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Report
IN-052/2019

Incident involving an ATR 72-212 A aircraft, registration EC-MPI, operated by Canarias Airlines at the Tenerife North Airport (GCXO) on 15 October 2019

GOBIERNO
DE ESPAÑA

MINISTERIO
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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) nº 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.

Contents

Abbreviations

° ' "	Sexagesimal degrees, minutes and seconds
AD	Airworthiness directive
AESA	Spain's National Aviation Safety Agency
ANSV	Agenzia Nazionale per la Seguritat del Volo
AOC	Air operator certificate
ATC	Air traffic control
ATPL(A)	Airline transport pilot license (airplane)
CIAIAC	Spain's Civil Aviation Accident and Incident Investigation Commission
CPL(A)	Commercial pilot license (airplane)
CVR	Cockpit voice recorder
DESATI	Safety Evaluation and Technical Audit Office of the National Aviation Safety Agency
DSA	Aircraft Office of the National Aviation Safety Agency
EASA	European Aviation Safety Agency
ECI	Eddy-current testing
ECR-SRIS	European central repository
ECTM	Engine condition trend monitoring
EDS	Energy-dispersive X-ray spectroscopy
EMM	Engine Maintenance Manual
FAA	Federal Aviation Administration
FI (A)	Flight instructor rating for single-engine airplanes
FDR	Flight data recorder
FR	Form rib
ft	Feet
FWD	Forward
GCLP	Designator of the Las Palmas Airport
GMC	Ground control service
GCXO	Designator of the Tenerife North Airport
h	Hours
HSI	Hot section inspection
HP	High pressure
IFR	Instrument flight rules
IR(A)	Instrument rating
kg	Kilograms
km	Kilometers
kt	Knots

LCL	Local control service
LEMD	Designator of the Adolfo Suárez Madrid-Barajas Airport
LEER	Designator of the Lanzarote Airport
LONG.	Longitude
LPT	Low-pressure turbine
m	Meters
mm	Millimeters
NM	Nautical miles
N	North
No.	Number
P/N	Part number
P&WC	Pratt & Whitney Canada
PCRT	Process compensated resonance testing
PT1	First stage of the power turbine
PT2	Second stage of the power turbine
S	Second
SB	Service bulletin
SIL	Service information letter
SNS	Occurrence reporting system of the National Aviation Safety Agency
ST	Station
TR	Transport Canada
TRI (MPA)	Type instructor rating
UTC	Coordinated universal time
V1	Decision speed
VFR	Visual flight rules
W	West

Synopsis

AIRCRAFT	
Owner and operator:	Canarias Airlines
Aircraft:	ATR 72-212A, registration EC-MPI
Date and time of incident:	15 October 2019 at 09:38 (local time[1])
Site of incident:	Tenerife North Airport
Persons on board:	46 (uninjured)
Flight rules:	IFR
Type of flight:	Commercial air transport. Takeoff
Date of approval:	30 September 2020

Summary of event

On 15 October 2019, an ATR 72-212A aircraft, registration EC-MPI, was scheduled to fly from the Tenerife North Airport (Tenerife) to the airport in Gran Canarias (Las Palmas).

During the takeoff run on runway 12, while near its rotation speed, the crew decided to abort the maneuver when they heard a strange noise, followed by a vibration. They then saw abnormal readings for the parameters for the right engine.

They vacated the runway via exit E4 and returned to the stand.

Once there, they saw that the fuselage had been damaged and they were informed that small fragments of parts that had probably been released by the engine exhaust detached from the engine had been removed from the runway.

There were no injuries and the passengers disembarked normally.

The investigation has determined that the engine distress that forced the crew to abort the takeoff was caused by the fatigue fracture of a blade in the second stage of the power turbine (PT2), followed by the overload fracture of several more blades.

[1] Unless otherwise specified, all times in this report are local. To obtain UTC, subtract one hour from local time.

1. FACTUAL INFORMATION

1.1. History of the flight

On 15 October 2019 at 09:38, an ATR 72-212A aircraft, call sign RSC1XV and registration EC-MPI, was preparing to make flight NT112 from the Tenerife North Airport (GCXO) to the Gran Canaria Airport (Las Palmas, GCLP).

During the takeoff run on runway 12, while near the rotation speed (vr), the pilots heard a strange noise from the right side, followed by a strong vibration.

They then saw abnormal readings for the parameters for the right engine, so they decided to abort the takeoff.

After braking the airplane, they stopped the right engine and vacated the runway via exit E4. They then reported the event to the airport tower, which cleared them to taxi to parking, where they parked at stand 18.

There were no injuries and the passengers disembarked normally.

The pilots then conducted an external inspection of the aircraft and noticed damage to several areas (scratches on the aft part of the fuselage).

Moments later, airport officials informed them that various metal fragments had been removed from the runway and from the vicinity of exit taxiways E1 and E2, which were later determined to have released from the right engine through the gas exhaust.

Figure 1. Fragments removed from the runway

1.2. Injuries to persons

Injuries	Crew	Passengers	Total in the aircraft
Fatal			
Serious			
Minor/None	4	42	46
Total	4	42	46

1.3. Damage to aircraft

The aircraft sustained significant damage to its right engine and minor damage to the fuselage.

1.4. Other damage

None.

1.5. Personnel information

The pilot, 42, had an airline transport pilot license, ATPL(A), since 3 October 2007. He had obtained his commercial pilot license, CPL(A), on 17 April 2001.

He had a rating for ATR 42/72 aircraft, a rating for instrument flight, IR(A), and a type instructor rating, TRI(MPA), for the ATR 42/72 in a full flight simulator (FFS) only. His license, ratings and the relevant medical certificate were all valid.

He had a total of 7800 flight hours, of which 7000 had been on the type, 5500 as the captain and 1500 as the first officer.

The copilot, 24, had a commercial pilot license, CPL(A), since 12 September 2017.

He had a rating for ATR 42/72 aircraft, a rating for instrument flight, IR(A), and a flight instructor rating, FI(A), for single-engine aircraft. They were all valid, as was the relevant medical certificate.

At the time of the event he had a total of 970 flight hours, of which 750 had been on the type.

1.6. Aircraft information

1.6.1. General information

The ATR 72-212 A is a high-wing airplane powered by two turboprop engines that is used primarily for regional flights.

It is 27.166 m long, 7.65 m high and it has a wingspan of 27.05 m. It has a wheel track of 4.1 m and a wheel base of 10.77 m.

Its empty weight is 13566 kg and its maximum takeoff weight is 23000 kg.

The incident aircraft was manufactured in 2017. Its serial number is 1396 and at the time of the event it had 4508:37 flight hours and 8257 cycles.

It had a valid airworthiness review certificate.

The aircraft's weight and balance during the incident flight were within the limits specified by the manufacturer.

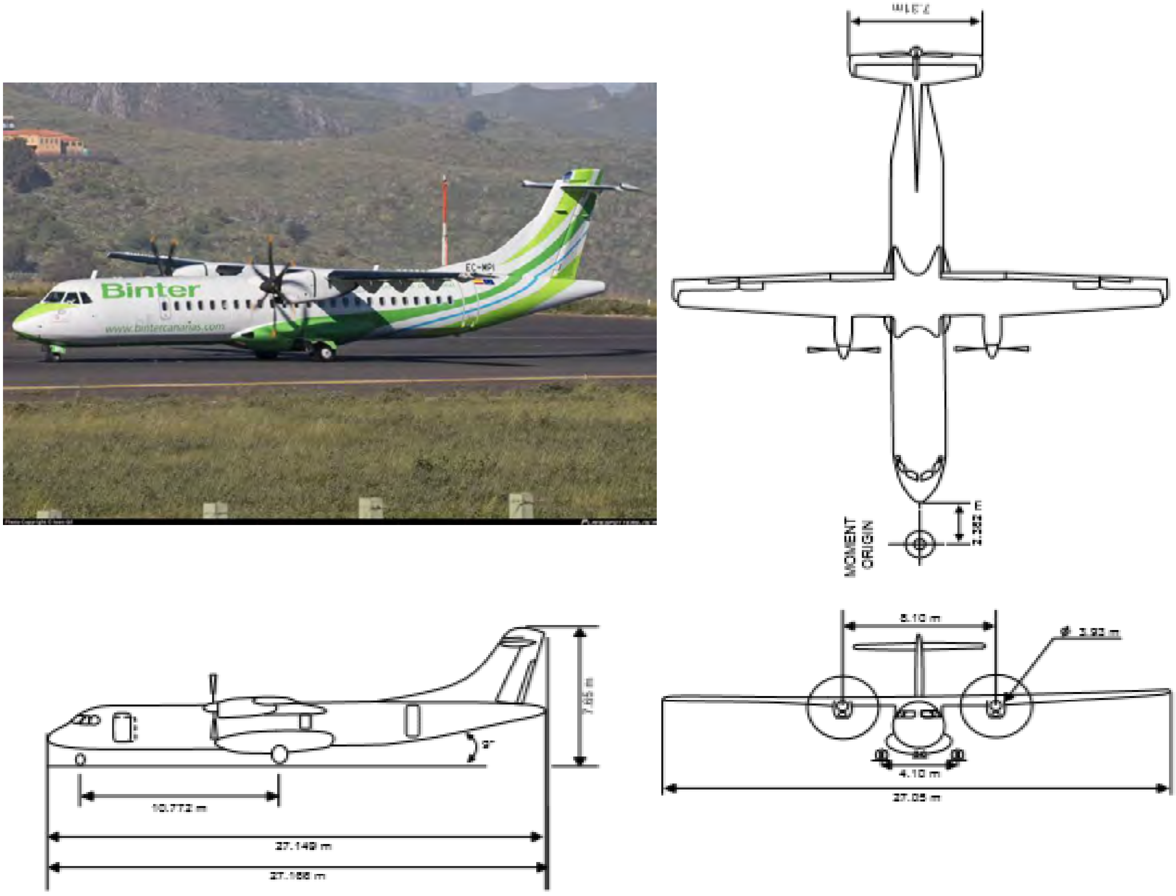

Figure 2. Views of the aircraft

1.6.2. Information on the powerplant

The aircraft was equipped with two Pratt & Whitney Canada PW127M- engines. This model belongs to the PW100 family of engines. It is of the turboprop variety and it is used on the ATR72-500/72-600 fleet of airplanes. It weighs 1060 lb (480.8 kg) and provides 2750 hp.

The serial numbers of this model begin with ED, and the manufacturing specification number is 1237. The ones on the aircraft had serial numbers ED1403 (left engine) and ED1404 (right engine).

Both engines had 2765:08 h (5148 cycles) on 14 October 2018, when they underwent the last maintenance check. On the day of the incident they had 4509:5 h (8259 cycles).

The engines are divided into two independent modules: the turbomachine and the reduction gearbox (RGB).

They use a three-shaft configuration with a free turbine, two reverse centrifugal compressors, one low pressure (LP) and the other high pressure (HP). They have a straight flow design (air intake at the front and exhaust at the back), inverse flow in the combustion chamber, two reduction stages in the reduction gearbox for the propeller, a digital electronic fuel control system with manual stand-by mode to mechanically control the fuel.

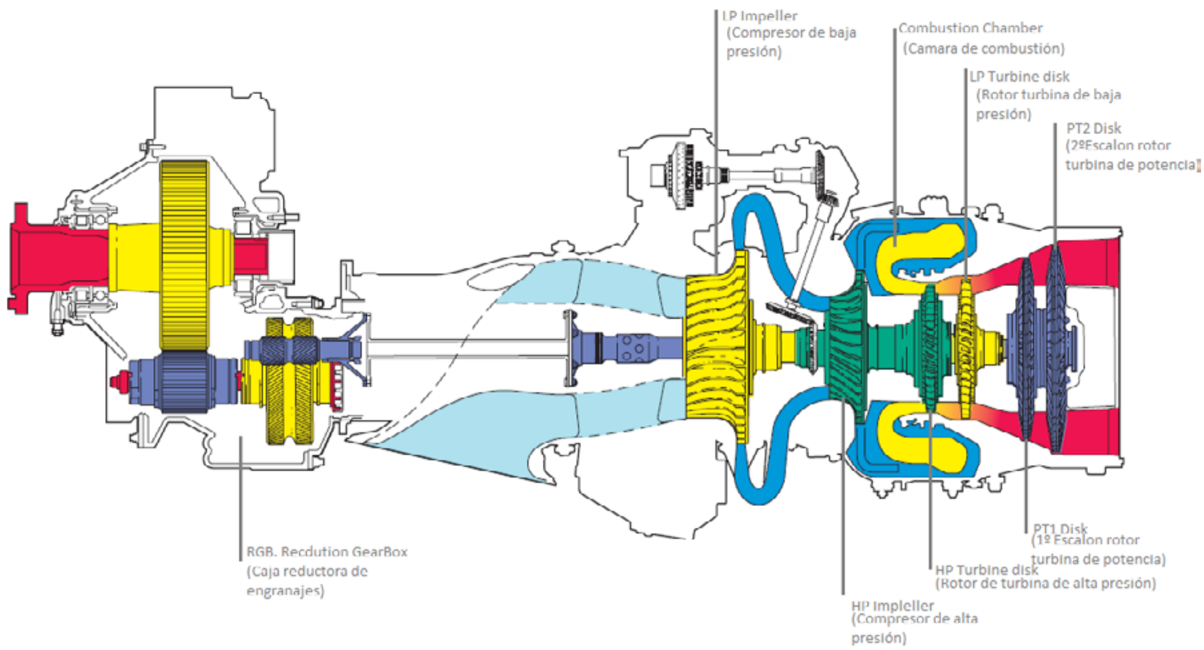

Figure 3. PW 100 engine

The right engine, which had the distress, was manufactured in October 2016. It had undergone a borescope inspection on 20 May 2019, a power verification check on 4 June 2019, and the fuel injectors had been replaced on 4 October 2019.

The blades in the turbine's first power stage had P/N 3123943-01, and in the second stage they had P/N 3124654-01.

The latter were installed as per Service Bulletin 21876, issued in July 2015, and featured a chromium coating on the leading edge of the blades improve resistance to corrosion caused by sulfidation.

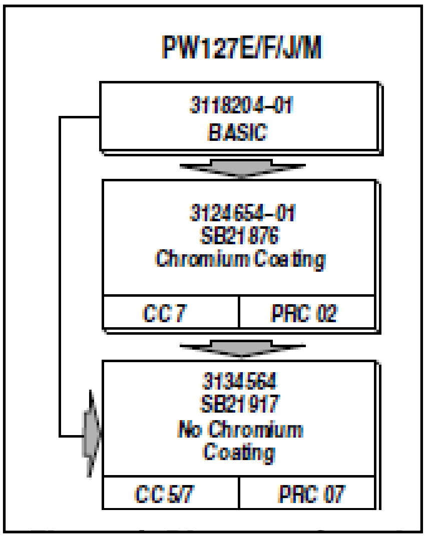

Figure 4. Diagram of service bulletins (SB)

In November 2017, Pratt & Whitney Canada published SB 21917, the latest revision to which (No. 7) is from 20 March 2019. This SB was published because the protective layer on the leading edge of the blades proposed in SB 21876 is not ideal for increasing the durability of the blades due to corrosion problems, and the SB recommends replacing the blades with PN 3124654-01 (which affect engine ED-1404) with other blades with PN 3134564. The SB recommends doing this when the engine is removed and accessible. However, the engine had never been dismantled.

The engine (ED-1404) did not have this SB implemented on the day of the incident.

1.7. Meteorological information

They did not affect the outcome of the event.

1.8. Aids to navigation

They did not affect the outcome of the event.

1.9. Communications

A summary of the communications between the crew and ATS is provided next.

At 09:32:31, ground control (GMC) cleared the crew of the aircraft, callsign RSC1XV, to push back and taxi to the runway 12 holding point. The pilot acknowledged the instruction correctly.

At 09:34:30, GMC instructed the crew to call the tower on 118.7 MHz when ready, which the crew acknowledged correctly.

At 09:36:09, the crew called local control (LCL) on 118.7 MHz, reporting they were at the runway 12 holding point ready to take off. The controller cleared them to line up and hold on runway 12.

At 09:37:12, LCL provided the crew wind information and cleared them to take off.

At 09:37:58, the crew informed the tower they were aborting the takeoff and that they would call to report their intentions. The controller acknowledged and replied that they could exit the runway via E3 or E4, and asked the crew to report their intentions. The crew replied that they would rather exit via E4.

At 09:39:34, the crew informed LCL that they needed to return to parking, and the controller cleared them to taxi to area Romeo, and specifically to R2.

At 09:40:11, LCL instructed the crew to continue to stand 9 and asked about the reason for the aborted takeoff. The crew replied they had an engine problem. They then asked LCL to stop at Romeo to complete a checklist before proceeding to parking, which they were cleared to do.

At 09:41:17, the crew informed LCL they were ready to taxi to stand 9, which the LCL controller authorized.

1.10.Aerodrome information

The Tenerife North airport, designator GCXO, is located on the north of the island of Tenerife (Canary Islands), 13 km west of the city of San Cristóbal de la Laguna. The aerodrome reference point (ARP) is at coordinates 28° 28′ 58″ N – 16° 20′ 30″ W.

The airport accommodates commercial traffic. General aviation traffic (both IFR and VFR) is restricted with the exception of medical, military, search and rescue and state flights, as well as flights of aircraft based at the airport itself.
It has one runway in a 12/30 orientation that is 3171 m long and 45 m wide.

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Figure 5. General view of the airport

1.11. Flight recorders

By the time the CIAIAC was aware of the incident, it was not possible to retrieve the flight recorders and download their contents at its laboratory. However, the operator had downloaded them and provided the resulting data.

1.11.1. Flight data recorder (FDR)[2]

The information provided by the FDR indicates that the airplane started moving at 09:32:50 and began its takeoff run at 09:37:21, after receiving clearance from ATC.

At 09:37:52, it reached the maximum speed, 98.4 kt, after which it began to drop off, matching a drop in the N1, NP, NL and ITT parameters for the right engine. The parameters for the left engine remained at normal values.

At 09:37:58, the incident was reported to ATS and they exited the runway at 09:38:46. The speed at the time was 27.9 kt.

[2] Annex 2 includes a graph with the most significant parameters obtained from the FDR.

1.11.2. Cockpit voice recorder

The cockpit voice recorder (CVR) yielded four tracks, each one 16:34 minutes long, which contained no information of use to the investigation.

One of the tracks had a pulse signal. Two other tracks, probably corresponding to the recording of the sound picked up by the captain's and first officer's microphones, respectively, had not recorded anything. The fourth track, containing the sounds recorded by the area microphone, had a constant noise but did not contain any conversations nor did it record the moment when the engine failed.

1.12. Wreckage and impact information

During the engine failure, several metal pieces detached that caused damage to the right side of the fuselage, between form ribs 28D and 33, and stations 9 and 15 (see Annex 1), as listed below:

TYPE OF DAMAGE	LOCATION	LENGTH	WIDTH	DEPTH	PHOTOGRAPH
1.Scratch	85 mm FWD FR 28D 18 mm below ST 14	11 mm	0,35 mm		
2.Arañazo (scratch)	150 mm FWD FR 28D 8 mm below ST 14	7 mm	2,5 mm		
3.Scratch & dent	225 mm AFT FR 31 90 mm below ST 14	42 mm	25 mm	0,25 mm	
4.Scratch	180 mm FWD FR 31 90 mm below ST 15	16 mm		0,4 mm	
5.Muesca (nick)	223 mm FWD FR 32 6 mm above ST 10			0,62 mm	

The following additional damage was also observed:

6. Nick located 67 mm FWD FR 31 and 18 mm below ST 15.

7. Nick located 125 mm FWD FR 31 and 12 mm below ST 15.

8. Nick located 10 mm FWD FR 31 and 12 mm above ST 14.

9. Scratch located 125 mm FWD FR 32 and 20 mm below ST 13.

10. Scratch located 35 mm FWD FR 32 and 69 mm below ST 13.

11. Nick located 47 mm FWD FR 32 and 38 mm above ST 14.

12. Scratch located 168 mm FWD FR 33 and 19 mm above ST 14.

13. Nick located 95 mm FWD FR 33 and 19 mm above ST 14.

14. Nick located 62 mm FWD FR 32 and 30 mm below ST 13.

15. Nick located 140 mm FWD FR 3 and on ST 15.

16. A perforation was also found on the vertical stabilizer on the dorsal fin panel. vertical.

1.13. Medical and pathological information

Not applicable to this event.

1.14. Fire

None.

1.15. Survival aspects

There were no injuries. The passengers exited the aircraft under their own power and in an orderly fashion once it was parked at the stand.

1.16. Tests and research

The damaged engine was removed from the aircraft and sent to Pratt & Whitney Canada headquarters in Canada, along with the detached fragments that were found. There, it underwent a detailed analysis between 2 and 4 December 2019 to study and analyze the components that had been damaged and to try to determine the causes.

The following damage was observed:

The blades in the second stage of the power turbine (PT2) were found fractured, and multiple fragments were missing. The exhaust cover was fractured and deformed (red arrow, Fig. 4).

However, the turbine case was not perforated, meaning all the fragments exited via the same route as the exhaust gases.

As a result, the engine contained all the detached and projected components, which were collected and sent for analysis, along with the engine (the orange arrow points to the bag where the fragments found on the runway were placed).
The purge valve was loose, attached only by one bolt, which was partially unscrewed. The valve connector and cable were damaged.

Figure 6. Engine seen from behind

The chip collector on the engine contained some fine metallic particles. The chip collector on the reduction gearbox was clean.

The main engine oil filter and the return filter from the reduction gearbox were also clean.

All the blades in the second stage of the power turbine (PT2 disk) were fractured at various lengths. The case on this stage of the turbine was also fractured, and multiple secondary damages were found on the trailing edge of the stator on the power turbine (PT2 vane).

The ring of blades on the second stage of the power turbine (PT2 vane) was fractured.

The first stage of the power turbine (PT1 disk) showed damage from secondary impacts to the trailing edges of the blades. The deflector on this stage was fractured and dented, and some components were missing.

The tips of the blades on the low-pressure turbine disk exhibited wear due to friction associated with the wear observed on the segments of the LPT casing. The tips of the blades on the high-pressure disk were found to have considerable wear due to friction and loss of material. Most of the cooling holes on the blades were not visible.

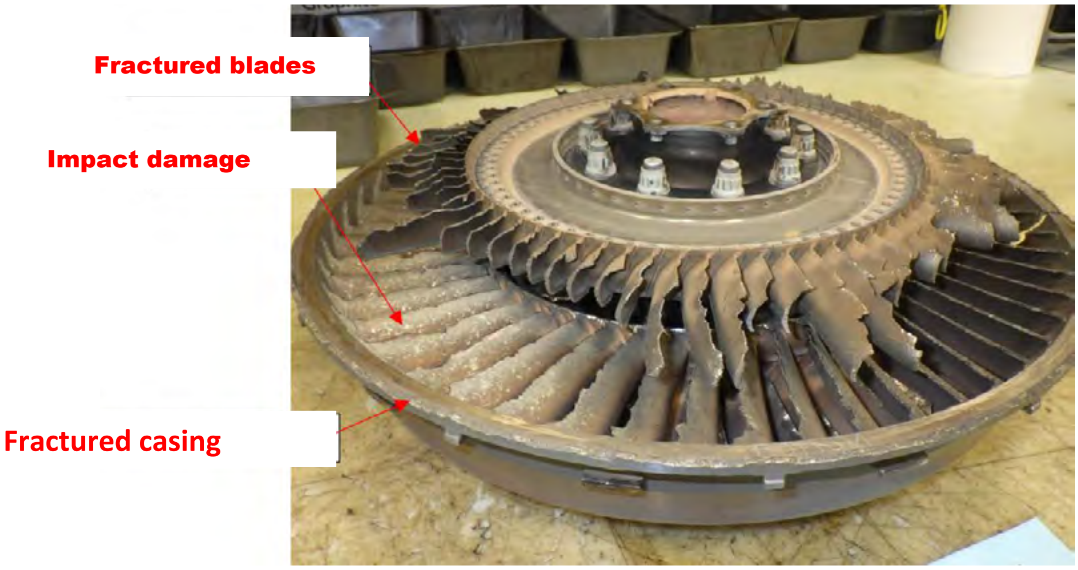

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Figure 7. Damage to PT2

The HP vane exhibited damage due to excess temperature and cracks on the aerodynamic airfoils. In addition, the LP shaft contained marks from rubbing against the HP disk.

The profiles on the LP impeller were also worn due to friction with the casing.

The outer diameter of the PT shaft was also worn due to friction with the inner diameter of the LP shaft.

The profiles of the blades on the HP impeller were worn and matched the wear found on the HP casing.

Figure 8. Damage to PT2 stator

As noted earlier, numerous blade fragments were found that had a type of localized straight fracture either directly on or just above their respective platforms. Other blades exhibited impact damage and angled fracture planes that were consistent with secondary damage.

Figure 9. Blade fragments found

The analysis of all the PT2 blades that exhibited a plane fracture near the platform revealed that only one of them (#8) showed evidence of fatigue near the leading edge, exhibiting significant wear.

The remaining blades had fractures consistent with overload.

On the blade that showed signs of fatigue, most of the fracture was located approximately 0.25" above the platform, and the region where the fatigue characteristics were found was located about 0.125" above the platform. The fatigue characteristics were around 0.150" away from where the leading edge would have been.

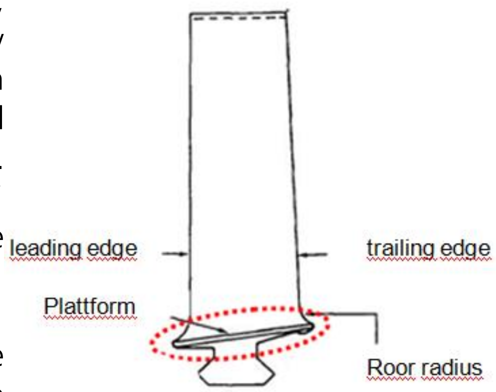

Figure 10. Parts of a blade

The area with the fatigue crack exhibited more oxidation than the rest. Upon noticing that the fatigue crack on the only affected blade was small, it was decided to perform a metallographic test of another blade (#18), as its profile was in the best overall condition, although since its leading edge was also missing, its trailing edge was examined.

The analysis found that the original material in the longitudinal transversal cross sections did not exhibit anomalies, nor were there significant heat alterations of the gamma prime precipitates.[4]

The energy-dispersive X-ray spectroscopy (EDS) analysis of the chromium layer and the base material in the longitudinal transversal section of the front edge of the reference blade (#18) showed that the ratios of the main elements detected were consistent with the usual requirements, meaning there was no evidence of sulfidation in the regions examined.

During the study and analysis, it was also noted that, historically, the data has shown that engines that operate in environments prone to sulfidation are more susceptible to experience fatigue in the PT2 blades. , Crack initiation at the blade leading edge from sulfidation and propagation by fatigue until final fracture by overload Although the chromium coating could not be characterized due to the presence of oxidated cracks on the leading edge, since the evidence was destroyed by the secondary damage, it is thought that the fatigue crack initiation and propagation method was similar to the historically documented process.

[4] The creep resistance of the alloys in turbine blades is strongly influenced by the morphology of the gamma prime precipitates. After the thermal treatment, the blades tend to have a simple gamma prime precipitate structure measuring 10-50 nm.

1.17. Organizational and management information

According to the company's Operations Manual, the company was founded in 2005 and it provides both passenger and air cargo transport services.

It has directors in the following areas: Flight Operations, Maintenance System, Crew Training, Ground Operations, Operational Safety and Compliance Control.

Said directors are also tasked with ensuring risk management and operational safety, the threats to airport safety from aircraft operations, and that operations are conducted in accordance with the conditions and restrictions in the Air Operator Certificate (AOC) and with CANAIR regulations and standards.

Part A of the manual, General, specifies in section 8.1.3.3, Takeoff minimums, that said minimums must ensure sufficient controllability of the aircraft in adverse circumstances, both in the event of an aborted takeoff and if the takeoff is continued after an engine failure.

Part B of the manual, Operational aspects involving the airplane type, Section 3, Abnormal and emergency procedures, and specifically sub-section 3.2.9, Aborted takeoffs, states that the cabin crew, in the event of an aborted takeoff, shall be on maximum alert until the captain gives the appropriate information for the situation, which may be Cabin Crew Operations Normal, or Cabin Crew Evacuate.

Part D of the manual, Training, covers the aborted takeoff maneuver during both the theory and practical phases, only in the simulator when at speeds close to the rotation speed.

1.18. Additional information

The CIAIAC, in concert with the State Air Safety Agency (AESA), searched for previous cases in the ECCAIRS database involving power turbine blade failures in the fleet of aircraft in Spain that use the PW100 family of engines, such as the Embraer 120, the ATR42 and the ATR72, since this blade type is the same on the entire family of engines, although it is more common in the PW127 models (which is the larger model of the PW100 family), which is installed on the ATR72.

A search of ECCAIRS was also conducted involving foreign operators, although no incidents were identified related to the power turbine. The 3452 public recommendations published to date in the European central repository (ECR-SRIS), and issued by European investigation authorities, were also analyzed.

The cases identified are presented below.

PREVIOUS CASES IN SPAIN

Three events involving fractured blades in PT1 were found (2010S04298 AIR NOSTRUM, 2018S16156 BINTER CANARIAS and 2018S18139 BINTER CANARIAS), and another three related to fractures in PT2 (2013S07251 SWIFTAIR, 2015S09676 CANARIAS AIRLINES and 2018S14184 BINTER CANARIAS).

Events were also identified involving blade failures in the high-pressure turbine (HPT), but they are not included in this analysis because there were not many occurrences in a short period of time.

1. AIR NOSTRUM 30 June 2010 (2010S04298)

This event was investigated by the CIAIAC (IN-019/2010). It occurred on 30 June 2010 and involved an ATR 72-500 aircraft, registration EC-HJI, operated by AIR NOSTRUM, which took off from the Madrid-Barajas Airport (LEMD) en route to the airport of Melilla (GEML) with 68 persons on board.

While climbing to 9000 ft, the fire alarm for the left engine was activated. The crew carried out the emergency procedure and returned to the airport.

The investigation determined that a blade in PT1 fatigue fractured as a result of microporosity during the casting process. The failed blade damaged PT1 and PT2, and caused oil lines to detach, which triggered the engine fire alarm. At the time of the incident, the engine had 674 hours since its last maintenance inspection. The report noted the improvements proposed by Pratt & Whitney Canada between the time of the incident and the publication date of the final report (27 March 2014), namely:

- Replacement of defective blades.
- Improved X-ray inspections during the casting process.
- Introduction of the process compensated resonance testing (PCRT) inspection method.
- Introduction of a flexible 10000-h interval to replace the blades in the higher-powered engine models.
- Improved pipe supports and fasteners.
- Inclusion in the Maintenance Manual of acceptance criteria for contact zones of the tip shrouds in order to ensure that the blades are effectively buffered during operation.

2. BINTER CANARIAS 4 July 2018 (2018S16156)

On 4 July 2018, an ATR-200 aircraft, registration EC-JQL, operated by BINTER CANARIAS, landed at the Tenerife North Airport (GCXO) from the airport of Las Palmas de Gran Canaria (GCLP). During the landing, the crew smelled something strange and notified maintenance personnel, who inspected the engines before stopping them and found visible damage (detached blades and cracks) in PT2 in the left engine.

The company's technical service determined that a blade in PT1, P/N 3054053-01, had fractured due to premature fatigue, causing additional damage to PT1 and also to PT2.

At the time of the incident, the engine had 8,850 h since its last overhaul.

The engine manufacturer, Pratt & Whitney Canada, had introduced P/N 3054053 as an improvement on P/N 3120983-01 in Service Bulletin 21758 on 13 December 2007; then, on 6 November 2013, it issued SB21852, introducing P/N 3078563-01 as an improved replacement of P/N 3054053-01, and on 1 October 2015, it issued SB 21878, which introduced new P/N 3123943-01 (improved replacement of P/N 3078563-91) with a longer soft time interval (25,000 h).

3. BINTER CANARIAS 24 July 2018 (2018S18139)

On 24 July 2018, an ATR 72-200 aircraft, registration EC-JQL, landed at the airport of Gran Canaria (GCLP).

While the technical service operators were doing maintenance, they found visible damage (detached blades and cracks) in PT2 of the left engine.

According to the engine workshop, one blade in PT1 with P/N 3054053-01 had fractured due to premature fatigue (crack due to casting defect during manufacture, and fatigue propagation), causing additional damage to PT1 and PT2 as well.

At the time of the incident, the engine had 1,211 h since the last hot section inspection (HSI) and the blade had a total of 5,243 h.

4. SWIFTAIR 24 June 2013 (2013S07251)

Also investigated by the CIAIAC (IN-017/2013). It took place on 24 June 2013 and involved an ATR 72-212A aircraft, registration EC-KKQ and operated by SWIFTAIR, which was flying from the Madrid-Barajas Airport (LEMD) to the Vigo Airport (LEVG) with 74 persons on board.

During the climb, shortly after takeoff, the left engine fire alarm was received. The crew carried out the emergency procedure and returned to the airport.

The investigation concluded that a blade in PT2 fractured due to fatigue that had originated at the leading edge of the blade, producing vibrations that resulted in the detachment of oil lines, causing the engine fire warning.

At the time of the incident, the engine had a time since new (TSN) of 5,819 h. During the investigation, the aircraft manufacturer reported that 11 other failures involving the same PT2 had taken place between 2010 and 2014.

The final report discussed the improvements proposed by Pratt & Whitney Canada between the date of the incident and the publication date of the final report, 27 May 2015, which were:

- Introduction of an eddy current inspection (ECI) for the leading and trailing edges of the blades in PT2 to be done on-wing (with the engine installed on the aircraft).
- Improved blade design, as reflected in SB 21876.
- Improved fastening of oil lines.

5. CANARIAS AIRLINES 5 July 2015 (2015S09676)

On 5 July 2015, an ATR 72-200, operated by CANARIAS AIRLINES with registration EC-JEH, was descending into the airport of La Palma (GCLA) when the crew in the passenger cabin heard a strange noise coming from the left engine, which they reported to the cockpit. The flight crew did not see any abnormal readings. When they reduced power during the approach, the noise went away. After landing, maintenance personnel were alerted, and when said personnel conducted a detailed inspection, they found visible damage (detached blades and cracks) in PT2.

The operator’s technical service concluded that the damage had been caused by the detachment of a blade from PT2, which resulted in severe vibrations. At the time of the incident, the engine had 6,477 h since the last overhaul.

6. BINTER CANARIAS 15 June 2018 (2018S14184)

On 15 June 2018, an ATR-72-20-212A, registration EC-LAD and operated by BINTER CANARIAS, was flying from the Lanzarote Airport (GCRR) to the airport of Gran Canaria (GCLP). After landing, several blades (P/N 3118204-01) in PT2 in the right engine were found to have fractured.

The company's technical service identified the source of the failure as a crack on the leading edge caused by material fatigue. The material that had detached from this blade impacted other blades, causing them to fracture. At the time of the incident, the engine had 3,513 h since the last overhaul.

The engine manufacturer, Pratt & Whitney Canada, concluded that the PT2 blades, P/N 3118204-01, which had a factory "chromium bath", was not performing as desired and thus issued a new service bulleting, SB 21917, on 15 November 2017 to remove that coating and introduce a new P/N 3134564 to replace the existing blades, as well as P/N 3124654-01 (ineffective improvement introduced in SB21876 of 24 July 2015).

PREVIOUS CASES INTERNATIONALLY

A summary of the recommendations issued by various European investigation authorities is provided.

1. ANSV (Italy)

According to the recommendations published in July 2012 by the Italian accident investigation authority (ANSV), PT1 blades had failed due to fatigue as many as 28 times between 2005 and 2011, peaking between 2008 and 2009. Based on the ANSV's findings, and as a result of these failures, in April 2008, Pratt & Whitney Canada improved the x-ray inspection of the PT1 blades and set a life limit as per SB 21766 for some of these blades (ANSV 11-1826).

2. TSB (Hungary)

Between June and October 2011, the Hungarian investigation authority (TSB) recorded three events involving PT1 failures and issued recommendations similar to the ANSV's pertaining to necessary improvements to the PT1 blades.

3. EASA/TC/FAA

Due to repeated PT1 failures, 2013 saw the publication of airworthiness directives (AD) by the EASA (CF-2013-02) and the FAA (2013-0197) that required inspecting the PT1 blades as per SB 21823 (P/Ns 3120973-01, 3120983-01, 3054053-01) by 31 January 2018. As an alternative, the old P/Ns could be replaced by the new ones, which were not affected by the AD.

4. Other

In addition to the above cases, the graphs below show failure data for PT2 recorded by P&WC through the end of 2014 (37 incidents).

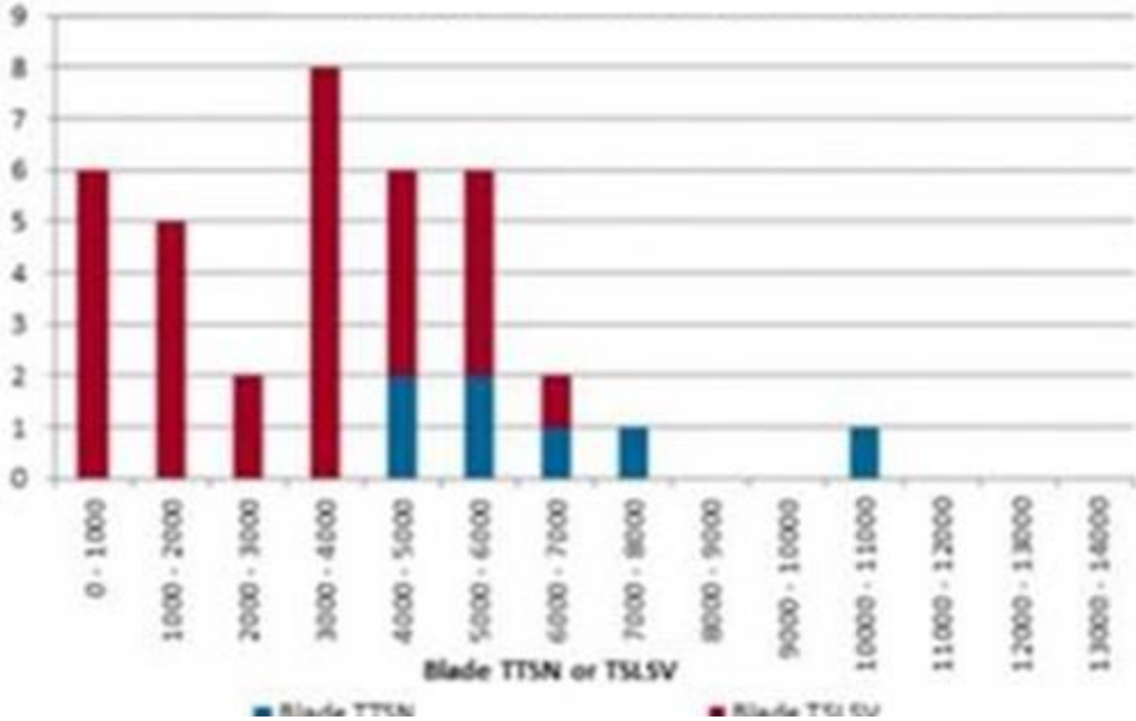

Figure 10. Events involving blades on PW100 engines between 2005 and 2015

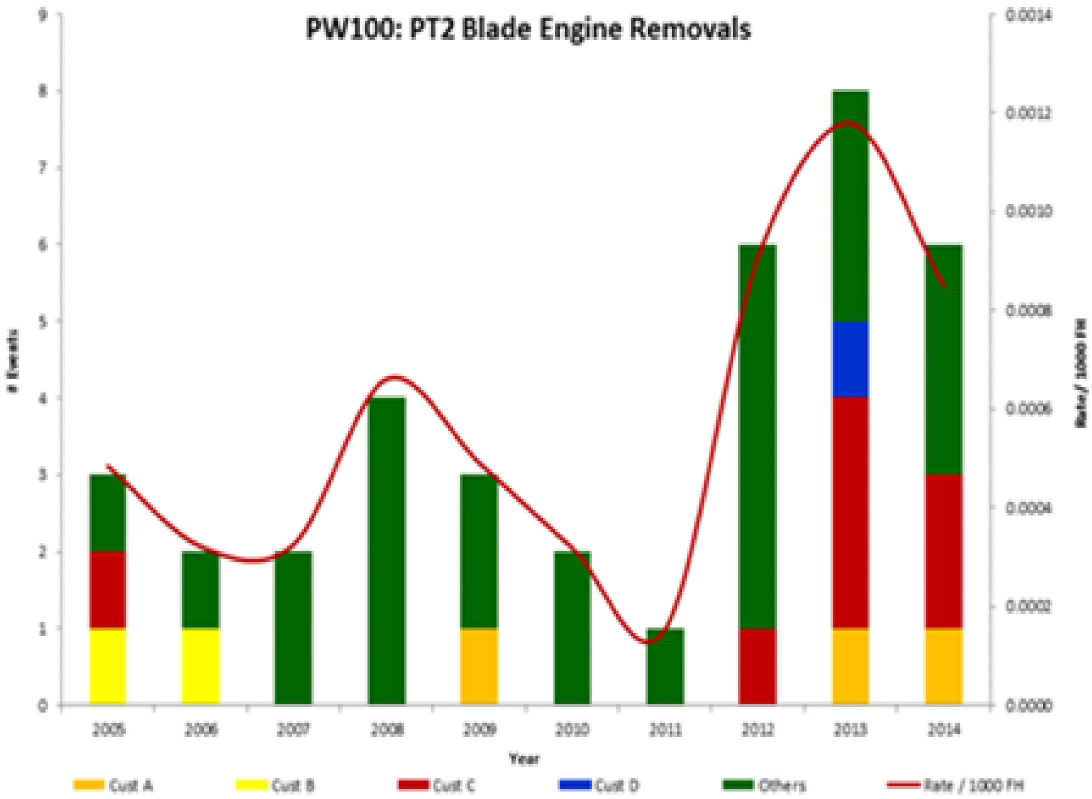

Figure 11. PT2 replaced in PW 100 engines from 2005 to 2014

ACTIONS TAKEN BY PRATT & WHITNEY CANADA

Pratt & Whitney Canada has attempted to improve the life time of the power turbine blades and has issued recommendations on the periodic washing of the turbine, especially when operating in saline environments. As a result, it recommends that operators contact it to establish customized recommendations for continued airworthiness depending on the type of operation.

Three types of washings with different frequencies are recommended, as shown in the table below, based on three possible operating environments for the engines, as specified in the EMM: dust, salinity and general contamination.

TASK / EXPOSURE	Wash lines and compressor	Wash turbine	Wash to restore performance
Continuous	Daily	Weekly	As required by ECTM (engine condition trend monitoring)
Frequently	Weekly (65 h)	Every 2 weeks	As required by ECTM
Occasionally	Every 2 weeks (130 h)	Monthly	As required by ECTM

As concerns the PT1 blades, Pratt & Whitney Canada introduced P/N 3054053-01 to replace P/N 3120983-01 in SB21758, dated 13 December 2007. On 6 November 2013, it issued another service bulletin, SB21852, where it introduced P/N 3078563-01 to replace P/N 3054053-01, and on 1 October 2015, it issued SB21878, where it introduced P/N 3123943-01 (replacing P/N 3078563-01), an improved version with a longer service life, according to the Engine Maintenance Manual (EMM), where the service life is specified (10,000 hours for blades prior to SB21878, and 25,000 hours for blades after SB21878).

With regard to the PT2 blades, on 24 July 2015, an improvement was introduced in SB21876, which replaced P/N 3118204-01 with P/N 3124654-01, but the improvement did not have the desired results. Pratt & Whitney Canada, aware of the upward trend in the number of PT2 blade failures between 2012 and 2014, identified that the blades were cracking due to stress corrosion, mainly on the leading edge. As a result, in September 2015, it introduced eddy current inspections (ECI) for these blades, which could be done with the engine on the wing or in the workshop.

On 28 March 2017, it published SIL No. PW100-185, where it acknowledged the increasing trend in PT2 blade failures and recommended that ECI be conducted with the engine on the wing at the next available opportunity.

On 15 November 2017, a new service bulletin, 21917, was issued to introduce a new P/N, 3134564, with addition of blade serial number.

In 2021, the company is planning to release a new blade with a different geometry and a new treatment on the leading edge.

ACTIONS TAKEN BY AESA

Based on the information gathered (AD, SB, previous failures contained in the European repository), the Safety Evaluation and Technical Audit Office (DESATI) is conducting a study on the fatigue failure of power turbine blades in the PW100 family of engines (specifically, the PW127 engine), which will be submitted to the Commercial Air Transport Safety Committee.

In addition, in coordination with the Aircraft Safety Office (DCA), the flight safety offices tasked with overseeing the six national operators that currently use these engines (BINTER CANARIAS, CANARIAS AIRLINES, CANARY FLY, SWIFTAIR, AIR NOSTRUM and AERONOVA) are being asked for the following information:

- How EASA Directive CF-2013-02 has been implemented at their organizations.
- The P/N of the power turbine blades installed (PT1 and PT2).
- Service life limit for the PT1 and PT2 blades, and if it is included in the maintenance program.
- Intervals of hot-zone inspections and overhauls.

ACTIONS TAKEN BY THE OPERATOR

The operator contacted Pratt & Whitney Canada immediately after the incident, and the engine manufacturer recommended that it conduct eddy current inspections of certain engines in its fleet. It also made this same recommendation to similar operators.

On 31 October 2019, P&WC sent the operator an initial list of engines to inspect, prioritizing those in which the power turbine blades had more than 10000 flight hours.

The operator did the inspections and found no adverse results, although an irregularity was found in an engine of another operator.

On 26 February 2020, P&WC sent it another list of engines to inspect.

This time, one anomaly was found in one of the operator’s engines, specifically on ED1403, on the incident aircraft (EC-MPI).

This anomaly was found on the evening of 25 March and reported the next day to P&WC.

P&WC recommended removing the engine within 50 FH (which the operator did before the next flight). This was all reported to AESA's Occurrence Notification System.

Finally, on 28 April, P&WC sent the operator a recommendation to inspect certain engines before 4,000 FH, and then every 500 FH.

This action is currently underway.

1.19. Useful or effective investigation techniques

A metallographic study and an energy-dispersive X-ray spectroscopy (EDS) analysis were carried out on the chromium layer and the base material of the longitudinal transversal section of the front edge of one of the blades.

2. ANALYSIS

In this case, the crew were able to abort the takeoff maneuver since the aircraft had not yet reached its rotation speed, which allowed the crew to brake and exit the runway without further incident. The crew reacted quickly and in accordance with the procedures and training they had received from the company.

They also quickly reported the incident to ATC, which promptly gave them the information needed to vacate the runway without any risks.

The question remains of why the information on the cockpit voice recorder was lost, since of the four tracks provided by the operator to the investigation team, none had valid information on it.

There was no clear determination as to whether the data were lost because the crew did not follow the procedure when opening the relevant breaker, or whether the data were lost when downloaded and processed after the fact by the operator's technical services.

As for the cause of the engine distress, given all the previous cases presented, it seems that the problem is well known to both the European Aviation Safety Agency (EASA) and the Spanish National Aviation Safety Agency (AESA), as well as to the manufacturer.

AESA is conducting a study of the fatigue failure of power turbine blades in the PW100 family of engines (specifically, the PW127 engine), and the flight safety offices are gathering information from national operators on the implementation of EASA Directive CF-2013-02 in their organizations, on the blades installed in the turbines of their engines, and on the frequency of hot-zone inspections and overhauls.

For its part, the manufacturer has been improving the design and continues to work to design a PT2 blade with a different geometry and a new coating for the leading edge, which it plans to have ready in 2021.

Having identified certain environments, such as those that are prone to corrosion, salinity or general contamination, where the likelihood of turbine blade wear is higher, it would be advisable for Pratt & Whitney Canada to not only offer the option to have a specific plan to ensure operators of their continuing airworthiness, but also to contact each of them and directly create a plan that is tailored to their needs.

As for the specific event of concern in this report, it should be noted that Service Bulletin 21917, published in November 2017 and whose latest revision (#7) is from March 2019, specifies replacing the blades with PN 3124654-01 with blades with PN 3134564. This is because the protective layer on the leading edge of the blades proposed in the previous service bulletin, 21876, is not ideal to increasing the resistance of the blades to corrosion problems.

This change affected engine ED-1404, which experienced a PT2 blade fracture d, but on the date of the event, said bulletin had not been implemented since the bulletin did not give a specific deadline, instead recommending that it be done when the engine is removed and accessible.

The analysis of the fractured blades that were recovered concluded that the material had no existing faults and that only one of them had fatigue problems, with the remaining blades fracturing as a result of the failure of the first blade.

3. CONCLUSIONS

3.1. Findings

- The aircraft was scheduled to fly from the Tenerife North Airport to the Gran Canaria Airport.
- The right engine lost power during the takeoff run on runway 12.
- The crew aborted the takeoff run and vacated the runway via taxiway E4.
- The airport tower cleared the crew to taxi to parking, which they did, proceeding to stand #18.
- There were no injuries and the passengers disembarked normally.
- A subsequent inspection of the aircraft revealed that the fuselage had sustained various damages.
- Airport personnel retrieved several metal fragments from the runway and near exit taxiways E1 and E2, fragments that had detached from the right engine.
- An analysis of the engine concluded that it flost power when several blades in the second stage of the turbine fractured.
- The metallographic study and a subsequent spectroscopic analysis concluded that only one PT” blade fracture in fatigue , and that the material did not have any pre-existing damage.
- The decreased service life of power turbine blades in saline, dusty or generally contaminated environments is a well-known problem that Pratt & Whitney Canada has dealt with by giving operators recommendations on continuing airworthiness that are specific to their types of operations.
- Between 2007 and 2017, Pratt & Whitney Canada issued five service bulletins and one service letter in an effort to improve the service life of the blades in both stages of the power turbine (PT1 and PT2).

3.2. Causes/Contributing factors

The investigation has determined that the engine distress that forced the crew to abort the takeoff was caused by the fatigue fracture of a blade in the second stage of the power turbine (PT2), followed by the overload fracture of several more blades.

4. SAFETY RECOMMENDATIONS

None.

ANNEX 1. DAMAGE TO THE FUSELAGE

ANNEX 2 – FDR DATA