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FINAL INVESTIGATION REPORT

IN FLIGHT ENGINE #1 FAILURE INCIDENT OF M/S INDIGO A321-251NX AIRCRAFT VT-ILN ON 10/06/2023 AT DELHI

DIRECTORATE GENERAL OF CIVIL AVIATION
GOVERNMENT OF INDIA
NEW DELHI-110003

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FOREWORD

This document has been prepared based upon the evidences collected during the investigation and opinion 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 13 (1) of Aircraft (Investigation Accidents and Incidents) Rules, 2017.

The investigation is conducted not to apportion blame or to asses individual or collective responsibility. The sole objective is to draw lessons from this incident which may help to prevent future accident or incident.

ABBREVIATIONS

Abbreviation	Expanded form
ADC	Air Defense Clearance
ARC	Airworthiness Review Certificate
ARP	Aerodrome Reference Point
ASMGCS	Advanced-Surface Movement Guidance and Control System
ATC	Air Traffic Control
ATB	Air Turn Back
BSI	Borescope inspection
CNR	Customer Notification Report
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CSN	Cycle Since New
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
DME	Distance Measuring equipment
ECAM	Electronic Centralized Aircraft Monitoring
EGT	Exhaust Gas temperature
ESN	Engine Serial Number
FC	Flight Cycle
FADEC	Full Authority Digital Electronic Control
FH	Flight Hour
FIC	Flight Information Center
FL	Flight Level
FORDEC	Facts, Options, Risks & Benefits, Decision, Execution, Check
FRTO	Flight Radio Telephony Operator's License
HPTS1B	High Pressure Turbine Stage 1 Blade
IFR	Instrument Flight Rule
ILS	Instrument Landing System
IR	Instrument Rating
LPT	Low Pressure Turbine
METAR	Metrological Aerodrome Report
NOSIG	No Significant
OEM	Original Equipment Manufacturer
PAN	Possible Assistance Needed
PAPI	Precession Approach Path Indicator
PF	Pilot Flying
PM	Pilot Monitoring
SB	Service Bulletin
SCT	Scattered
TSN	Time Since New
UTC	Universal Coordinated Time
VFR	Visual Flight Rules
VOR	Very High Frequency Omni Range

FINAL INVESTIGATION REPORT OF IN FLIGHT ENGINE #1 FAILURE INCIDENT OF M/S INDIGO A321-251NX AIRCRAFT VT-ILN ON 10/06/2023 AT DELHI

1.	Aircraft	Type	A321-251NX
		Nationality	Indian
		Registration	VT-ILN
2.	Owner and Operator		M/s SMBC Aviation Capital Limited & M/s Indigo
3.	Pilot – in –Command		ATPL Holder
	Extent of injuries		Nil
4.	Date & Time of Incident		10.06.2023, 16:43:00 UTC
5.	Place of Incident		Delhi
6.	Co-ordinates of Incident site		Latitude 28° 23' 46.32" N Longitude 76° 48' 32.04" E
7.	Last point of Departure		Delhi (VIDP)
8.	Intended place of landing		Chennai (VOMM)
9.	Number of Passengers on board		233
10.	Type of Operation		Schedule (Passenger) Flight
11.	Phase of flight		Climb
12.	Type of Incident		ENG#1 failure

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

SYNOPSIS:

M/s Indigo, A321-251NX aircraft VT-ILN while operating a schedule passenger flight 6E-2789 from Delhi to Chennai was involved in an air turn back incident at Delhi due to in flight ENG#1 failure on 10.06.2023. The aircraft took off from Delhi and while climbing passing through FL120, a loud bang noise was heard by the flight crew followed by ENG#1 stall with ENG#1 fail ECAM alert. Subsequently flight crew carried out emergency procedures for engine stall and informed Delhi ATC about their intension to return back. Flight crew declared "PAN PAN" and ENG#1 was shutdown as per procedure. A single engine landing was executed safely on RWY 28 at Delhi.

During post flight inspection, observed metal particles in exhaust of ENG#1. Borescope inspection revealed that HPT STAGE 1 and 2 BLADES damaged beyond AMM limits. LPT stage 1, 2 & 3 blades damaged beyond AMM limits. Also, observed metal deposits in stage 4, 5, 6 & 7. The involved ENG#1 was sent to OEM for shop/strip examination to establish the actual cause of the incident.

There were no evidences of external fire or sign of smoke available in the aircraft or in the vicinity. There were no injuries to any of the crew member or passengers on board the aircraft.

DGCA instituted the investigation by appointing investigator-in-Charge under Rule 13(1) of the Aircraft (Investigation of Accidents and Incidents) Rules 2017. The investigation revealed that the probable cause of in flight ENG#1 failure is attributed to HPT Stage#1blade liberation, most likely due to enormous stress acting on the blades.

1. FACTUAL INFORMATION:

1.1 History of flight:

1.1.1 On 10/06/2023, M/s Indigo, A321-251NX aircraft VT-ILN was operating a schedule passenger flight 6E-2789 from Delhi to Chennai. The flight was under the command of duly licensed PIC on type along with the duly qualified First Officer. There were 05 cabin crew and total 233 passengers on board the aircraft. This was the 5th sector for the aircraft and 1st sector for the flight crew, PIC was the pilot flying & first officer was the pilot monitoring.

1.1.2 Before the flight, both the flight crew had undergone Breath Analyzer examination at Delhi and the test results were found negative. The flight was operating Delhi to Chennai after having proper ADC and FIC obtained. The flight plan revealed that the flight was planned to be conducted under IFR. Before undertaking the flight, aircraft was declared airworthy after carrying out Pre-flight Inspection by appropriately authorized AME.

1.1.3 As per flight plan Bangalore was planned as destination alternate aerodrome and fuel was uplifted accordingly. There was total 9800 kg of fuel on board the aircraft. The actual take-off weight of the aircraft was 80219 kg which was well within the max takeoff weight of 97000 kg. The CG of the aircraft was well within limits during the entire flight. The flight preparation was done normally and the aircraft was airworthy.

1.1.4 Following a normal pre-flight check and taxi to the runway, aircraft took off uneventfully from Delhi around 16:37:06 UTC. At time 16:42:56 UTC, while climbing passing through FL120, a loud bang noise was heard by the flight crew followed by ENG#1 stall with ENG#1 fail ECAM alert. Flight crew leveled off at around FL120 and carried out emergency procedures for engine stall and informed Delhi ATC about their intension to return back. Flight crew carried out FORDEC, NITES briefings and passengers were informed accordingly.

1.1.5 Flight crew requested ATC for lower altitude, same was approved by ATC. Flight Crew declared **"PAN PAN PAN PAN PAN PAN"** due to ENG#1 failure and ENG#1 was shutdown as per procedure. Flight crew obtained latest weather for Delhi and carried out landing weight calculations. Subsequently approach and landing checklist was carried out by flight crew and a single engine landing was executed safely on RWY 28 at Delhi around 17:08:59 UTC.

1.1.6 After landing aircraft taxied by its own to parking stand no. 242 and passengers were disembarked normally. There were no evidences of external fire or sign of smoke available in the aircraft or in the vicinity. There were no injuries to any of the crew member or passengers on board the aircraft.

1.1.7 Post landing during visual inspection of the front and rear of the engine, no visible damage was noticed on the front of the engine and observed fine metal particles/debris in the exhaust of the engine. No visible damage noticed on the last stage of the LPT when viewed from rear of the engine. Oil filter checked and no visible debris found. Post incident involved ENG#1 (ESN # 59A095) was sent to OEM for shop/strip examination to establish the actual cause of the incident.

1.2 Injuries to persons:

Injuries	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
Minor	Nil	Nil	Nil
None	02+05	233	Nil

1.3 Damage to aircraft:

Damage to the aircraft was restricted to ENG # 1 only, during visual inspection of the engine inlet, engine exhaust and turbine rear frame metal particles were observed in exhaust. FADEC exceedance report shows EGT 1108 ^{0}C for 2 seconds which was above idle. Borescope inspection revealed that HPT 1 and 2 stages, LPT stages 1, 2 & 3 damaged beyond AMM limits. Metal deposits were observed on LPT stages 4, 5, 6 and 7.

1.4 Other damages: There were no other damages.

1.5 Personnel Information:

1.5.1 Pilot-in-Command

Age	:	42 Years/Male
License	:	ATPL
Date of issue	:	18-05-2016
Valid up to	:	10-06-2026
Category	:	Aeroplane
Date of medical Exam	:	22-11-2022
Exam valid up to	:	25-11-2023
Date of issue of FRTO license	:	01-03-2026
FRTO license valid up to	:	28-02-2026
IR rating and instructor rating	:	IR: 27/07/2022Endorsement date as PIC-20/01/2011
Total flying experience	:	14237:19 Hrs
Total flying experience during last 1 year	:	670:44 Hrs
Total flying experience during last 6 months	:	344:05 Hrs
Total flying experience during last 30 days	:	52:15 Hrs
Total flying experience during last 07 days	:	10:23 Hrs
Total flying experience during last 24 hours	:	00:00 Hrs
Duty time last 24 hours	:	00:00 Hrs

1.5.2 Co- Pilot

Age	:	30 Years/Male
License	:	CPL
Date of issue	:	05-04-2018
Valid up to	:	04-04-2028
Category	:	Aeroplane
Date of medical Exam	:	23-05-2023
Medical Exam valid up to	:	17-06-2024
Date of issue of FRTO license	:	05-04-2018
FRTO license valid up to	:	31-12-2068
IR rating and instructor rating	:	IR: 09/10/2022 & NA
Total flying experience	:	449:09 Hrs
Total flying experience during last 1 year	:	234:05 Hrs
Total flying experience during last 6 months	:	234:05 Hrs
Total flying experience during last 30 days	:	60:14 Hrs
Total flying experience during last 07 days	:	13:47 Hrs
Total flying experience during last 24 hours	:	00:00 Hrs
Duty time last 24 hours	:	00:00 Hrs

(The aforementioned crew information is prior to operating subject incident flight)

1.6 Aircraft Information:

1.6.1 Technical Information:

Manufacturer	Airbus	
Type	A321-251NX	
Sr. No.	10151	
Year of manufacturer	2021	
Certificate of airworthiness, date of issue and validity	04-03-2021 and valid till Airworthiness Review Certificate (ARC no. 7402 & Validity-03.03.2024)	
Certificate of registration	5299	
Owner	M/s SMBC Aviation Capital Limited	
Maximum all up weight authorized	97000.000 kg	
Last major inspection	Performed intermediate (7500 FH/5000 FC/24 month) inspection schedule dated 05/02/2023	
Last inspection	Layover inspection dated 09/06/2023	
Airframe Hrs since new	7218:41 Hrs	
Airframe Hrs since last C of A/ARC	7218:41 Hrs	
ENGINE INFORMATION	**No.1**	**No.2**
Manufacturer	CFM LEAP	CFM LEAP
Type	A320	A321
Serial No.	59A095	59B603
Hrs done since new	7218:41 Hrs	72:56 Hrs
Hrs done since overhaul	NA	NA
Last major inspection carried out	NA	NA
Last inspection	Layover inspection	Layover inspection
Average oil consumption	0.077 Qtz/hr	0.099 Qtz/hr
Type of fuel used	Jet A1	Jet A1

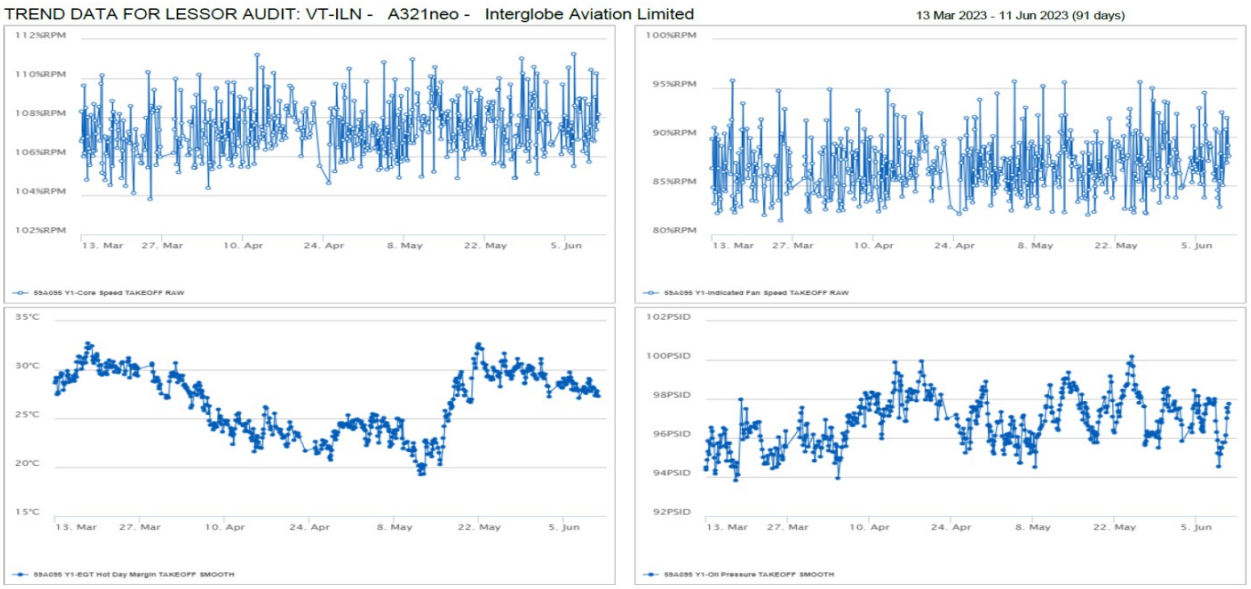
1.6.2 Similar incident on CFM Leap Engines: There have been 04 similar incidents of engine failure on CFM Leap Engines (including 59A095) in M/s Indigo until the finalization of this report:

S/N	Date	Place	Reg.	Type	Flight Number	Sector	Type of Occurrence	Brief Description	ENG #1/# 2	ENG S/N
1	10.06.23	DEL	ILN	A321N	6E-2789	DEL-MAA	ENG#1 FAIL & ATB	ENG#1 STALL FOLLOWED BY ENG#1 FAIL; ECAM ACTIONS CARRIED OUT AS PER PROCEDURE.	ENG #01	**59A095**
2	02.10.23	AMD	IMD	A321N	6E-274	UDR-BOM	ENG#1 FAIL & DIVERSION	ENG#1 FAIL with bang sound at approx 14000ft. ENG#1 EGT OVERLIMIT. ENG#1 STALL. Initially MAYDAY was declared later downgraded to PAN PAN. A/C Diverted to VAAH. (It was an un-commanded Engine shut down)	ENG #01	59A587
3	26.01.24	AMD	ISP	A320N	6E-296	BOM-AMD	ENG#1 FAIL	ENG#1 STALL followed by ENG#1 FAIL. Manually shutdown the engine as per ECAM.	ENG #01	599967
4	03.05.24	HYD	ILM	A321N	6E-6494	HYD-CCU	ENG#2 FAIL & ATB	ENG#2 EGT OVERLIMIT / ENG#2 STALL/ENG#2 FAIL. (It was an un-commanded Engine shut down)	ENG #02	599969

1.6.3 Engine (59A095) History: ENG#1 (S/N: 59A095) was installed in original on VT-ILN aircraft. TSN and CSN of the engine were 7218 Hrs and 4405 respectively as on date of incident. Engine was never sent for shop visit prior to subject occurrence. Engine was under repeat inspection as per SB 72-00-0485 issued on 27.09.2022. As per SB repeat Borescope inspection (BSI) of HPT stage 1 blades (P/N: 2747M92P01) to be carried out within 150 cycles for the engine with thrust rating 32K and flight cycle more than 2500 since new. Initial inspection of HPT stage 1 blades of involved engine was carried out on 21.10.2022 at CSN 2897 FC and last inspection was carried out on 23.05.2023 at CSN 4292 FC. The next repeat inspection was due at CSN 4442 FC and no inspection was pending before the incident flight.

Below are engine trend charts prepared by OEM monitoring team. In case of any limit exceedance, the relevant OEM notification is generated for that engine.

Proprietary Information – Subject to Restrictions under the Terms



Proprietary Information – Subject to Restrictions under the Terms

There has been no related OEM notification and customer notification report (CNR) on the engine prior to the engine removal post subject incident. The engine has no related maintenance history. Scrutiny of the tech log pages 30 days prior to the date of occurrence revealed that no similar snag was reported on this aircraft.

1.7 Meteorological Information:

The prevailing weather at Delhi was within approved minima of crew and aircraft. The reported visibility was 3500 meters, winds 100^0/05 knots cloud SCT 3500 feet & SCT 10000 feet, QNH 1000, temperature 33^0 C, Dew Point 15^0 C and trend NOSIG. Runway surface condition was dry and there were no rain or turbulence.

1.8 Aids to Navigation:

Delhi Airport is equipped with DVOR, Cat IIIB ILS, PAPI and High Power DME. It has also a secondary surveillance RADAR for providing route navigation services. ASMGCS is also functional on the airport for surveillance aircraft and vehicular movement in operational area. All the equipments were serviceable. Navigational Aids fitted in the aircraft were also serviceable.

1.9 Communication:

There was always two ways communication between the ATC and the aircraft. Communication equipment in the aircraft and ATC were serviceable.

1.10 Aerodrome Information:

Indira Gandhi International (IGI) Airport, New Delhi is a civil aerodrome. The operations are controlled by GMR and ATC is controlled by Airports Authority of India. Airport has got ICAO Code VIDP, ARP coordinates are 28°34'07"N, 77°06'44"E and is located 15 KM from Delhi railway station. The elevation is 777 feet and type of traffic permitted is IFR/VFR. Aerodrome category for firefighting is CAT-10 and Rescue equipment's are available as per category. Delhi airport has three runways with orientation 27/09, 28/10 and 29/11.

1.11 Flight Recorders:

The Cockpit Voice Recorder (CVR) and the Digital Flight Data Recorder (DFDR) were downloaded and the following information was available from them:

1.11.1 DFDR:

Time (UTC)	RA (Feet)	Master caution	ENG1 TLA	ENG2 TLA	Fuel Flow 1	Fuel Flow 2	N11	N21	ENG 1 Oil Pressure	ENG1 N2 VIB	Sequence of events
16:20:54	0	0	0	0	149	0	4.6	30.3	8	0.625	ENG#1 started
16:28:46	0	0	4.6	-0.4	488	147	32.5	84.3	58	0.375	ENG#2 started
16:36:18	0	0	8.4	8.4	468	445	22.8	74.3	46	0.125	Takeoff roll initiated
16:37:06	0	0	34.8	34.8	3494	3418	88	108.3	98	0.625	Aircraft airborne
16:37:13	147	0	34.8	34.8	3475	3387	87.9	108.2	98	0.75	Landing Gear selected up
16:37:18	1484	0	34.8	34.8	3464	3386	88.1	108.3	98	0.625	Auto pilot #1 armed and subsequently after 04 sec Auto Thrust was selected & Thrust leavers of both engine reduced to 34.8 to 25.

16:42:56	2500	0	25	25	577	2705	66	89.3	66	0.25	ENG #1 stalled & oil pressure reduced from 90 to 66, fuel flow of ENG#1 dropped from 2445 to 577 in 1 sec. N11 dropped from 90.2 to 66, N21 dropped from 107.8 to 89.3.
16:43:00	2500	1	25	25	13	2702	28.3	63.2	30	6.625	Master caution came and remained ON for 10 sec, ENG#1VIBN2 increased from 0.625 to 6.625 within 5 seconds
16:43:03	2500	1	10.9	25	169	2691	26.7	55.3	20	6.625	ENG#1TLA retarded after 03 seconds of master caution.
16:43:15	2500	0	-0.4	25	107	2557	25.2	35.5	8	1.125	ENG#1TLA reduced to idle in 11 seconds and was not advanced again. Master caution went off.
16:43:59	2500	0	-0.4	25	102	1740	23.3	14.7	2	1	ENG#1 Master Lever Selected Off
16:44:30	2500	0	-0.4	34.8	0	1983	22.8	11.4	2	0	ENG#2 TLA increased from 25 to 34.8
17:01:07	2500	0	-0.4	34.8	0	426	0	0	0	0.5	Auto pilot #2 armed
17:06:17	3112	0	-0.4	34.8	0	988	0	0	0	0	Landing gear lever were selected down
17:08:59	0	0	-0.4	-0.4	0	450	0	0	0	0	Aircraft touched down
17:14:01	0	0	-0.4	-0.4	0	0	0	0	0	0	ENG#2 turned off

1.11.2 CVR:

Time	ATC/Tower	First Officer (P2)	Captain (P1)
01:27:41-01:27:44	Flight 2789 RWY 28 clear for takeoff wind calm	Clear for takeoff RWY 28 I fly 2789	
01:29:18		Radar I fly 2789 good evening climbing passing 1900 ACRIF 5B	
01:29:47-01:29:49	Flight 2789 climb level 90 on restricted	Climb level 90 on restricted I fly 2789	
01:31:54-01:31:58	Flight 2789 climb level 210 on restricted	Climb level 210 on restricted I fly 2789	
01:32:28-01:32:31	Flight 2789 direct to BULDI	BULDI I fly 2789	
01:34:31	**FIRST BEEP WITH SCATTER SOUND HEARD FROM CVR SEEMS LIKE MASTER CAUTION**		
01:34:40			Level off
01:34:42-01:34:48		Check Master caution ENG#1 fail ECAM Actions. No …no tech notices ENG#1 fail.	
01:34:55		Radar I fly 2789 request heading due technical	
01:35:02-01:35:04	Oh confirm want to return back	Affirm I fly 2789	
01:35:06-01:35:08	Left heading 090	Left heading 090 I fly 2789	
01:35:10			I have control on communication ECAM actions
01:35:12-01:35:14	Climb maintain 130	Maintain FL130 I fly 2789	
01:35:21-01:35:24		ENG#1 fail Engine master 1 off Engine master 1 off parameter constant failure is confirmed	off

01:35:50-01:37:48	**Flight crew were heard discussing about ENG#1 Fail, Loud bang confirmed, Engine vibration followed by ENG#1 Stall and immediately ENG#1 fail. They were also discussing about no fuel leak or imbalance.**		
01:37:50-01:37:55	Flight 2789 radar	Sir we are on a heading 090 we will call you back. Also we would like to lower level I fly 2789	
01:38:05	Descent to level 110	Level 110	
01:38:08	Any assistance required sir?	Sir we will get back to you	
01:38:15-01:40:48	**Flight crew were heard discussing about damage confirmed in ENG#1, ENG#1 shut down as per ECAM procedure. Flight crew were also heard discussing about possible threats, facts, options, risks, decision & execution of right course of action for ENG#1 failure.**		
01:41:02		PAN PAN PAN PAN PAN PAN I fly 2789 engine fail we are currently maintaining heading and we will get back to you. Standby for the instructions	
01:41:08-01:41:19	Roger	Radar I fly 2789 can we descent lower level if possible.	
01:41:23-01:41:29	Descent 2600 feet QNH999	Descent 2600 QNH999 I fly 2789 will get back to you sir	
01:41:33-01:41:34	2789 report Request of RWY	We will be requesting RWY 28	
01:44:24	**Cabin Crew called for NITES briefing. Cabin Crew was briefed by captain**		
01:52:30-01:52:36	Flight 2789 descent 2600 feet clear ILS approach for RWY 28	Descent 2600 feet clear ILS approach for RWY 28 I fly 2789	
01:53:32-01:53:35	Flight 2789 latest QNH 1000	QNH 1000 copy I fly 2789	
01:54:02-01:54:34	**Approach checklist carried out**		
01:57:24		I fly 2789 on ILS runway 28	
01:57:27-01:57:32	Flight 2789 RWY 28 clear to land wind calm	Clear to land RWY 28 I fly 2789	
01:57:35-01:58:13	**Landing checklist completed landing clearance obtained.**		
01:58:53-02:05:52	**Aircraft landed on RWY 28, Vacated via taxiway K2 and got Fully parked at allocated parking stand by its own.**		

1.12 Wreckage & Impact Information: Nil

1.13 Medical & Pathological Information:

Before the flight, both the flight crew had undergone Breath Analyzer examination at Delhi and the test results were found negative.

1.14 Fire: There was no fire.

1.15 Survival Aspects: The incident was survivable.

1.16 Tests & Research:

1.16.1 The ENG#1 (ESN # 59A095) was removed from VT-ILN on 11th June 2023 and was sent to Engine Shop (M/s Safran Aircraft Engine Services, Brussels) on 04th July 2023.

The Shop Report of the failed ENG#1 (ESN: 59A095) as shared by CFM, revealed the following main damages on the Engine:

- Numerous fractures are observed at the root area of several HPT Stage 1 Blades.
- Multiple impacts and areas of missing material are evident on HPT Stage 2 Blades.

- HPT Stage 1 Shrouds were missing.
- HPT Stage 2 Nozzles exhibited Leading Edge missing material and multiple impacts.
- Multiple impacts were observable on the LE/TE of the Stage1 LPT nozzles.
- Damage and debris were observed in B-Sump cavity after the removal of the LPT major module.
- Multiple impacts / missing material on Leading Edge & Trailing Edge of the LPT Blades Stages 1, 2, 3 & 4
- Molten material observed on the airfoils and root area of the LPT Blades Stages 1, 2, 3 & 4.

As per the OEM, Engine (ESN #59A095) was exposed to Structural overstress, sudden rotor stoppage (N2 seized) & excessive G-loads.

1.16.2 OEM response on shop investigation report of failed ENG#1 (ESN #59A095):

1.16.2.1 OEM informed that HPT stage 1 blades (**P/N: 2747M92P01**) were not subjected to further investigation or metallurgical analysis because CFM is well-acquainted with the signatures associated with blade liberation, drawn from their extensive experience gained through inspections of both incident and non-incident engines during shop visits in the past. Given CFM's robust understanding of these signatures and their extensive learning curve from past incidents, they believe that additional investigation of the blades will be Superfluous. Further OEM added that their assessment is that such an investigation would not provide any additional insights which are unknown to CFM, and the event aligns with their field experience derived from pre and post-event data analysis. **As per OEM, there have been a total of 3 comparable incidents (including 59A095), all attributed to the root cause of HPTS1B liberation.**

1.16.2.2 Based on CFM's extensive global experience, it has been observed that SB 72-0485, issued in September 2022, has proven effective in mitigating such failures. Additionally, a range of borescope training sessions are available to ensure best practices in stage 1 blade inspections. Following field experience gained from SB 72-0485, a comprehensive borescope inspection guide has been developed and shared with operators, providing valuable insights for inspectors and power plant teams.

1.16.13 Furthermore, CFM actively shares critical findings during customer connection calls from time to time to enhance knowledge exchange between CFM and operators. Moreover, **CFM is nearing the final stages of releasing a newly designed HPTS1B**. There designed blades have demonstrated improved durability during production testing. **CFM is expecting the release of the redesigned blades with subsequent retrofitting across the global fleet.**

1.17 Organizational & Management Information:

InterGlobe Aviation Ltd (Indigo) is an Indian schedule airline headquartered in Gurgaon, Haryana, India. It has a fleet of Airbus A320, A-320 Neo, A321 and ATR-72. The airline started its operation in the year 2006. The airline has approximately 342 aircrafts in its fleet and operates to various domestic and international destinations.

1.18 Additional Information: Nil

1.19 Useful or Effective Investigation Techniques: Nil

2. ANALYSIS:

2.1 Airworthiness & Serviceability of the aircraft:

2.1.1 A320-251NX is a twin turbofan powered aircraft fitted with two CFM LEAP engines. The aircraft and its engines were being maintained as per the approved maintenance program. No snag was pending for rectification before the incident flight nor was any repetitive/similar defect entered in the log book of the aircraft. The aircraft was operated within the provision of valid Certificate of Airworthiness and Certificate of Registration before the incident flight. All the concerned Airworthiness Directive, Service Bulletins, Mandatory Modifications on this aircraft and its engines were found complied with.

2.1.2 On 10/06/2023, M/s Indigo, A321-251NX aircraft VT-ILN while operating flight 6E-2789 from Delhi to Chennai returned back to Delhi due in flight ENG #1 failure. ENG#1 was shut down by the flight crew as per procedure and a single engine landing was executed safely on RWY 28 at Delhi. Post landing inspection revealed that the damage was restricted to ENG#1 only. The damaged ENG#1 (ESN # 59A095) was removed from the aircraft and sent to Engine Shop. Before the incident, ENG#1 was under repeat inspection as per SB 72-00-0485. As per SB repeat Borescope inspection (BSI) of HPT stage 1 blades (P/N: 2747M92P01) to be carried out within 150 cycles for the engine with thrust rating 32K and flight cycle more than 2500 since new. Initial inspection of HPT stage 1 blades of involved engine was carried out on 21.10.2022 at CSN 2897 FC and last inspection was carried out on 23.05.2023 at CSN 4292 FC. The next repeat inspection was due at CSN 4442 FC and no inspection was pending before the incident flight.

2.1.3 OEM shop/strip examination report revealed that the involved engine was exposed to structural overstress, sudden rotor stoppage (N2 seized) & excessive G-loads. OEM informed that HPT stage 1 blades (P/N: 2747M92P01) were not subjected to further investigation or metallurgical analysis because CFM is well-acquainted with the signatures associated with blade liberation. As per OEM, there have been a total of 3 comparable incidents (including 59A095), all attributed to the root cause of HPTS1B liberation. CFM is nearing the final stages of releasing a newly designed HPTS1B. There designed blades have demonstrated improved durability during production testing. CFM is expecting the release of the redesigned blades with subsequent retrofitting across the global fleet.

2.1.4 Based on the nature of the damages observed, Crew report & the DFDR parameter analysis, it can be concluded that during high power operation of the Engine during climb, suddenly one blade of HPT Stage 1 got fractured & liberated from its root, causing consequential damages to all Stage 1 HPT Blades. The liberated blade pieces further damaged Stage 2 HPT Blades & the downstream LPT blades as observed during striping of the Engine. Due such sudden failure of the engine, there was heavy STALL, N2 rotor imbalance, high Vibrations & the N2 rotor got seized. Such failure of Stage 1 HPT Blade is an industry issue on CFM LEAP Engines. Sudden Failure of the Stage 1 Turbine Blades is most likely due to enormous stress acting on the blades.

2.2 Pilot handling of the situation:

After takeoff from Delhi while climbing passing through FL120, a loud bang noise was heard by the flight crew followed by ENG#1 stall with ENG#1 fail ECAM alert. Flight crew requested ATC for lower altitude, same was approved by ATC. Flight crew discussed about ENG#1 fail and confirmed among themselves regarding loud bang, Engine vibration and did assessment about no fuel leak or imbalance. Flight crew confirmed damage in ENG#1 and also discussed about possible threats, facts, options, risks, decision & execution of right course of action for ENG#1 failure. Flight Crew declared **"PAN PAN"** due to engine 1 failure and ENG#1 was shutdown as per procedure. Flight crew obtained latest weather for Delhi and carried out landing weight calculations. Subsequently approach and landing checklist was carried out by flight crew and a single engine landing was executed safely on RWY 28 at Delhi.

In view of the above, Flight crew actions were appropriate in the interest of safety of passengers & aircraft.

2.3 Weather:

On 10/06/2023, M/s Indigo, A321-251NX aircraft VT-ILN was operating a schedule passenger flight 6E-2789 from Delhi to Chennai. The prevailing weather at Delhi was within approved minima of crew and aircraft. Runway in use 10-28, reported visibility was 3500 meters, winds 250^0/06 knots, cloud SCT 3500 feet & SCT 10000 feet, QNH 1000, temperature 33 ^{0}C, Dew Point 15 ^{0}C, and trend NOSIG. Runway surface condition was dry and there were no rain or turbulence. Metrological report did not show any significant change in trend of the prevailing weather. Weather was conducive for operations under Instrument Flight Rule (IFR). Hence weather was not a contributory factor to the incident.

3. CONCLUSION:

3.1 Findings:

3.1.1 The flight crew members were appropriately licensed and qualified to operate the flight.

3.1.2 The aircraft was operated within the provision of valid Certificate of Airworthiness and Certificate of Registration before the incident flight.

3.1.3 All the concerned Airworthiness Directive, Service Bulletins, Mandatory Modifications on this aircraft and its engines were found complied with.

3.1.4 The aircraft was maintained in airworthy condition and no defect was pending for rectification.

3.1.5 Engine was under repeat inspection as per SB 72-00-0485 and last (Borescope) inspection was carried out on 23.05.2023 at CSN 4292 FC. No repeat inspection was due before the incident flight.

3.1.6 After takeoff from Delhi while climbing passing through FL120, a loud bang noise was heard by the flight crew followed by ENG#1 stall with ENG#1 fail ECAM alert.

3.1.7 Flight Crew declared **"PAN PAN"** due to ENG#1 failure and ENG#1 was shutdown as per procedure.

3.1.8 Post landing during visual inspection fine metal particles/debris was observed in the exhaust of the ENG#1 and same was sent for shop examination.

3.1.9 As per shop report, ENG#1 was exposed to structural overstress, sudden rotor stoppage (N2 seized), excessive G-loads.

3.1.10 As per OEM, there have been a total of 3 comparable incidents (including 59A095), all attributed to the root cause of HPTS1B liberation.

3.1.11 ENG#1 failure was caused due to HPT Stage#1blade liberation, most likely due to enormous stress acting on the blades.

3.1.12 CFM is nearing the final stages of releasing a newly designed HPTS1B with subsequent retrofitting across the global fleet.

3.1.13 Flight crew actions were appropriate & weather was not a contributory factor to the incident.

3.2 PROBABLE CAUSE OF THE INCIDENT:

The probable cause of in flight ENG#1 failure is attributed to HPT Stage#1blade liberation, most likely due to enormous stress acting on the blades.

4. SAFETY RECOMMENDATIONS:

M/s Indigo to carry out Borescope Inspection (BSI) of the existing design blades meticulously as per SB 72-00-0485 till the time newly designed HPTS1B is made available by CFM.

MAHENDRA KUMAR MEENA
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(Mahendra Kumar Meena)
Air Safety Officer-Member

VISHAL YADAV
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(Vishal Yadav)
Dy. Director Air Safety
Investigating-in-Charge

Date: 31.05.2024
Place: New Delhi