



## **FOREWORD**

*This document has been prepared based upon the evidences collected during the investigation and opinions obtained from the experts. The investigation has been carried out in accordance with Annex 13 to the convention on International Civil Aviation and under Rule 11 of Aircraft (Investigation of Accidents and Incidents), Rules 2017 of India.*

*The investigation is conducted not to apportion blame or to assess individual or collective responsibility. The sole objective is to draw lessons from this serious incident which may help in preventing such incidents in future.*

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## **GLOSSARY**

AAIB	Aircraft Accident Investigation Bureau, India
AMSL	Above Mean Sea Level
ARC	Airworthiness Review Certificate
ATB	Air Turn Back
ATC	Air Traffic Control
ATPL	Airline Transport Pilot License
AUW	All Up Weight
BOAS	Blade Outer Air Seal
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CAR	Civil Aviation Requirements
CEO	Current Engine Option
CPL	Commercial Pilot License
DGCA	Directorate General of Civil Aviation
ECAM	Electronic Centralized Aircraft Monitor
EEC	Electronic Engine Controller
ESN	Engine Serial Number
FCOM	Flight Crew Operating Manual
FRTOL	Flight Radio Telephone Operators License
IATA	International Air Transport Association
GTB	Ground Turn Back
HPC	High pressure compressor
HPT	High Pressure Turbine
ICAO	International Civil Aviation Organization
IFSD	In-Flight Shut Down
LPT	Low Pressure Turbine

MOC	Material of Construction
NEO	New Engine Option
NGV	Nozzle Guide Vanes
OEM	Original Equipment Manufacturer
PHMU	Prognostics and Health Management Unit
PIC	Pilot in Command
P&W	Pratt and Whitney
QRH	Quick Reference Handbook
RTO	Reject Take-off
SB	Service Bulletin
TEC	Turbine Exhaust Case
SSCVR	Cockpit Voice Recorder
SSDFDR	Digital Flight Data Recorder

**FINAL INVESTIGATION REPORT ON SERIOUS INCIDENT INVOLVING M/S**  
**INDIGO AIRBUS A320 (NEO) AIRCRAFT VT-ITG ON 02/04/2019**

- |     |                                    |   |  |
|-----|------------------------------------|---|--|
| 1.  | <b>Aircraft Type</b>               | : | Airbus A320-271 NEO                    |
|     | <b>Nationality</b>                 | : | Indian                                 |
|     | <b>Registration</b>                | : | VT - ITG                               |
| 2.  | <b>Owner</b>                       | : | M/s Ravi Aviation Leasing Limited      |
| 3.  | <b>Operator</b>                    | : | Inter Globe Aviation Ltd (IndiGo)      |
| 3.  | <b>Pilot – in –Command</b>         | : | ATPL holder                            |
|     | <b>Extent of Injuries</b>          | : | Nil                                    |
| 4.  | <b>First Officer</b>               | : | CPL Holder                             |
|     | <b>Extent of injuries</b>          | : | Nil                                    |
| 5.  | <b>Place of Serious Incident</b>   | : | Enroute (Near Pune)                    |
| 6.  | <b>Date &amp; Time of Incident</b> | : | 02 <sup>nd</sup> April 2019 & 0549 UTC |
| 7.  | <b>Last Point of Departure</b>     | : | Pune Airport                           |
| 8.  | <b>Point of Intended Landing</b>   | : | Nagpur Airport                         |
| 10. | <b>Type of Operation</b>           | : | Scheduled Operation                    |
| 11. | <b>Passengers on Board</b>         | : | 93 (Including 04 Cabin Crew Members)   |
|     | <b>Extent of Injuries</b>          | : | Nil                                    |
| 12. | <b>Phase of Operation</b>          | : | Climb                                  |
| 13. | <b>Type of Occurrence</b>          | : | Air Turn Back due to Engine Stall.     |

(All the timings in this report are in UTC unless otherwise specified)

## **SYNOPSIS**

On 02<sup>nd</sup> April 2019, M/s Indigo Airbus A320-271 (NEO) aircraft VT-ITG, while operating a scheduled flight from Pune to Nagpur was involved in an Air Turn Back due to Engine Stall during climb. The aircraft was under the command of an ATPL holder with a CPL holder co-pilot. There were 93 passengers on board the aircraft including 04 cabin crew members.

The aircraft took off from Pune and flight was uneventful till climbing pass 14300 feet altitude when a loud bang was heard by the crew from left side. Subsequently, 'Engine No # 1 STALL' ECAM was triggered. This was followed by 'ENG 1 EGT OVERLIMIT' and "ENG 1 HGH VIB" on ECAM. The Engine parameters i.e., N1 and N2 vibrations were observed to be at 10 and 7 respectively, and the EGT was noticed to be increasing past 1000°C. The Engine # 1 power was brought back to Idle. The crew carried out ECAM and QRH procedures. Owing to abnormal engine parameters, the crew decided to return to Pune. No emergency was declared and the aircraft landed safely at Pune after obtaining permission from ATC. On visual inspection of the engine inlet area and exhaust area, all blades of LPT 3rd stage were found damaged.

The occurrence was classified as Serious Incident and an investigation to investigate into the probable cause(s) of the serious incident, was instituted under Rule 11 (1) of Aircraft (Investigation of Accidents and Incidents), Rules 2017.



## **1 FACTUAL INFORMATION**

### **1.1 History of the Flight**

On 02<sup>nd</sup> April 2019, M/s Indigo Airbus A320-271 (NEO) aircraft VT-ITG, was scheduled to operate flight 6E-134 from Pune to Nagpur. There was no abnormality reported on the aircraft during any of the previous flights on the day.

The aircraft was scheduled to depart from Pune at 0535 UTC and arrive at Nagpur at 0700 UTC. The aircraft took-off from Pune at around 0529 UTC. At 0549 UTC, while climbing passing Flight Level 143, a loud bang was heard by the crew from the left side. Subsequently, 'ENG 1 STALL' triggered on ECAM. This was followed by 'ENG 1 EGT OVERLIMIT' and 'ENG 1 HGH VIB' on ECAM. The crew followed ECAM actions and QRH checklist/procedures for Engine Stall, Engine Vibration and EGT overlimit. The Engine # 1 power was brought back to idle. The Engine parameters i.e., N1 vibrations was at 10 and N2 vibrations was at 7 and the EGT was noticed to be increasing past 1000°C.

As the Engine parameters were abnormal, the crew decided to return to Pune. Accordingly, crew informed ATC, Pune and also Mumbai about Turn Back. No Emergency was declared by the crew. After obtaining necessary clearances from ATC, Pune, the aircraft landed safely at Pune at 0608 UTC. Upon landing, the aircraft vacated the runway and taxied to bay. The passengers were disembarked normally. There was no fire and no injury to any occupant on board the aircraft. During post flight inspection, while carrying out visual inspection of the involved engine, i.e., inlet area and exhaust area of Engine # 1, Low Pressure Turbine 3rd stage blades were found damaged.

### **1.2 Injuries to Persons**

There was no injury to any of the occupant on board the aircraft.

### **1.3 Damage to Aircraft**

During post flight inspection and tear down examination the following salient damages on Engine # 1 were observed: -

1. The Combustion Chamber was observed to have burn marks, cracks and coating loss.
2. Low Pressure Turbine (LPT) Drive shaft was found to have score marks.

3. Some blades of LPT Stage 1 were found to be damaged.
4. Some blades of LPT Stage 2 were found to be damaged.
5. All blades of LPT Stage 3 were found damaged (Fractured).
6. LPT Stage 3 vanes were observed to have impact damages.
7. LPT Case was found to have impact damages on multiple locations.
8. Turbine Exhaust Case was found to have significant impact damages.
9. Accessory Gear Box, Metal Chip Detector (AGB, MCD) was observed to have more than 60% metallic fines.

#### **1.4 Other Damages**

Nil

#### **1.5 Personnel Information**

##### **1.5.1 Pilot – In – Command**

Age	50 Years
License	ATPL
Date of Issue	19/04/2016
Valid up to	18/04/2021
Class I Medical Validity	Valid
Date of issue FRTOL License	22/02/2016
FRTOL License Valid up to	21/02/2021
Endorsements as PIC	A320-10.09.2018
Total flying experience	3847:38 Hours
Total flying experience on type	1341:28 Hours
Last Flown on type	01-04-2019
Total flying experience during last 1 year	661:25 Hours
Total flying experience during last 6 Months	397:32 Hours
Total flying experience during last 30 days	64:10 Hours

Total flying experience during last 07 Days	15:49 Hours
Total flying experience during last 24 Hours	3:36 Hours
Rest period before flight	17:00 Hours

### **1.15.2 Co-Pilot**

Age	22 Years
License	CPL
Date of Issue	20/04/2017
Valid up to	19/04/2022
Class I Medical Valid up to	17/09/2020
Date of issue FRTOL License	20/04/2017
FRTOL License Valid up to	19/04/2022
Total flying experience	541:17 Hours
Total flying experience on type	341:17 Hours
Last Flown on type	01-04-2019 Hours
Total flying experience during last 1 year	341:17 Hours
Total flying experience during last 6 Months	341:17 Hours
Total flying experience during last 30 days	76:23 Hours
Total flying experience during last 07 Days	16:45 Hours
Total flying experience during last 24 Hours	3:36 Hours
Rest period before flight	17:00 Hours

## **1.6 Aircraft Information**

### **1.6.1 Airbus A-320 NEO**

The Airbus A320 is narrow-body (single-aisle) aircraft with a retractable tricycle landing gear and is powered by two wing pylon-mounted turbofan engines. The A320 family aircraft fitted with new engines were named as NEO (New Engine Option) and the rest were named as CEO (Current Engine Option). These new engines were manufactured with the idea that it will consume less fuel as compared to other engines, reduced CO2 emissions and reduction in engine noise. A320 NEO can be fitted with either:

- The PW1127G-JM, manufactured by Pratt & Whitney or;
- The LEAP-1A, manufactured by CFM International.

The A320 NEO aircraft made its first flight on 25th September 2014 and it was first introduced by Lufthansa on 20th January 2016. A total of 38 operators worldwide are operating A320 NEO family aircraft. After acceptance of Type Certification by DGCA, these A320 NEO aircraft (fitted with PW1127G-JM engines) were inducted by two airline operators in India i.e. M/s Indigo and M/s Go Air.

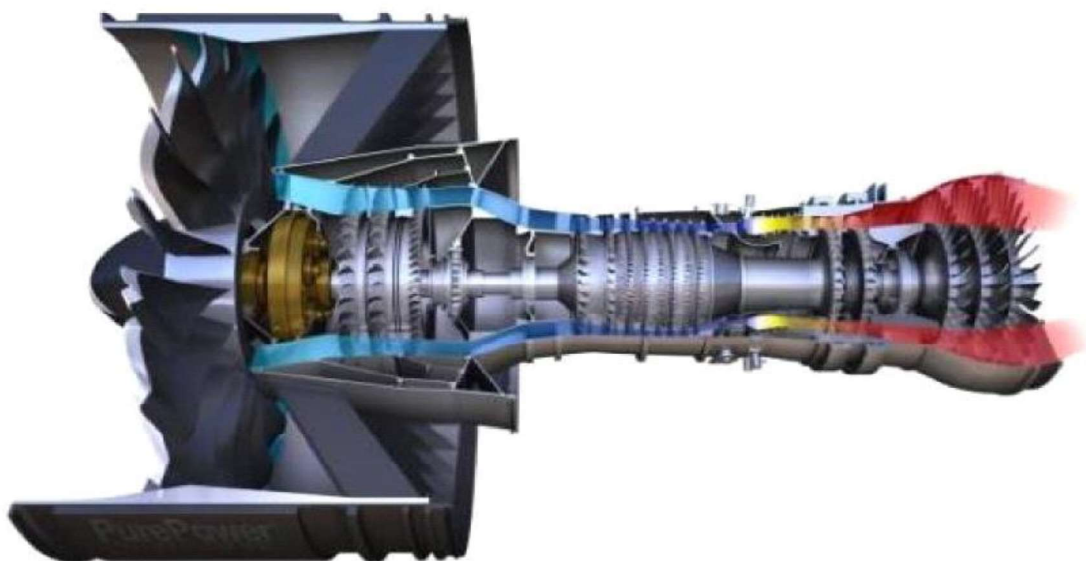
M/s Indigo inducted the first A320 NEO aircraft in its fleet on 11th March 2016. The number of A320 NEO family fleet operating in India and globally (as of November 2020) is given below: -

	<b>Airlines</b>	<b>A320 NEO</b>		<b>A321 NEO</b>		<b>Total</b>
Global (Including India)	All	<b>485</b>		<b>249</b>		<b>734</b>
India	Indigo	115	<b>161</b>	25	<b>25</b>	<b>186</b>
	Go Air	46		0		

***Table 1: A320/A321 Neo fleet Global vs India.***

### **1.6.2 Brief Technical Description of PW1127G-JM Engine**

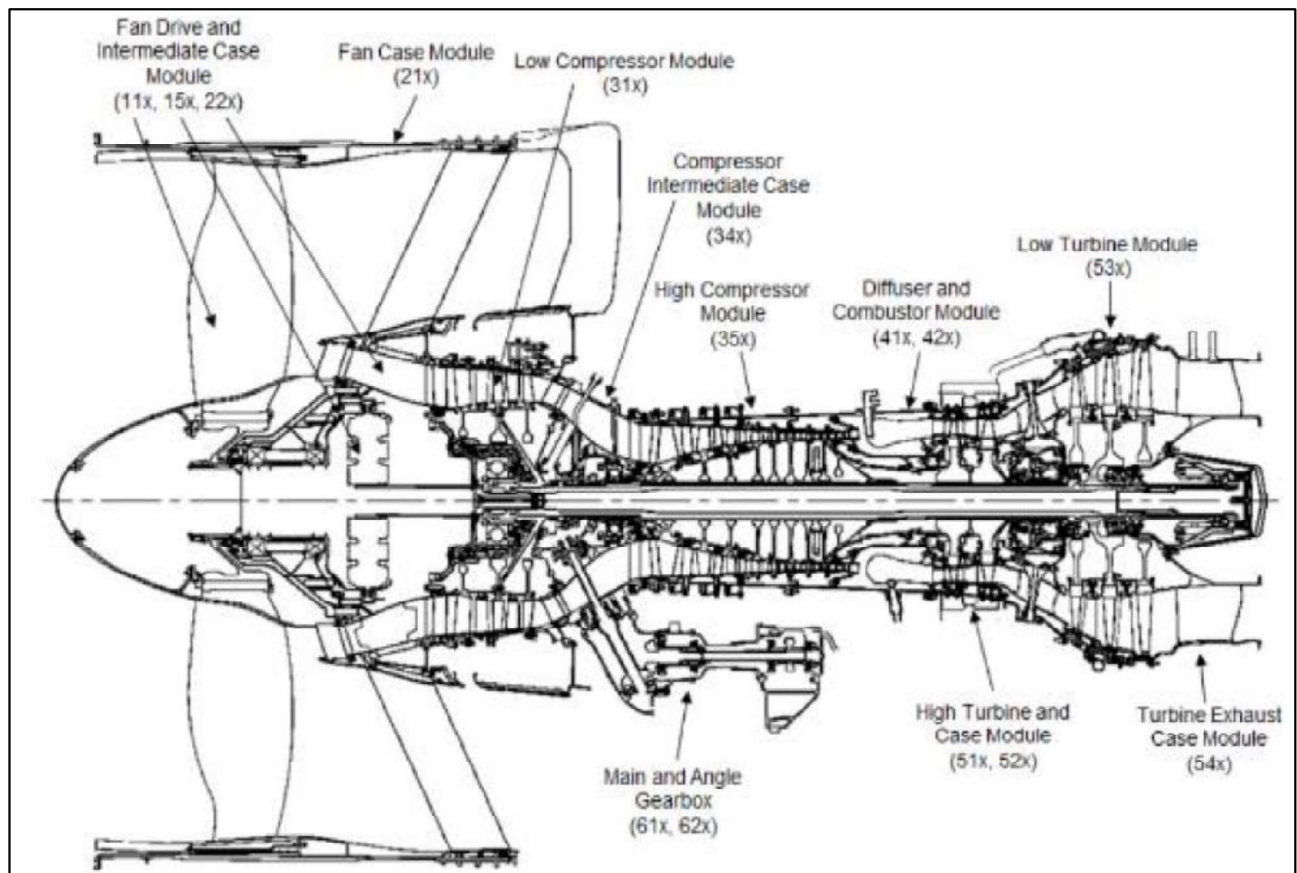
The PW1127G-JM turbofan engine is an axial-flow, twin spool turbofan engine with an ultra-high bypass ratio, low speed gear-driven fan.



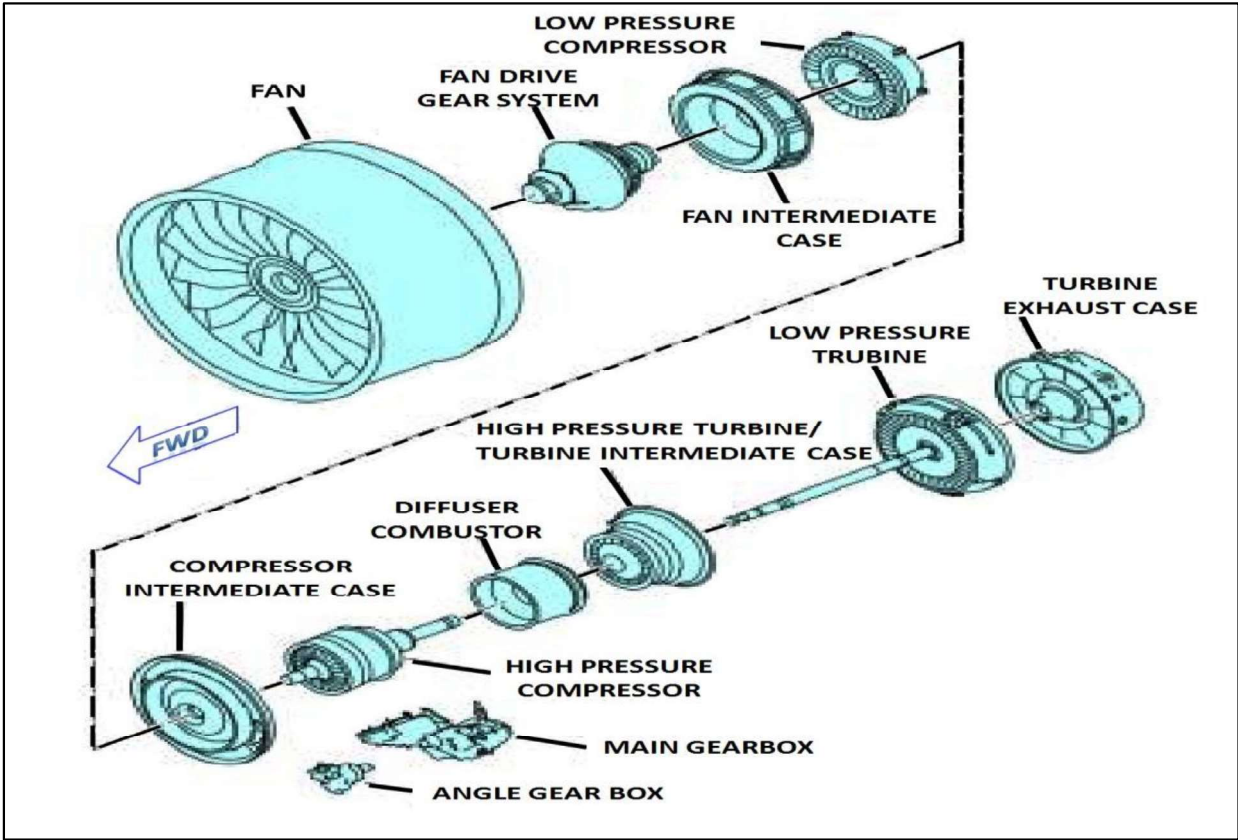
***Figure 1: ENGINE CROSS SECTION***

The engine comprises of Modules/Build Groups as shown below: -

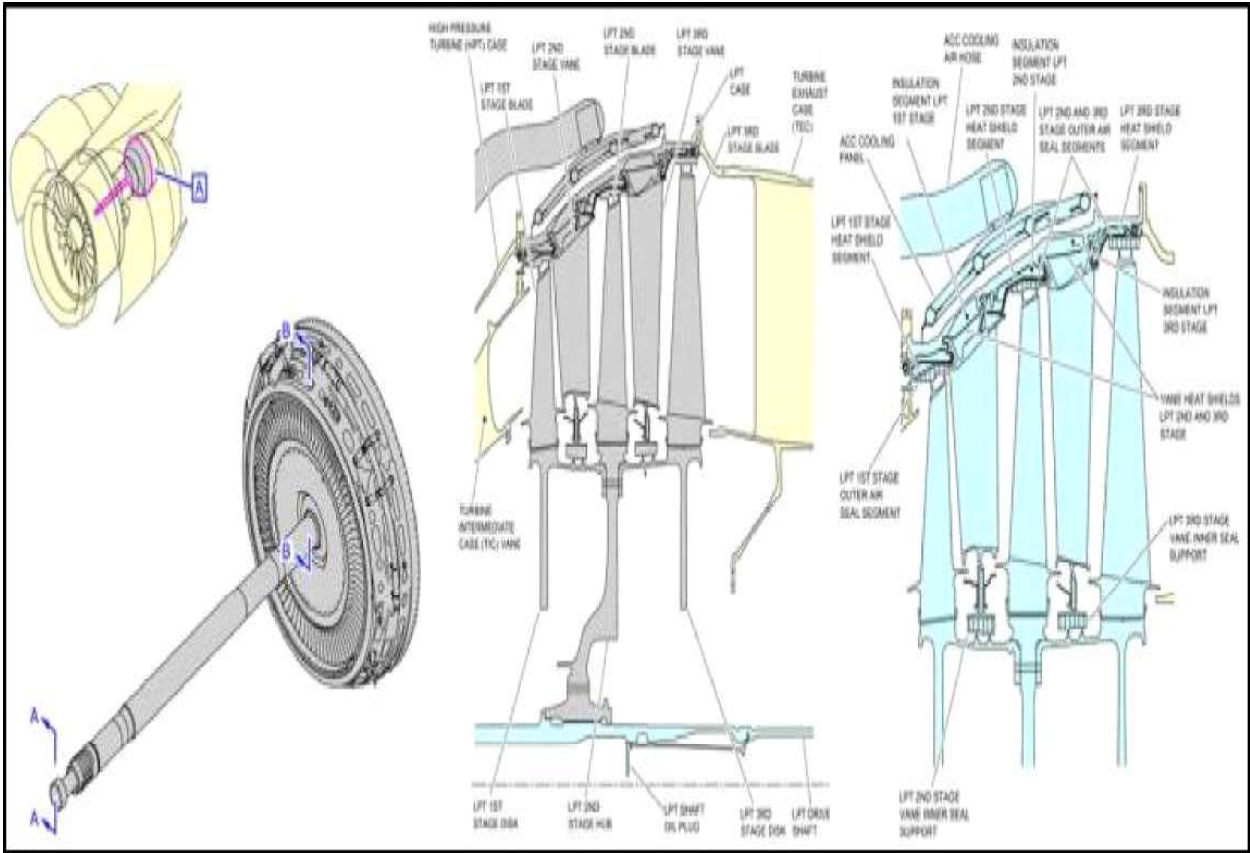
1. Fan Rotor Group	13. High Compressor Front Case Group
2. Fan Drive Bearing Group	14. High Compressor Rotor Group
3. Fan Drive Gear Group	15. Diffuser Case Group
4. Fan Intermediate Case Group	16. Combustor and Turbine Nozzle Group
5. No. 2 Bearing Group	17. High Turbine Stator Group
6. Fan Case Group	18. High Turbine Rotor Group
7. Low Compressor Stator Group	19. Turbine Intermediate Case Group
8. Low Compressor Rotor Group	20. Low Turbine Stator Group
9. 2.5 Bleed Group	21. Low Turbine Rotor Group
10. Compressor Intermediate Case Group	22. Turbine Exhaust Case Group
11. No. 3 Bearing Group	23. Main Gearbox Group
12. High Compressor Rear Stator Group	24. Angle Gearbox Group



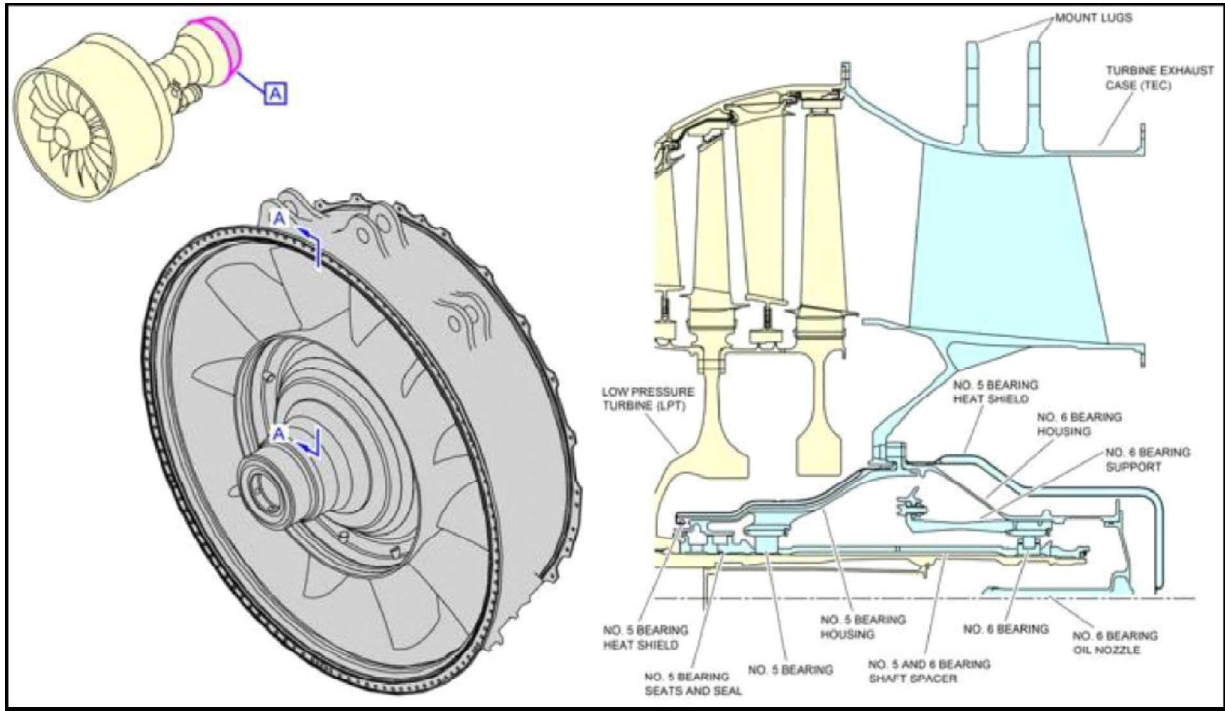
**Figure 2: Engine Modules/ Build Group**



**Figure 3: Engine Modules/ Build Group**



**Figure 4 : LTM – LOW TURBINE MODULE**



**Figure 5: TECM - TURBINE EXHAUST CASE MODULE**

### 1.6.3 Aircraft VT-ITG General Information

Aircraft Model	AIRBUS A320-271N
MSN	6868
Year of Manufacturer	2016
Name of Owner	M/s RAVI AVIATION LEASING LIMITED
C of R	4695/3
C of A	6805
Category	NORMAL
C of A Validity	NO VALIDITY
A R C issued	14.09.2018
ARC valid up to	18.09.2019
Aircraft Empty Weight	39631.290 KG
Maximum Take-off weight	73500.000 KG
Date of Aircraft weighment	06.09.2016
Operating Empty Weight	43212.055 KG
Max Usable Fuel	18622.000 KG
Max Payload with full fuel	11665.945 KG

Operating Empty Weight C.G	24.884 % MAC
Next Weighing due	05.09.2021
Total Aircraft Hours	8554:53
Last major inspection	1500 FH/ 180 Days on 12.03.2019
List of Repairs carried out after last major inspection till date of incidence:	NIL
Engine Type	PW1127G-JM
Date of Manufacture LH	30.10.2017
Engine Sl. No. LH	P770530
Last major inspection (LH)	1500 FH/ 180 Days on 12.03.2019
List of Repairs carried out after last major inspection till date of incidence:	NIL
Total Engine Hours/Cycles LH	3118:00/ 2038
Date of Manufacture RH	10.06.2018
Engine Sl. No. RH	P770528
Last major inspection (RH)	1500 FH/ 180 Days on 12.03.2019
List of Repairs carried out after last major inspection till date of incidence:	NIL
Total Engine Hours/Cycles RH:	2991:15/ 1949
Aero mobile License	30.11.20121

All concerned Airworthiness Directives, mandatory Service Bulletins, and DGCA Mandatory Modifications on this aircraft and its engines were complied with as on date of event.

### **1.7 Meteorological Information**

Enroute METAR information is given below: -

- VAPO 020400Z 29004KT 6000 NSC 30/08 Q1017 NOSIG=
- VAPO 020530Z 36003KT 6000 SKC 35/04 Q1016 NOSIG=
- VAPO 020600Z 02005KT 6000 SKC 36/01 Q1016 NOSIG=
- VAPO 020630Z 13003KT 6000 SKC 37/02 Q1015 NOSIG=

However, weather has no relevance to the subject incident.



## **1.8 Aids to Navigation**

All Navigational Aids available at Pune airport were serviceable. The aircraft was equipped with standard navigational equipment and there was no recorded defect with the navigational equipment prior to the flight.

## **1.9 Communications**

There was always a positive two-way communication between the aircraft & ATC.

## **1.10 Aerodrome Information**

Pune Airport is located in City of Pune. The IATA Location Identifier Code is PNQ and ICAO Location Indicator Code is VAPO. The airport has one runway with orientation 10/28. Airport Co-ordinates and elevation are as below: -

Lat	:	18° 34' 56" N
Long	:	073° 55' 11" E
Elevation	:	1942 feet (592 meters)

## **1.11 Flight Recorders**

Both Solid State Cockpit Voice Recorder (SSCVR) and Solid-State Flight Data Recorder (SSFDR) were downloaded and readout was carried out. Relevant data was used for analysis and correlating with other evidences.

## **1.12 Wreckage and Impact Information**

Not applicable as the damages were confined to core Engine # 1 only.

## **1.13 Medical and Pathological Information**

The crew had undergone pre-flight medical including BA (Breath Analyzer) Test as per requirements. The test result was negative.

## **1.14 Fire**

There was no fire.

## **1.15 Survival Aspects**

The Incident was survivable.

## **1.16 Test and Research**

### **1.16.1 Tear Down Reports from Pratt & Whitney**

As per agreement between M/s Indigo and OEM, the damaged engine was replaced with a serviceable engine. The damaged LH engine was sent to OEM after the incident. The Engine was inducted in OEM's facility and, Engine Disassembly and Inspection was carried out. There were several similar occurrences involving the failure of LPT 3<sup>rd</sup> stage blades preceding this incident. The LPT 3<sup>rd</sup> stage blade failure was considered to be a known issue, which had a developed corrective action in place. No Technical Investigation was carried out by the OEM on the incident Engine (ESN P770530).

During Disassembly and Inspection and subsequent repair, The 3<sup>rd</sup> stage LPT blades and disk were replaced IAW SB 72-0111. The TEC and LPT case were replaced with new due to excessive damage. Some 1<sup>st</sup> stage and 2<sup>nd</sup> stage LPT blades were also found damaged and replaced with new. Borescope inspection of the HPC Tie shaft ID revealed HPC Tie shaft scoring and HPC was disassembled to replace the HPC shaft. The combustor was replaced with new Block C hardware and the 1<sup>st</sup> stage HPT blades and BOAS were replaced with new. The main gearbox was also modified per SB 72-00-0129 and the EEC/PHMU software upgraded to FCS5.0 per SB 73-00-0037.

### **1.16.2 Failure Analysis Report from National Aerospace Laboratories, Bengaluru**

AAIB, India got the fractured blades from Engine ESN P770187, P770530 and P770516 which had failed during different flights tested at National Aerospace Laboratories (NAL), Bengaluru to carry out Failure Analysis on these blades. ESN P770530 was fitted on VT-ITG at the time of incident. NAL carried out failure analysis of these blades and submitted a report to AAIB. Following are the salient observations made in the failure report: -

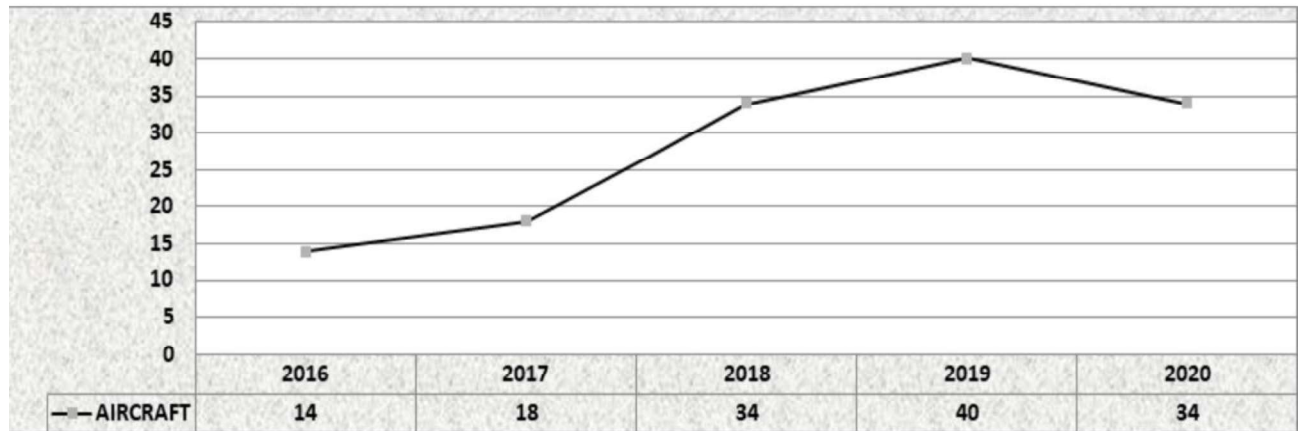
- Examination revealed that all 78 LPT 3<sup>rd</sup> stage blades had fractured in the airfoil at varying heights from the blade root platform.
- Impact damages were found present predominantly along trailing edge (TE) of the available part of the airfoil.

- Fracture surfaces of the blades showed a flat appearance with vaguely delineated chevron marks emanating from the crack origins in many occasions.
- Fractography study confirmed that LPT 3<sup>rd</sup> stage blades had fractured instantaneously in a brittle manner. None of the blades showed presence of any signatures of progressive failure such as fatigue.
- Scanning electron fractography study confirmed that the crack propagation in the blades was by mixed mode of cleavage and interlamellar separation. In the fractured blades, the fracture process in gamma-phase was by cleavage while it was by interlamellar separation in lamellar colonies.
- Metallurgical evaluation of the Material of Construction (MoC) showed that stage 3 LPT blades were made of a Gamma base Titanium Aluminide (TiAl), an intermetallic material. The MoC of the blades has the nominal composition of 52% Titanium (Ti) , 43% Aluminium (Al), 4% Niobium (Nb) and 1% Molybdenum (Mo). The material did not have any metallurgical abnormalities that could be responsible for failure of the LPT blades.
- TiAl-base intermetallic materials are, in general, brittle in nature having low fracture toughness. Although, the alloy used for stage III LPT blades is an improved version of TiAl alloys with engineered microstructure, the material still lacks adequate damage tolerance properties compared to the conventional Nickel (Ni)-base superalloy that is generally used in this section of gas turbine engines.
- The MoC possessed a duplex microstructure consisting of mostly colonies of lamellae and isolated single phase gamma grains.
- Fatigue test conducted in this laboratory on the MoC of LPT 3<sup>rd</sup> stage blades showed that the material does not have enough crack growth resistance and after initiation, the crack propagates instantaneously leading to fracture.

### **1.17 Organizational and Management Information**

The aircraft VT-ITG is operated by M/s Indigo which is an Indian registered Scheduled airline and one of the launch customers for the Airbus A320 NEO aircraft fitted with PW1127G-JM engines. It operates scheduled flights to both domestic and international sectors. It has got a fleet of Airbus A320/A321 and ATR-72 aircraft. As of November 2020, M/s Indigo has a total fleet of 140 (A320/A321) NEO aircraft. The operator first inducted

NEO aircraft in the year 2016. Initially, a total of 14 NEO aircraft were inducted by M/s Indigo in the year 2016. The year wise induction of NEO fleet (Graphical Representation) by M/s Indigo is shown below: -



**Figure 6: Year wise induction of NEO fleet**

## 1.18 Additional Information

### 1.18.1 Typical Snags Reported in PW1127G-JM Engines

Since the induction of PW1127G-JM engines in India in the year 2016, there have been a number of snags reported on aircraft fitted with these engines. Most of the snags were repetitive in nature. In order to prevent reoccurrence of such failures, Pratt & Whitney came up with some rectification actions/modifications for each snag.

The following table depicts the Typical Snags and Rectification Action/Modification carried out by Pratt & Whitney along with the status of action taken by M/s Indigo as of 17<sup>th</sup> Nov 2020: -

Sr.	Typical Snag Reported	Rectification Action proposed by P&W	Action Taken by M/s Indigo (As of 17 <sup>th</sup> Nov 2020)
1.	#3 bearing seal failure	Issued SB 72-00-087	All Indigo engines are post SB 72-00-0087.
2.	Combustor failure	Issued SB 72-00-0136	176 IGO engine are post SB 72-00-0136.
3.	Low Pressure Turbine failure	Issued SB 72-00-0111	All IGO engine are post SB 72-00-0111.
4.	N2 Vibration	SB 72-00138 was released to replace HPC stage 6 ring seal with modified one.	134 engines are flying with post mod HPC 6 ring seal
5.	MGB IDG/LSOP gear failure.	Issued SB 72-00-0129	30 engines are Pre SB 72-00-0129.

**Table 2: Typical Engine Failures and Rectification Action by Pratt & Whitney.**

The typical engine failures discussed in above para led to significant occurrences like In-Flight Shut Down (IFSD), Air Turn Back (ATB), Ground Turn Back (GTB), Rejected Take-Off (RTO), etc. The type and number of occurrences (Involving Indigo & Go Air aircraft) corresponding to each of the typical engine failures are listed below: -

<b>Type of Failure</b> →	<b># 3 bearing seal failure</b>	<b>Combustor failure</b>	<b>LPT failure</b>	<b>N2 Vibration</b>	<b>MGB IDG/LSOP gear failure.</b>
<b>Type of Event</b> ↓					
<b>RTO (Rejected Take-off)</b>	Nil	1	Nil	2	Nil
<b>Engine Stall</b>	Nil	Nil	1	Nil	Nil
<b>ATB (Air Turn Back)</b>	Nil	1	18	5	3
<b>GTB (Ground Turn Back)</b>	Nil	Nil	Nil	1	Nil
<b>Diversion</b>	Nil	Nil	6	1	1
<b>Emergency Landing</b>	1	Nil	Nil	Nil	Nil

**Table 3. Type of Occurrences corresponding to each engine failure.**

Out of the significant occurrences mentioned in the table above, 18 occurrences were classified as serious incidents by AAIB and Annex 13 investigation were instituted to investigate these serious incidents. Further distribution of these 18 serious incidents corresponding to type of failure is as below: -

<b>Type of Failure</b>	<b>Number of Serious Incidents</b>
<b># 3 bearing seal failure</b>	01
<b>LPT failure</b>	15
<b>N2 Vibration</b>	01
<b>MGB IDG/LSOP gear failure.</b>	01

**Table 4. Number of serious incidents corresponding to type of failures.**

As per the above table, it can be seen that majority of these serious incidents corresponds to LPT failure wherein the Blades of 3<sup>rd</sup> Stage of LPT failed in flight. As per agreement between M/s Indigo and OEM, the damaged engines were replaced by serviceable engines. All engines involved in the 18 serious incidents discussed above were quarantined after the occurrence and sent to OEM (Pratt & Whitney) facility in USA and Germany for repair.

Pratt and Whitney did not subject any of these engines to any technical investigation as the events were similar to various prior occurrences and considered to be a known issue.

The Shop Visit report of all these Engine was shared with AAIB through Accredited Representative of NTSB.

### **1.18.2 Service Bulletin 72-00-0111**

Service Bulletin (SB) on "Engine - Disk, LPT 3rd Stage and Blade, LPT 3rd Stage and Shroud-Segment, Ring, 3rd Stage - Introduction of a New LPT 3rd Stage Blade which is more resistant to Impact Damage". The SB was initially issued on 14th May 2019, thereafter Issue 2 was issued on 18th October 2019 and finally, Issue 3 was issued on 28th May 2020.

The reason for issue of this SB was given as "LPT 3rd stage blades fractured in service due to impact damage". The cause of failure was given as "The LPT 3rd stage blade material is sensitive to impact damage." The solution to this failure was given as "Introduction of a new LPT 3rd stage blade made of a different material which is more resistant to impact damage."

The SB required that the LPT 3rd stage disk, blades, locking plates, and shroud segments be replaced by the new set made of different material.

### **1.18.3 Guidelines/Deadline given & action taken by DGCA.**

DGCA issued a deadline (to M/s Indigo) stating that, each A320 NEO aircraft with PW1127G-JM engine (where both engines of which has done more than 2900 FH) must have at least one LPT modified engine installed forthwith. Further, it stated that, all the A320 NEO aircraft fitted with Pratt and Whitney engines must have LPT modified for both its engines by 31st January 2020.

On 25th November 2019, DGCA issued an order stating that the new aircraft which has been inducted will slip into the role of one existing aircraft with unmodified (LPT) engines. It was also stated that no leased engines without modified LPT 3rd stage shall be imported. Thereafter, DGCA on 19th December 2019 issued an order stating that the order dated 25th November 2019 and 16th December 2019 will be kept in abeyance to the extent of grounding an existing aircraft with both unmodified engines upon induction of new aircraft in the fleet of Indigo. However, it said all other advisories issued by DGCA regarding the same will continue to remain in force.

DGCA issued order dated 13th January 2020 in which they extended the deadline of replacement of un-modified engines with modified engines to 31st May 2020. Later on, 27th May 2020, DGCA issued yet another order wherein the deadline was further extended to 31st August 2020 keeping in view of the COVID19 pandemic.

By 26th August 2020 all the PW1127G-JM engines (280 engines) of Indigo had complied with SB 72-00-0111 i.e., all its NEO fleet (140 aircraft) were installed with LPT modified engines.

### **1.19 Useful or Effective Investigation Techniques**

Nil

## **2 ANALYSIS**

### **2.1 General**

- Both pilots were appropriately licensed and qualified to operate the flight.
- The aircraft had a valid Certificate of Airworthiness at the time of incident. The Aircraft held a valid Certificate of Release to Service which was issued at the airport of departure. Airworthiness Directives & Service Bulletins were complied with. Transit Inspections were carried out as per the approved Transit Inspection Schedules and all higher Inspection Schedules including checks/inspection as per the manufacturer's guidelines and specified in Maintenance Programme.

### **2.2 Circumstances Leading to the Incident**

VT-ITG was equipped with PW1127G-JM engine Sr. No. 770530. This engine was fitted with pre-modified LPT 3<sup>rd</sup> stage blades which had less crack growth resistance and impact tolerance. The aircraft suffered LPT 3<sup>rd</sup> stage blade failure while climbing passing Flight Level 143. A loud bang was heard by the crew from the left side followed by 'ENG 1 STALL', 'ENG 1 EGT OVERLIMIT' and 'ENG 1 HGH VIB' warnings on ECAM. The crew followed ECAM actions and QRH checklist/procedures for Engine Stall, Engine Vibration and EGT overlimit. The Engine # 1 power was brought to idle. Observing Engine parameters to be abnormal, the crew decided to return to Pune. No Emergency was declared by the crew. The aircraft landed safely at Pune after obtaining necessary clearances from ATC, Pune.

During post flight inspection while carrying out visual inspection of the involved engine, Low Pressure Turbine 3rd stage blades were found damaged. Incident was one amongst series of similar events and hence Pratt and Whitney did not carry out Technical Investigation into this case.

### **2.3 LPT 3<sup>rd</sup> stage blade failure and preventive action.**

Based on the analysis by NAL, Bengaluru to study Material of Construction (MoC) it was determined that the pre-modified LPT stage 3 blades are made of gamma-based Titanium Aluminide (TiAl) which is, in general, brittle in nature having low fracture toughness. Although, the alloy used for LPT blades 3<sup>rd</sup> stage blades is an improved version of TiAl alloys with engineered microstructure, the material still lacked adequate damage tolerance properties. It was confirmed during the fractography study conducted by NAL, Bengaluru that LPT 3<sup>rd</sup> stage blades of the Engine ESN 770187, 770530 and 770516 had fractured instantaneously in a brittle manner and none of the blades showed presence of any signatures of progressive failure such as fatigue.

The fatigue test further confirmed that the material does not have enough crack growth resistance and after initiation, the crack propagated instantaneously leading to fracture. It is, therefore, evident that the LPT stage 3 blades failed in flight as these blades could not withstand possible impact from material liberated upstream and got fractured instantaneously. This led to engine high vibration and EGT overlimit.

Subsequent to directions issued by the DGCA to equip all aircraft with LPT modified engines, the airlines complied with SB 72-00-0111 and all its A320 NEO fleet (140 aircraft) were installed with LPT modified engines.

## **3 CONCLUSION**

### **3.1 Findings**

1. The aircraft had valid Certificate of Airworthiness, Certificate of Registration and the Certificate of Flight Release before operating the incident flight.
2. Both pilots were appropriately qualified to operate the flight.
3. There was no fire and no injury to any occupant on board the aircraft.



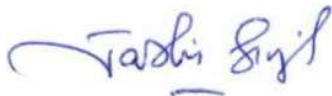
4. During post flight inspection, while carrying out visual inspection of the involved engine, i.e., inlet area and exhaust area of Engine # 1, Low Pressure Turbine 3rd stage blades were found damaged.
5. The incident was similar to series of other events where LPT 3<sup>rd</sup> stage blades failed during operation. The failure was considered to be a known issue by the OEM and no Technical Investigation was carried out by the OEM.
6. Failure Analysis of blades at NAL, Bengaluru indicated that the LPT 3<sup>rd</sup> stage blades material had less crack growth resistance and damage tolerance which causes the crack to propagate instantaneously after initiation leading to fracture.
7. Pratt & Whitney has issued SB 72-00-0111 to Introduce of a new LPT 3rd stage blade made of a different material which is more resistant to impact damage. The airline has incorporated the said SB in all its affected aircraft.

### **3.2 Probable Cause of the Incident**

The incident was caused by failure of LPT 3<sup>rd</sup> stage blades in flight as the blade material lacked crack growth resistance and damage tolerance to withstand any impact from material that may have liberated upstream.

## **4. SAFETY RECOMMENDATIONS**

In view of corrective action initiated by the OEM to introduce new blades with better impact resistance and subsequent compliance by the Airline no recommendation is made.



**Jasbir Singh Larhga**  
**Investigator - In - Charge**



**K Ramachandran**  
**Investigator**