



**COMISIÓN DE
INVESTIGACIÓN
DE ACCIDENTES
E INCIDENTES DE
AVIACIÓN CIVIL**

Report IN-040/2018

Incident involving an Airbus A320, registration EC-MDZ, operated by Vueling Airlines, S.A., at the Bilbao Airport (Vizcaya, Spain) on 25 October 2018



GOBIERNO
DE ESPAÑA

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Notice

This report is a technical document that reflects the point of view of the Civil Aviation Accident and Incident Investigation Commission (CIAIAC) regarding the circumstances of the accident object of the investigation, and its probable causes and consequences.

In accordance with the provisions in Article 5.4.1 of Annex 13 of the International Civil Aviation Convention; and with articles 5.5 of Regulation (UE) n° 996/2010, of the European Parliament and the Council, of 20 October 2010; Article 15 of Law 21/2003 on Air Safety and articles 1., 4. and 21.2 of Regulation 389/1998, this investigation is exclusively of a technical nature, and its objective is the prevention of future civil aviation accidents and incidents by issuing, if necessary, safety recommendations to prevent from their reoccurrence. The investigation is not pointed to establish blame or liability whatsoever, and it's not prejudging the possible decision taken by the judicial authorities. Therefore, and according to above norms and regulations, the investigation was carried out using procedures not necessarily subject to the guarantees and rights usually used for the evidences in a judicial process.

Consequently, any use of this report for purposes other than that of preventing future accidents may lead to erroneous conclusions or interpretations.

This report was originally issued in Spanish. This English translation is provided for information purposes only.

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Abbreviations

| | |
|----------|--|
| °C | Degrees centigrade |
| AD | Airworthiness directive |
| AESA | Spain's National Aviation Safety Agency |
| AGL | Above ground level |
| AMM | Aircraft Maintenance Manual |
| AMT | Aviation maintenance technician |
| AOC | Air operator certificate |
| ATA | Air Transport Association |
| ATPL (A) | Airline transport pilot license (airplane) |
| BRK | Brakes |
| BSCU | Braking steering control unit |
| CDL | Configuration deviation list |
| CFDS | Centralized fault display system |
| CFM | CFM International (engine manufacturer) |
| cm | Centimeters |
| CM1 | Captain |
| CPL (A) | Commercial pilot license (airplane) |
| CVR | Cockpit voice recorder |
| DGAC | Civil Aviation General Directorate |
| EASA | European Aviation Safety Agency |
| ECAM | Electronic centralized aircraft monitoring |
| ENG | Engine |
| FA | Flight attendant |
| F/CTL | Flight control |
| FCOM | Flight Crew Operating Manual |
| FCTM | Flight Crew Training Manual |
| FDR | Flight data recorder |
| FOLD | Factored operational landing distance |
| ft | Feet |
| GND | Ground |
| h | Hours |
| HST | High-speed tape |
| IAE | International Aero Engines |
| ICAO | International Civil Aviation Organization |
| IDG | Integrated drive generator |
| IFR | Instrument flight rules |
| IR | Instrument rating |
| kg | Kilograms |
| km | Kilometers |
| kt | Knots |

| | |
|-------|--|
| L/G | Landing gear |
| LEBB | ICAO code for the Bilbao Airport |
| LGCIU | Landing gear control interface unit |
| LH | Left hand |
| m | Meters |
| MCDU | Multifunction control and display unit |
| MEL | Minimum equipment list |
| METAR | Meteorological aerodrome report |
| MLG | Main landing gear |
| OEB | Operational engineering bulletin |
| OM-B | Operations Manual Part B |
| PFR | Post flight report |
| QAD | Quick attack-detach |
| RH | Right hand |
| S/N | Serial number |
| SB | Service bulletin |
| SOP | Standard operating procedure |
| SYS | System |
| TLB | Technical logbook |
| UTC | Coordinated universal time |

Synopsis

| | |
|-------------------------------------|--|
| Aircraft owner and operator: | Vueling Airlines S.A. |
| Aircraft: | Airbus A-320-232, registration EC-MDZ, S/N 6377 |
| Date and time of incident: | Wednesday, 25 October 2018 at 05:07 h ¹ |
| Site of incident: | Bilbao Airport (Vizcaya) |
| Persons on board: | 6+114, uninjured |
| Type of flight: | Commercial air transport – scheduled – domestic – passenger |
| Phase of flight: | Takeoff – Takeoff run |
| Flight rules: | IFR |
| Date of approval: | 3 June 2020 |

Summary of event

On Wednesday, 25 October 2018 at 05:07 UTC, an Airbus A-320-232 aircraft, registration EC-MDZ, operated by Vueling Airlines, S.A., was making the first flight of the day, from Bilbao to Barcelona, with a total of 120 persons on board.

During the takeoff run on runway 12, both fan cowls detached from the left engine. The crew were unaware of this fact until they arrived at Barcelona, where they landed normally at 05:55 UTC on runway 25R.

Once on the ground, the crew started receiving multiple ECAM messages. They continued taxiing to parking, where the passengers disembarked normally. It was then that they were informed that both fan cowls had detached from the left engine. Fragments from the cowls were found embedded in the left leg of the main landing gear.

There were no personnel injuries and the aircraft sustained minor damage, caused when the cowls impacted various parts of the airplane's structure.

On the night of 24-25 October, maintenance work had been performed that required opening and closing the cowls on the airplane's left engine.

¹ UTC time. To obtain local time, add 2 h to UTC time. Unless otherwise specified, all times in this report are in UTC.

The investigation has determined that the incident was caused by flying the airplane without closing and properly latching the cowls on the airplane's left engine, which was in turn the result of an improper maintenance operation and of the incorrect performance of the walk-around check prior to the flight.

No safety recommendations are issued.

1. FACTUAL INFORMATION

1.1. History of the flight

On Wednesday, 25 October 2018 at 05:07 UTC, an Airbus A-320-232 aircraft, registration EC-MDZ, operated by Vueling Airlines, S.A. with flight number VY1431, experienced the detachment of both fan cowls from the left engine while taking off from runway 12 at the Bilbao Airport.

The aircraft was making the first flight of the day, from Bilbao to Barcelona, with a total of 120 persons on board, 6 of whom were crewmembers (2 pilots and 4 cabin crew). On this flight, the first officer was the pilot flying and the captain was the pilot monitoring.

At the moment of rotation, the crew heard a different sound than usual, and seconds after takeoff, an ECAM LGCIU2 FAULT message was received. The crew carried out the relevant procedure and after analyzing the situation, they decided to continue the flight to the Barcelona Airport, where they landed normally at 05:55 UTC on runway 25R.

Once on the ground, the crew started receiving multiple ECAM messages. They continued taxiing to parking, where the passengers disembarked normally. It was then that they were informed that both fan cowls had detached from the left engine. Fragments from the cowls were found embedded in the left leg of the main landing gear.

There were no personnel injuries and the aircraft sustained minor damage, caused when the fan cowls impacted various parts of the airplane's structure. On the night of 24-25 October, maintenance work had been performed that required opening and closing the fan cowls on the airplane's left engine.



Fig. 1 and 2: side views of the aircraft's left engine after the incident

1.2. Injuries to persons

| Injuries | Crew | Passengers | Total in the aircraft | Other |
|----------|-------|------------|-----------------------|-------|
| Fatal | | | | |
| Serious | | | | |
| Minor | | | | |
| None | 2 + 4 | 114 | 120 | |
| TOTAL | 6 | 114 | 120 | |

1.3. Damage to aircraft

The aircraft sustained minor damage, namely the loss of the left engine (or engine 1) fan cowls and the damage that their detachment caused to the airplane:

- Fuselage (damages of varying extent², where the detached parts impacted)
- Left belly fairing
- The LH and RH fan cowls on engine 1
- Nose cowl on engine 1
- RH thrust reverser cowl on engine 1
- Left engine pylon (front structure and outer panels)
- Left wing: outboard flaps and inboard flap, and slat 1
- LH MLG fixed door
- Landing gear light torn out (located below left wing)
- Cabling for sensor 23GA disconnected, and damage to the connection that links LGAB3 with connector 4029VC (all located in the left leg of the MLG)³

1.4. Other damage

After the incident, the fragments that had detached from the aircraft were picked up at the Bilbao Airport. Even though some were of considerable size, they did not cause damage to the airport infrastructure or to other aircraft.

1.5. Personnel information

1.5.1. Information on the aircraft's flight crew

The captain, a 38-year-old Spanish national, had an airline transport pilot license for airplanes (ATPL(A)) that was first issued on 2 December 2008, with A320 and IR(A)

² Various types of dents and/or scratches (superficial or deep, penetrating the surfaces or not, etc.).

³ The repercussions of this are explained later.

ratings, all of them valid until 31 March 2019. He also had a class-1 medical certificate that was valid until 23 January 2019. He had a total of 5860:29 flight hours, of which 4719:29 had been on the type and 1994:47 as the pilot in command. He started working for Vueling in April 2012.

The first officer, a 35-year-old Spanish national, had a commercial pilot license for airplanes (CPL(A)) that was first issued on 21 December 2011, with A320 and IR(A) ratings, all of them valid until 31 March 2019. He also had a class-1 medical certificate that was valid until 28 April 2019. He had a total of 3202:47 flight hours, of which 2744:11 had been on the type. He started working for Vueling in March 2015.

1.5.2. Information on the aircraft's cabin crew

The purser was 40 years old and had a cabin crew certificate issued by Spain's National Aviation Safety Agency (AESA) on 11 November 2013. He also had a cabin crew medical certificate that was valid until 27 November 2019. He had a total of 9317:36 hours as a FA, of which 3654:31 had been as a purser. He started working for Vueling in January 2007.

He took the type rating course (A320) in December 2006. His last annual refresher training to renew his qualification had been on 26 September 2018, which extended the validity of his certificate until 31 October 2019.

The flight attendant number 2 (FA2) was 24 years old and had a cabin crew certificate issued by AESA on 16 April 2013. He also had a cabin crew medical certificate that was valid until 5 May 2022. He had a total of 4605:11 hours as a FA, and started working for Vueling in July 2013.

He took the type rating course (A320) in March 2013. His last annual refresher training to renew this qualification had been on 11 October 2018, which extended the validity of the certificate until 30 November 2019.

The FA3 was 28 years old and a had cabin crew certificate issued by AESA on 14 December 2012. He also had a cabin crew medical certificate that was valid until 4 April 2022. He had a total of 4191:50 hours as a FA, and started working for Vueling in April 2013.

He took the type rating course (A320) in September 2015. His last annual refresher training to renew this qualification had been on 27 September 2018, which extended the validity of the certificate until 30 September 2019.

The FA4 was 26 years old and a had cabin crew certificate issued by AESA on 7 April 2014. He also had a cabin crew medical certificate that was valid until 11 June 2023. He had a total of 1855:36 hours as a FA, and started working for Vueling in April 2015.

He took the type rating course (A320) in May 2018, meaning his qualification was valid until 31 May 2019.

1.5.3. Information on the Aviation Maintenance Technicians

In the early morning of 25 October, during the night stop, two aviation maintenance technicians (AMT1 and AMT2) who worked for Iberia Mantenimiento⁴ performed maintenance tasks that required opening and closing the fan cowl on the airplane's left engine.

The AMT1 was 48 years old and had a Category B1 (EASA Part-66) Aircraft Maintenance License for turbine engine aircraft issued by AESA that was valid until 3 September 2023.

He also had a certificate for Vueling's fleet of Airbus A-319/320/321 aircraft with the IAE PW1100G, IAE V2500, CFM56 and CFM LEAP-1A engines, which was valid until 30 April 2020.

He started working for Iberia Mantenimiento in January 1999, and his first certificate for doing work on the A320 fleet dates from April 2002.

The AMT2 was 33 years old and had a Category B1 (EASA Part-66) Aircraft Maintenance License for turbine engine aircraft issued by AESA that was valid until 3 September 2023.

He also had a certificate for Vueling's fleet of Airbus A-319/320/321 aircraft with the IAE PW1100G, IAE V2500, CFM56 and CFM LEAP-1A engines, which was valid until 30 April 2020.

He started working for Iberia Mantenimiento in July 2012, and his first certificate for doing work on the A320 fleet dates from February 2017.

1.6. Aircraft information

The Airbus A320-232 aircraft, registration EC-MDZ and serial number 6377, was manufactured in 2014 and entered in AESA's aircraft registry on 28 April 2015. The aircraft had a maximum takeoff weight of 77000 kg, an empty weight of 42000 kg and was equipped with two IAE V2527-A5 engines.

Its main dimensions are:

- Length: 37.57 m
- Wingspan: 34.1 m

⁴ AESA-approved maintenance organization with number ES.145.011

- Height: 11.8 m

It had a certificate of airworthiness issued by AESA, the last review of which extended its validity to 21 December 2018.

The aircraft was being operated by Vueling S.A., whose Air Operator Certificate (AOC) was last renewed on 14 August 2018. This AOC allowed the aircraft to operate Airbus A320-200 aircraft like EC-MDZ.

At the time of the incident, the aircraft had 11051 flight hours and 7572 cycles.

The last scheduled maintenance check, a 20- and 40-month inspection as per Iberia WP S8074830, was carried out by Iberia Mantenimiento at its Barcelona hangar, with 8696:44 flight hours and 5892 cycles on the aircraft, which was released to service on 15 January 2018.

It listed a door on the rear wastewater panel as a deferred maintenance item, which was dispatched as per the CDL.

1.6.1. Recent maintenance on the left engine

The aircraft's left engine (or number 1) had serial number V17517 and had 11051 flight hours and 7572 cycles.

On the night of 24-25 October 2018, aircraft EC-MDZ was scheduled to undergo maintenance involving the daily check and a check of the torque on the tension bolt on the QAD in IDG #1 (AMM Task 24-21-41-200-010-B).

A non-scheduled task was also added to drain the water from the fuel tanks.

The daily check was done first, followed by the check of the torque on the tension bolt on the QAD in IDG #1, as per AMM Task 24-21-41-200-010-B. This was done by AMT1 and AMT2.

This task involves the sub-tasks of opening (AMM Task 71-13-00-010-010-A) and closing (AMM Task 71-13-00-410-010-A) the fan cowls on engine #1.

The opening sub-task (Task 71-13-00-010-010-A), in Section 3, Job set-up, states to "Make a record in the aircraft logbook that the fan cowl doors have been opened" so the pilots are aware that the cowl doors on one (or both) engines were opened for maintenance.

Similarly, the closing sub-task (Task 71-13-00-410-010-A), in Section 5, Close-up, states to "Make a record in the aircraft logbook that the fan cowl doors have been closed" so the pilots are aware that the cowl doors on one (or both) engines were closed after the relevant maintenance.

According to the statements from AMT1 and 2, once the above task was finished or nearly finished (their memory of this is not clear), the cleaning crew asked for their help with the door on the rear wastewater panel, since the cover was sealed with high-speed tape (HST) that had to be removed. AMT2 went to the storage area to pick up some HST while AMT1 stayed behind to remove the tape covering the panel. Due to the problems they were having removing it, they had to return to the storage area to get a spatula. Once the task was completed, AMT2 went to another airplane to do the same task involving checking the torque on the QAD tension bolt. AMT1 reapplied the HST to the water panel as per CDL 52-03 and completed the unscheduled task to drain the water from the fuel tanks.

After finishing the tasks on aircraft EC-MDZ, AMT1 made three entries in the logbook, the first for the daily check, the second for draining the water in the fuel tanks, and the third for tightening the torque on the QAD tension bolt in IDG #1. The last entry, however, did not make any reference to opening and/or closing the cowls on the left engine. The entry made in the logbook involving this third (and final) task is shown below:

Actions taken and completed by ☒ Pilot ☒ Maint ID 645805
WORK PACKAGE EC-MDZ-271018, 242100-06-1-1 FOR EC-MDZ C/OUT
Doc. ref. Part 21-41-200-010 Rev A Ref. MEL/CDL Limitation ☒ YES ☒ NO
Part Number On

Fig. 3: Logbook entry for the task performed on the #1 engine

1.6.2. Fan cowls. Description and operation

The fan cowls on the engine consist of two semi-cylindrical sections installed between the inlet nose cowl and the translating thrust reverser cowl. Each semi-circular cowl is approximately 1.3 m wide and 3.1 m high, measured around the circumference. They are made of an aluminum honeycomb material with a carbon fiber coating. The left panel weighs 42 kg and the right one 47 kg.

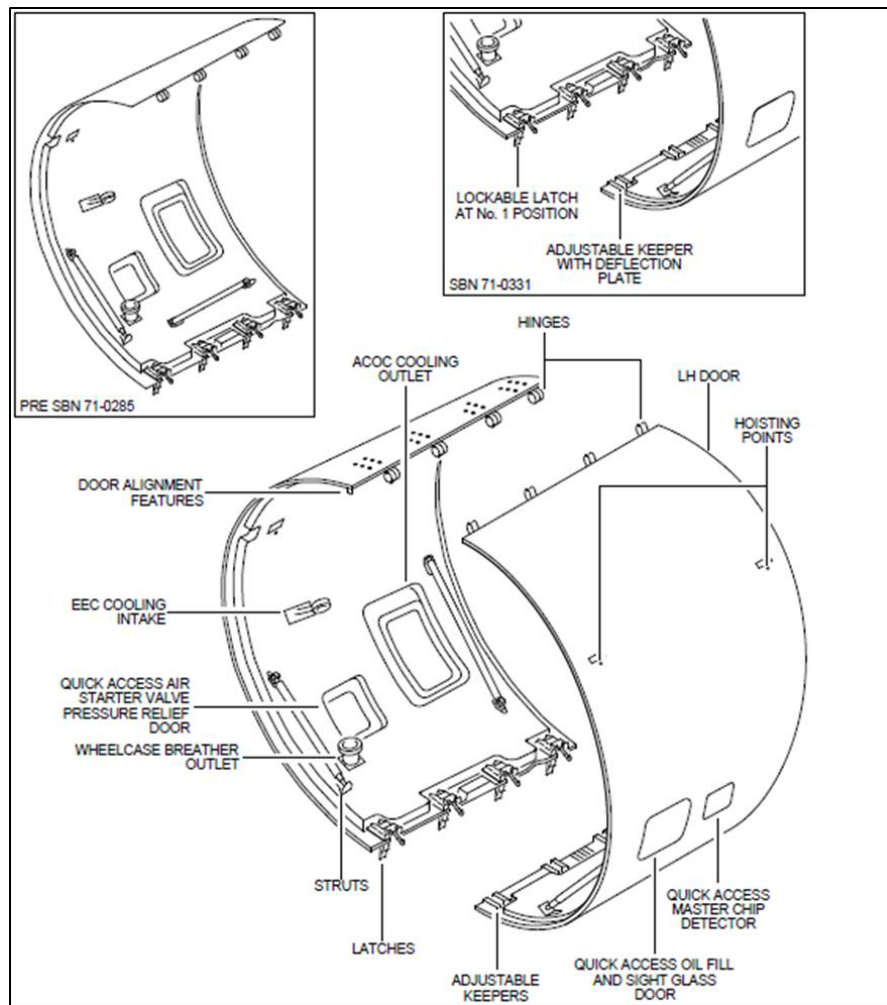


Fig. 4: General diagram of the cowls and their main parts

Each cowl is coupled to the engine pylon at the top using four screwed hinges. At the bottom, each cowl is coupled and attached to the other cowl using four latches. Each latch moves a hook that engages a keeper that is installed on the other cowl (see figure below).

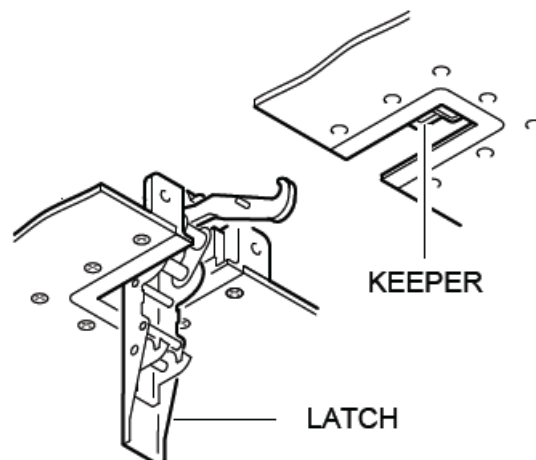


Fig. 5: Close-up of the latch-keeper system

Opening the cowl

The cowls are opened as specified in airbus task 71-13-00-010-010-A, which calls for using a fan cowl flag once the cowls are opened. The cowls are held open using a pin to keep them from accidentally closing. The figures below show the flag and its location once attached.



Fig. 6: Fan cowl flag

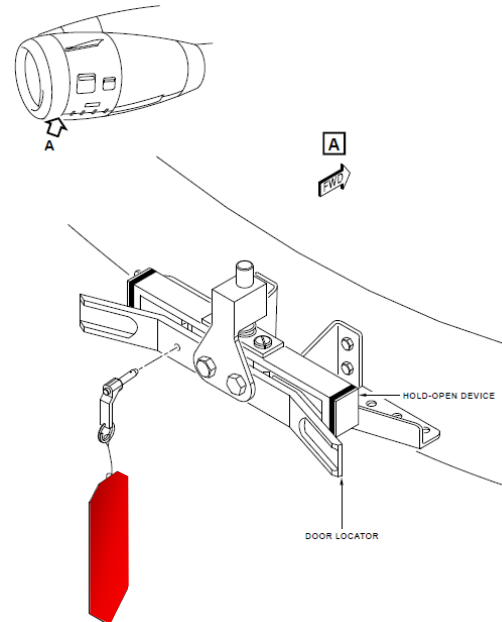


Fig. 7: Fan cowl flag attached

As indicated earlier, the AMT has to document the opening of the cowls in the logbook.

Closing the cowl

Closing the cowl is detailed in airbus Task 71-13-00-410-010-A, which specifies to first remove the hold-open rods on the cowls and to lower the cowls by hand, without letting them drop, until they reach their lowest position. This safety position is such that there is a 3-4 cm gap between the cowls and the structure they attach to, and is intended to prevent crushing the fingers of the AMT.

With the two cowls in the above position, the latches do not reach the keepers due to the safety distance, and from outside it is clear to the naked eye that the cowls are not closed. The procedure then instructs to remove the fan cowl flag.

To fully close the cowls, the AMT has to lie down and push up on a safety pin (located where the two cowls come together, at the front end, in the direction of motion of the aircraft). When this pin is pressed, the two cowls drop and the edges of their panels touch, making it possible to close the four latches.

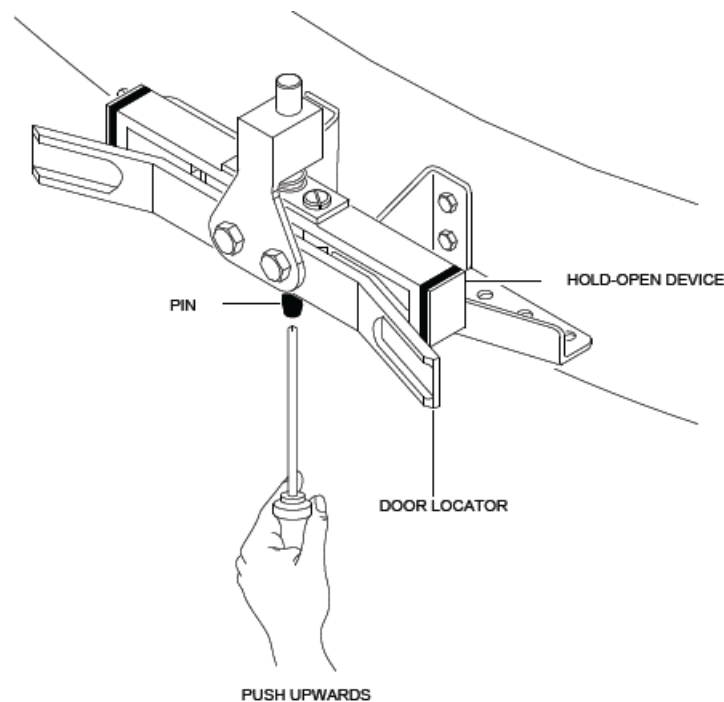


Fig. 8: Close-up of the safety pin and its operation to close the cowl

In the above position, a latch is manually lined up with the corresponding keeper. The closing lever is pushed toward the cowl, causing a distinctive sound. The latch is now closed even though the handle is not flush with the cowl and is visible from underneath.

If the handle continues to be pressed into the cowl, it becomes flush with it (making another distinctive sound), leaving it in a position that is safe for flight.

As indicated earlier, the AMT must document the closing of the cowl in the logbook.

1.6.3. Directives and Service Bulletins involving the cowl

Since 1992, the number of lost fan cowl door events have led the manufacturer and authorities to issue various directives and/or service bulletins, which have introduced changes to the cowl to help identify improperly closed cowl after maintenance.

On 18 December 2015, Airbus issued service bulletin (SB) A320-71-1069, titled POWER PLANT - FAN COWL DOORS - INTRODUCE NEW FAN COWL DOOR LATCH WITH KEY & FLAG ON IAE V2500 ENGINE. This document was revised on 28 April 2016.

The manufacturer of the cowl, GOODRICH AEROSTRUCTURE, in turn issued SB No. V2500 NAC-71-0331, titled NACELLE – FAN COWL – INTRODUCTION OF A NEW LOCKABLE LATCH ON THE RIGHT-HAND COWL DOOR AND NEW KEEPER CLEVIS ON THE LEFT-HAND COWL DOOR on 22 December 2015, with two subsequent revisions in 2016 and 2017. It provided technical guidance to make the relevant modifications and comply with Airbus SB A320-71-1069.

Additionally, on 14 March 2016, EASA published airworthiness directive (AD) 2016-53, titled ATA 71 – Power Plant – Fan Cowl Door Latch with Key and Flag, IAE engines – Modification and replacing France DGAC AD 2001-381(B), dated 5 September 2001. The AD had an implementation period of 36 months from its effective date of 28 March 2016 (meaning it had to be implemented on the affected aircraft by 28 March 2019). This directive mandated the implementation of Airbus SB A320-71-1069.

SBN71-0325, which corresponded to the status prior to the issue of SB 71-1069 and SB V2500 NAC-71-0331, was implemented on aircraft EC-MDZ.

SBN71-0325 required the implementation and use of the pin and the fan cowl flag.

Vueling had planned to gradually implement AD 2016-53 in its fleet by the end of 2018. Specifically, for aircraft EC-MDZ, implementation was scheduled for November 2018. After the incident involving EC-MDZ in Bilbao, Vueling accelerated the implementation of SB 71-1069 in its fleet, with EC-MDZ being the last aircraft in its fleet to implement it on 15 January 2019, following the repairs due to the damage sustained in the incident.

Content of SB 71-1069

Bulletin 71-1069 entails making a series of modifications to the latch assembly located closest to the engine air intake, and replace the fan cowl flag with another device called a key and tethered flag, whose use resembles that of the fan cowl flag but with a very important new feature: the cowl cannot be opened without first inserting the key and tethered flag into the pin on the latch. The pin also cannot be removed while the cowl is open.

This is a significant difference, since before the implementation of SB 71-1069, cowls could (physically, though not procedurally) be opened and closed without using the fan cowl flag. With the modification implemented, the new key and tethered flag is always hanging and highly visible until it is removed, which cannot be done until the cowls are fully and securely closed.

According to information provided by Airbus over the course of this investigation, in every case of an incident similar to this one where SB 71-1069 had also not been implemented, it was concluded that the engine cowls had been left open, or were closed but not latched, causing them to accidentally open and break off on the following flight.

1.6.4. LGCIU – Landing gear control interface unit

The flight crew normally operate the landing gear by means of the landing gear lever, located on the center instrument panel.

The two Landing Gear Control Interface Units (LGCIU) electrically control the sequence of operation of the landing gear and the wheel well doors. One LGCIU controls one full landing gear cycle, automatically switching to the other LGCIU at the completion of the retraction cycle.

The LGCIUs receive information on the position of the landing gear, the cargo compartment doors and the flaps.

The LGCIUs receive the following information on the landing gear from proximity sensors:

- landing gear locked in the up or down position
- compression or extension of the landing gear struts
- landing gear doors open or closed

If one LGCIU fails electrically, the other LGCIU takes control of the landing gear. In addition, if they detect any problems, they also generate messages that are shown on the cockpit instruments.

1.6.5. CFDS and post-flight report

The purpose of the Centralized Fault Display System (CFDS) is to facilitate maintenance tasks by displaying fault messages in the cockpit instruments. The CFDS can be used to access maintenance reports, such as the post-flight report.

The table below shows an excerpt from the post-flight report that was generated after the incident flight:

| UTC time | Phase | ATA | Message on ECAM |
|----------|-------|-------|--------------------------|
| 05:07 | 05 | 32-00 | L/G LGCIU2 FAULT |
| 05:07 | 05 | 27-00 | F/CLTL |
| 05:55 | 08 | 77-11 | ENG 2 REVERSER FAULT |
| 05:55 | 08 | 30-31 | ANTI ICE CAPT PITOT |
| 05:55 | 08 | 77-11 | ENG 2 EIU |
| 05:56 | 09 | 27-00 | F/CTL SLAT SYS 2 FAULT |
| 05:56 | 09 | 21-58 | FUEL INERTING SYS FAULT |
| 05:56 | 09 | 22-00 | AUTO FLT RUD TRIM1 FAULT |
| 05:56 | 09 | 22-00 | AUTO FLT RUD TRV LIM 1 |
| 05:56 | 09 | 34-48 | NAV GPWS TERR DET FAULT |
| 05:56 | 09 | 22-00 | AUTO FLT YAW DAMPER 1 |

The various phases of flight are as follows.

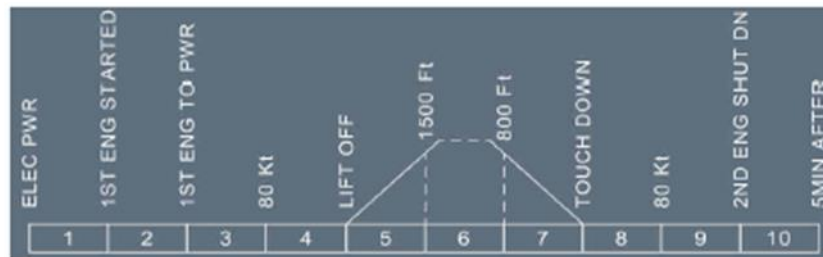


Fig. 9: Number assigned to each phase of flight for identification purposes

Note that the LGCIU2 fault message occurred in phase 5, which is between rotation and 1500 ft AGL. The following messages sent to the CFDS were generated 48 minutes later, after landing in Barcelona. They were in phases 8 and 9, meaning between touchdown and 80 kt on the landing run for phase 8, and from there to second engine shutdown for phase 9.

1.7. Meteorological information

The 04:30 and 05:00 UTC METARs for the Bilbao airport were:

- 250430Z 10003KT 080V140 9999 3000SE BCFG SCT002 08/08 Q1022 TEMPO 1500 BCFG BKN002=
- 250500Z 10004KT 2500 BCFG SCT002 08/08 Q1022 TEMPO BKN002=

At the time of takeoff, visibility was 2500 m at the surface, with fog banks. The local temperature and dew point were both 8° C, which confirms that the atmosphere was saturated with humidity.

As for the sunrise times at the airports of origin and destination in relation to the departure and arrival times, respectively, that information is as follows:

- Takeoff in Bilbao: 05:07 UTC
- Sunrise in Bilbao: 06:38 UTC
- Landing in Barcelona: 05:55 UTC
- Sunrise in Barcelona: 06:15 UTC

The sun had not yet risen during either operation.

The image below, taken from a camera in the airport building (at 04:45 UTC on 25 October 2018), shows the visibility conditions at the stand where the aircraft was parked. Note that there were no problems with the visibility (at distances on the scale of the airplane's size) due to the presence of artificial lighting.



Fig. 10: Aircraft parked at the stand minutes before chocks off

1.8. Aids to navigation

All navigational aids worked correctly during the incident flight.

1.9. Communications

Investigators had access to the cockpit voice recorder (CVR), which contained the communications between the flight crew and operations personnel on the ground and air traffic control services, the most relevant of which are summarized below:

- 04:52:22 UTC: the crew request final checks from handling personnel, who report to the crew that all doors and covers are closed.
- 05:07:03 UTC: after starting the takeoff run, the captain calls out "rotate", with a snapping noise being heard two seconds later.
- 05:07:07 UTC: the captain announces "positive climb" and the first officer requests "gear up".
- 05:07:49 UTC: the captain announces ECAM LGCIU2 FAULT. The flight crew carry out the relevant procedure and decision-making process and continue the flight normally to Barcelona.
- 05:14:40 UTC: the purser goes into the cockpit and informs the pilots of a noise that was heard during rotation. The captain tells him they had a fault message for a landing gear computer and that they will request maintenance after landing in Barcelona.
- 05:22:23 UTC: the purser again goes into the cockpit to inform the pilots that a passenger indicated to him that "the cover is missing" from an engine (left), and

they have a conversation about this. They note that there is more noise than usual, but there are no abnormal readings in the cockpit.

- 05:40:22 UTC: the crew contact Barcelona Material, informing them of their arrival in 20 minutes with an LGCIU2 FAULT. The flight crew were analyzing the LGCIU2 FAULT for the duration of the flight and its potential cause and effects on flight operations. The crew hold the approach briefing, which includes a mention of the LGCIU2 FAULT.
- 05:55:28 UTC: after completing the landing run on runway 25R at Barcelona Airport, the first officer transfers control of the aircraft to the captain.
- 05:56:34 UTC: the flight crew express surprise at the number of ECAM messages being received.
- 06:04:44 UTC: after arriving at stand 230 at Barcelona Airport, the crew are informed that they have lost the left engine fan cowls.

1.10. Aerodrome information

The Bilbao Airport (LEBB) is 9 km north of the city of Bilbao. It is at an elevation of 136 ft and has two runways, designated 12/30 and 10/28, that are 2540 and 1910 m long, respectively, and 45 m wide.

At the time of the incident, the lighting was in the nighttime configuration at intensity 3 for landings and takeoffs on runway 12.

1.11. Flight recorders

The aircraft was equipped with a flight data recorder (FDR) and a cockpit voice recorder (CVR) that recorded the last 25 and 2 hours, respectively.

The section on Communications summarizes the conversations of interest that were recorded in the cockpit by the CVR.

The graph below is for the takeoff phase, and show the time when the two fan cowls on the left engine were lost, triggering the LGCIU2 FAULT.

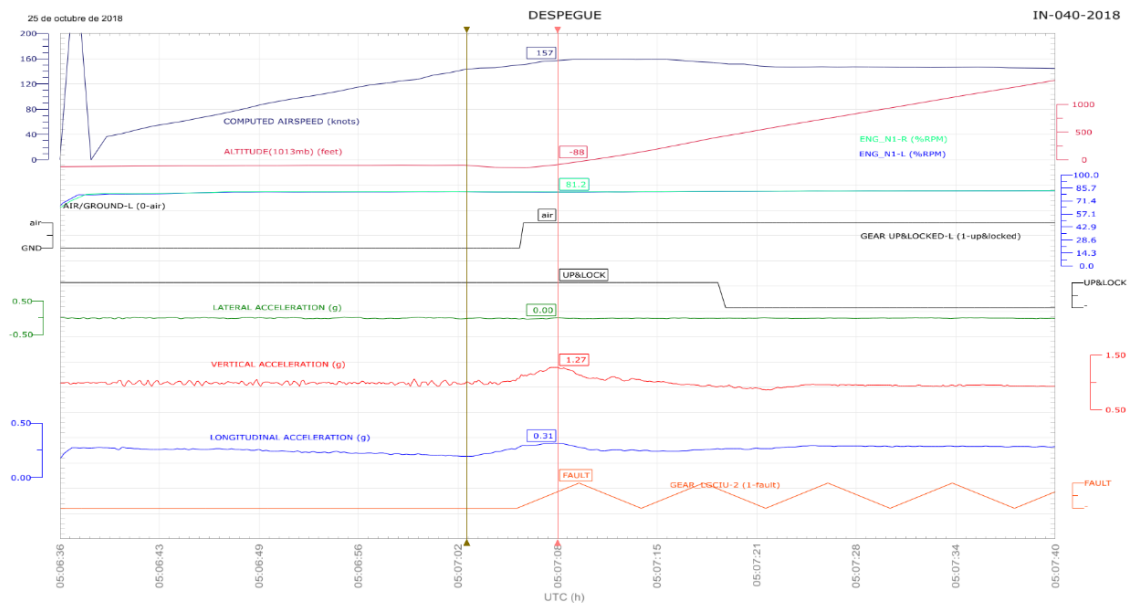


Fig. 11: Parameters of interest during takeoff phase

The graph below shows the landing phase.

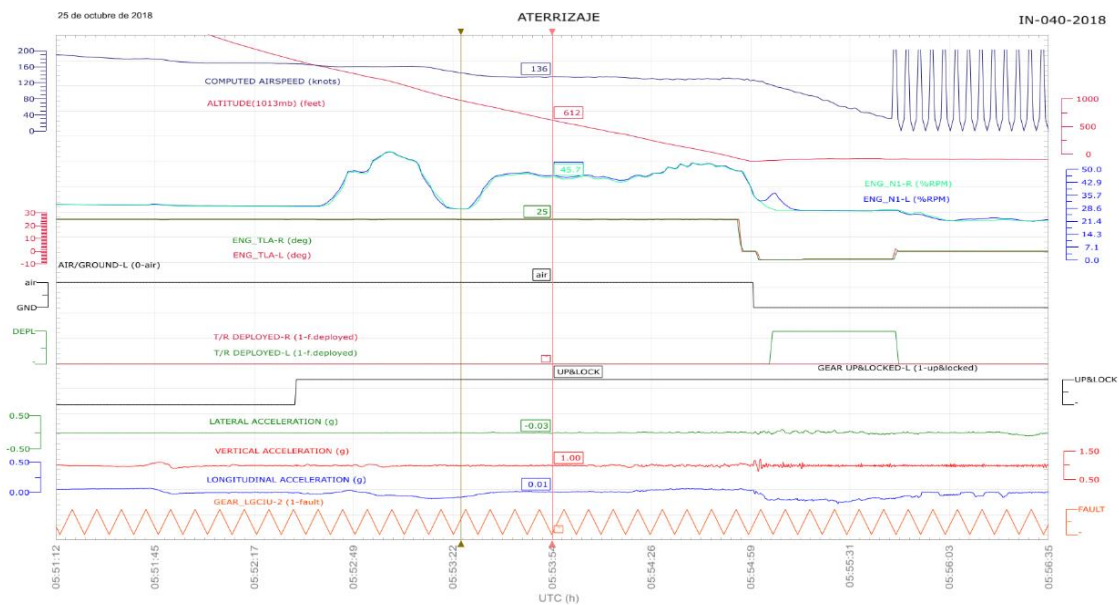


Fig. 12: Parameters of interest during landing phase

It should be noted that the parameters contained in the FDR pertaining to the operation of the two engines during the incident flight were analyzed. No significant differences were found in their performances.

Specifically, the vibrations in the left engine were analyzed, and nothing significant was found. This finding agrees with the pilots' statements involving the readings in the cockpit during the flight.

1.12. Wreckage and impact information

Sequence of events

During the takeoff run at the Bilbao Airport, the two fan cowls for the left engine detached from aircraft EC-MDZ. The detached cowls struck several surfaces on the aircraft, damaging them and causing additional elements to detach, such as the landing light located underneath the left wing.

All the parts that detached from the aircraft came to rest on the sides and shoulder of runway 12 at the Bilbao Airport, with the exception of one cowl fragment, which was embedded in the structure of the left main landing gear leg, where it remained until Barcelona.



Fig. 13: Locations of largest fragments found at the Bilbao Airport

After the takeoff of EC-MDZ (05:07 UTC), another ten aircraft took off from the same runway (the chocks-off time of the last one was 06:15 UTC). None of their crews reported seeing any objects on the runway or having any problems during the takeoff run or once they were airborne.

At 06:16 UTC, the operations department at the Bilbao Airport was notified by Barcelona of the possibility that the fan cowls that had detached from EC-MDZ could be inside the airfield at the Bilbao Airport.

At 06:18 UTC, a marshaller at the Bilbao Airport double checked runway 12/30 (once in each direction) and only found two pieces on the runway, whose size was much smaller than that of a fan cowl (see previous figure, the sub images at the lower right corner).

Landings on runway 12 at the Bilbao Airport (after the departure of EC-MDZ) began at 05:21 UTC. Seven were uneventful, but during the eighth, at 06:46 UTC, the crew of the aircraft reported seeing large pieces on the shoulders of runway 12.

At 06:19 UTC, a marshaller at the Bilbao Airport again checked runway 12, and this time was able to locate large pieces (fan cowls) on the shoulders of runway 12. The runway was closed at 06:51 UTC.

The runway was opened at 07:17 UTC following an inspection and removal of debris (about 40 pieces from the engine nacelle and another 50 smaller parts).



Fig. 14: Location of one of the fan cowls

Inspection of the fragments

The fragments that detached from the aircraft in Bilbao were sent to the maintenance hangar in Barcelona where the aircraft was parked for an inspection and subsequent repairs.

The inspection yielded the following findings:

- 1) With respect to the two fan cowls, its four closing mechanisms (fixed and moving parts) and latched attachment to the pylon:
 - The four housings of the latch hooks did not exhibit any kind of damage or deformation, not even scratches on the metal surfaces that could be indicative of a forced separation.

- Of the four moving parts that are actuated to open and close and that are exposed once the fan cowls are opened, two were not damaged and were able to move normally. One of them was severely dented and deformed, but it was still able to move, and the other was slightly dented, exhibiting little deformation and able to move.
- The findings indicate that when the cowls opened in flight, there was no physical connection between the closing mechanisms and their respective housings, meaning the two cowls were open.
- The fittings on each cowl that hinged to the engine nacelle were still in place and did not detach, meaning the two cowls detached, but not at the hinges.

2) With respect to the damage found on the aircraft:

- The left engine did not have any dents.
- The structure of the left main landing gear leg exhibited damage, especially where the cowl fragment had been embedded.
- There was damage of varying extent⁵ in several areas that were impacted by detached pieces.
- Specifically, on the left main landing gear leg, sensor 23GA of LGCIU2 was disconnected (due to impact). This is what caused the fault message in phase 5 at 05:07 UTC (the proximity sensor L L/G EXT, SYS 2 (23GA) is connected to LGCIU2). There was also damage to the cable that connects LGAB3 to connector 4029VC, which remained attached. Both the tachometer 19GG and the brake cooling fan motor assemblies are connected to 4029VC (tachometer 19GG is connected to the BSCU, which exchanges information with LGCIU2, and the brake cooling fan motor assembly is connected to the hydraulic/BRK fan wheels through contactor 5GS, which sends a signal to LGCIU2 about the status of the connectors).



Fig. 15 and 16: Damage to connectors (close-up at right showing two impacts)

⁵ Various types of scratches and/or dents (superficial or deep, penetrating the surfaces or not, etc.)

1.13. Medical and pathological information

There were no injuries.

1.14. Fire

None.

1.15. Survival aspects

Other than the loss of the two fan cowls on the left engine, the flight was completely normal.

Upon arriving at the destination, the aircraft taxied to its assigned stand and the passengers were disembarked normally.

1.16. Tests and research

1.16.1. Statement from the aircraft's captain

A summary of the report written by the captain of the aircraft, along with additional comments he made during a personal interview, is provided below.

"After signing at 04:15 UTC and picking up all the flight documentation, we proceeded to the airplane, parked at stand 6 on the apron at Bilbao. Once there, we reviewed all the documents, calculated the fuel needed for the flight, and decided that the first officer would be the pilot flying on the first leg of the day.

We reviewed the Technical Logbook and saw that the airplane only had one deferred item (a cover on the aft wastewater panel, dispatched as per the CDL), and we confirmed that the daily check was done. Maintenance had signed the "Release to Service" box. We also saw entries indicating various work packages that were done at night, but none showing that maintenance had opened the engine cowls, as per their procedure whenever they do tasks that require opening/closing it.

We had the joint briefing with the cabin crew and after that, I began with my tasks as the pilot monitoring. After finishing the preliminary cockpit preparation, I went down to do the walkaround check with a vest and flashlight.

Before doing that, I signed the fuel order and then proceeded to do the visual, routine nighttime check as per the points described in the FCOM. I did not notice anything on the engines that made me think that the latches on the fan cowls were not closed properly.

After I finished, I went up to the cockpit and we continued our tasks, like on any other flight.

Before requesting pushback, I asked the coordinator for the final checks, to which he replied "all doors and panels are closed and the pin is in position". After pushback and engine start-up, the coordinator gave us the all clear on the right of the airplane after doing the visual checks and disconnecting the pin.

Once cleared to take off on runway 12, with practically no wind, we applied power and began the takeoff run normally. During rotation, with the nose wheel already in the air but with the main landing gear on the ground, we heard a low noise, similar to the noise the nose wheel makes when running over the runway centerline lights (but it was so normal that in the cockpit we did not look at each other or make any comments).

The airplane rotated normally. We did not notice any strange motions, any loss of power or of aerodynamic control, and with a positive climb, we raised the gear, which retracted normally at the usual speed. We received a MASTER CAUTION for the LGCIU2 FAULT, which cannot be reset in flight, only on the ground. We verified that no OEB was applicable in this case, so we did the ECAM steps (which did not have any actions, only status (Approach Idle and Rev #2)) and continued climbing. The doors on the ECAM were OK.

After checking the MEL and FCOM, we calculated the FOLD and decided that with the fault we had, the best option was to continue the flight to the destination.

The F/CTL message (which came in on the PFR at the same time as LGCIU2) was not present on ECAM. We saw it on the ground upon opening the MCDU maintenance page.

About 20 minutes after takeoff, the purser came in to bring us breakfast. He also mentioned that a passenger had told him that he had seen something strange in the engine, so the purser inspected it visually from the aisle but could not see anything, since it was dark. The passenger's explanation was also not very clear, so the purser put his mind at ease, telling him everything was fine. The purser told us that the passenger did not appear to be a frequent traveler and did not seem to know what he wanted to say. He also told us that from the wings back, the airplane was noisier than at the front, but no more so than in other airplanes we typically fly. We had already noticed an increase in the noise level after accelerating to 250 kt before reaching 10000 ft, but no more so than in other, older aircraft. After checking the cockpit readings and seeing they were all normal, we continued the flight to Barcelona.

We prepared for the approach to runway 25R at Barcelona, taking into account that the only fault present at the time was LGCIU2, which rendered the reverser on engine #2 inoperative. During the briefing, I reminded the first officer of the need to arm both

reversers even though we knew the #2 reverser would not work, and I informed him that we would receive a MASTER CAUTION during the landing run when the reverser failed to deploy (reverse 2 FAULT).

Once we were told our stand, we called maintenance to inform them of the fault so they could fix the problem during the stopover.

We landed normally and upon arming the reversers on both engines, we received a Master Warning REVERSE 2 FAULT, as expected since it was inoperative. Once we vacated the runway, and below the taxi speed, was when we received more master cautions that were unrelated to one another (capt pitot, gpws terrain det fault, slats sys 2 fault, yaw damper 1, rud trim1 fault and rud trv lim 1). The airplane was braked manually.

Once the doors were opened, I went outside to check on the cause of the warnings and I saw parts of the airplane were missing. I walked around the airplane and saw damage to several parts. I notified crew control at that point to have them call the Bilbao and Barcelona airports, thinking we could have left debris on some of the runways. Once confirmed that the airplane was inoperative, we got a call from the company office to arrange a meeting between the safety team, the pilots and the purser. In the afternoon, we returned on a ferry flight to Bilbao”.

When asked if he would have done anything differently in hindsight, he said he might have gone out to look at the engine through the window. He added that even if he had seen the fan cowls were missing, he would probably have continued flying to Barcelona instead of diverting to Zaragoza, since the readings in the cockpit were normal.

When asked if he had flown with the same crew before, he answered that he had.

1.16.2. Statement from the aircraft's first officer

A summary of the report written by the first officer of the aircraft, along with additional comments he made during a personal interview, is provided below, omitting any observations that repeat those already made by the captain.

As concerns the approach phase, he stated:

“I told the captain that I would try to lower the gear as late as possible within the company's SOP so that if any sensor on LGCIU2 was loose or some part was damaged, it would minimize the likelihood that it would fly off. Once on short final, I asked him to lower the gear at about 165 kt, near mile 6. The landing was smooth, with a crosswind from the right at about 15 kt, idle reverse and manual braking”.

1.16.3. Statement from the purser

A summary of the report written by the purser, along with additional comments he made during a personal interview, is provided below, omitting any observations that repeat those already made by the captain or first officer.

"Just as we were taking off, at the scheduled departure time, we heard a noise, a thud, not excessively loud, not sure where it had come from, as when the wheels go over a bump. I asked my coworker next to me if he heard it, and he said he did⁶. At the same time, we noticed that the passenger in row 2D had also heard it, because he looked at us at that moment, but nothing else happened and everything continued normally.

Once in the air, after the captain turned off the seatbelt sign, I contacted the cockpit and told them what we had heard, and they said they heard it too. They told us they had a caution come on for a landing gear computer, but that it was nothing serious.

I then returned to the passenger cabin and as I was going to the aft galley to get breakfast for the cockpit (I guess it was probably 15-20 minutes after takeoff), a passenger seated in row 9A⁷ called me and said "there's something strange outside, like the engine is missing a cover, you can see the inside of the engine". He was unable to explain himself well (although he spoke Spanish). I got as close as I could to see what he was talking about, but there was a passenger sleeping in the aisle seat, which restricted my view. Plus, it was nighttime so I could not see anything outside, just darkness.

I talked to him to try to make sense of what he is saying, but I could hardly see. I asked him if he was talking about the engine, where the fan blades are at the front, and he said yes, and I understood he thought there should be a cover over the front. He relaxed and did not say anything else.

When I got to the aft galley, I spoke to my coworkers and then, when I went back to the forward galley and then to the cockpit, I told the pilots. No other passengers said anything during the flight. I recall there were two young men sitting at the emergency exits on the left side, talking, and they also did not say anything.

The flight to Barcelona lasted about 50 minutes, which went by very fast, so once I left the cockpit, we offered the bar service as usual. Nobody mentioned anything strange or said anything. Most of the passengers were asleep. We finished the service approximately 25 minutes before landing.

It was a normal flight for the FAs, although we did discuss how, when walking through the cabin, the noise in the overwing section was a little louder than usual, which I also mentioned to the pilots.

⁶ The purser and FA4 were seated at the front of the passenger cabin and 2 and 3 were at the rear.

⁷ Seat 9A is a window seat, row 9, on the left side of the passenger cabin, and provides a clear view of the left engine.

We secured the cabin for landing as usual, and the landing was normal for us. We did not hear any strange noises when the landing gear was lowered, or during the final descent or while taxiing.

Once we reached the jet bridge and we started disembarking, I went inside the cockpit and the captain told me they had received ECAM faults and that he was going to see what was wrong. When I returned to the passenger cabin, the FA who was doing the stopover tasks for the next flight told me that a passenger had asked "if we knew about the condition of the left engine", which is when we realized what had happened".

When asked if, in hindsight, he would have done anything differently, he said that one of the rows behind 9 was empty and that he could have gotten close to the window and looked out to get a good look at the engine (despite the absence of any light outside).

1.16.4. Statement from AMT1

A summary of the report written by AMT1, who did the maintenance on the aircraft prior to the incident flight, along with additional comments he made during a personal interview, is provided below.

"The night of 24 to 25 October, we opened and closed the fan cowls on EC-MDZ. We started doing the scheduled work for the airplane, starting with the daily checks. Once finished, instead of bleeding the fuel tanks, AMT2 and I started doing the task scheduled for the left engine. We went to the office to get the tool we needed for the task. We took the "(HA2273-1) 1 KEY AND TETHERED FLAG" tool (including the flag) from the warehouse, which had been used on another aircraft. But we didn't need it on this airplane since the cowls are one of the few that didn't have the modification. We did the task between about one and two in the morning.

We opened the cowls, checked the torque on the QAD and closed the cowls. Neither AMT2 nor I recall not completing the process of closing out the cowls, including the inspection.

While we were finishing this task on the airplane, the cleaning crew told us that the potable water tank panel was covered with tape and that they had to top it off if possible. AMT2 went to get a roll of tape from the office, and I started taking off the HST. We had to go back for a spatula so we could remove it completely. Once the tank was topped off, we decided to have AMT2 go to another airplane to do the same scheduled task involving the QAD, which he did, taking the tools with him. I stayed to drain the tanks. I then went into the cockpit to fill out the logbook. We both took for granted that all the work that had to be done on the airplane was completed.

Earlier we had checked the oil level in the IDGs on both engines in another airplane, opening and closing the fan cowls, and then later on another one, which makes it

difficult to remember exactly what could have happened with the cowls on the incident airplane”.

When asked about the operation of closing the cowls on aircraft EC-MDZ specifically, he stated that when they lowered the two cowls, they did not lie down on the ground to close them for a reason he could not remember. They were no doubt called out for another maintenance task and they left. If he (or AMT2) had laid down, they would have closed the cowls, since the only reason for lying down is to close them. He stated that the most natural thing to do after lowering the cowls is to lie down. He could not explain why he did not do it this time and accepts that the cowls were not locked using the four latches.

He added that while there is a safety mechanism to keep the cowls from crushing your fingers, sometimes, if you lower them forcefully, the mechanism can be compressed, the gap is closed and the cowls are flush with the engine (which would make it unnecessary to press the pin with the screwdriver later). In this situation, if you walk by the engine, it looks like it is in the normal flight position (even though the latches are not closed). He stated having been very close to the engine that night after lowering the cowls and not seeing anything out of the ordinary.

When asked about the logbook entries, he stated that he remembered going to the cockpit to make three entries in the logbook, but he admits that he forgot to log the opening and closing of the fan cowls in the TLB (as is required) in order to inform the pilots of this.

When asked if he was physically well that night, he stated that he was not fatigued and that it was like any other work night.

1.16.5. Statement from AMT2

AMT2 also provided a written report and was interviewed. His recollection was practically the same as that of AMT1, and provided no new information.

1.16.6. Engine fan cowl opening and closing test

During the inspection of aircraft EC-MDZ after the incident at the maintenance hangar in Barcelona, the fan cowls on the right engine were cycled through a full opening and closing sequence.

The sequence of steps to take is as described in the above sections. The images below show the condition of the cowls once lowered, before the screwdriver is used to push the pin and close the safety gap. Note the gap that remains visible.



Figs. 17 and 18: Cowls lowered, before pressing the safety pin

The figure below shows the four latches open.



Fig. 19: Cowls lowered, four latches open

1.17. Organizational and management information

The following information was taken from the Vueling Operations Manual, OM-B, Normal Procedures:

- 1) 2.1.12.2.3 Exterior Inspection
See FCOM-PRO-NOR-SOP-05⁸.
The manual refers to the steps specified in the FCOM for the exterior inspection.
- 2) 2.1.12.2.5 Before Pushback or Start-Up
Before starting pushback, the CM1 (captain) asks ground personnel for the final checks.

⁸ Its contents are detailed in the next section.

3) 8.2.2.7.1 Start-up

Point 8.2.2.7, "Start-up, apron departure and arrival procedures", of the Vueling OM-A is copied below, which details the standard phraseology for all verbal or hand communications between the cockpit and ground personnel (GND).

- CM1: "Cockpit to ground, can you give me your final checks, please?"
- GND: "All doors and panels are closed and locked, the safety pin is in position. Ready to start pushback, please confirm parking brake is set".

As part of the procedure, ground personnel confirm to the captain that all doors and panels are closed.

1.18. Additional information

1.18.1. On the exterior inspection of the aircraft before the flight

1.18.1.1. Airbus FCTM

The goals of the walkaround inspection done by the crew, as described in the Airbus FCTM, include identifying potential abnormalities in the engines and verifying that the cowls are properly closed:

- *To observe any possible abnormality on the engines:*
 - *Fan blades, turbine exhaust, engine cowl and pylon status*
 - *Access door closed*
 - *Correct Closure/Latching condition of the fan cowls*

1.18.1.2. Airbus FCOM

Some of the steps for the crew to take during the exterior inspection, taken from the Airbus FCOM (PRO-NOR-SOP-05), are provided below:

STANDARD OPERATING PROCEDURES - EXTERIOR INSPECTION

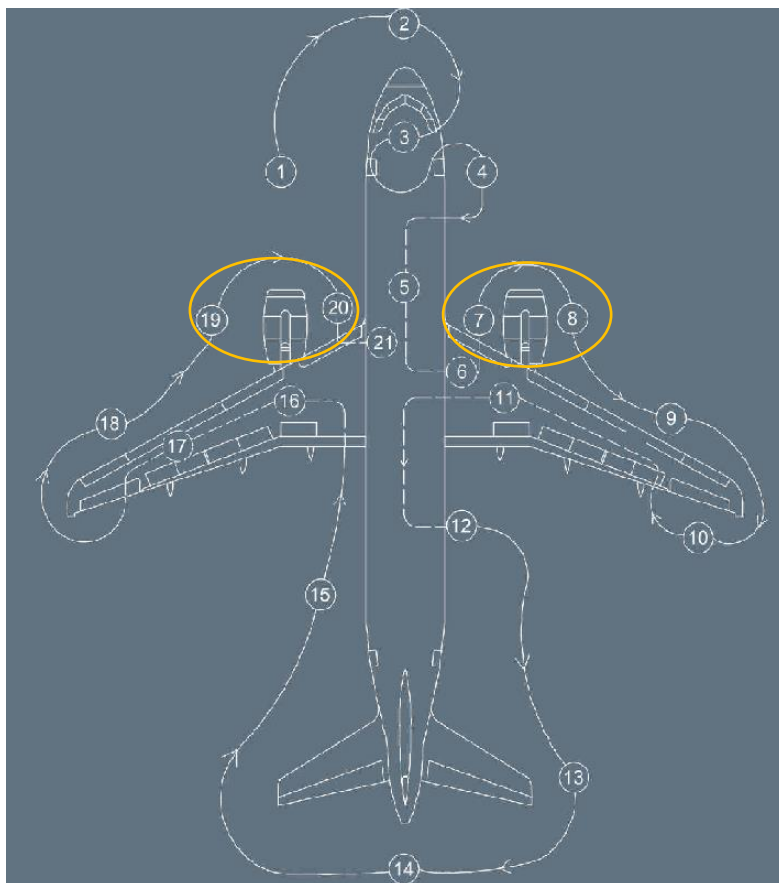


Fig. 20: Pre-flight exterior inspection, with areas of interest

Points 7, 8, 19 and 20 of the procedure specify the following (pertaining to the engine cowl):

ENG 2 LH SIDE

* Fan cowl doors.....CLOSED/LATCHED

ENG 2 RH SIDE

* Fan cowl doors.....CLOSED/LATCHED

ENG 1 LH SIDE


* Fan cowl doors.....CLOSED/LATCHED

ENG 1 RH SIDE

* Fan cowl doors.....CLOSED/LATCHED

1.18.2. On the procedure to perform after an LGCIU2 fault

The procedure to perform after an LGCIU2 fault, taken from the Airbus FCOM, is shown below:

| | |
|---|--|
| vueling VLG A319/A319/A320/A321 FLIGHT CREW OPERATING MANUAL | PROCEDURES ABNORMAL AND EMERGENCY PROCEDURES LANDING GEAR |
| L/G LGCIU 2 FAULT | |
| Applicable to: ALL | |
| Ident.: PRO-ABN-32-H-00011297.0001001 / 05 AUG 10 | |
| [E2] Crew awareness Ident.: PRO-ABN-32-H-00011298.0001001 / 05 AUG 10 | |
| <div> <div> [E12] ENG 2 APPR IDLE ONLY See ⁽¹⁾ </div> <div> STATUS INOP SYS LGCIU 2 REVERSER 2 </div> </div> <p><u>Note:</u> 1. The partial spoiler extension  at landing when only one main landing gear is compressed is not available. The spoilers extend normally on ground when wheel speed greater than 72 kt. 2. Depending on the LGCIU failure, only a part of the above systems may be lost.</p> <p>⁽¹⁾ When idle is selected on the ground with slats extended, only approach idle is available.</p> | |

The procedure calls for the crew to be vigilant after an LGCIU2 fault. It also notes that once on the ground with the slats extended, engine 2 will remain at approach idle, and that reverser 2 will be inoperative, along with LGCIU2.

1.18.3. Other information from the manufacturer

In July 2012 and 2019⁹, in its “Safety First” publication, Airbus published two articles that discussed the loss of engine fan cowls in flight.

The articles highlighted the need for maintenance technicians to strictly adhere to the instructions in AMM 71-13-00 to ensure the cowls are properly closed and latched. It contains recommendations and best practices for closing the engine fan cowls, and explains how, during the walkaround check, the most effective way to verify that the cowls and closed and latched is to bend down in order to have a more direct line of sight to the latches.

1.19. Useful or effective investigation techniques

Not applicable.

⁹ The latter issue was published after this incident.

2. ANALYSIS

2.1. General considerations

On Wednesday, 25 October 2018, an Airbus A-320-232, registration EC-MDZ, operated by Vueling Airlines, S.A., was preparing to make the first flight of the day, from Bilbao to Barcelona. On this flight, the first officer was the pilot flying and the captain was the pilot monitoring. There were 120 persons on board.

The crew had the necessary, valid licenses and medical certificates required to make the flight.

The aircraft was airworthy and its documentation was valid.

On the night of 24-25 October, during the night stop, maintenance had been performed that required opening and closing the fan cowls on the left engine.

The personnel who did the maintenance tasks on EC-MDZ had the licenses and certificates required to perform these tasks.

At 05:07 UTC, as the aircraft rotated while taking off from runway 12 at the Bilbao Airport, the fan cowls detached from the left engine.

The weather during the incident flight was not limiting and did not have any adverse effects on the flight.

2.2. Situation prior to the incident flight

EASA AD 2016-53 mandated the implementation of Airbus SB A320-71-1069 by 28 March 2019 in all affected aircraft (which included EC-MDZ). On the date of the incident, it had not yet been implemented on EC-MDZ, as there were still about five months remaining before the EASA deadline. However, it was scheduled to be implemented in November 2018, that is, one month after the incident.

Due to the incident involving EC-MDZ in Bilbao, Vueling accelerated the implementation of SB 71-1069 in its fleet, with EC-MDZ being the last aircraft in the fleet to receive the implementation, on 15 January 2019, once the damage sustained during the incident was repaired.

On the date of the incident, SBN71-0325, which corresponded to the state prior to the issue of SB 71-1069 and SB V2500 NAC-71-0331, had been implemented on EC-MDZ. SBN71-0325 required the installation and use of the fan cowl pin and flag. Once implemented, SB 71-1069 replaced the use of the fan cowl flag with another called key and tethered flag, whose use resembles that of the flag and pin but adds an important

new feature: the cowl cannot be opened without first inserting the pin from the key and tethered flag in the latch, and the pin cannot be removed as long as the cowl stays open.

Maintenance tasks prior to the incident flight

Several hours before the incident, during the night of 25 October 2018, two maintenance technicians performed tasks that required opening the engine fan cowls on both aircraft where SB 71-1069 had been implemented (using the key and tethered flag) and on aircraft where it had not (such as EC-MDZ, where the fan cowl flag was used instead).

The above notwithstanding, in both cases, the maintenance technicians should have documented the opening and closing of the cowls in the aircraft's logbook, as required by the Aircraft Maintenance Manual (AMM Task 71-13-00-010-010-A and AMM Task 71-13-00-410-010-A). In the case of EC-MDZ, the maintenance technicians did not make these entries.

When asked about this later, they recalled having gone to the aircraft's cockpit to make three entries in the logbook, but the technician in question recognized that he had forgotten to document the opening and closing of the cowls in the logbook, as is required.

The maintenance technicians who had worked on the left engine of EC-MDZ hours before the incident flight also stated that when they lowered the two cowls, they did not lie down face up on the floor to close them, though they could not remember why. Even though lying down to close them is second nature after lowering the cowls, they could not explain why this time they did not do it, as was their habit, and they acknowledged that the cowls were not properly locked using the four latches.

They also stated that they had been very close to the engine after lowering the cowls on several occasions that night and did not see anything unusual.

Based on these findings, it may be concluded that the cowls were not properly closed and locked using the four latches. It is very likely that the safety gap that exists between the lowered cowl and the nacelle was very small (or practically non-existent) such that despite walking by the engine on several occasions afterward, they did not see anything unusual.

The fact that EASA AD 2016-53 was fully implemented on the Vueling fleet two and a half months before the deadline is considered a positive, as it significantly reduces the risk of improperly latched cowls in the future.

Actions taken by the crew before the incident flight

From the point of view of the aircraft's operation and the crew's actions, the crew had three sources of information to determine the condition of the cowls:

- 1) The aircraft logbook, in which the tasks to open and close the fan cowls should have been documented.
- 2) The visual check of the status of the cowls during the exterior inspection, and
- 3) The confirmation from ground personnel that all doors and covers are closed and locked before pushback.

The first involves checking the aircraft logbook for the maintenance tasks performed, and specifically the opening and closing of the cowls. This entry informs the crew that the cowls were operated during maintenance activities, and focuses their attention to check the condition of the cowls during the external inspection. These entries were not made, meaning the crew did not have this indication to inform them that the cowls had been opened and closed.

The second involves the crew checking the condition of the cowls during the exterior inspection. This inspection was done by the captain, who did not notice anything on the engines that made him question whether the latches on the cowls were properly secured. This reinforces the idea that the cowls, once lowered, left a very small gap with the engine fairing, being practically flush with it. However, if the pilot who did the exterior inspection had crouched to see if the latches were flush with the nacelle, he would have noticed that they were not (see Figure 19), and would have therefore realized that they were open.

The third and final source involves the check by ground personnel that all the doors and covers are closed and locked, which was the message relayed to the crew before pushback. In light of the previous paragraph, it can be deduced that the ground personnel had the same problems as the crew identifying the condition of the cowls.

Even though the sun was not yet up when the maintenance tasks and exterior inspections of the airplane were carried out, in light of the eyewitness statements and of the lighting conditions evident in Figure 10, the visibility conditions are not deemed to have been a limiting factor in conducting these tasks.

2.3. Situation after the cowls detached

Once airborne, the detaching of the cowls triggered the ECAM LGCIU2 FAULT alert.

An analysis of the flight recorders shows that the crew carried out the relevant procedure and considered the impact of this fault on the aircraft's operation. Since there were no other alerts, after assessing its consequences, they decided to continue to the destination.

The engine parameter readings in the cockpit were normal at all times and there were no warnings indicative of a malfunction, fault or abnormal operation in the left engine. This is confirmed by the analysis of the FDR data, which show no sign of any malfunction in the left engine during the flight, or any operating parameters that differed from those for the right engine.

The only issue that the pilots discussed was the aerodynamic noise at high speed that the aircraft was making, which they did not consider to be unusual, and the specific noise they heard at the moment of rotation, which they also dismissed as nothing unusual or very different from the noise made when running over a runway centerline light.

There was one later indication that could have helped them identify the situation: the comment made by the purser to the pilots about what a passenger seated in 9A involving the "engine cover". However, the purser told the pilots that he had not seen anything out of the ordinary when he looked at the engine (from the aisle) after the passenger's comment. While the dark conditions outside did make it difficult to see the engine, the purser could have tried to get a clearer view from a window, since there were unoccupied seats behind the passenger in 9A. And he could even have asked the pilots to turn on the external lights on the airplane.

The above indicates that the only source of information that could have alerted the crew to the loss of the cowls was a visual confirmation of said loss. In light of the warnings received in the cockpit and of the information provided by the cabin crew, the flight crew did not have any indications that would have made them think that they had lost the cowls.

Based on the information available to the pilots, their decision to continue flying to Barcelona, as well as the measures taken by the pilots in response to the ECAM LGCIU2 FAULT message and its potential implications, are deemed to have been correct.

3. CONCLUSIONS

3.1. Findings

- On Wednesday, 25 October 2018, an Airbus A-320-232, registration EC-MDZ, operated by Vueling Airlines, S.A., was making the first flight of the day with a total of 120 persons on board from Bilbao to Barcelona.
- The crew of the aircraft had the licenses and medical certificates required for the flight and they were valid.
- The aircraft's documentation was valid and the aircraft was airworthy.
- The weather during the incident flight was not limiting and did not adversely affect the flight.
- On the night of 24 to 25 October, during the night stop, maintenance tasks had been performed on aircraft EC-MDZ that required opening and closing the left engine fan cowl.
- The personnel who performed the maintenance on aircraft EC-MDZ had the licenses and certificates required to perform said tasks, and they were valid.
- The maintenance technicians did not make the relevant entries in the aircraft logbook to document the opening and closing of the left engine fan cowl.
- The maintenance technicians did not close and secure the four latches on the cowl.
- During the walk-around inspection, the aircraft captain did not notice that the left engine fan cowl was not properly closed and latched.
- Ground personnel informed the pilots that all the covers were closed and latched before starting pushback.
- The visibility conditions did not limit the performance of the nighttime tasks prior to the flight.
- At 05:07 UTC, during the takeoff run on runway 12, the two fan cowl detached from the left engine. The crew did not realize this until they arrived at the Barcelona Airport, where they landed normally at 05:55 UTC on runway 25R.
- After aircraft EC-MDZ took off, ten additional aircraft took off from the same runway (the chocks-off time for the last one was 06:15 UTC). None of their crews reported seeing any objects on the runway or having any problems during the takeoff run or after takeoff.
- At 06:16 UTC, the operations department at the Bilbao Airport was notified from Barcelona of the possibility that the fan cowl that had detached from EC-MDZ could be inside the airfield at the Bilbao Airport.
- At 06:18 UTC, a marshaller at the Bilbao Airport double checked runway 12/30 (once in each direction) and only found two pieces on the runway, which were much smaller than a fan cowl.

- Landings on runway 12 at the Bilbao Airport (after the departure of EC-MDZ) began at 05:21 UTC. Seven were uneventful, but during the eighth, at 06:46 UTC, the crew of the aircraft reported seeing large pieces on the shoulders of runway 12.
- At 06:19 UTC, a marshaller at the Bilbao Airport again checked runway 12, and this time was able to locate large pieces (fan cowls) on the shoulders of runway 12. The runway was closed at 06:51 UTC.
- The runway was opened at 07:17 UTC following an inspection and removal of debris (about 40 pieces from the engine nacelle and another 50 smaller parts).
- In terms of the latches on the engine fan cowls, EASA AD 2016-53 mandated the implementation of Airbus SB A320-71-1069 by 28 March 2019 on affected aircraft (EC-MDZ was one of them). On the date of the incident, it had not been implemented on EC-MDZ.
- On the date of the incident, SBN71-0325, which corresponded to the condition prior to the issue of SB 71-1069, had been implemented on EC-MDZ.
- Vueling finished implementing EASA AD 2016-53 on its affected airplanes on 15 January 2019.
- After takeoff, an LGCIU2 FAULT was received on the ECAM in the cockpit. The crew did the relevant procedure and considered the implications of this fault on the operation of the aircraft. Since no further warnings were received, after weighing its consequences, they decided to continue to their destination.
- The indications in the cockpit were normal at all times. There were no messages warning of a malfunction, fault or abnormal operation in the left engine.
- One passenger in seat 9A informed the purser that "the left engine seemed to be missing a cover".
- The purser looked at the engine from the aisle and saw nothing unusual. The pilots were informed of this.

3.2. Causes/Contributing factors

The investigation has determined that the incident was caused by flying the airplane without closing and properly latching the cowls on the airplane's left engine, which was in turn caused by an improper maintenance operation and by the incorrect performance of the walk-around check prior to the flight.

The following factors contributed to the incident:

- The improper performance of the maintenance task before the flight, after which the cowls were left open and unlatched, and without the relevant entries being made in the logbook documenting the opening and closing of the fan cowls on the left engine.

- The incomplete performance of the visual inspections before the flight, during which the fan cowls were not identified as not having been properly closed and latched.

4. SAFETY RECOMMENDATIONS

None.