter cover (40) as follows:

CAUTION: MAKE SURE THAT THE BACK-UP SEAL IS INSTALLED. THE ABSENCE OF THE BACK-UP SEAL CAN CAUSE AN IMPORTANT OIL LEAKAGE DURING ENGINE OPERATION WITH POSSIBLE ENGINE FAILURE.

CAUTION: MAKE SURE THAT THE BACK-UP SEALS OF THE DRAIN PLUG AND THE COVER ARE CORRECTLY SET WHEN YOU INSTALL THEM. IF NOT, DAMAGE TO THE SEALS AND LEAKS FROM THE DRAIN PLUG OF THE COVER CAN OCCUR.

(a) If the cover back-up seal (90) has been removed, you must install a new back-up seal as follows:

NOTE: For a correct installation of the back-up seal (90), it is necessary to put the lip of seal positioned to the chamfer of the filter housing.

1 Lubricate a new IPC -CSN (79-21-10-01-260) back-up seal (90) with engine oil (Material No. CP2442).

2 Make sure that the back-up seal groove is clean and in good condition.

3 Install the new back-up seal (90) in the groove of the filter cover (40).

(b) Lubricate a new IPC -CSN (79-21-10-01-270) O-ring (30) with engine oil (Material No. CP2442).

(c) Make sure that the O-ring groove is clean and in good condition.

(d) Install the new O-ring (30) in the groove of the filter cover (40).

(4) Install the new oil supply filter element (20) in the lube filter housing.

CAUTION: MAKE SURE THAT THE FILTER PIN IS CORRECTLY LOCATED BETWEEN TWO INNER RIBS OF THE COVER. INCORRECT INSTALLATION CAN CAUSE IMPORTANT OIL LEAKAGE DURING ENGINE OPERATION WITH POSSIBLE IN-FLIGHT SHUTDOWN AND ENGINE FAILURE.

(a) Install the new filter element (20) into the filter cover (40) with the filter locator pin correctly located between two inner ribs of the cover.

(b) Make sure that the filter element (20) touches the ribs of the filter cover (40).

(c) Lubricate a new IPC -CSN (79-21-10-01-230) packing (50) with engine oil (Material No. CP2442).

(d) Make sure that the O-ring recess on the supply filter cover is clean and in good condition.

(e) Install the new packing (50).

CAUTION: DO NOT INSTALL THE BLACK PACKING (50) ON THE DRAIN PLUG (60).

1 Install the new packing (50) in the recess of the supply filter cover.

Figure 11: Misleading top line (header) in Part (4)

The actual installation of the filter (already attached to the filter cover) into the lube filter housing of the engine does not occur until in part (7). See Figure 12 for details.

(5) Install the drain plug (60) as follows:

CAUTION: MAKE SURE THAT THE BACK-UP SEAL IS INSTALLED. THE ABSENCE OF THE BACK-UP SEAL CAN CAUSE AN IMPORTANT OIL LEAKAGE DURING ENGINE OPERATION WITH POSSIBLE ENGINE FAILURE.

CAUTION: MAKE SURE THAT THE BACK-UP SEALS OF THE DRAIN PLUG AND THE COVER ARE CORRECTLY SET WHEN YOU INSTALL THEM. IF NOT, DAMAGE TO THE SEALS AND LEAKS FROM THE DRAIN PLUG OF THE COVER CAN OCCUR.

(a) If the drain plug back-up seal (80) has been removed, you must install a new back-up seal as follows:

NOTE: For a correct installation of the back-up seal (80), it is necessary to put the lip of seal positioned to the chamfer of the filter housing.

1 Lubricate a new IPC -CSN (79-21-10-01-220) back-up seal (80) with engine oil (Material No. CP2442).

2 Make sure that the back-up seal groove is clean and in good condition.

CAUTION: MAKE SURE THAT THE BACK-UP SEAL IS CORRECTLY SET WHEN YOU INSTALL IT.

a Install the new back-up seal (80) in the groove of the drain plug (60).

(b) Tighten the drain plug (60) in the supply filter cover (40) by hand until the head of the drain plug touch the filter cover.

1 If you can see the green back-up seal (80), it is possible that the packing (50) is not correctly installed. Remove the drain plug (60) and do an inspection.

NOTE: If the inner packing (50) sits on the back-up seal (80), the packing installation done before is possibly incorrect.

a Remove the drain plug (60) from the filter cover (40).

b Remove and discard the packing (50), install again a new packing (50) and make sure that it is correctly installed in the oil filter cover (40) recessed groove.

c If necessary, remove and discard the back-up seal (80), and install again a new back-up seal (80) on the drain plug (60).

(6) Do a check of the correct installation of the filter element (20).

(a) Turn the filter element (20) clockwise and counter-clockwise.

NOTE: The filter must turn freely between two filter cover ribs and you must feel and hear the pin stopping against the ribs.

(7) Install the filter cover (40) as follows:

(a) Set the supply filter cover in position. Push the cover that has the filter into the lube unit housing until it comes against the filter housing flange.

(b) Lubricate the threads of the bolts (70) with engine oil (Material No. CP2442).

(c) Install the bolts (70).

CAUTION: TORQUE THE BOLTS WITH APPLICABLE TOOLS (PRESET TORQUE WRENCH). DO NOT OVERTORQUE THE BOLTS BECAUSE THIS CAN CAUSE AN IMPORTANT OIL LEAKAGE DURING ENGINE OPERATION WITH POSSIBLE IN-FLIGHT SHUTDOWN AND ENGINE FAILURE.

1 TORQUE the bolts (70) **to between 34 and 45 lbf.in (0.38 and 0.51 m.daN).**

(d) TORQUE the drain plug (60) **to between 65 and 75 lbf.in (0.73 and 0.85 m.daN).**

(e) Safety the plug (60) to the filter cover (40) with lockwire 0.032 in. (0.8 mm) dia. (Material No. CP8001) or lockwire 0.032 in. (0.8 mm) dia (Material No. CP8002).

(8) Remove the oil drain container from under the lube filter.

Figure 12: The actual installation of the filter into the lube unit housing is in Part (7)

2.4. Replacement of the Engines 1 and 2 Oil Supply Filters

The ITSB[14] investigation determined that Adria Tehnika did not follow the Airbus AMM subtask 79-21-10-420-060-A correctly during the C-check.

The work was being performed based on the top line (header), instead of following the work instructions in detail. Because of this, and the misleading top line subject title, the supply filter element (item 20) was installed into the lube unit housing in part (4). Then the cover (item 40) was installed onto the lube unit housing, followed by the drain plug (item 60) to be installed.

By performing the installation this way, parts (4) to (7) were accomplished with the filter already installed into the engine. This prevented the possibility to inspect the correct installation of the filter onto the filter cover. This also prevented the possibility of a detailed check of the correct alignment of the locator pin after installation, as it is out of view. Finally, this also prevented the possibility of ensuring that the filter element pin (20) touched the sides of the ribs of the filter cover (40), instead of being on top of them.

The ITSB concluded that with an incorrect installation, a gap could still exist between the filter element (20) and the filter cover (40), when the required torque was reached during installation of the drain plug (60), for example if the filter locator pin was sitting (possibly partially) on top of a rib inside the filter cover (40).

Vibration and time over the 56:25 block hours between the installation and the serious incident flight could then have caused the filter element to move, shifting the filter locator pin off the top of the rib inside the filter cover.

This would allow the filter element (20) to move freely due to vibration closer to the filter cover (40), closing the gap between the filter element and the filter cover.

This would result in the drain plug no longer being fastened tightly against the filter cover (40), which would render the torque value of the drain plug useless and allow for the drain plug (60) to turn to the right. This could explain why the safety wire was found loose and the required torque on the drain plug no longer sufficient, regardless of the torqueing during the installation.

[14] Icelandic Transportation Safety Board, or RNSA (Rannsóknarnefnd samgönguslysa) in Icelandic

Safran Aircraft Engines, on behalf of CFM, has issued a training video[15] of the correct installation of the oil supply filter. Figure 13 to Figure 16 show part of this process. This video highlights the importance of installing the filter element (20) into the filter cover (40) [as per AMM subtask 79-21-10-420-060-A part (4)], before installing it into the lube filter housing of the engine [as per AMM subtask 79-21-10-420-060-A part (7)].

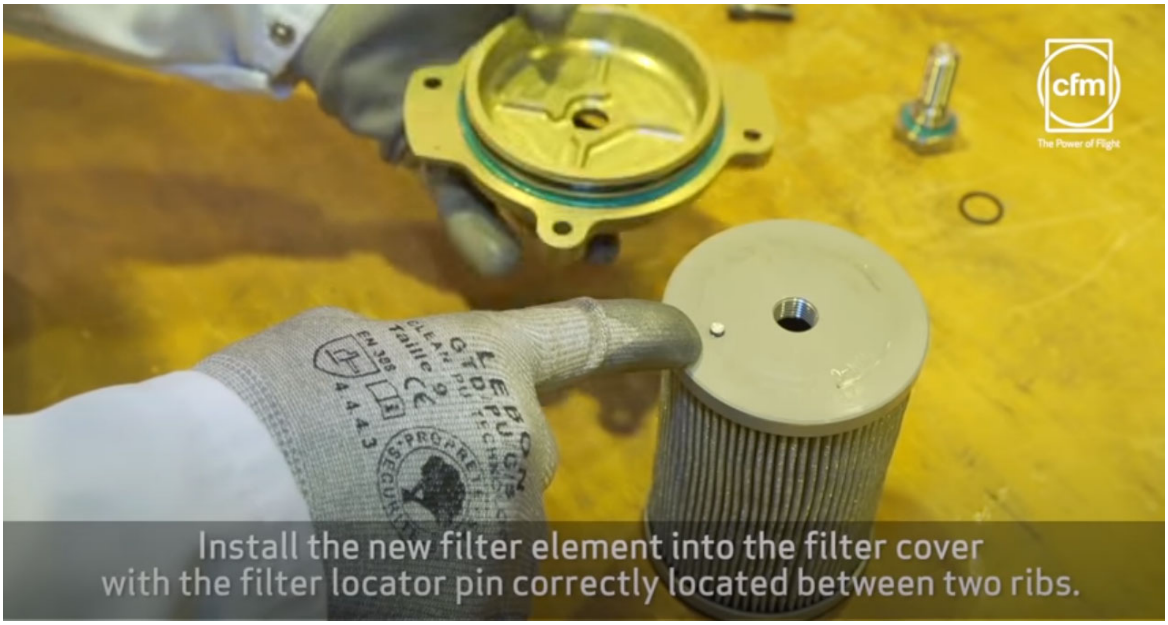


Figure 13: The filter locator pin

Figure 14: Correct installation of the filter cover (40)

[15] https://www.youtube.com/watch?v=y4YKBv4o8QA

Figure 15: Install the black O-ring (50) into the filter cover (40) recess

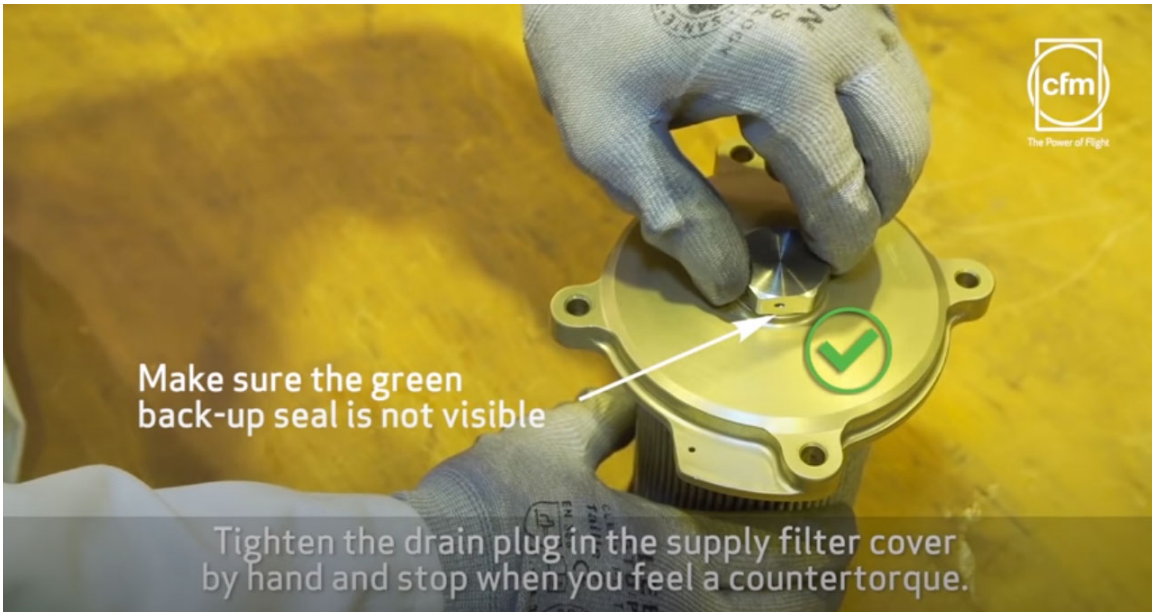


Figure 16: Fasten the drain plug (60) through the filter cover (40) and into the filter (20)

2.5. Inspection of other aircraft for the same condition

Following this incident, the operator inspected the drain plugs on all the engines in its Airbus fleet having the same drain plug. Three aircraft were found with problems relating to this incident, as follows:

Aircraft TF-DAD:

- Engine no. 2 filter drain plug found with a damaged O-ring (back up ring).
    - Engine no. 2 last main oil filter replacement performed by Adria Tehnika on WO#2290 WC#2469.

Aircraft TF-GMA:

- Both Engine no. 1 and 2 found with incorrect installation of the drain plugs
    - Engine no. 1 last performed main oil filter replacement by the operator on WO#8410 WC#1544 LP 44228.
    - Engine no. 2 last performed main oil filter replacement by the operator on WO#8411 WC#1545 LP 43006.

Aircraft TF-SON:

- Both Engine no. 1 and 2 found with incorrect installation of the drain plugs
    - Engine no. 1 last performed main oil filter replacement by the operator on WO#7419 WC#2346 LP 43873.
    - Engine no. 2 last performed main oil filter replacement by the operator on WO# 7420 WC 2347 LP 43876.

The incorrect installation of the drain plug was therefore not isolated to Adria Tehnika at Ljubljana Airport in Slovenia.

Furthermore, as part of the investigation Adria Tehnika in Slovenia also inspected all the Airbus aircraft in its hangar with the same engine oil drain plug installation.

One other loose engine oil drain plug installation was discovered. That engine had just been received back from Lufthansa Technik in Brussel and the engine oil drain plug had not been worked on by Adria Tehnika.

Adria Tehnika also reported to the Investigator-In-Charge issues of torqueing and then retorquing later on, where it seemed that the drain plug could still be torqued, as it had not

been torqued to the required levels before, but they were certain they had torqued it correctly.

2.6. Cause of the oil leak

The ITSB observed that the design of the oil filter element and the oil filter cover is such that it could lead to an incorrect assembly.

With regards to the oil leak, the investigation determined that Adria Tehnika technicians describing a *"more desirable way of installing"* O-RING item 50 in Figure 10 on the drain plug instead of installing it into the filter cover as per the AMM. This is incorrect, as stated in the caution in subpart (e) of part (4):

> CAUTION: DO NOT INSTALL THE BLACK PACKING (50) ON THE DRAIN PLUG (60)

After removal of the leaking drain plugs (60), O-ring (50) was discovered nesting against the green back-up seal (80). See Figure 17.

Figure 17: Black O-ring (50) nesting against green Back-up Seal (80)

In part (5) installation of the drain plug, subpart b), there is the following note:

> NOTE: If the inner packing (50) sits on the back-up seal (80), the packing installation done before is possible incorrect.

The investigation determined that the cause of the oil leak during this incident was an incorrect installation of the black O-ring, as can be seen in Figure 17.

According to both Airbus and Safran Aircraft Engines, the black O-ring should have been located at the shoulder in the dark green circled area in Figure 18 (the one further away from the hexagon head).

Figure 18: Correct location of O-ring (50) shown with the dark green circle

The ITSB determined the reason for this to be the incorrectly used *"more desirable way of installing"* the black packing O-ring (50) that the Adria Tehnika technicians had practiced by installing the oil filter element (20) into the engine's lube filter housing, before attaching the filter cover (40) with the drain plug (60).

The upside down installation of the filter cover (40) and the drain plug (60) made it difficult to install the black packing (50) into the filter cover's (40) recess as it could fall down out of the recess (see Figure 19).

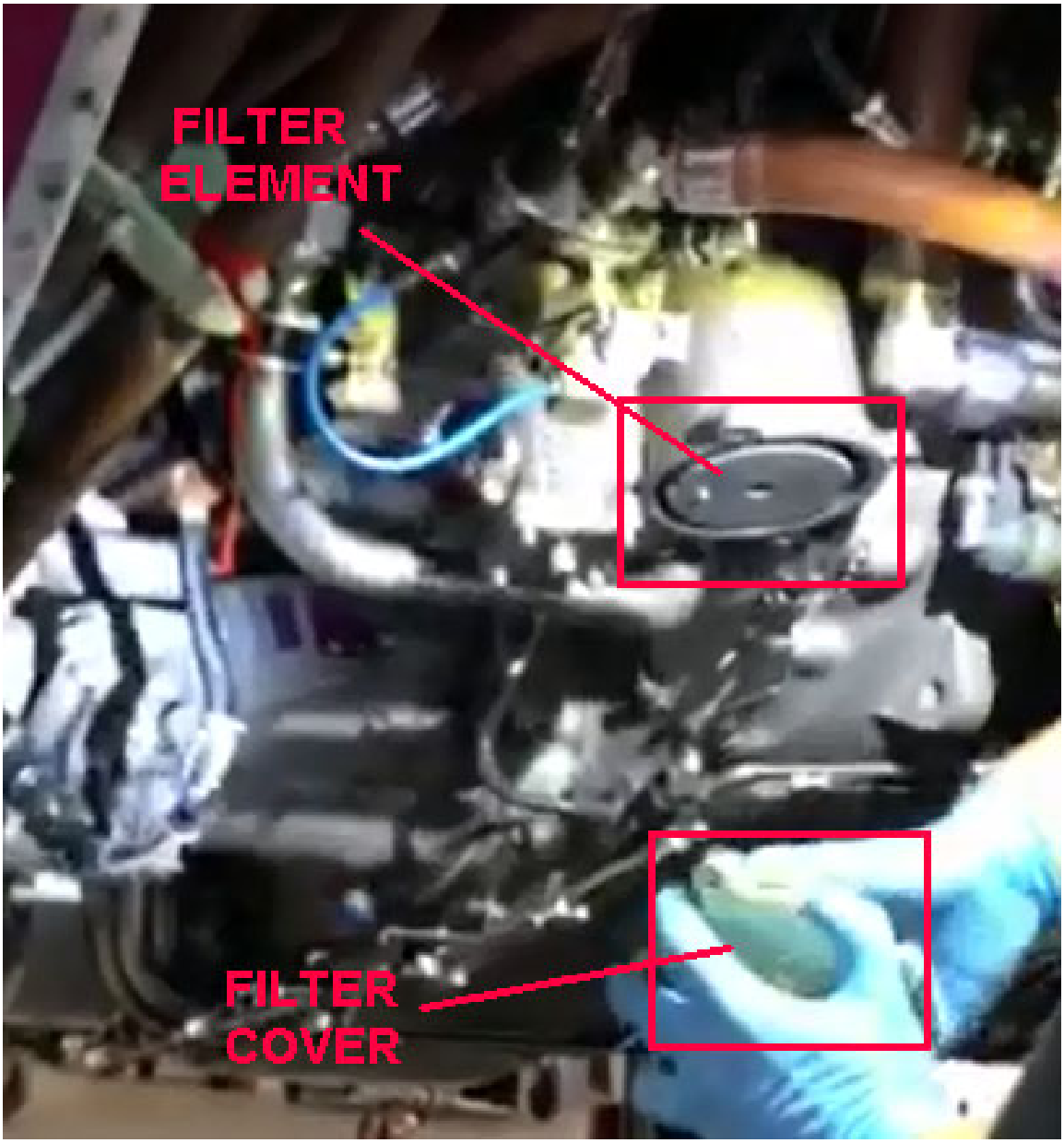


Figure 19: Filter cover installed incorrectly

The filter element should not be installed into the housing without being first installed onto the filter cover.

2.7. Safety actions taken

Based on the investigation findings of loose drain, Airbus AMM subtask 79-21-10-420-060-A for installation of the main supply oil filter had not been followed correctly.

The work instructions for the task could however be improved to prevent misunderstanding and the investigation brought this to the attention of both Airbus and Safran Aircraft Engines.

At the time of the incident (01-Nov-2018) the top line/heading (4) and (7) in AMM subtask 79-21-10-420-060-A were as follows:

> (4) Install the new oil supply filter element (20) in the lube filter housing
> (7) Install the filter cover (40) as follows

During the investigation, Safran Aircraft Engines and Airbus implemented a change to the top line/heading of Part (4) and Part (7) in AMM subtask 79-21-10-420-060-A, in a revision issued on 01-Nov-2019, to prevent the possible misunderstanding that the oil supply filter element is to be installed in the lube filter housing in the wrong step.

On 01-Nov-2019 the top line/heading in AMM subtask 79-21-10-420-060-A were changed to:

> (4) Install the new supply filter (20) in the filter cover (40)
> (7) Install the filter cover (40) with the supply filter (20) as follows

A safety action was taken by Safran Aircraft Engines in the year 2019 with the introduction of a revised supply filter per Service Bulletin 79-0038 for CFM56-5B. The purpose of the SB was to reduce the risk of incorrect assembly due to alignment of the filter element pin.

3. SAFETY RECOMMENDATIONS

None.

The following board members approved the report:

- Geirþrúður Alfreðsdóttir, chairman
- Bryndís Lára Torfadóttir, board member
- Hörður Arilíusson, deputy board member
- Tómas Davíð Þorsteinsson, deputy board member

Reykjavík, 5. August 2021

On behalf of the Icelandic Transportation Safety Board

Ragnar Guðmundsson
Investigator-In-Charge