



Powerplant failure or malfunction [SCF-PP]  
Airbus model 320-271N, serial number 8894, registration XA-VIO  
Operated by Viva Aerobus, S. A. de C. V.  
Commercial air transport, revenue operations, passenger flight  
Guadalajara International Airport "MMGL"  
December 24, 2022, at 01:56 local time [1956 UTC]





## FINAL REPORT

Approved in Session 08/2025 of the Commission  
Researcher dated April 14, 2025

Aircraft Registration:  
File number:

XA-VIO  
INCGDTAFA182/2022MMGL

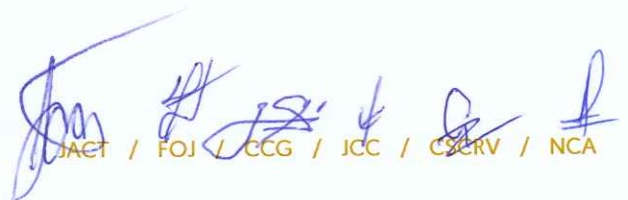
## SUMMARY

On December 24, 2022 at 13:56 hour (1956 UTC), a serious incident involved the Airbus aircraft model A320-271N, serial number 8894, registration XA-VIO, flight number VB2135, operated by Viva Aerobus, S.A. de C.V., which had a rejected take-off at between 60 to 80 knots due to right engine failure, model PW1127GA-JM, while attempting to take off from runway 29R Guadalajara International Airport, Jalisco, Mexico. Upon inspection on the runway surface done a fluid leak was found, blades fragments, damage found left hand side on C duct adjacent to air oil cooler (AOC), thrust reverser and inner barrel structure. Visual meteorological conditions were clear skies at the moment of the serious incident, the 111 passengers and five-crew members were not injured.

The Dirección de Análisis de Accidentes e Incidentes de Aviación [DAAIA], [State of occurrence] was notified by Civil Aviation Authority of the Guadalajara Airport, of the serious incident, after that DAAIA notified at National Transportation Safety Board [NTSB] as State of engine manufacturer and the Bureau of Inquiry and Analysis for Civil Aviation Safety [BEA] as state of aircraft manufacturer, also State of Operator [Viva Aerobus, S.A. de C.V.]. During the incident field investigation, the non-volatile memories [CVR, FDR and QAR] recovered and read out in NTSB laboratory.

The NTSB and BEA each one nominated an accredited representative and technical advisors from Airbus and Pratt & Whitney were appointed.

The Comisión Investigadora y Dictaminadora de Accidentes Aéreos emphasizes that, in no case, the probable cause of this serious incident, the contributing factors and/or the recommendations issued in this final report, or the content of its annexes indicate a responsibility or guilt, regarding occurrence of the event.

  
JACT / FOJ / CCG / JCC / CSERV / NCA



## WARNING

The Dirección de Análisis de Accidentes e Incidentes de Aviación indicates that this final opinion report is issued and based on Mexican Articles 1, 2 section I, 14, 16, 18, 26, and 36 section XXVII of the Organic Law of the Administration Federal Public; Article 7 subfraction II Internal Regulations of the Secretaría de Infraestructura, Comunicaciones y Transportes (SICT); 185, 187, 189 and 190 of the Regulations of the Civil Aviation Law, as well as the first, second, third and fourth Transitory articles of the *"Agreement establishing that activities related to search and rescue, as well as the investigation of accidents and incidents suffered by civil aircraft referred to in articles 80, 81, 81 BIS and 81 TER of the Civil Aviation Law will be carried out by the Subsecretaría de Transporte of the SICT"*, published in the Official Gazette of the Federation on August 24, 2021.

This final serious incident report is a technical document that reflects the point of view of the Dirección de Análisis de Accidentes e Incidentes de Aviación (DAAIA) and the Subsecretaría de Comunicaciones y Transportes de la Secretaría de Infraestructura, Comunicaciones y Transportes (SICT), regarding the circumstances in which the event that is the subject of this technical investigation occurred, identifying the probable cause and contributing factors and preventive recommendations to all administrative authorities, concessionaires or permit holders of air and airport transportation as well as to the aeronautical technical personnel who intervene during the operation of a fixed-wing aircraft.

In accordance with the provisions of Annex 13 [Investigation of Aviation Accidents and Incidents], to the Convention on International Civil Aviation (CAI); Articles 81 of the Mexican Civil Aviation Law and 185 of the Regulations of the Mexican Civil Aviation Law, the main objective of the investigation of aviation accidents and incidents is to prevent and avoid the recurrence or recurrence of similar events. The purpose of this activity is not to determine the guilt or civil or criminal responsibility of those involved in the event, nor to establish judicial responsibilities.

Consequently, the dissemination, distribution, copying and other use given to the information in this Final Incident Report, for purposes other than the prevention of future accidents, may lead to erroneous conclusions and interpretations.



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## 1. Factual information.

### 1.1. History of the flight.

On December 24, 2022, at approximately 1:56 p.m. [1956 UTC], the aircraft registration XA-VIO left of the position of the Terminal A of the Guadalajara International Airport "MMGL" the crew received instructions to road by taxiway, after that take runway 29R, once in position and hold the tower authorized the takeoff, according with the crew interview and with the videos from the airport's cameras, during the takeoff roll, at approximately between 60 to 80 knots before VI, the flight crew felt a strong force in the pedestal control of the aircraft, they observed on centralized electronic aircraft monitor [ECAM] a failure on engine No. 2, then proceed to act brakes to reject the takeoff. During the reject takeoff the ECAM message changes to engine fire. A passenger recorded through aircraft window that during the takeoff the engine generated fire and smoke at the rear [exhaust gas area].

The flight crew carried out engine fire procedures in accordance with the Quick Reference Handbook [QRH] and the fire indication was extinguished after the aircraft stopped on the runway.

The aircraft remained on the runway until 02:30 hours [2030 UTC] and was towed into position in terminal airport. Airport technical personnel detected a hydraulic fluid spill on the runway surface.

The engine inspection carried out showed a hydraulic fluid leak around the [MGB] Main Gear Box, the High Pressure Compressor [HPC] 7th Stage Integrally Bladed Rotor [IBR-7] fractured, due to the burst or explosion in the engine.

The non-volatile memories CVR, FDR and QAR of the aircraft were recovered and was read out by National Transport Safety Board [NTSB].

### 1.2. Injuries to persons.

|                  | Fatal | Serious | Minors/None |
|------------------|-------|---------|-------------|
| Pilot            | --    | --      | 1           |
| Copilot          | --    | --      | 1           |
| Flight Attendant | --    | --      | 3           |
| Passengers       | --    | --      | 105         |
| Total            | --    | --      | 111         |

### 1.3. Damage to aircraft.

The boroscope inspection found the High Pressure Compressor [HPC] 7th Stage Integrally Bladed Rotor [IBR-7] missing & fractured, due to uncontained engine failure on takeoff roll. as shown on Fig. 1.3.a.



Fig. 1.3.a. High Pressure Compressor [HPC] 7th Stage Integrally Bladed Rotor [IBR-7].

The uncontained engine failure of High Pressure Compressor (HPC) 7th Stage Integrally Bladed Rotor (IBR-7) on engine No. 2, generated a lot of metal debris and two larger fragments labeled as # 1 & # 2. Fragment # 2 remained embedded in the engine as shown on Fig. 1.3b and Fig. 1.16.1.b.

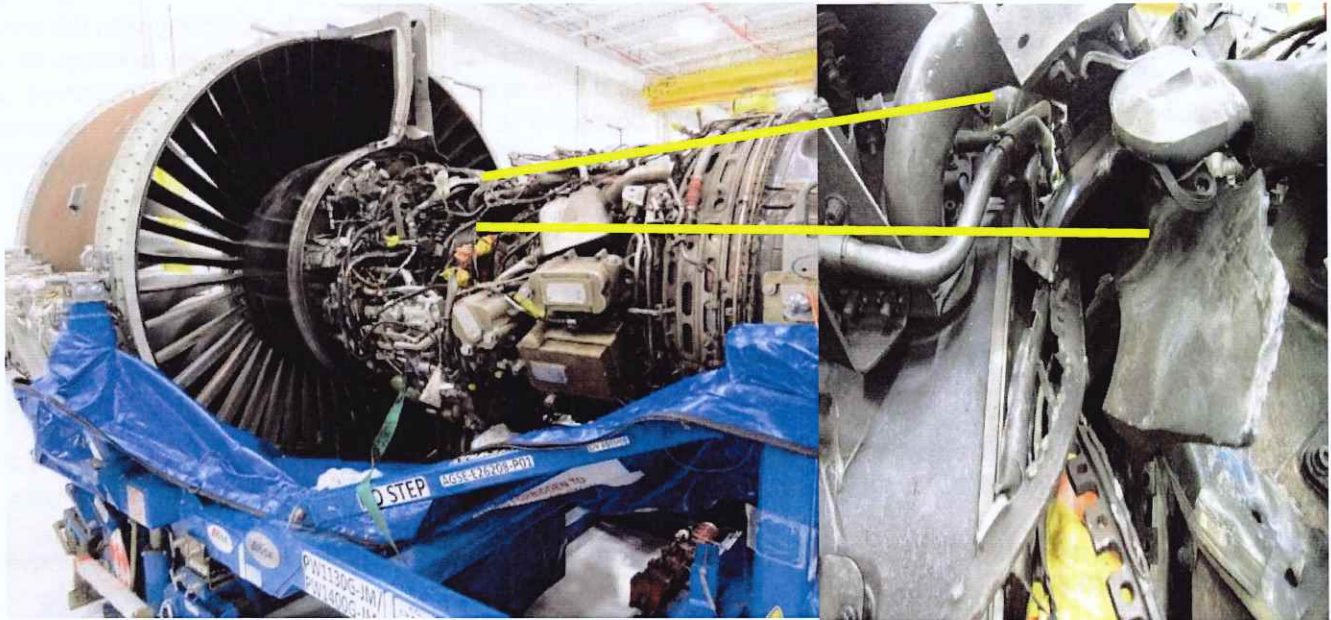


Fig 1.3.b. High Pressure Compressor (HPC) 7th Stage Integrally Bladed Rotor (IBR-7) of engine No. 2, fracture and damage zone for explosion.

Nacelle of LH Thrust Reverser (Inner board) and the Heat Exchanger with damage that contributed to prevent full uncontainment of the fragment #2. as shown on Fig. 1.3c.

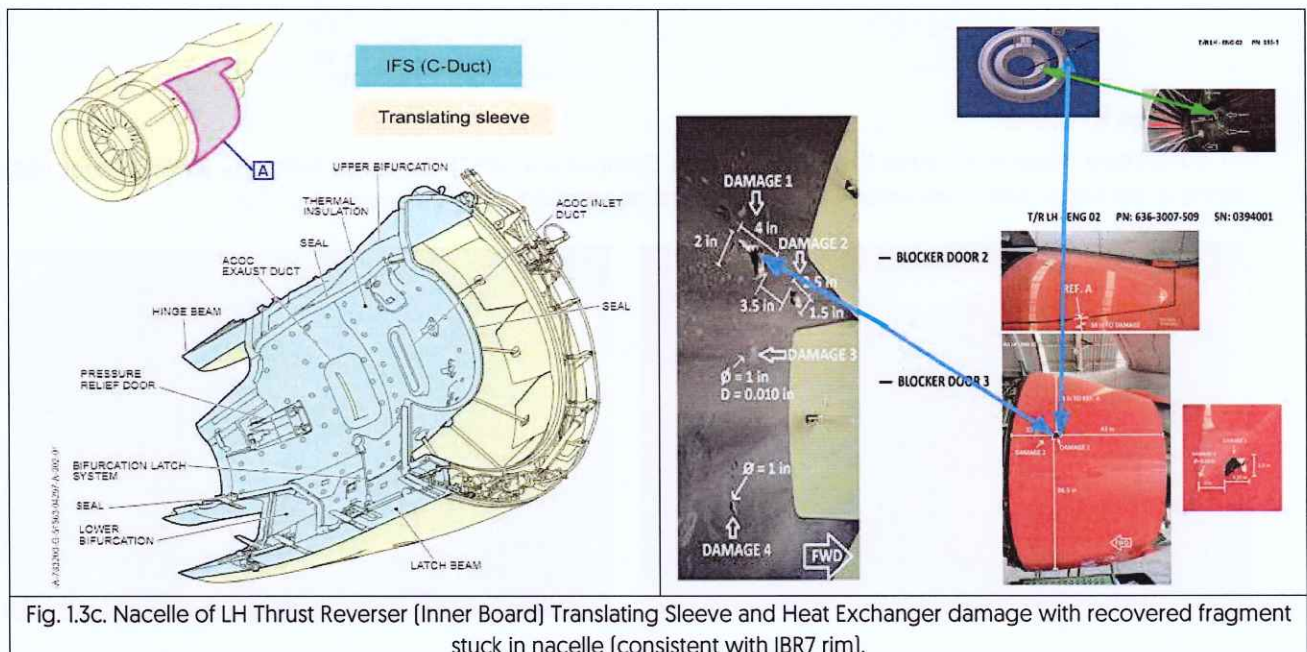


Fig. 1.3c. Nacelle of LH Thrust Reverser (Inner Board) Translating Sleeve and Heat Exchanger damage with recovered fragment stuck in nacelle (consistent with IBR7 rim).



The No. 2 engine was removed from the XA-VIO aircraft, sent to induced to the Pratt and Whitney Facility in Columbus Engine USA, for investigation and repair.

#### 1.4. Other damage.

There is no damage to the airport facilities.

#### 1.5. Personnel information.

|                                      | Pilot        | Copilot      |
|--------------------------------------|--------------|--------------|
| Age                                  | VER 1        | VER 2        |
| Type of License                      | ATP          | ATP          |
| License number                       | VER 1        | VER 2        |
| Issued                               | OCT 19, 2021 | SEP 23, 2022 |
| Capacities                           | A320 FAM     | A320 FAM     |
| Total flight hours with Viva Aerobus | 768:40       | 4,353.       |
| Total hours on aircraft              | 10953:39     | 4,353.       |
| Total hours last 90 days             | 191:17       | 106.11       |
| Total hours las 24 hours             | 4:25         | 6:06         |
| Medical Certificate                  | Class 1      | Class 1      |
| Issued                               | JUL 10, 2022 | AUG 31, 2022 |
| Limitations                          | Use glasses  | None         |

##### 1.5.1. Training courses.

| Pilot                                                |       |              |                    | First Officer (Copilot)                   |       |                               |                     |
|------------------------------------------------------|-------|--------------|--------------------|-------------------------------------------|-------|-------------------------------|---------------------|
| Course                                               | Hours | Trained by   | Period             | Course                                    | Hours | Trained by                    | Period              |
| Recurrent Pilot family A320 [A318/ A319/ A320/ A321] | 24    | UNAQ         | January 11 2023    | Airbus A320 Type Rating Couse.            | 160   | Airbus Mexico Training Center | August 04-31, 2022. |
| Recurrent Civil Aviation Safety                      | 3:45  | Viva Aerobus | December 08, 2022  | Virtual CRM Pilots 2.                     | 5:00  | CIASA                         | September 09, 2022. |
| Recurrent Safety Management System (SMS)             | 2:30  | Viva Aerobus | December 08, 2022. | Initial Civil Aviation Safety.            | 5:00  | Viva Aerobus                  | September 12, 2022. |
|                                                      |       |              |                    | Recurrent Safety Management System (SMS). | 3:00  | Viva Aerobus                  | September 12, 2022. |
|                                                      |       |              |                    | Virtual CFIT/ALAR                         | 6:00  | CIASA                         | September 27, 2022. |

#### 1.6. Aircraft information.

|                       |           |
|-----------------------|-----------|
| Manufactured          | Airbus    |
| Model                 | A320-271N |
| Serial number         | 8894      |
| Manufacturing date    | 2019      |
| Aircraft registration | XA-VIO    |



|                             |                |
|-----------------------------|----------------|
| Operator                    | Viva Aerobus   |
| Airworthiness certificate   | 20210624       |
| Certificate of registration | April 12, 2023 |
| Aircraft flight hours       | 10,108         |
| Time to last major repair   | N/A            |
| Aircraft Flight Cycles      | 5,794          |
| Cycles since last services  | N/A            |
| Hours Since last Services   | N/A            |

## 1.6.1. Engine information.

| Engine No. 2 information                                                              |                |
|---------------------------------------------------------------------------------------|----------------|
| Manufactured                                                                          | IAE LLC (P&W)  |
| Model                                                                                 | P&W1127GA-JM   |
| Serial number                                                                         | P771325        |
| Manufacturing date                                                                    | May 13, 2019   |
| Engine Installed Date                                                                 | April 05, 2022 |
| Engine Installed Cycles                                                               | 4352           |
| Engine Installed Hours                                                                | 7434:56        |
| Engine Removed Date                                                                   | Jan 04, 2023   |
| Engine Cycles Since New                                                               | 5,794          |
| Engine Time Since New                                                                 | 10,108         |
| Engine TSO Cycles / Engine Shop Visit Cycles                                          | 4352           |
| Engine TSO Hours / Engine Hours Shop Visit                                            | 7434:56        |
| Engine Last Shop Visit                                                                | 02/26/2022     |
| Engine Last Maintenance Shop Repair performed to HPC 5th Stage and IBR LPC 1st Stage. | 02/26/2022     |

## 1.7. Meteorological information.

The weather conditions nearest to the incident were:

METAR MMGL 250142Z 30004KT 10SM SKC 16/M02 03014.

METAR report from Guadalajara Jalisco Airport on December 24<sup>th</sup>, 2022, at 1956 UTC, with a wind of 300° and a speed of 04 knots (7.408 km/hr), with a visibility of 10 SM (18.52 km), clear sky, ambient temperature of 16°C and dew point of 02°C, altimeter correction of 30.14 inches of mercury, no significant change in weather conditions.

The event occurred at 1956 UTC [01:56 Local time]. The weather forecast highlights no adverse wind conditions during takeoff. At the time of the event there was calm wind. The runway was dry, with no contamination.

## 1.8. Aids to navigation.

The Guadalajara Jalisco Mexico International Airport has VOR/DME, NDB ILS/RNP (Primary Radar), CAT 1. However, they were not used by the aircraft flight crew since it was on the takeoff roll.



### 1.9. Communications.

The crew of flight VB2135 established communication and coordination with the Guadalajara control tower services on the 118.55 Mhz. frequency. The communications between them were recorded but illegible communication, reason don't transcript is available.

### 1.10. Aerodrome information.

The international airport of Guadalajara Jalisco Mexico has the ICAO designator of MMGL, it has two parallel runways, at an elevation of 5,016 feet (1,529m), the runway used by the airplane, has the identifiers 11L/29R, this runway has 4,000m long by 45m wide, has white runway edge lights, the surface is asphalt.

### 1.11. Flight recorders.

The aircraft had two flight recorders installed and one QAR, which recovered from their design position. Both recorders show no damage and have the following characteristics:

| Recorder         | Flight Recorders |              |           |               |               |
|------------------|------------------|--------------|-----------|---------------|---------------|
|                  | Manufactured     | P/N          | SN        | Recovery date | Download date |
| FDR <sup>1</sup> | L3 Harris        | 2100-4245-00 | 002006468 | Dec-26-22     | Dec-26-22     |
| CVR <sup>2</sup> | L3 Harris        | 2100-1228-02 | 002005227 | Dec-26-22     | Dec-26-22     |
| QAR <sup>3</sup> | Teledyne         | 2243800-362  | RA09153   | Dec-26-22     | Dec-26-22     |

#### 1.11.1. Flight Data Recorder [FDR].

The aircraft was equipped with a L3 Harris Flight Data Recorder [FDR], part number 2100-4245-00, serie 002006468, it was in its design position at the rear of the aircraft, the exterior showed no damage, this model uses solid-state memory as a recording medium, the recording was available until both engines were stopped.

From the FDR reading of both engines, the following parameters were obtained. Take Off Lateral Axis, Spoilers Position, Fuel Quantity, Hydraulic Pressure, Pressurization Pneumatic, Single Aisle Bleed & APU, Single Aisle PW Engines Main, Engine Oil, Engine Vibration, Single Aisle PW Reverse, Validity Computers and Flight Configuration, Warnings Operation, Elec AC/DC and AC/DC Electrical Power, among other parameters.

The left engine remained stable.

#### 1.11.1.1. Lining up and start of takeoff roll.

The sequence of events was established from the readout of the DFDR data. All times in UTC unless otherwise started. In all the following description. Factual Recording commences at 19:23:25 UTC and ends at 20:05:13 UTC.

| Time [UTC] | Actions                                                                                                                                                                                                                                                                                                                             |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19:41:52   | Engine 2 Master Lever was turned ON.                                                                                                                                                                                                                                                                                                |
| 19:44:10   | Engine 1 Master Lever was turned ON.                                                                                                                                                                                                                                                                                                |
| 19:52:04   | Aircraft was taking off from Runway 29R in MMGL Airport (Elevation = 5010ft, TORA = 4000m) with: <ul style="list-style-type: none"><li>• GW = 61.6 T (&lt;MTOW=73.5 T).</li><li>• CG = 23.4%.</li><li>• S/F Conf was at CONF 2.</li><li>• Ground Spoilers were armed for Take-off.</li><li>• Auto brake was Armed at MAX.</li></ul> |

<sup>1</sup> FDR - Flight Data Recorder.

<sup>2</sup> CVR - Cockpit Voice Recorder.

<sup>3</sup> QAR- Quick Access Recorder.



| Time [UTC] | Actions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|            | <ul style="list-style-type: none"><li>• Thrust levers were at FLX detent.</li><li>• Engine 1/2 N1 = 53%/56% and increasing.</li><li>• Engine 1/2 N2 = 84%/86% and increasing.</li><li>• Engine 1/2 EGT = 666°C/678°C.</li><li>• Engine 1/2 Fuel Flow = 923kg/hr / 1100kg/hr.</li><li>• Engine 1/2 Oil Pressure = 155psi / 158 psi.</li><li>• Engine 1/2 Oil Quantity = 11.5qts / 11qts.</li><li>• Engine 1/2 Oil Temperature = 89°C</li></ul>                                                                                                                                                                        |
| 19:52:17   | On take-off roll, CAS = 80kt, GS = 76kt. <ul style="list-style-type: none"><li>• Engine 1 Oil Pressure was at 181psi.</li><li>• Engine 2 Oil Pressure was at 184psi.</li><li>• Engine 2 Low Oil Pressure switched to 0.</li><li>• N1A2 (Engine 2 N1) started decreasing from 83%.</li><li>• N1A1 (Engine 1 N1) remained at 83%, stable.</li><li>• Bus Transfer Contactor 1 position changed from Open to Closed.</li><li>• Two samples later, Bus Transfer Contactor 2 position changed from Open to Closed.</li><li>• Two samples later, Generator Line Contactor 2 position changed from Closed to Open.</li></ul> |
| 19:52:18   | On take-off roll, CAS = 83kt. <ul style="list-style-type: none"><li>• N1A2 was decreasing below 46%, while N1A1 was still at 83%.</li><li>• N2A2 (Engine 2 N2) started decreasing from 92% to 50% in one second while N2A1 (Engine 1 N2) remained at 92%.</li><li>• Lateral acceleration changed from +0.04 to -0.07g (acceleration to the right).</li></ul>                                                                                                                                                                                                                                                         |
| 19:52:19   | On take-off roll, CAS = 83kt. <ul style="list-style-type: none"><li>• Engine 2 N2 decreased from 50%. Thrust levers were pulled to Idle and then to MAX REV in one second (at 19:52:20 UTC).</li><li>• Full rudder pedal was applied, and the rudder reached its full deflection [30°] one second later.</li><li>• Ground Spoilers started extending.</li></ul>                                                                                                                                                                                                                                                      |
| 19:52:20   | CAS started to decrease after having reached a maximum of 86kts. <ul style="list-style-type: none"><li>• Engine 2 N2 vibration decreased from 0.3 CU to 0 while Engine 1 N2 vibration stayed stable.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                       |
| 19:52:21   | CAS = 75kt, Master Caution triggered for 8 seconds. <ul style="list-style-type: none"><li>• According to PFR, it was likely associated with ECAM ENG 2 FAIL, which triggers when N2 is detected below 50%.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                 |
| 19:52:22   | CAS = 61kt. <ul style="list-style-type: none"><li>• Lateral acceleration reached 0.12g (acceleration to the left).</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 19:52:24   | N2A2 was recorded at 0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 19:52:26   | Engine 2 N2 vibration reached 0.5 CU.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 19:52:27   | CAS = 37kt, thrust levers were pushed to REV IDLE. <ul style="list-style-type: none"><li>• Engine 2 EGT parameter became invalid (with error code Failure Warning). The last recorded valid value was 610°C.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                               |
| 19:52:29   | Eng 2 N1A was recorded at 0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 19:52:32   | Engine 2 N2 vibration was durably recorded at 0.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 19:52:33   | Ground Speed = 11kt. <ul style="list-style-type: none"><li>• Engine 1 thrust reversers were recorded fully deployed.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 19:52:34   | ENG 2 FIRE ECAM warning triggered (16s after N2 drop / 7s after EGT2 invalidity). Master warning triggered for 4 seconds (till 19:52:39 UTC).                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 19:52:37   | GS = 0kt, Master caution triggered for 8 seconds (till 19:52:45 UTC).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 19:52:46   | GS = 0kt, Engine 2 Master Lever was set to OFF.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 19:52:48   | Eng 2 Start Air Valve opened during 3s.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |



| Time [UTC] | Actions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 19:52:52   | the Eng2 FIRE P/B was pushed. <ul style="list-style-type: none"><li>• This action was consistent with the ECAM procedure ENG 2 FIRE.</li><li>• The FADEC parameters became invalid.</li><li>• Action on Eng 2 FIRE P/B cut the power supply of Eng 2 FADEC.</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 19:52:58   | ENG 2 FIRE ECAM warning stopped. <ul style="list-style-type: none"><li>• According to Viva feedback, only the FWD bottle was discharged.</li><li>• According to the PFR, the last recorded messages were ENG 2 FIRE LOOP A FAULT (still in the minute 19:52) and ENG 2 FIRE DET FAULT (in the minute 19:53).</li><li>• It is not possible to conclude with PFR and DFDR data if the ENG 2 FIRE stopped because:<ul style="list-style-type: none"><li>– the fire was extinguished at that time. A delay of 6s since the action on the FIRE P/B could be consistent with the effective extinguishment, or.</li><li>– Loops A and B loss. During the engine teardown, Loop A and Loop B of the core</li></ul></li><li>• Vent detection line (rear area) was found cut. ENG 2 FIRE DET FAULT was necessarily triggered when the second loop (A or B) was cut. If ENG 2 FIRE was still displayed at that time, it would have disappeared and been replaced by ENG 2 FIRE DET FAULT.</li></ul> |
| 19:53:04   | GS = 0kt, Master caution triggered.<br>This last Master caution is likely linked to the ECAM ENG 2 FIRE DET FAULT recorded in the PFR at 19:53.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

#### 1.11.2. Cockpit Voice Recorder [CVR].

The aircraft also had an L3 Harris Cockpit Voice Recorder [CVR] installed, part number 2100-1228-02, serie 002005227, it is solid state, the intercommunications of the air-ground-air pilots and pilot-copilot-pilot. The CVR was sent to NTSB laboratory. The read out generated 4 audio files, each lasting 2 or more hours. The audio begins recorded at the moment of engines start until the moment in which the engines are turned off. The audios files communications are illegible for that reason, but the transcription was not available.

#### 1.12. Wreckage and impact information.



Fig. 1.12.a. Engine Failure Runway Distance 3250 Feet.



#### 1.13. Medical and pathological information.

No medical examination was carried out in this serious incident.

#### 1.14. Fire.

There was presence of fire during takeoff roll due to uncontained engine failure, the No. 2 engine fire suppression bottle that was discharged. The fire was controlled without spreading towards the aircraft.

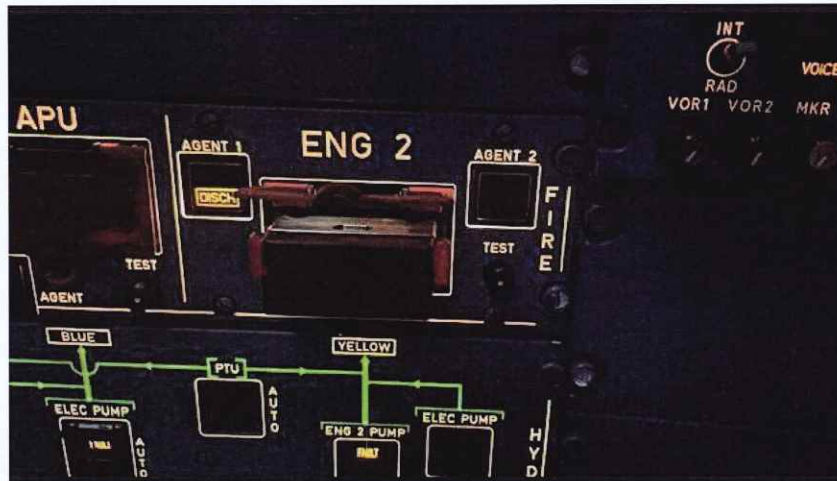


Fig. 1.14.a. Guard raised and discharged the No. 1 fire bottle on engine No. 2

#### 1.15. Survival aspects.

No survival action was necessary in this serious incident, all passengers and crew evacuated the airplane by mobile ladders, the evacuation was done secure and coordinated by flight crew members and ground personnel.

#### 1.16. Tests and research.

The PW1127GA-JM turbofan engine has a high bypass ratio, axial-flow, dual spool, turbofan geared engine, controlled by a full authority digital electronic control (FADEC). The low pressure spool consists of a three stage, low pressure turbine (LPT) that directly drives a three stage low pressure compressor (LPC), and a single stage high bypass ratio fan through a fan drive speed reduction system. The high-pressure compressor (HPC) has eight axial stages driven by a two-stage cooled high pressure turbine (HPT). The fan rotates in a clockwise direction aft looking forward (ALF). The engine has seven main line bearings to provide radial and axial support to the core.

##### 1.16.1. Engine shop findings.

The engine No. 2 was disassembly the evidence shows the HPC 7<sup>th</sup> Stage Integrally Bladed Rotor (IBR-7) fracture, on shop recovered a big fragment identified with (PN: 30G2307 Rev. H, SN: LENCAX1027, heat code PIHSJ2042 and MFR 3JV93) and presence of radially damage from bore to rim in to places spaced 220 degrees apart, all airfoils from the disk showed fractured adjacent to the rim interior to outside diameter, as shown on Fig. 1.16.1.a.



Fig. 1.16.1.a. High Pressure Compressor (HPC) 7<sup>th</sup> Stage Integrally Bladed Rotor (IBR-7) recovered part identification.

The HPC 7th Stage IBR-7 fracture penetrated on the diffuser outer case, just aft of H flange an exit hole from about the 7:00 to 12:00 o'clock positions damage as. One hole measured approximately 4.5 to 5.0 inches axially by 25 inches circumferentially. Protruding from the hole was a section of the HPC 7th Stage IBR-7 and part of the ring case attachment flange.

The hardware in the vicinity of the diffuser outer case hole exhibited torn, cut and fractured tubes, lines and brackets; dented, twisted and displaced case material, thermally distressed, frayed and cut electrical wires and impact damaged accessories. Light sooting/oil residues were observed on the left side of the engine forward of the H flange to the firewall. The main gearbox (MGB) support flange and the support link, located on the left side of the engine, was intact and present but was distorted and twisted. as shown on Fig. 1.16.1.b.

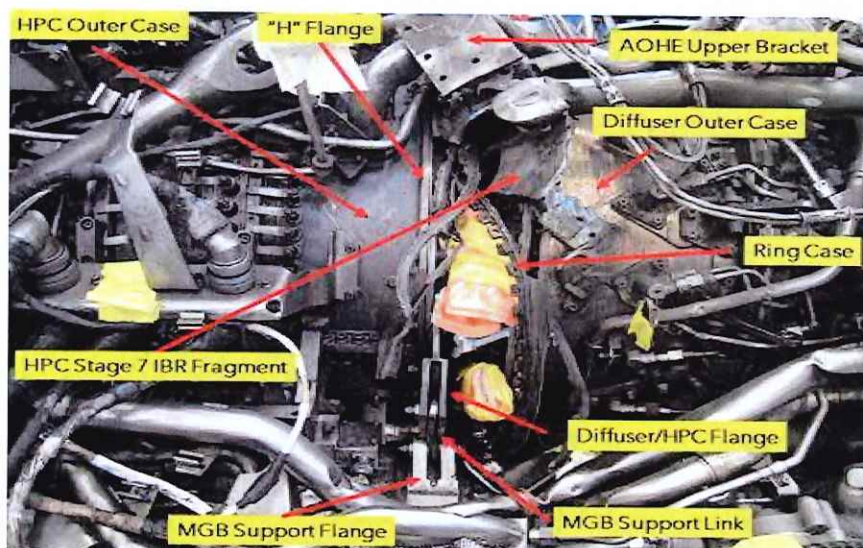


Fig. 1.16.1.b. Exit Hole in the Diffuser Outer Case with Collateral Damages

The HPC 7<sup>th</sup> Stage IBR-7 that was wedged in the diffuser outer case was removed using a pry tool to bend the wall of the diffuser outer case to release the IBR fragment. The recovered piece measured almost 12-inches across, was heavily sooted and appears to have the mating primary fracture.



The HPC 7<sup>th</sup> Stage IBR-7 was separated from engine No. 2, the aft side of the HPC 6<sup>th</sup> stage rotor IBR-6 and aft hub was exposed. HPC stage 6 exhibited the following impact damage:

1. Circumferential scoring around the web.
2. Rear arm fracture and the fracture surface heavily rubbed, material smeared, and impact damaged.
3. All the bolts that secured the HPC stage 6 air seal inner flange were fractured and the seal had Shifted.
4. All the stage 6 IBR blades were present and exhibited a combination of leading edge, trailing edge, tip material loss and gouges.
5. About a ¼ of the IBR web was coated in light soot and was oil stained.
6. The stage 6 blade abradable seal material was worn to the parent metal.
7. The HPC stage 6 air seal exhibited impact damage at heavy soot location.
8. The tie shaft was fractured flush with the HPC stage 6 IBR bore rear face; the inner diameter of the tie shaft exhibited circumferential scoring and material transfer.
9. The fracture surface of the tie shaft was heavily battered and smeared; a chunk of the shaft was also missing at the fracture face exposing the piston seal ring.

On HPC 8<sup>th</sup> stage rotor (IBR-8) was found loose on the LPT shaft, after HPC 7<sup>th</sup> Stage IBR-7 was fractured and exhibited the following damage:

1. All the blades were corn cobbled at the platform.
2. What remained of the blades were heavily damaged and smeared over.
3. The front side of the IBR had circumferential intermittent scoring throughout the web area as well as on the bore front face.
4. The rear side of the IBR with circumferential intermittent scoring as well but much less than what was observed on the front side.
5. The rear web also with some heat tinting (bluing).
6. The bore with scoring.
7. The forward arm of stage 8 IBR was not present and fractured off.
8. On the diffuser out case flange and to the aft hub bore front face, indicate that about 6-inches in length of the tie shaft was missing.
9. Large tie shaft fragments were found in the aft hub cavity.

#### 1.16.2. Maintenance records.

The engine had 10,108:00 hours [5,794 cycles] time since new and 7,434:56 hours [4,354 cycles] since last shop visit. Engine background reported by Viva Aerobus:

- Engine 1st shop visit.
- Aborted takeoff run due to fire.
- BSI showed HPC 7<sup>th</sup> Stage Rotor (IBR-7) Missing/Fracture.
- Multiple loose debris fragments collected outside engine.
- Metal debris was found inside all HPC with significant visible detachment material, becoming embedded Diffuser Outer Case with full perforation (On H Flange, Ring Case Open, HPC Flange), in Translating Sleeve LH on (acoustic panel, honeycomb, outer skin, smooth edges) and C Duct LH with damage.

#### 1.16.3. Laboratory investigation.

The rotor and blades of the HPC 7th Stage IBR-7 fractured, as a single part—known as a blisk. These high-tech components not only save space and weigh less than conventional rotors with individual blades, but they also provide for better blade aerodynamics. Furthermore, they reduce assembly work and increase engine efficiency.

HPC 7th Stage IBR-7 fragments labeled # 1, # 2 and two bags of debris and two larger fragments labeled as #1 and #2 for analysis with weighed 8.4 lbs. and 4.3 lbs, the debris parts identified were of zones as:

- HPC stator vanes.
- 6th stage HPC stator OD shroud liner.
- 7th – 8th stage HPC heat shield.

- 6th stage HPC aft heat shield and associated spacers.
- HPC inner case.
- Outer diffuser case.
- Fasteners [bolts, nuts, washers, etc.].
- Various external components [wires, hose clamps, etc.] & magnetic chip detector-
- HPC Tie Shaft Fragments.

#### 1.16.3.1. Visual Examination of HPC 7th Stage Rotor (IBR-7) Fragments #1 and #2.

Overall views of fragments arranged together with mating fragments fit into place, when possible, both sides. All fragments exhibited extensive event-related damage, some thermal discoloration, and varying amounts of adhered debris on surfaces. Several portions of the web and a rim fragment appeared to be missing. All airfoils had fractured adjacent to the rim [OD] outside diameter and were missing. The IBR No. 7 had fractured radially from bore to rim in two places spaced ~220 degrees apart. The two larger recovered IBR No.7 fragments containing the mating halves of both radial fractures were arbitrarily labeled #1 and #2 for investigation purposes as shown on Fig. 1.16.3.1.a.



1.16.3.1.a. Overall views of fragments and fracture radially from bore to rim in two places spaced ~220 degrees apart.

#### 1.16.3.2. Binocular Microscope Examination of HPC 7th Stage Rotor (IBR-7) Fragment #1.

Primary fracture on fragment #1 surface showing a thick layer [cladding] of adhered event debris deposits on the forward web/bore surfaces adjacent to the fracture. Portions of the fracture surface were also covered in this debris, which obscured fracture features, including the origin area. The debris had a matte grey metallized appearance, as shown on Fig. 1.16.3.2.a.



Fig. 1.16.3.2.a. Fragment #1 surface showing a thick layer [cladding] of adhered event debris deposits on the forward web/bore surfaces adjacent to the fracture.

Close-up view of fragment #1 fracture halves at bore region. Area denoted by yellow dashed line was observed on fragment fracture half, as a heavily damaged positive (proud) feature on fragment #1, indicating the surfaces mated. Areas denoted by green dashed lines were negative features on both fracture halves (not mating, i.e. piece(s) missing), as shown on Fig. 1.16.3.2.b.



Fig. 1.16.3.2.b. Fragment #1 fracture half at bore region.

On fragment #1 primary radial fracture surface, which was covered in a layer of debris that obscured fracture features. Certain features on the surface were still identifiable such as a small, continuous shear lip along the forward edge of the bore fracture and an angled surface plane along the bore "ID" inside diameter that was considered most likely secondary damage, possibly from contact with the HPC tie shaft immediately following fracture, the deposit layer had been locally removed from two small areas on the bore region of the fracture surface fragment # 1 during an initial ultrasonic cleaning, as show on Fig. 1.16.3.2.c.



Fig. 1.16.3.2.c. Fragment #1 primary radial fracture surface was covered in a layer of debris that obscured fracture & angled face likely secondary damage.

### 1.16.3.3. Metallography of HPC 7th Stage Rotor (IBR-7) Fragment # 1 Fracture Half Origin Area.

A transverse metallographic section was prepared through the fragment #1 fracture half ~0.84" radially outboard of the bore ID and serial polished in the inboard direction through the fatigue origin area. The section was mounted in clear epoxy resin so that progress serial of 35 polishing sections could be visually observed. Caliper measurements were used to ensure the targeted amount of material was removed at each polishing step. The known positions of smearing damage relative to the low-density indication areas found in the [micro-CT scans] scans micro computed tomography of the fragment #1 fracture half was used as guides for targeting the origin area during serial polishing



since the area was completely obscured by debris deposits. The section was reviewed at each polishing step in both the as-polished [unetched] and etched conditions for the presence of any intergranular cracking and any evidence of a [NMI] Non-Metallic Inclusions [particle cloud]. The dimensions of these features, including their distance from the aft bore face, were measured when present. The extent of secondary smearing damage on the fracture surface along the aft bore face was also measured when present. At select polishes, the angle of the intergranular crack zone relative to the plane of transgranular fatigue progression was estimated. The following map summarizing the results of the serial polishing and the types of damage as Intergranular Cracking, Smearing Damage, Diffuse Particle Cloud, Dense P.C. Particle Cloud & Gamma Prime Denuded Zone, as shown on Fig. 1.16.3.3.a.

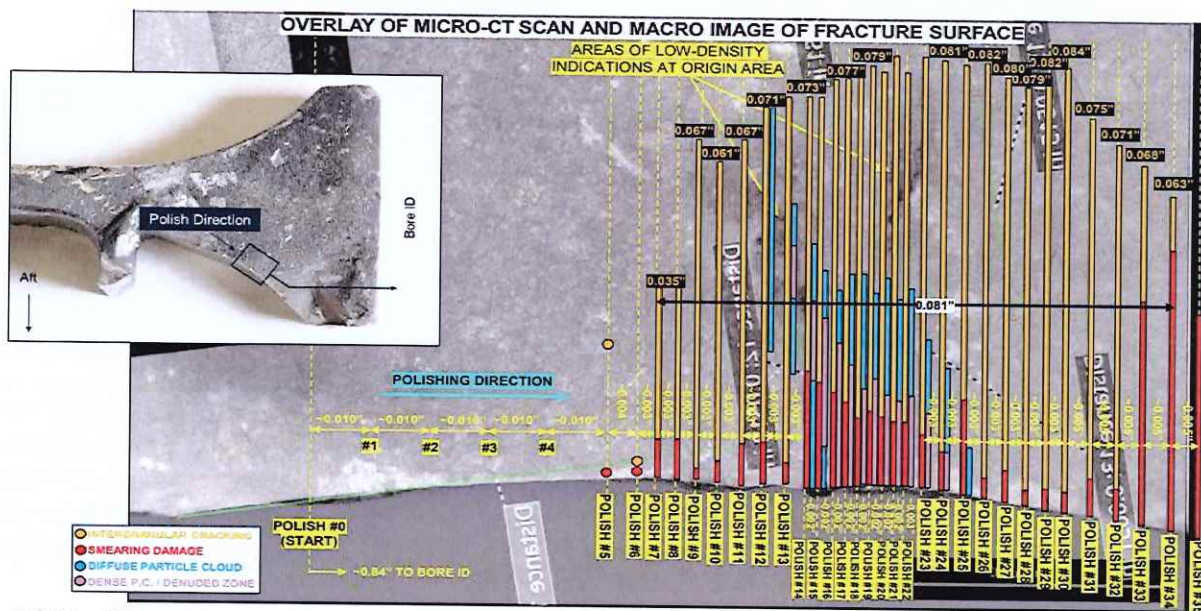


Fig. 1.16.3.3.a. Map summarizing results damage of a serial polishing through the origin area on the HPC 7<sup>th</sup> Stage Rotor [IBR-7] fragment #1 fracture half.

#### 1.16.3.4. Estimation of Intergranular Zone and Particle Cloud Size/Shape on Fragment # 1.

The serial polishing summary map shown on Fig. 1.16.3.4.a was refined to estimate the size and shape of both the intergranular crack zone and the particle cloud, and the extent of smearing damage on the fracture surface. A graphical representation of the intergranular crack zone, particle cloud and smearing damage was overlaid [to scale] onto macro images of the fragment #1 fracture half. As previously mentioned, the smearing damage prevented conclusive determination as to how much of the intergranular crack zone had been connected to the aft bore surface. However, based on previous evaluations of intergranular crack zones associated with particle clouds compared with the size/shape and orientation of each in the subject HPC 7th Stage Rotor [IBR-7], it was considered reasonable to conclude that both the particle cloud and the intergranular crack zone had intersected the aft bore surface and some portions of each had been machined away at manufacture. The remaining portion of the particle cloud measured ~0.018" long at the aft bore surface and up to ~0.048" deep from the surface. The remaining portion of the intergranular crack region measured up to ~0.092" wide by 0.083" deep from the aft bore surface. The distance from the center of the particle cloud to the bore [ID] Inside Diameter measured ~0.750", as shown on Fig. 1.16.3.4.a.

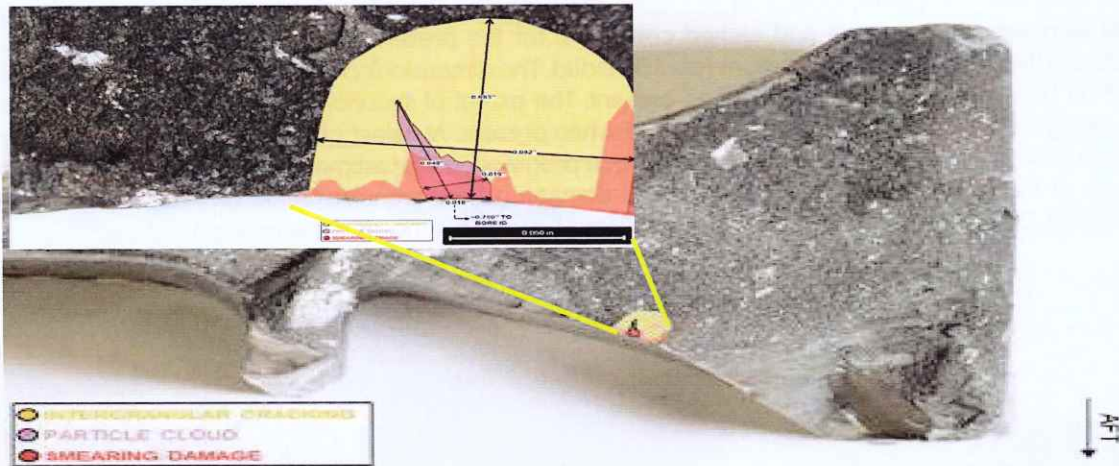


Fig. 1.16.3.4.a. Intergranular Crack surface length in Lab at P&W the OEM measured ~0.092" wide by 0.083" deep from the aft bore surface, the particle cloud measured ~0.018" long at the aft bore surface and up to ~0.048" deep from the surface and the distance from the center of the particle cloud to the bore (ID) Inside Diameter measured ~0.750".

#### 1.16.3.5. [EMP] Electron Microprobe Analysis of Particle Cloud Chemistry at polish #14 on the Fragment # 1.

Carried out the Electron microprobe [EMP] analysis of the particle cloud at polish #14 on the fragment # 1 revealed particles with material of [Al-Mg-O and Al-O] Aluminum-Magnesium-Oxygen type particles with isolated [P-Ti-Ni-Co] Phosphorus, Titanium, Nickel- Cobalt particles with a higher concentration of [SI] silicon and No significant [P] Phosphorous concentrations were observed within the reacted zone; the particle cloud chemistry of P771325 HPC Stage Rotor IBR No. 7th fractured origin areas, these were similar on P&W previous examination of cracking in powder metal nickel alloy has identified particle cloud type nonmetallic inclusions [NMIs] and associated intergranular processing cracking at crack origin areas, as shown on Fig. 1.16.3.5.a.

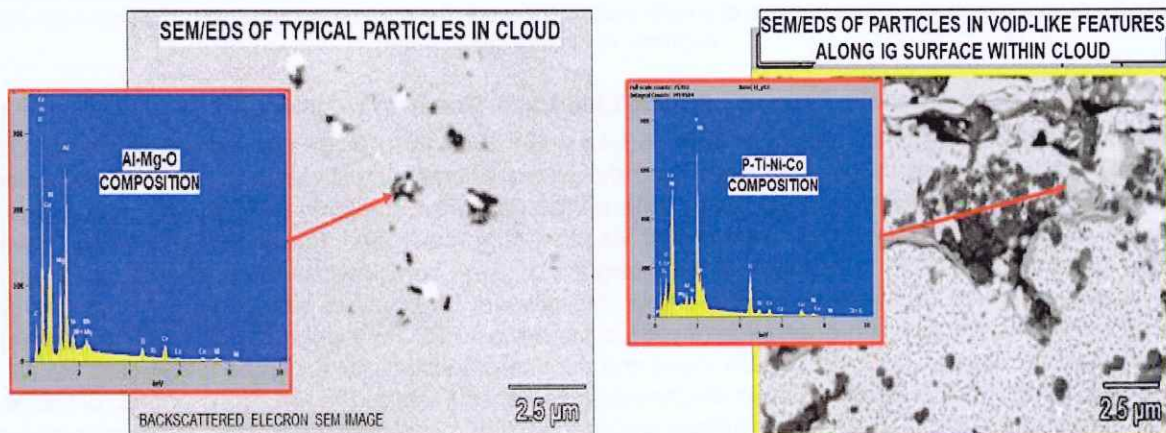


Fig. 1.16.3.5.a. [EMP] Electron Microprobe Analysis of Particle Cloud Chemistry at polish #14. With particles material of Al-Mg-O and Al-O.

#### 1.16.3.6. Binocular Microscope Examination of HPC 7th Stage Rotor [IBR-7] Fragment #2.

The suspected primary fracture origin area on a planar region of fracture was observed in the bore area on one of the two radial fractures on the fragment # 2 on this exhibited overstress features through the web with directionality towards the rim from the bore area, as shown on Fig. 1.16.3.6.a.

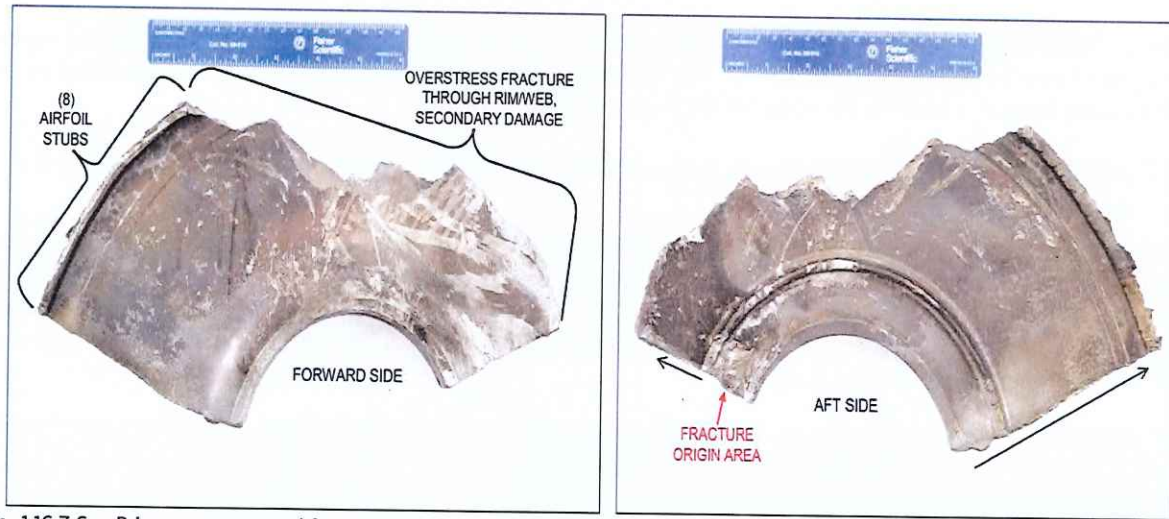


Fig. 1.16.3.6.a. Primary suspected fracture origin area on a planar region with overstress features through the rim/web with extensive secondary smearing damage.

Close-up view of fragment #2 fracture halves at bore region. The area denoted by yellow dashed line was observed on fragment fracture half, as a negative feature on fragment #2, indicating the surfaces mated. Areas denoted by green dashed lines were negative features on both fracture halves [not mating, i.e. piece(s) missing,] as shown on Fig. 1.16.3.6.b.

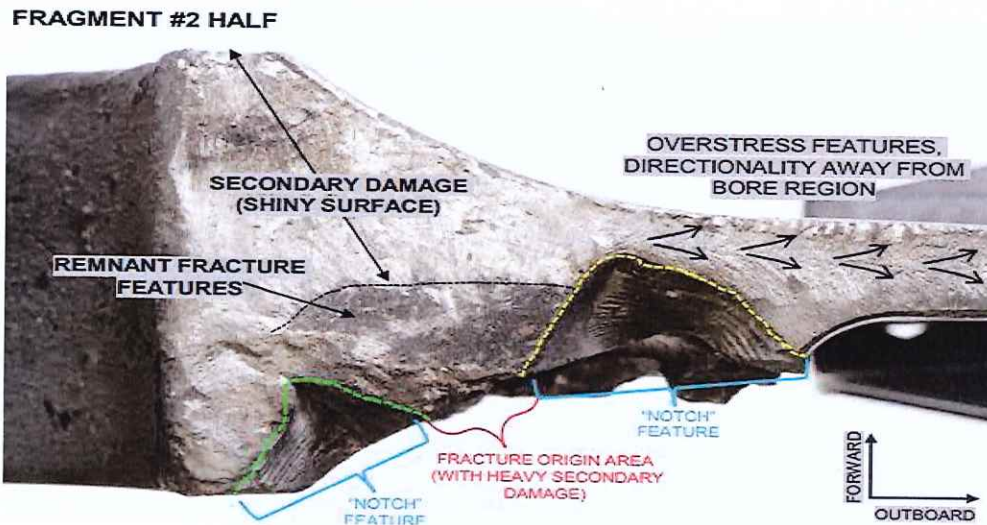


Fig. 1.16.3.6.b. Fragment #2 fracture half at bore region

On the HPC 7th Stage Rotor (IBR-7) fragment #2 the primary fracture origin area was on the radial surface after ultrasonically cleaning to remove extraneous dirt/debris revealed extensive secondary smearing damage, which removed a large percentage of fracture surface features within the bore area. The fracture origin area on the aft side of the bore had also sustained heavy secondary impact damage measuring up to 0.085" deep from the aft bore surface. Fracture surface features just beyond this damage [steps in crack plane] indicated the fracture origin was likely located within the secondary damage zone. The bore region of fracture exhibited two large "notch" features on the aft side associated with shear planes of fracture.



The bore region of fragment 2 fracture surface was sectioned off to facilitate evaluations by (SEM), scanning electron microscopy Keyence 3D Scanning, Micro-CT Scanning and Metallography examinations of the surfaces to evaluate the secondary impact smearing damage on the fragment #2, revealed.

#### 1.16.3.7. [SEM] Scanning Electron Microscopy Examination of HPC 7th Stage Rotor (IBR-7) Fragment # 2 Fracture Half.

On SEM examination of the HPC 7<sup>th</sup> Stage Rotor (IBR-7) fragment #2 fracture origin area intergranular features in isolated pockets within the secondary impact damage zone and along the periphery of the damage on the aft side of the origin area. A sharp transition from these intergranular features to transgranular fatigue progression was observed. Both transgranular and intergranular features appeared oxidized. No evidence of overstress was observed at the transition, as shown on Fig. 1.16.3.7.a.

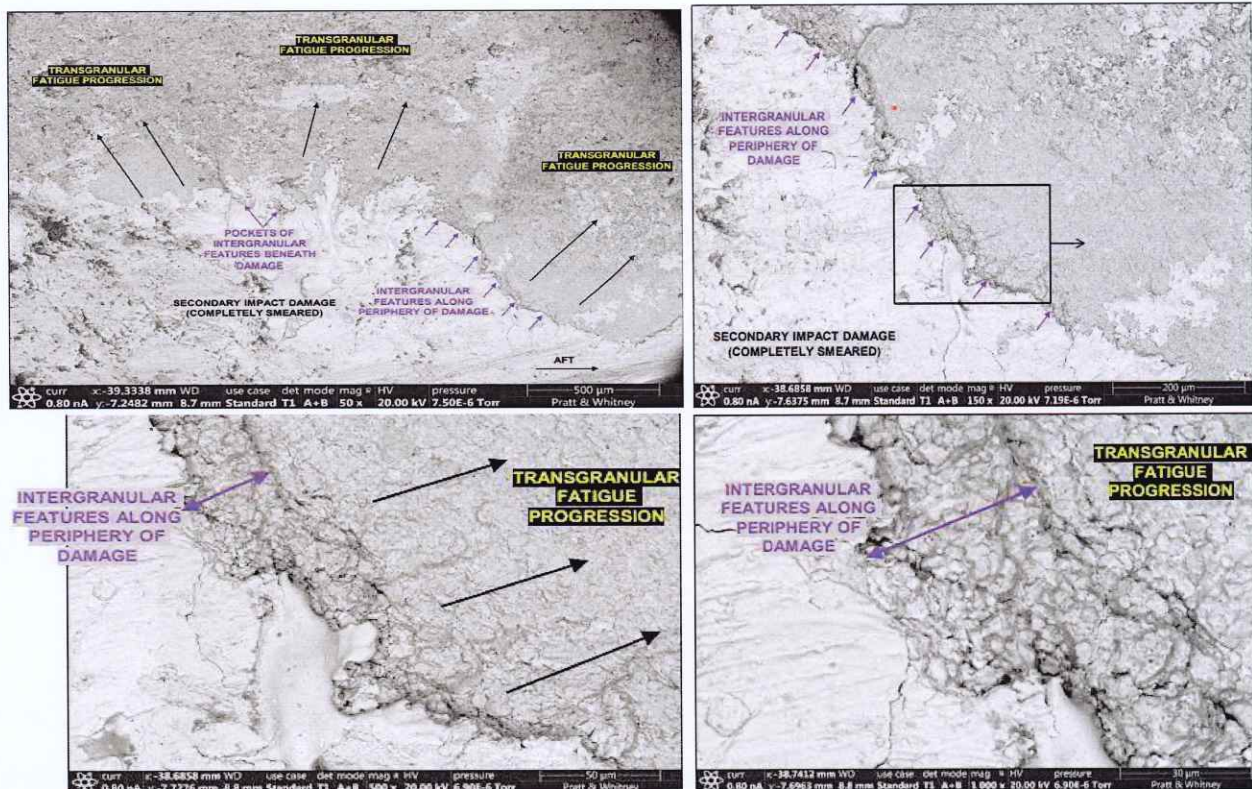


Fig. 1.16.3.7.a. Scanning Electron Microscopy examination of the HPC 7<sup>th</sup> Stage Rotor (IBR-7) fragment #2 revealed intergranular features to transgranular fatigue

Patches of heavily oxidized [obscured] and poorly resolvable fatigue striations typical of low cycle fatigue (LCF) were occasionally observed in between areas of secondary smearing and surface deposits throughout the transgranular fatigue progression. A striation counts to estimate the number of LCF crack propagation cycles was not possible. Attempts to remove the oxide scale from the surface with iterative cleanings in an Alconox detergent solution [200°F / 10 – 30 min.] to provide limited striation spacing data for a crack growth rate assessment were unsuccessful.

Continued examination of pockets of intact fracture features found a gradual transition from stable fatigue crack growth to unstable/cyclic tearing up to 0.408" from the aft bore face, beyond which crack surface features were completely removed by secondary smearing damage. It was not possible to identify the transition to entirely overstress features, representing the crack extremity, due to the damage on the fracture surface. Evidence of ductile dimple features were first observed ~0.147" from the aft bore face. Secondary cracking/tearing and >50% ductile

simple features indicative of unstable crack growth were observed  $\sim 0.232''$  from the aft bore face and beyond, as show on Fig. 1.16.3.7.b.

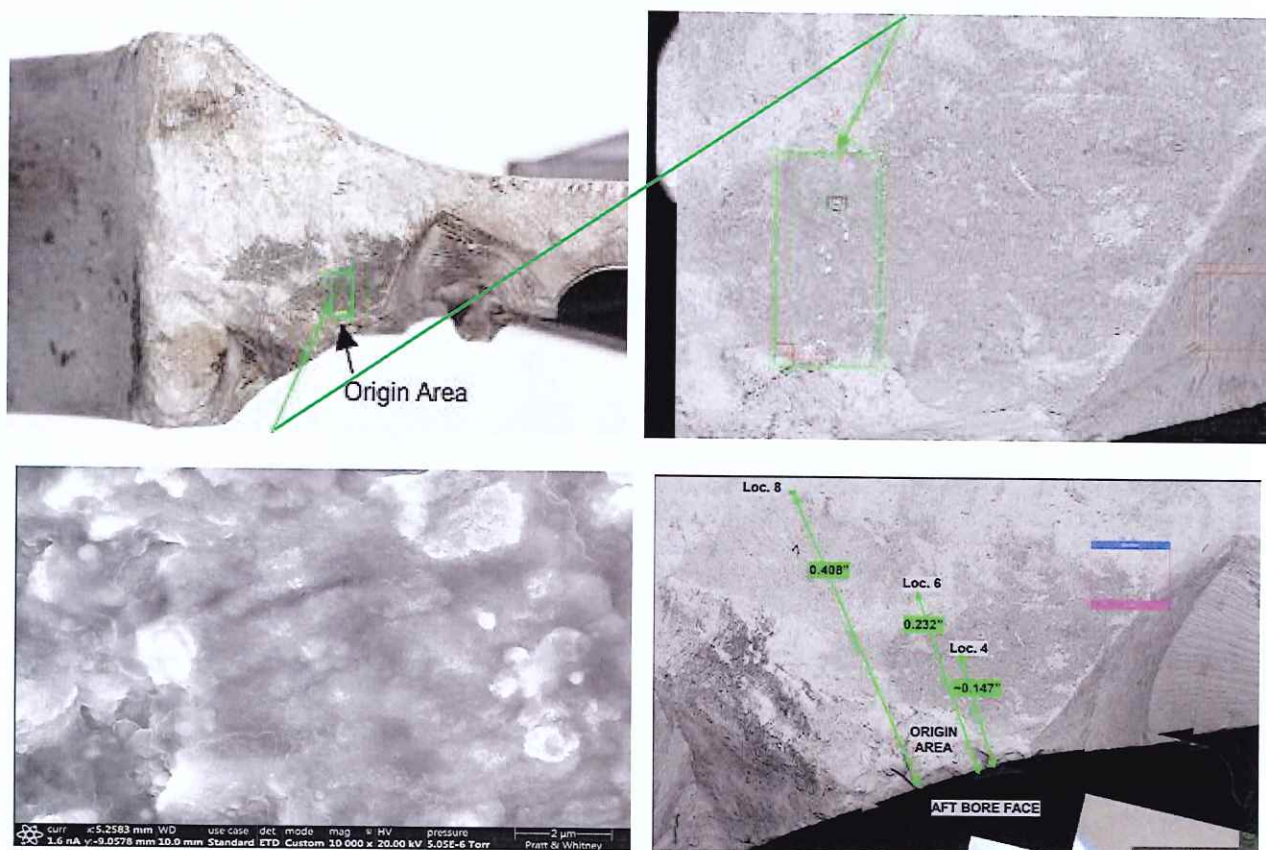


Fig. 1.16.3.7.b. Patches of heavily oxidized [obscured] fatigue striations typical of low cycle fatigue (LCF) observed in between areas of secondary smearing and surface deposits throughout the transgranular fatigue progression.

#### 1.16.3.8. Keyence 3D Scanning of Fragment #2 Fracture Half Origin Area.

Keyence 3D light interferometer profile scan was carried out on the fragment #2 fracture half at the fatigue origin area to assess how much material was removed by the secondary impact damage, based on the known depth of the particle cloud from the aft bore face (up to  $\sim 0.048''$  deep) determined by serial polishing of fragment #1, a large amount of the particle cloud on the fragment #2 half was expected to have been removed.

A portion of the fragment #2 fracture surface containing the origin area was sectioned off via wire [EDM] electrical discharge machining to facilitate micro computed tomography (micro-CT) scanning. The piece measured  $0.100''$  thick to allow for optimal scan spatial resolution ( $\sim 6\mu\text{m}$  pixel resolution). No clear low-density indications were found in the scan, as shown on Fig. 1.16.3.8.a.

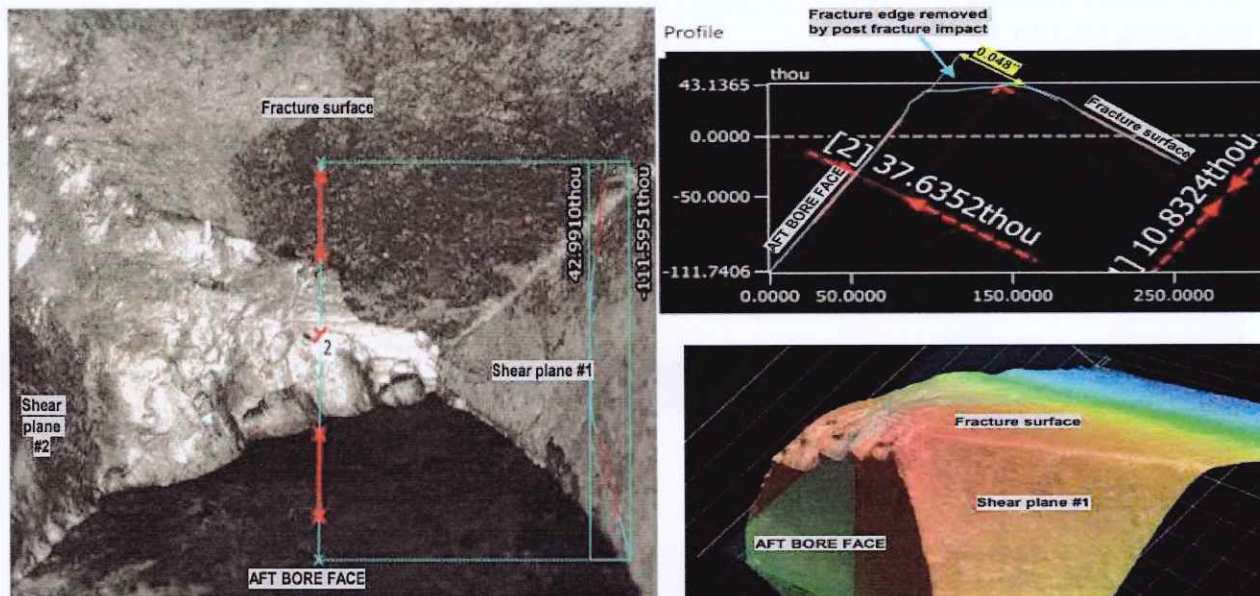


Fig. 1.16.3.8.a. A Keyence 3D light interferometer profile scan was carried out on the fragment #2 fracture half at the fatigue origin area to assess how much material was removed by the secondary impact damage, based on the known depth of the particle cloud from the aft bore face (up to ~0.048" deep).

#### 1.16.3.9. Metallography of HPC 7th Stage Rotor [IBR-7] Fragment #2 Fracture Half Origin Area.

Decided to serial polish through the fatigue origin area on the fragment #2 half primarily to acquire any additional dimensional information regarding the intergranular zone and particle cloud. A transverse metallographic section was prepared through the origin area by mounting the aft bore face of the piece down in clear epoxy resin and grinding through the curvature of the aft bore face until the section was plane, which placed the starting polish plane [polish #0] ~0.018" from the aft bore face. Examination of the section at polish #0 revealed a small area of diffuse particle cloud in line with the approximate origin up to ~0.028" deep beneath the estimated original fracture plane. No dense particle cloud/gamma prime denuded zone was observed.

The section was serial polished in 0.005" increments up to a depth of 0.048" from the aft bore face, resulting in six (6) polishes. Caliper measurements were used to ensure the targeted amount of material was removed at each polishing step. Over the course of these polishes, the small area of diffuse particle cloud was consistently observed and generally diminished in size/depth from the estimated original fracture plane. The only evidence of dense particle cloud / gamma prime denuded zone was observed in polish #2. The zone was contained within the diffuse cloud and measured ~0.003" wide by <0.001" deep. The actual size/shape of this zone was affected by microstructural smearing damage. Intergranular cracking up to 0.002" deep from the damaged surface was noted in polish #4. Polishes #5 and #6 intersected the region of intergranular crack surface previously found along the aft edge of the damage zone during SEM examination. Since the known depth of the particle cloud on the fragment #1 half had already been reached (0.048"), no further serial polishing through the origin area was carried out. Serial polishing confirmed that most of the intergranular zone and particle cloud on fragment #2 had been removed by the secondary impact damage, as shown on Fig. 1.16.3.9.a.

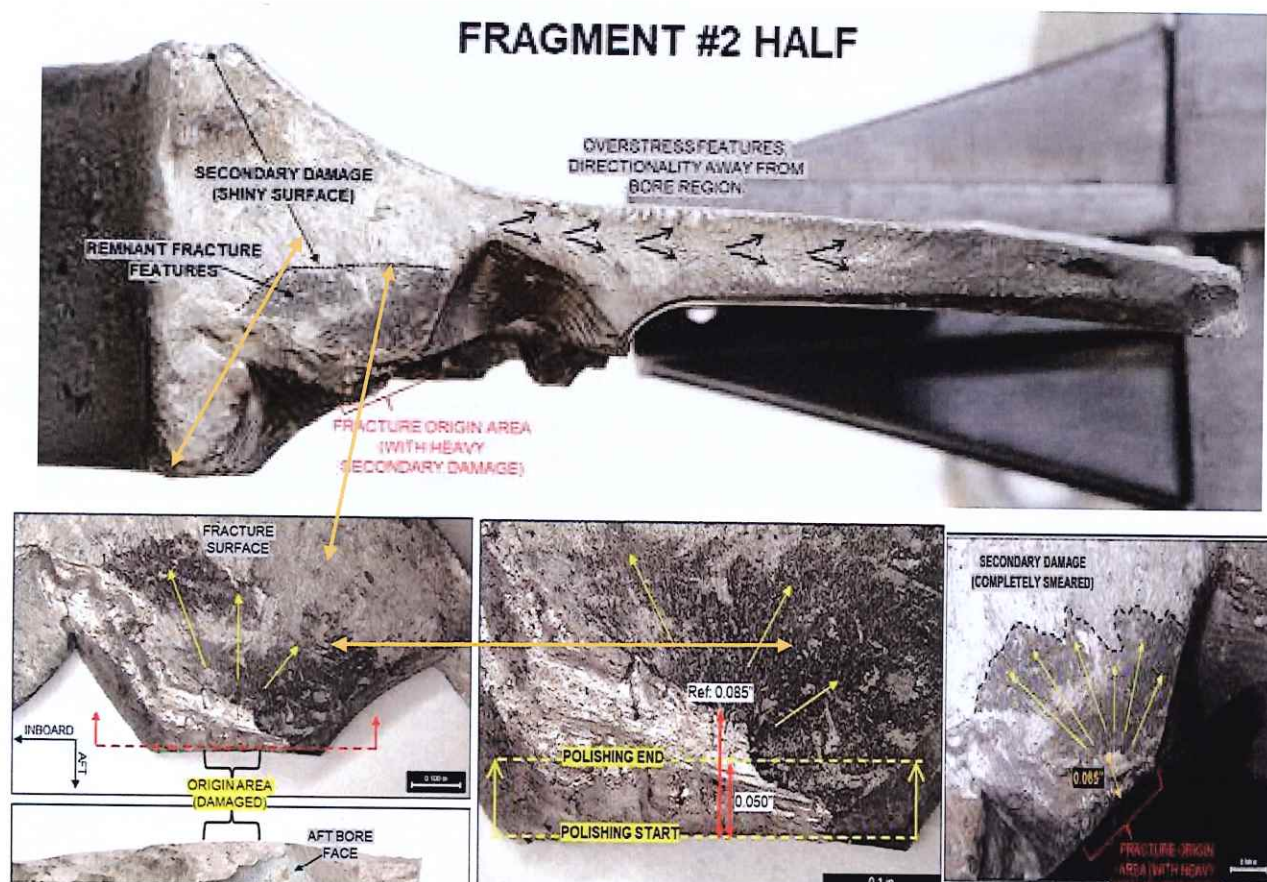


Fig. 1.16.3.9.a. Fragment #2 with six polishing on the fatigue origin area half primarily carried out, confirmed that most of the intergranular zone and particle cloud had been removed to detect the secondary impact damage.

### 1.17. Organizational and management information.

Aeroenlaces Nacionales S.A DE C.V [Mexican Company] operated, has an AOC No. VIV/2006 [V8OF230F] in Transport Commercial Passenger category. Viva Aerobus has twenty-two models A320-271N (NEO) and thirty A321-271NX (NEO), with a total of 52 aircraft, of these models on your fleet.

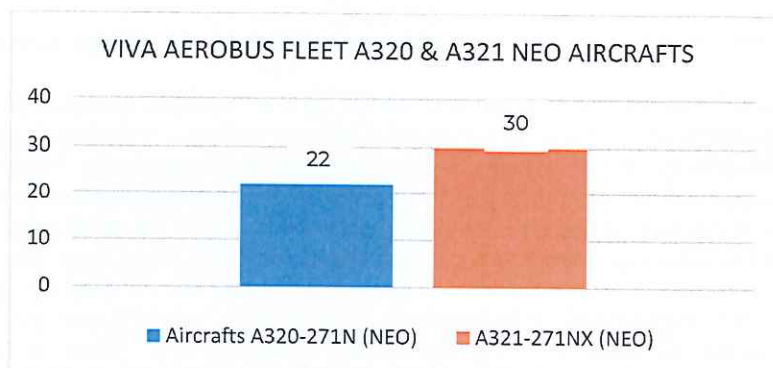


Fig. 1.17.a. Viva Aerobus fleet



## 1.18. Additional information.

### 1.18.1. Safety actions.

Since the induction of PW1100G-JM engines in Viva Aerobus in the year 2013 on December 24, 2022, an Airbus Model A320neo, with registration XA-VIO airplane powered by IAE LLC Model PW1127GA-JM engines, the aircraft engine No. 2 experienced a failure on the High-Pressure Compressor (HPC) 7th-Stage Integrally Bladed Rotor (IBR-7) with separation that resulted in an aborted takeoff, no reports are known of similar incidents on this part, in order to prevent reoccurrence of failures of this type, IAE-PW Pratt & Whitney following this event, the manufacturer conducted a records review of production and field-returned parts, and re-evaluated their engineering analysis methodology, come up to carried out the modifications on all engines PW1100G-JM models do an Angled Ultrasonic Scan Inspection (AUSI) Of the High Pressure Compressor (HPC) 7th Stage Rotor and the HPC 8th Stage Compressor Rotor, also identifies parts life retirement limits for the (HPC) 7th Stage Rotor and the HPC 8th Stage Compressor Rotor and HPC Rotor Rear Hub, part of the fleet management plan on engines and parts with material manufactured from powdered metal. [See Fig. 1.18.1.a.]

Other safety actions can be mentioned on manufacture:

- Manufacturing quality improvements.
- Additional Non Destructive Testing in production.

| No. | PW1127GA-JM engine report                                                                     | Action proposed by IAE-PW<br>The compliance of                                       | Action Taken by Mexican affected<br>operators.<br>(As of January 2024)                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Failure on the High-Pressure<br>Compressor (HPC) 7th-Stage<br>Integrally Bladed Rotor (IBR-7) | Issued SB 72-00-0224, Rev. 001,<br>date. 2023-11-03, effective. January<br>01, 2024. | Do an Angled Ultrasonic Scan Inspection<br>(AUSI) on. <ul style="list-style-type: none"><li>• High Pressure Compressor (HPC) 7<sup>TH</sup><br/>stage rotor.</li><li>• High Pressure Compressor (HPC) 8<sup>TH</sup><br/>stage rotor.</li></ul> Parts Life Retirement Limits. <ul style="list-style-type: none"><li>• High Pressure Compressor (HPC) 7<sup>TH</sup><br/>stage rotor.</li><li>• High Pressure Compressor (HPC) 8<sup>TH</sup><br/>stage rotor.</li><li>• High Pressure Compressor (HPC) rotor<br/>rear hub.</li></ul> |

Fig. 1.18.1.a. Engine HPC 7<sup>TH</sup> stage IBR7 failure and action proposed and taken by IAE-PW on all engines PW1100G-JM

The engine manufactured due to the findings and results of the fractures obtained in the laboratory during examinations to the fragments # 1 and # 2 recovered from the explosion of the High Pressure Compressor (HPC) 7th Stage Integrally Bladed Rotor (IBR-7) development and alert service bulletin No. PW1000G-C-72-00-0224-00A-930A-D issue No. 001, Issue Date November 03, 2023, the purpose is that the maintenance areas will make an (AUSI) Angled Ultrasonic Scan Inspection of the High Pressure Compressor (HPC) 7th stage rotor and the HPC 8th stage compressor rotor, also identifies part life retirement limits for the HPC 7th stage rotor, HPC 8th stage compressor rotor and HPC rotor rear hub). Allowing operators to begin with inspection on affected engine (PW1100) models PW1122G-JM, PW1124G1-JM, PW1124G-JM, PW1127G1-JM, PW1127GA-JM, PW1127G-JM, PW1129G-JM, PW1130G-JM, PW1133GA-JM, PW1133g-JM, PW1428G-JM, PW1428GA-JM, PW1428GH-JM, PW1431G-JM, PW1431GA-JM and PW1431GH-JM, installed on the A320 and 321 NEO aircrafts and replace the engines that found damaged during each inspection (AUSI) or by parts service limit established in the Alert Service Bulletin related to rare material anomalies that can occur in powdered metal forgings.



Safety actions that will allow the engines that are currently in operation to be handled safely by being monitored and if powdered metal anomalies are found in the parts or these reach life retirement limits, the engines will immediately be removed from aircraft operation and the safety of the aircraft will be maintained.

The previous part of the engine failure resulted in the [FAA] Federal Aviation Administration issued the AD 2023-16-07 effective date August 28, 2023, superseded by Airworthiness Directive [AD] 2024-05-11 effective date April 11, 2024. The investigation determined an increased risk of powder metal anomalies for all powder metal parts in certain powder metal production campaigns, which are susceptible to failure significantly earlier than previously determined.

Accelerated replacement of the HPC IBR-7, HPC IBR-8, HPC Rear Hub, The FAA is proposing this AD 2024-05-11 to address the unsafe condition on these products.

#### 1.18.2. Alert Service Bulletin PW1100G-JM-C-72-00-0224-00A-930A-D, [72-00-0224].

Alert Service Bulletin [ASB] purpose on Engine is to do an Angled Ultrasonic Scan Inspection [AUSI] of the High Pressure Compressor [HPC] 7TH Stage Rotor and High Pressure Compressor [HPC] 8TH Stage Rotor parts to identify cracks or premature failure for material manufactured from powdered metal and also perform the Part Life Retirement Limits as High Pressure Compressor [HPC] 7TH Stage Rotor Part, High Pressure Compressor [HPC] 8TH Stage Rotor Part, High Pressure Compressor [HPC] Rotor Rear Hub Part installed on all PW1100G-JM engine models and engine serial numbers, as shown in table of the Fig. 1.18.2.a.

| High Pressure Compressor [HPC] 7TH Stage Rotor Part Numbers. | High Pressure Compressor [HPC] 8TH Stage Rotor Part Numbers. | High Pressure Compressor [HPC] Rotor Rear Hub Part Numbers. |
|--------------------------------------------------------------|--------------------------------------------------------------|-------------------------------------------------------------|
| 30G2307                                                      | 30G5608                                                      | 30G4008                                                     |
| 30G4407                                                      | 30G5908                                                      | 30G8208                                                     |
|                                                              | 30G8908                                                      |                                                             |

Fig No 1.18.2.a. Part Life Retirement Limits on all PW1100G-JM Engine.

The operator [s] with these parts installed on engine [s] should be remove the engine [s] when – the parts life retirement arriving to limit or are exceeded the limits according with the effective date of Alert Service Bulletin: January 1, 2024, as show in table of the Fig. 1.18.2.b.

| Part Number                                                                                                                                                               | 27G* engine models and lower (part cycles).        | 29G* engine models and higher (part cycles).       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|----------------------------------------------------|
|                                                                                                                                                                           | Parts Retirement to Cycles Since New [CSN] 7000[*] | Parts Retirement to Cycles Since New [CSN] 5000[*] |
| High Pressure Compressor [HPC] 7 <sup>TH</sup> Stage Rotor Part 30G2307 & 30G4407.                                                                                        | 7000[*]                                            | 5000[*]                                            |
| High Pressure Compressor [HPC] 8 <sup>TH</sup> Stage Rotor Part 30G5608, 30G5908 & 30G8908.                                                                               |                                                    |                                                    |
| High Pressure Compressor [HPC] Rotor Rear Hub Part 30G4008 & 30G8208.                                                                                                     |                                                    |                                                    |
| [*] Identified 100 cycle drawdown period after the effective date of this Alert Service Bulletin, Remove engine by cyclic limit or in 100 cycles. Whichever occurs later. |                                                    |                                                    |

Fig. No. 1.18.2.b. Intervals of part life retirement limit of the engine [s].

The Alert Service Bulletin [SB]<sup>4</sup> was initially issued on November 03rd, 2023, a solution for this failure was given as Introduction of a new High Pressure Compressor [HPC] 7TH Stage Rotor, High Pressure Compressor [HPC] 8TH Stage Rotor and High Pressure Compressor [HPC] Rotor Rear Hub with same material manufactured from powdered metal with more durability.

<sup>4</sup> See attach A of this document.



### 1.18.3. Useful or effective investigation techniques.

No specification investigation techniques were used.

## 2. ANALYSIS.

The flight crew was properly certificated and qualified. Flight crew fatigue was likely not a factor in this incident.

The aircraft was properly certificated, equipped and maintained.

### 2.1. Operational.

At 19:41:52 UTC, Engine 2 Master Lever was turned ON. At 19:52:04 UTC, Aircraft taxied to runway 29R:

- GW = 61.6 T [<MTOW=73.5 Tons].
- CG = 23.4%.
- S/F Conf was at CONF 2.
- Ground Spoilers were armed for Take-off.
- Auto brake was Armed at MAX.
- Thrust levers were at FLX detent.
- Engine 1/2 N1 = 53%/56% and increasing.
- Engine 1/2 N2 = 84%/86% and increasing.
- Engine 1/2 EGT = 666°C/678°C.
- Engine 1/2 Fuel Flow = 923kg/hr / 1100kg/hr.
- Engine 1/2 Oil Pressure = 155psi / 158 psi.
- Engine 1/2 Oil Quantity = 11.5qts / 11qts.
- Engine 1/2 Oil Temperature = 89°C.

At 19:52:17 UTC, on take-off roll, CAS = 80kt, GS = 76kt,

- Engine 1 Oil Pressure was at 181psi.
- Engine 2 Oil Pressure was at 184psi.
- Engine 2 Low Oil Pressure switched to 0.
- N1A2 (Engine 2 N1) started decreasing from 83%.
- N1A1 (Engine 1 N1) remained stable at 83%.
- Bus Transfer Contactor 1 position changed from Open to Closed.
- Two samples later, Bus Transfer Contactor 2 position changed from Open to Closed.
- Two samples later, Generator Line Contactor 2 position changed from Closed to Open.

At 19:52:18 UTC, on take-off roll, CAS = 83kt.

- N1A2 decreased to below 46%, while N1A1 was still at 83%.
- N2A2 (Engine 2 N2) started decreasing from 92% to 50% in one second while N2A1 (Engine 1 N2) remained at 92%.
- Lateral acceleration changed from +0.04 to -0.07g [acceleration to the right].

At 19:52:19 UTC, on take-off roll, CAS = 83kt.

- Engine 2 N2 decreased from 50%.
- Thrust levers were pulled to Idle and then to MAX REV in one second (at 19:52:20 UTC).
- Full rudder pedal was applied, and the rudder reached its full deflection [30°] one second later. Ground Spoilers started extending.

At 19:52:20 UTC, CAS started to decrease after having reached a maximum of 86kts.

- Engine 2 N2 vibration decreased from 0.3 CU to 0 while Engine 1 N2 vibration stayed stable.

At 19:52:21 UTC, CAS = 75kt, Master Caution triggered for 8 seconds. According to PFR, it was likely associated with ECAM ENG 2 FAIL, which triggers when N2 is detected below 50%.

At 19:52:22 UTC, CAS = 61kt. Lateral acceleration reached 0.12g [acceleration to the left].



At 19:52:24 UTC, N2A2 was recorded at 0.

At 19:52:26 UTC, Engine 2 N2 vibration reached 0.5 CU.

At 19:52:27 UTC, CAS = 37kt, thrust levers were pushed to REV IDLE. Engine 2 EGT parameter became invalid (with error code Failure Warning). The last recorded valid value was 610°C.

At 19:52:29 UTC, Eng 2 N1A was recorded at 0.

At 19:52:32 UTC, Engine 2 N2 vibration was durably recorded at 0.

At 19:52:33 UTC, Ground Speed = 11kt. Engine 1 thrust reversers were recorded fully deployed.

At 19:52:34 UTC, ENG 2 FIRE ECAM warning triggered (16s after N2 drop / 7s after EGT2 invalidity).

- Master warning triggered for 4 seconds (till 19:52:39 UTC).

At 19:52:37 UTC, GS = 0kt, Master caution triggered for 8 seconds (till 19:52:45 UTC).

At 19:52:46 UTC, GS = 0kt, Engine 2 Master Lever was set to OFF.

At 19:52:48 UTC, Eng2 Start Air Valve opened during 3s.

At 19:52:52 UTC, the Eng2 FIRE P/B was pushed.

- This action was consistent with the ECAM procedure ENG 2 FIRE.
- The FADEC parameters became invalid.
- Action on Eng2 FIRE P/B cut the power supply of Eng2 FADEC.

At 19:52:58 UTC, ENG 2 FIRE ECAM warning stopped.

- Only the FWD bottle was discharged.
- According to the PFR, the last recorded messages were ENG 2 FIRE LOOP A FAULT (still in the minute 19:52) and ENG 2 FIRE DET FAULT (in the minute 19:53).

At 19:53:04 UTC, GS = 0kt, Master caution triggered. This last Master caution is likely linked to the ECAM ENG 2 FIRE DET FAULT recorded in the PFR at 19:53.

Meteorological factors were not contributing to the cause of the serious incident.

The flight crew carried out the (RTO) Rejected Take Off normal procedure.

The engine was disassembly, and the fragment # 1 & fragment # 2 debris parts from the No. 2 engine retrieved for lab examination, this engine experienced an explosion and fracture on High Pressure Compressor (HPC) 7th Stage Integrally Bladed Rotor (IBR-7), that successively revealed to:

- The two larger recovered High Pressure Compressor (HPC) 7<sup>th</sup> Stage Integrally Bladed Rotor (IBR-7) fragments containing the mating halves of both radial fractures were arbitrarily labeled #1 and #2 for investigation. All fragments exhibited extensive event-related damage, some thermal discoloration, and varying amounts of adhered debris on surfaces. Several portions of the web and a rim fragment appeared to be missing. All airfoils had fractured adjacent to the rim (OD) outside diameter and were missing. The stage rotor had fractured radially from bore to rim in two places spaced ~220 degrees apart.
- On Binocular Microscope Examination carried out to the surface of High Pressure Compressor (HPC) 7th Stage Integrally Bladed Rotor (IBR-7) fragment #1, the primary fracture covering with a thick layer (cladding) of adhered event debris deposits on the forward web/bore surfaces adjacent to the fracture and portions of the fracture surface obscured were also covered in this debris.



- On Binocular Microscope Examination carried out to the surface of High Pressure Compressor (HPC) 7th Stage Integrally Bladed Rotor (IBR-7) fragment #1, the primary radial fracture surface, which was covered in a layer of debris that obscured fracture features. Certain features on the surface were still identifiable such as a small, continuous shear lip along the forward edge of the bore fracture and an angled surface plane along the bore (ID) Inside diameter that was considered most likely secondary damage, possibly from contact with the HPC tie shaft immediately following fracture.
- A transverse metallographic section was prepared through the fragment #1 of High Pressure Compressor (HPC) 7th Stage Integrally Bladed Rotor (IBR-7) fracture half of ~0.84" radially outboard of the bore (ID) inside diameter and serial polished in the inboard direction through the fatigue origin area. The section was mounted in clear epoxy resin so that progress serial of 35 polishing sections carried out, all supported with (micro-CT scans) Scans Micro Computed Tomography and (EMP) Electron microprobe analysis of Particle Cloud Chemistry methods, with damage as: intergranular cracking, evidence of a "NMI" Non Metallic Inclusions (particle cloud), Smearing Damage, Diffuse Particle Cloud, Dense P.C-Particle Cloud & Gamma Prime Denuded Zone.

Note: the serial of polishing carried out on fragment # 1 confirmed the cracking in *powder metal nickel alloy has identified particle cloud type nonmetallic inclusions (NMIs) and associated intergranular processing cracking at crack origin areas.*

- On Binocular Microscope Examination carried out to the surface of High Pressure Compressor (HPC) 7th Stage Integrally Bladed Rotor (IBR-7) fragment #2 was suspected the fracture origin area on a planar region of fracture was observed, in the bore area on one of the two radial fractures on this exhibited overstress features through the web with directionality towards the rim from the bore area.
- On the High Pressure Compressor (HPC) 7th Stage Integrally Bladed Rotor (IBR-7) fragment #2 the primary fracture origin area on the radial surface after ultrasonically cleaning to remove extraneous dirt/debris revealed extensive secondary smearing damage, the fracture origin area on the aft side of the bore had also sustained heavy secondary impact damage measuring up to 0.085" deep from the aft bore surface.
- The bore region of the fragment # 2 fracture surface was sectioned off to facilitate evaluations performing the scanning electron microscopy (SEM), Keyence 3D Scanning, Micro-CT Scanning and Metallography methods, were observed on the fracture origin area an intergranular and transgranular fatigue progression, on both features appeared oxidized.
- A transverse metallographic section was prepared through the fragment #2 of HPC stage rotor IBR No. 7th fracture half origin area mounting the aft bore face of the piece down in clear epoxy resin and grinding curvature to starting polish plane [polish #0] ~0.018" from the aft bore face. Examination of the section at polish #0 revealed a small area of diffuse particle cloud in line with the approximate origin up to ~0.028" deep, the section done serial polished in 0.005" increments up to a depth of 0.048" from the aft bore face, resulting in six (6) polishes, the material was removed at each polishing step, Over the course of these polishes, the small area of diffuse particle cloud was consistently observed and generally diminished in size/depth from the estimated original fracture plane. evidence of dense particle cloud / gamma prime denuded zone, microstructural smearing damage, Intergranular and transgranular cracking up, confirmed on fragment #2.

### 3. CONCLUSIONS.

The flight crew was properly certificated and qualified.

Flight crew fatigue was not a factor in this serious incident.

The airplane and engine were properly certificated and maintained.

The Flight Data Recorder data provided the information results for the analysis of the event sequence, observing was developed as follows:

- Lining and beginning of takeoff roll were normal, with correct engine thrust.
- At Ground Speed = 80 knots to 83 knots, engine 2, started decreasing the engine parameters on takeoff roll, causing the lateral acceleration changed from +0.04 to -0.07 g [acceleration to the right].



- Thrust levers were pulled to Idle by flight crew and then to MAX REV in one second [at 19:52:20 UTC].
- Full rudder pedal was immediately applied, and the rudder reached its full deflection [30°] one second later.
- Ground spoilers started extending.
- During takeoff roll = 75 knots, engine 2 failed, with master caution triggered for 8 seconds on ECAM, which triggers when N2 is detected below 50%.
- "RTO" Rejected Take Off was carried out by the flight crew.
  - Thrust levers were pushed to REV IDLE.
  - On ECAM the engine 2 EGT parameter last recorded value was 610°.
  - Engine 2 fire ECAM warning triggered [16s after N2 drop / 7s after EGT 2 value was 610°.
  - Master warning triggered for 4 seconds.
  - Engine 2 fire ECAM warning stopped only the FWD bottle was discharged.

The subject HPC 7th Stage Rotor [IBR-7] fractured due to LCF [Low Cycle Fatigue], which had progressed through the bore region along an axial-radial plane from an intergranular crack zone encompassing a reactive [NMI] nonmetallic inclusion particle cloud on the aft bore surface ~0.75" radially outboard of the bore [ID] inside diameter.

Particle cloud morphology and chemistry were consistent with previous P&W experience. The particle cloud was likely introduced during processing of the raw powder metal alloy. The intergranular crack zone was suggestive of prior thermo-mechanical processing-related cracking that had occurred at manufacture, such as during heat treat after forging. It was inconsistent with being engine-generated cracking given the predicted operating temperature range at the bore.

Significant damage to both HPC 7th Stage Rotor [IBR-7] fracture halves fragments # 1 & # 2 had occurred during the event which prevented conclusive determination of [1] the size/shape of the intergranular crack zone and particle cloud, and surface crack length at time of manufacture, [2] the estimated size of the fatigue crack at the last [FPI] fluorescent penetrant inspection and [3] the size of the fatigue crack prior to final overstress fracture.

Based on the available evidence, it was considered reasonable to conclude that both the particle cloud and the intergranular crack zone had intersected the aft bore surface and some portion of each had been machined away at manufacture. The size and shape of the particle cloud and intergranular crack zone were estimated from metallographic serial polishing. The remaining portion of the particle cloud measured ~0.018" long at the aft bore surface and up to ~0.048" deep from the surface. The remaining portion of the intergranular crack region measured up to ~0.092" wide by 0.083" deep from the aft bore surface.

Fatigue striations could not be resolved well enough to accurately measure spacings for a crack growth rate assessment due to the heavily oxidized condition of the crack surface. Multiple attempts to remove the oxide scale from the surface by various cleaning methods were unsuccessful.

A gradual transition from stable fatigue crack growth to unstable/cyclic tearing was observed up to 0.408" from the aft bore face, beyond which crack surface features were completely removed by secondary smearing damage. No transition to entirely overstress features, representing the crack extremity, could be identified on the remaining fracture surface.

Bulk microstructure of the HPC 7th Stage Rotor [IBR-7] bore conformed to P&W Quality standards and specification requirements.

### 3.1. Probable cause.

The Comisión Investigadora y Dictaminadora de Accidentes e Incidentes Aéreos indicates that this final opinion report is issued and based on Mexican Articles 1, 2 section I, 14, 16, 18, 26, and 36 section XXVII of the Organic Law of the Administration Federal Public; Article 7 subfraction II Internal Regulations of the Secretaría de Infraestructura, Comunicaciones y Transportes [SICT]; 185, 187, 189 and 190 of the Regulations of the Civil Aviation Law, as well as the first, second, third and fourth Transitory articles of the *"Agreement establishing that activities related to search and rescue, as well as the investigation of accidents and incidents suffered by civil aircraft referred to in articles 80, 81, 81 BIS and 81 TER of the Civil Aviation Law will be carried out by the Subsecretaría de Transporte of the*



SICT", published in the Official Gazette of the Federation on August 24, 2021; determined the probable cause of this incident.

**"The uncontained failure on No. 2 engine High Pressure Compressor (HPC) 7th stage Integrally Bladed Rotor (IBR-7), occurred during the aircraft takeoff roll, is a powdered metal anomaly originating from the manufacturing process."**

Flight Phase: Takeoff Roll.

### 3.2. Contributing factors.

- a. The particle cloud was likely introduced during the raw powder metal allow manufacture process of the High Pressure Compressor (HPC) 7th Stage Integrally Bladed Rotor (IBR-7) and the Non Destructive Test controls in place at the time of manufacture did not allow to detect it during manufacture.

### 4. RECOMMENDATIONS.

Due to the uncontained failure originated in the No. 2 engine High Pressure Compressor (HPC) 7th stage Integrally Bladed Rotor (IBR-7), the National Transport Safety Board "NTSB" (USA) coordinated with the Manufacturer Pratt & Whitney the issuance of Alert Service Bulletin No. PW1000G-C-72-00-0224-00A-930A-D, (72-00-0224) and with the Federal Aviation Administration "FAA" (USA) the Airworthiness Directives AD 2023-16-07 & AD 2024-05-11, allowing monitoring and inspection for a manufacturing anomalies and part life retirement limit of the High Pressure Compressor HPC 7<sup>th</sup>, 8<sup>th</sup> Stage, Hub, Rear, HPC Rotor, repetitive inspection for a manufacturing anomalies and part life retirement limits affected in all PW1100 engine models installed on A320 & A321 NEO aircrafts, upon detecting the particle cloud that was likely introduced during the raw powder metal allow during the manufacture rotor process, the Comisión Investigadora y Dictaminadora de Accidentes e Incidentes de Aviación, recommended the following:

To the Agencia Federal de Aviación Civil [AFAC] Mexican Authority.

**Rec. 10/2025** Review that Mexican operators flying with Airbus A320 and 321 NEO aircraft with engines IAE P&W1100 GTF in models: PW1122G-JM, PW1124G1-JM, PW1124G-JM, PW1127G1-JM, PW1127GA-JM, PW1127G-JM, PW1129G-JM, PW1130G-JM, PW1133GA-JM, PW1133G-JM, PW1428G-JM, PW1428GA-JM, PW1428GH-JM, PW1431G-JM, PW1431GA-JM & PW1431GH-JM, complying with the inspection of [AUSI] Angled Ultrasonic Scan Inspection to detect cracks and prevent premature failure of the HPC 7th stage rotor, HPC 8th stage compressor rotor and identifies the parts life retirement limits for the HPC 7th stage rotor, HPC 8th stage compressor rotor and HPC rotor rear hub by anomalies on material manufactured from powdered metal, according to Alert Service Bulletin No. PW1000G-C-72-00-0224-00A-930A-D, (72-00-0224) Issued No. 1, effective date: 2023-11-03 and the Airworthiness Directives; International Aero Engines, LLC [IAE LLC] No. AD 2023-16-07 effective date August 28, 2023, and AD 2024-05-11 effective date April 11, 2024.

Importance to review the AUSI Inspection and identifies the parts life retirement limits on engines affected.

increased risk of failure for additional powdered metal parts in certain powdered metal production campaigns, including the HPC IBR-7 and HPC IBR-8, and that all affected parts are susceptible to failure significantly earlier than previously determined. The condition, if not addressed, could result in uncontained hub failure, release of high-energy debris, damage to the engine, damage to the airplane, and loss of the airplane.

Commission President

Eng. José Armando Constantino Tercero

| <b>Información confidencial.</b>                |                                                                                                              |
|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Área responsable:                               | Subsecretaría de Comunicaciones y Transportes / Dirección de Análisis de Accidentes e Incidentes de Aviación |
| Datos testados:                                 | VER 1: Edad y número de licencia de piloto.<br>VER2: Edad y número de licencia de copiloto.                  |
| Fundamento jurídico:                            | Artículos 115, primer párrafo de la Ley General de Transparencia y acceso a la Información Pública           |
| Fecha de resolución del Comité de Transparencia | 12 de mayo de 2026                                                                                           |