

FINAL INVESTIGATION REPORT ON SERIOUS INCIDENT TO M/S INTERGLOBE AVIATION LTD (INDIGO) A320 NEO AIRCRAFT VT-ITJ AT GUWAHATI ON 24 MAR 19

AIRCRAFT ACCIDENT INVESTIGATION BUREAU MINISTRY OF CIVIL AVIATION GOVERNMENT OF INDIA

FOREWORD

In accordance with Annex 13 to the Convention on International Civil Aviation Organization (ICAO) and Rule 3 of Aircraft (Investigation of Accidents and Incidents), Rules 2017, the sole objective of the investigation of an accident/serious incident shall be the prevention of accidents and incidents and not to apportion blame or liability. The investigation conducted in accordance with provisions of the above said rules shall be separate from any judicial or administrative proceedings to apportion blame or liability.

This document has been prepared based upon the evidences collected during the investigation, opinion obtained from the experts and laboratory examination of various components. Consequently, the use of this report for any purpose other than for the prevention of future accidents or incidents could lead to erroneous interpretations.

INDEX

<u>Para</u>			Content	<u>Page No.</u>
			SYNOPSIS	1
1.			FACTUAL INFORMATION	2
	1.1		History of Flight	2
	1.2		Injuries to Persons	3
	1.3		Damage to Aircraft	3
	1.4		Other Damage	3
	1.5		Personnel Information	3
		1.5.1	Pilot in Command (PIC)	3
		1.5.2	First Officer	4
	1.6		Aircraft Information	5
		1.6.1	General Information	5
		1.6.2	Aircraft Technical Information	6
		1.6.3	Engine System	7
		1.6.4	Engine Warning System	9
		1.6.5	Vibration Parameter Description	9
	1.7		Meteorological Information	10
	1.8		Aids to Navigation	10
	1.9		Communications	10
	1.10		Aerodrome Information	10
	1.11		Flight Recorders	10
	1.12		Wreckage and Impact Information	11
	1.13		Medical and Pathological Information	11
	1.14		Fire	11
	1.15		Survival Aspects	11
	1.16		Test and Research	12
	1.17		Organisational and Management Information	13
	1.18		Additional Information	14
		1.18.1	AME Qualification	14
		1.18.2	Maintenance Records	14
	1.19		Useful and Effective Techniques	15
2.			ANALYSIS	16
	2.1		Serviceability of Aircraft	16
	2.2		Maintenance Practices by Operator	16
	2.3		Preventive Measures	16
	2.4		Circumstances Leading to The Incident	17
3.			CONCLUSIONS	17
	3.1		Findings	17
	3.2		Probable Cause	18
4.			SAFETY RECOMMENDATIONS	18
	4.1		DGCA	18
	4.2		Aircraft Operator	18

GLOSSARY

AAIB	:	Aircraft Accident Investigation Bureau, India
AME	;	Aircraft Maintenance Engineer
ARC	:	Airworthiness Review Certificate
ASR	:	Airport Surveillance Radar
ATPL	:	Airline Transport Pilot Licence
ATC	:	Air Traffic Control
AUW	:	All Up Weight
C of A	:	Certificate of Airworthiness
C of R	:	Certificate of Registration
CAR	:	Civil Aviation Requirements
CPL	:	Commercial Pilot License
SSCVR	:	Solid State Cockpit Voice Recorder
DFDR	:	Digital Flight data Recorder
DGCA	:	Directorate General of Civil Aviation
ECAM	:	electronic centralised aircraft monitor
EEC	:	Electronic Engine Control
FO	:	First Officer
FADEC	:	Full Authority Digital Engine Control
FCOM	:	Flight Crew Operating Manual
FCTM	:	Flight Crew Training Manual
FRTOL	:	Flight Radio Telephone Operators License
ICAO	:	International Civil Aviation Organization
IFR	:	Instrument Flight Rules
ILS	:	Instrument Landing System
MCDU		Multipurpose Control Display Unit
NM	:	Nautical Miles
OEM	:	Original Equipment Manufacturer
PF	:	Pilot Flying
PFR		Post Flight Report
PHMU	:	Prognostic Health Monitoring Unit
PIC	:	Pilot in Command
PM	:	Pilot Monitoring
PDR	:	Pilot Defect Report
QRH	:	Quick Reference Handbook
SB	:	Service Bulletin
TSM	:	Trouble shooting Manual
TLA	:	Throttle Lever Angle
VFR	:	Visual Flight Rules
VMC	:	Visual Meteorological Conditions
VOR	:	VHF Omnidirectional Range
UTC	:	Coordinated Universal Time

SYNOPSIS

1.	Aircraft Type	:	Airbus A320 NEO
	Nationality	:	Indian
	Registration	:	VT-ITJ
2.	Owner	:	M/s Bank of Utah
3.	Aircraft Operator	:	M/s Interglobe Aviation Limited (INDIGO)
4.	Pilot-in-Command	:	ATPL Holder on Type
5.	First Officer	:	CPL Holder on Type
6.	Place of Incident	:	Sector Amritsar-Guwahati
7.	Date & Time of Incident	:	24 Mar 2019 & 1637 UTC
8.	Type of Operation	:	Scheduled Operation
9.	Phase	:	Climb & Cruise
10.	Last Point of Departure	:	Amritsar (ICAO Code: VEGT)
11.	Point of Intended Landing	:	Guwahati (ICAO Code: VIAR)
12.	Persons on Board	:	166 (6 Crew+ 160 Pax)

Abstract

On 24.03.2019, aircraft VT-ITJ took off from Amritsar at 1359 UTC. While operating flight 6E-895 (Amritsar-Guwahati), aircraft experienced high N2 vibration on Engine # 2 with ECAM warning during flight. The crew followed the QRH checklist, reduced thrust & speed and continued the flight to destination. Aircraft landed safely at Guwahati. The crew made PDR entry *"experienced high N2 vibration on Engine 2 with ECAM warning during flight"*. The AME at Guwahati in consultation with MCC carried out 'BITE' check and released the aircraft for further flight. Subsequently, the aircraft was released for flight and the crew accepted the aircraft. However, after accepting the aircraft for flight, the aircraft was grounded at Guwahati for replacement of Engine #2. No fire or injuries was reported.

Probable Cause

The cause of the incident was a High Cycle Fatigue crack generated on front Hub / Tie shaft which resulted in excessive rotor whirl and tie shaft imbalance which led to propagation of vibrations at high thrust settings.

Hazard identified during the investigation

After two consecutive incidents of high engine vibrations, BSI was not carried out at Night halt facility and the aircraft was released for further flight without establishing the root cause.

Consequence

High engine vibrations lead to damage of other internal components / parts of the engine.

1. FACTUAL INFORMATION

1.1 History of Flight

On 24/03/2019, M/s Interglobe Aviation Ltd (Indigo) Airbus A320neo aircraft VT-ITJ operated a scheduled flight on Amritsar - Guwahati sector. The aircraft was involved in a serious incident of high N2 vibrations on Engine #2 during the flight. The aircraft was under the command of a pilot holding ATPL as PIC and another pilot holding CPL was PM for the sector. There were 6 crew members and 160 passengers on board the aircraft. No injury to any onboard occupant was reported. Also, no fire or smoke was reported during the flight.

As per the Tech Log Book, on the day of incident aircraft operated 04 scheduled flights including the incidented flight. The first flight of the day was Guwahati- Delhi, second sector was Delhi-Guwahati, third was Guwahati-Amritsar and the last sector on which aircraft operated was Amritsar-Guwahati, before making a night halt at Guwahati. First two sectors were uneventful; however, PDR entries were raised by the cockpit crew after the last two sectors.

While operating third sector of the day i.e. Guwahati-Amritsar, crew experienced high Engine #2 N2 vibration during the flight and consequently made an PDR entry after landing at Amritsar which read as "*During cruise Engine 2 high vibrations*. *ECAM came and vibration Engine #2 N2 was observed 4.5*. *ECAM was momentarily*. *During entire flight at FL300, the speed was selected 270/280 Kts and Engine #2 vibration increasing upto 3.2 and decreasing upto 2.4 throughout*."

The company AME at Amritsar airport followed TSM task in coordination with MCC to classify the snag and troubleshooting. Further, MCDU was not downloaded while carrying out troubleshooting. MCC considered reported high N2 vibration on Engine #2 as transient (short duration) in nature under category "C". Thereafter, MCC advised AME to clear the aircraft for further flight to Guwahati.

Aircraft took off from Amritsar at 1359 UTC for the last sector of the day. During climb and cruise, the aircraft again experienced high N2 vibrations on Engine #2. The crew followed the checklist and as corrective measure, reduced the thrust and speed of the aircraft. Thereafter, crew continued the flight to destination. The aircraft landed safely at Guwahati airport at 1637 UTC.

After landing at Guwahati, PIC made an PDR entry at 1647 UTC which read as "experienced high N2 vibration of 7 units on Engine 2 during takeoff, cruise level selected FL290 & speed 250. Engine vibration range is between 3.2 & 2.4. Any higher speed selected, is increase Engine N2 vibration beyond 5 units & master caution".

Thereafter, the company AME stationed at Guwahati carried out rectification as per TSM in consultation with MCC and finally cleared the PDR by 1800 UTC.

On 25th Mar 2019, the aircraft was offered at 0200 UTC to operate first flight of the day. Crew rostered for the scheduled flight accepted the aircraft at 0208 UTC. However, crew could not accelerate Eng #2 and aborted takeoff and returned back to bay. MCC finally decided to ground the aircraft and change the Engine # 2. Subsequently, aircraft was grounded at Guwahati to carry out engine #2 change.

1.2 Injuries to Persons

INJURIES	Crew	Passengers	Others
Fatal	NIL	NIL	NIL
Serious	NIL	NIL	NIL
Minor/None	06	160	NIL

1.3 Damage to Aircraft

(i) Nil damage to aircraft.

(ii) After the incident, the involved engine was inducted at OEM facility on 14th May 2019 for root cause analysis of reported high N2 vibration during two consecutive flights. Damages were confined to internal parts of Engine #2 as noted by OEM during induction.

1.4 Other Damage

Nil

1.5 Personnel Information

1.5.1 Pilot-in-Command (PIC)

38 years 9 months
ATPL
20 Jul 2015
19 Jul 2020
Aeroplane
02 Jun 2020
16 Apr 2019
15 Apr 2024

Endorsement as PIC on Type	:	25 Sep 2017
Total flying experience	:	4532:11 Hrs
Total flying experience on type	:	4251:23 Hrs
Last Flown on type	:	24 Mar 2019
Total flying experience during last 1 year	:	716:30 Hrs
Total flying experience during last 6 Months	:	339:46 Hrs
Total flying experience during last 30 days	:	46:49 Hrs
Total flying experience during last 07 Days	:	18:20 Hrs
Total flying experience during last 24 Hours	:	9:39 Hrs
Rest period before flight	:	17:01 Hrs
Whether involved in Accident/Incident earlier	:	No
Date of latest Flight Checks and Ground Classes	:	ALRC (22/09/2018) and Annual Refresher (09/03/2019)

1.5.2 First Officer

Age	:	29 years
License	:	CPL
Date of Issue	:	22 Jul 2014
Valid up to	:	21 Jul 2024
Category	:	Aeroplane
Class I Medical Valid up to	:	07 May 2020
Date of issue FRTOL License	:	22 Jul 2019
FRTO License Valid up to	:	21 Jul 2024
Endorsements as PIC	:	N/A
Total flying experience	:	3955.16 Hrs
Total flying experience on type	:	76.16 Hrs
Last Flown on type	:	24 Mar 2019
Total flying experience during last 1 year	:	76.16 Hrs
Total flying experience during last 6 Months	:	76.16 Hrs
Total flying experience during last 30 days	:	96.10 Hrs
Total flying experience during last 07 Days	:	18.54 Hrs
Total flying experience during last 24 Hours	:	2.54 Hrs
Rest period before flight	:	17.01 Hrs
Whether involved in Accident/Incident earlier	:	Νο
Date of latest Flight Checks and Ground Classes	:	17 Mar 2019 (ALRC) 10 Sep 2018 (Annual Refresher)

1.6 Aircraft Information

1.6.1 General Information

The A320 is a subsonic, medium-range, civil transport aircraft. The aircraft is fitted with two Pratt & Whitney 1127G-JM engines.

The aircraft is certified in the public transport category (passengers and freight) for day and night operations, in the following conditions, when the appropriate equipment and instruments required by the airworthiness and operating regulations are approved, installed and in an operable condition:-

- VFR and IFR.
- Extended overwater flight.
- Flight in icing conditions.



FIG-1: 3D VIEW & DIMENSIONS

1.6.2 Aircraft Technical Information

Aircraft Model	:	AIRBUS A320-271N
Aircraft S. No.	:	6967
Year of Manufacturer	:	2016
Name of Owner	:	M/s BANK OF UTAH
C of R	:	4720
C of A	:	6823
Category	:	NORMAL
C of A Validity	:	NO VALIDITY
A R C issued on	:	22.11.2016
ARC valid up to	:	21.11.2019
Aircraft Empty Weight	:	39679.480 Kg
Maximum Take-off weight	:	73500 Kg
Date of Aircraft weighment	:	08.11.2016
Empty Weight	:	39679.480 Kg
Max Usable Fuel	:	18622 Kg
Max Payload with full fuel	:	11600.255 Kg
Empty Weight C.G	:	23.978 % MAC
Next Weighing due	:	07.11.2021
Total Aircraft Hours	:	7728:31
Last major inspection	:	3000 FH/360 Days on 17.03.2019
List of Repairs carried out after last major inspection till date of incidence Engine Type	:	NIL PW1127G-JM
Date of Manufacture I H		28-Dec-2018
Engine SI. No. LH	:	P771162 (Lease engine)
Last major inspection (LH)	:	3000 FH/360 Days on 17.03.2019
List of Repairs carried out after last	:	NIL
major inspection till date of incidence Total Engine Hours/Cycles LH	:	561 FH/355 FC (As on 24-Mar-2019)
Date of Manufacture RH	:	30-Apr-2018
Engine SI. No. RH	:	P770461 (Lease engine)
Last major inspection (RH)		3000 FH/360 Days on 17.03.2019
List of Repairs carried out after last major inspection till date of incidence	:	NIL
	:	34 01 2022
AD SR Modification complied	:	AD SR & Modification are complied
$\pi \nu$, 3μ , would all the complication	•	AD , $SD \propto WOULLCATION are complied.$

1.6.3 Engine System



FIG-2: ENGINE SECTIONS

The aircraft is fitted with two turbofan engines which have two compressor turbine assemblies:-

- The Low Pressure (LP) compressor turbine assembly.
- The High Pressure (HP) compressor turbine assembly.

Each turbine operates its associated compressor via a shaft.

- One accessory gearbox.
- One combustion chamber.
- > The rotation speed of the fan provides the N1 engine parameter.
- > The rotation speed of the HP rotor provides the N2 engine parameter.
- > The N1 and N2 engine parameters appear on the Engine/Warning Display (E/WD).
- The N1 and N2 engine parameters are current rotation speeds displayed in percentage.

LP Compressor Turbine Assembly

The LP compressor turbine assembly has:-

• One LP compressor.

- One Fan Drive Gear System (FDGS).
- One LP shaft.
- One LP turbine.

The FDGS is a planetary gear reduction unit that connects the LP shaft to the LP compressor. The LP shaft connects the LP compressor to the LP turbine. The LP compressor has a fan and 3 stages, and the LP turbine has 3 stages.

HP Compressor Turbine Assembly

The HP compressor turbine assembly has:-

- One HP compressor.
- One HP shaft.
- One HP turbine.

The HP shaft connects the HP compressor to the HP turbine. The HP compressor has 8 stages, and the HP turbine has 2 stages.

Combustion Chamber

The combustion chamber burns a mixture of fuel and HP air. The FADEC controls the fuel/air mixture in accordance with the position of the thrust lever and the aircraft operating conditions. The combustion chamber is an annular assembly with fuel nozzles and two igniters. The combustion chamber is between the HP compressor and the HP turbine.

Engine Bearings

The engine bearing provide reduced rolling friction and supports the rotor axially and radially within the structure. It bears the different loads of the rotating shaft. There are five bearing compartments containing a total of seven bearing.

- (a) No. 1 and 1.5 are tapered roller bearing and are used to support the fan rotor and FDGS.
- (b) No. 2 and 3 are ball bearings and support the front part of LP and HP rotor respectively.
- (c) No. 4 is roller bearing and supports the rear of N2.
- (d) No.5 and 6 are roller bearing and support the rear of N1 rotor.

The bearing compartment are lubricated, cooled and cleaned by engine oil. Bearing compartments are sealed using carbon seals to prevent oil leakage.

1.6.4 Engine Warning System



FIG -3: SYSTEM DISPLAY PAGE OF ECAM

<u>N1, N2 VIBRATIONS</u>

Green: The vibration of the LP (HP) rotor is in normal range.

Amber: The level of LP (HP) rotor vibration is excessive.

1.6.5 Vibration Parameters Description



FIG 4: POSITIONS OF SENSORS

The vibration monitoring function within the PHMU uses the two vibration sensors to measure the Fan related vibrations (VIB N1) and the Core related vibrations (VIB N2), stores this information and sends it to the EEC. It is used for ECAM display in the ENGINE SD page.

It's also used for the fan trim balance procedure. The PHMU receives Nf, N1 and N2 data from EEC to capture and compute the appropriate vibration data.

The Forward Vibration Sensor is a single channel piezoelectric accelerometer, installed at 10 o'clock on the HP Compressor casing. The Aft Vibration Sensor is a single channel piezoelectric accelerometer, installed at 3 o'clock on the LP Turbine casing.

If the signal from one vibration sensor (either forward or aft vibration sensor) is lost during engine operation, the vibration monitoring function is still able to provide both vibration signals (N1 and N2) for cockpit display. However, the display for the affected sensor will be presented in degraded mode.

1.7 Meteorological Conditions

Enroute weather was reported fine and has no bearing on the incident.

1.8 Aids to Navigation

The aircraft was equipped with standard navigational equipment and there was no recorded defect with the navigational equipment prior to the flight.

1.9 Communication

The aircraft always maintained a positive two way communication with ATC.

1.10 Aerodrome Information

Guwahati airport is the major hub for flights to North eastern states of India located in Assam State. The IATA location Identifier code is GAU and ICAO location Indicator code is VEGT. The airport is operated by Airports Authority of India (AAI). The elevation AMSL of airport is 49 m (160 ft). The Airport Reference point coordinates are 260618N and 0913508E. Rescue & Fire Fighting Services of Category VII (7) is available at Guwahati airport.

1.11 Flight Recorders

Aircraft was equipped with DFDR and SSCVR. After the incident, SSFDR was downloaded and analysed.



FIG 5: DFDR DATA ANALYSIS

DFDR data analysis by OEM revealed the following:

(a) Engine N2 vibrations reached upto 10 CU during start.

(b) Engine was unresponsive to TLA input on flight following aborted takeoff (ATO).

(c) Engine was unable to accelerate.

(d) During sector Amritsar Guwahati, Engine #2 N2 vibration had reached upto 6 CU.

<u>Note</u>: No abnormal shifts in engine #2 performances, oil system or effector scheduling at time of crack propagation was noted during DFDR analysis

1.12 Wreckage and Impact Information

N/A

1.13 Medical and Pathological Information

The crew had undergone pre-flight medical examination (BA Test) at Amritsar before the flight (Amritsar-Guwahati) as per requirement of CAR Section 5, Series F, Part III and the test results were negative.

1.14 Fire

No smoke and fire was reported in the aircraft during entire flight.

1.15 Survival Aspects

The incident was survivable.

1.16 Tests and Research

After the incident, the engine #2 was despatched to OEM facility for root cause analysis. During investigation, HCF (High Cycle Fatigue) Crack was observed in Tie shaft and Ni (Nickel) Front hub. Tie shaft crack was radial through wall and Front hub cracks were axial through threads.





FIG 6: TIE SHAFT & FRONT HUB



Fig 7: Comparison of RH Engine & LH Engine

Investigation of Eng#2 at OEM facility revealed that cracked Shaft resulted in excessive rotor whirl which created large tie shaft bow (imbalance). Rotor whirl drives

vibration into N2 sensor. Vibration at N2 sensor pickup prevents engine from accelerating if weight on wheels is present.

After the analysis, OEM has suggested two corrective measures.

- I. Short Term Corrective action.
- II. Long Term action.

<u>In short term action</u>, OEM has incorporated more durable coating to tie shaft threads for improved wear life. Changes incorporated by OEM have the following effects on the performance of Engine:-

- a) New coating system will have better capability under load.
- b) Adds new coating to Tie Shaft threads.
- c) Hub retains current coating to increase robustness of joint.

In the *long term plan*, OEM has proposed to redesign the threads which will eliminate the risk of thread cracking.



FIG 8: PROPOSED REDESIGN

The redesign will isolate threads from vibratory stress which will result into reduced relative motion in threads by 8X. Validation plan for long term redesign by OEM has already been completed with requisite tests. Production of engines with redesign plan incorporation will be ready by OEM by Q4 2020.

1.17 Organizational and Management Information

M/s Inter-globe is an Indian registered Scheduled airline with its headquarter in Gurugram, Haryana. The operator has more than 250 aircraft in its fleet mainly comprising of A320 neo aircraft. It operates scheduled flights to both domestic and international sectors. The Flight Safety Department is headed by Chief of Flight Safety approved by DGCA. M/s Inter-globe has a full established Operations training facility for the pilots.

1.18 Additional Information

1.18.1 AME Qualification

During course of investigation, it was observed that both AMEs (positioned by M/s Interglobe Aviation Ltd) who carried out the troubleshooting at Amritsar and Guwahati were neither holding B1 license on A320 aircraft nor had undergone any full scope training on A320 aircraft. However, both AMEs were holding category 'A' license under CAR 66 which limits work domain to a transit inspections covering weekly and minor snag rectifications.

Further, during investigation it was also observed that no "**one off**" authorisation was issued by the company QC to AMEs to clear the PDR entries as per the laid down guidelines of MOE (Maintenance Organisation Exposition).

1.18.2 Maintenance Records

While operating sector Guwahati-Amritsar, Crew observed high engine vibrations on Engine#2 resulting into ECAM warning in the cockpit. Subsequently, after landing at Amritsar, crew raised the PDR at 1310 UTC as "*During cruise Eng#2 high vibration ECAM came and N2 vibration-Eng#2 was observed 4.5, ECAM was momentary. During entire flight at FL300 the speed was selected 270/280 and Eng #2 N2 vibration seen increasing upto 3.2 and decreasing to 2.4 throughout"*.

Based on the PDR entry, company AME in consultation with MCC had raised a Work Order #485511 to carry out the maintenance action and snag rectification.

As per the Work Order, following actions were carried out:-

- i. ECAM was checked and the same was found normal.
- ii. FADEC self test was carried out for both the channels as per AMM task 73-21-00-710-806A. Test was found satisfactory.
- iii. GVI of inlet and exhaust area inspection of Engine #2 was carried out as per AMM task 72-00-00-210-812/813. No abnormalities were noticed.
- iv. Eng #2, N2 vibration found within limit as per AMM task 71-00-00-910-803-A.

At 1340 UTC at Amritsar, aircraft was released for further flight. PIC accepted the aircraft at 1345 UTC.

Next scheduled flight for sector Amritsar Guwahati was operated. During this flight, crew again observed ECAM warning. QRH was followed and crew continued the fight to destination. After landing at Guwahati Airport, crew raised a PDR at 1647 UTC as

"Experienced high N2 vibration of 7 on Eng 2 during t/o, crz level selected FL290 & speed 250, Eng vibration range is between 3.2 & 2.4. Any higher speed selected is increasing Eng2 N2 vibration beyond 5 units & master caution".

AME stationed at Guwahati in consultation with MCC again raised a Work Order# 42879 to attend to the PDR entry. As per the Tech log, AME raised the work order at 1730 UTC and after completion of maintenance action, closed the work order at 1800 UTC.

As per the Work Order, following actions were carried out again:-

- i. ECAM was checked and no abnormalities were found.
- ii. "Vibration Troubleshooting Flow Chart" was referred from TSM. TSM task 71-00-00-810-873-A was followed. As per TSM, event was classified under category 'C' and following additional sub tasks were carried out.
 - (a) FADEC self test for both channels was carried out. Test was found satisfactory.
 - (b) Engine Last Leg Report, Engine Previous Leg Reports, Scheduled Maintenance Fault information, Ground Fault information and Divergence Report were reviewed using MCDU PFR. Other than High N2 Eng#2 vibration no other fault found.
 - (c) Operational check of loop/squib was carried out as per AMM task 26-00-12-710-001-A which was found satisfactory.

As per Tech log, on 25th March 2019, aircraft was cleared for fight and handed over to PIC. PIC accepted the aircraft at 0208 UTC to operate the first fight of the day.

However, while operating the first flight of the day, crew could not accelerate the Eng#2 of aircraft at line up and returned to bay. MCC then decided to ground the aircraft to carry out replacement of engine#2 at Guwahati.

1.19 Useful and Effective Techniques

Nil

2. ANALYSIS

2.1 Serviceability of Aircraft

After the incident, Tech log of last 6 sectors was examined. It was observed that in the last sector (Amritsar – Guwahati) and the second last sector (Guwahati- Amritsar), crew had reported high N2 engine#2 vibrations alongwith ECAM caution/warning in the cockpit during the flights. The reported snag was confirmed during DFDR analysis. In addition, during engine strip examination at OEM facility, HCF (High Cycle Fatigue) cracks were noticed in the Tie shaft and Ni (Nickel) front hub. Further, as per OEM engine induction report, other components / parts of the engine too had crossed acceptable limits of failure.

From the above, it is inferred that aircraft engine #2 was not serviceable before the commencement of flight.

2.2 Maintenance Practices by Operator

During investigation, it was noticed that even after repeated snag of high N2 vibration on Eng #2 were reported during two consecutive flights, AME in coordination with MCC carried out the maintenance action without establishing the cause of high N2 engine vibrations. Even though Guwahati was the night halt base for the aircraft and AME had sufficient time to carry out detailed snag analysis, however, PDR was closed in a short span of time. Aircraft was cleared and handed over to PIC to operate the first scheduled flight of the next day. Further, AME who had attended the snag did not hold full scope authorization or type rated licence on the aircraft. However, MCC in consultation with QM issued one time authorization to AME to attend the Snag.

2.3 Preventive Measures

Due to higher reporting of high N2 engine vibrations on Neo Engines by operators, OEM, during root cause analysis has concluded that high cycle fatigue (HFC) cracks observed in Tie Shaft and Ni (Nickel) front hub on PW1000G engine could be improved with redesign. Two methods have been suggested by OEM. As per OEM, "*short term plan*" of recoating tie shaft thread would improve the wear life and has already been implemented. In "*long term plan*", redesign of component will be executed after validation of engineering change by June 2020.

2.4 Circumstances Leading to Incident

After completion of passengers boarding, aircraft taxied out to runway for takeoff. However, during take-off run, on TLA input by pilot, Engine #2 was unresponsive and N2 vibration went upto 10 CU due to a HCF crack which had developed in Tie shaft and Ni (Nickel) front hub during the previous flight. The pilot aborted take-off and returned to bay.

Further, cracks so developed had led to N2 vibration steps changes during flight on 24 Mar 19, which was controlled in accordance with QRH.

3. CONCLUSION

3.1 Findings

- (a) The Certificate of Airworthiness, Certificate of Registration and Airworthiness Review Certificate of the aircraft were valid on the date of incident.
- (b) Both Pilots were qualified to operate the flight.
- (c) The pre-flight BA tests of the crew were found to be negative.
- (d) In previous sector (Guwahati –Amritsar), the same (high N2 Vib Eng #2) snag was also reported by crew.
- (e) Company AME stationed at the Amritsar attended the snag in coordination with the MCC. However, AME did not hold the necessary approval on the aircraft.
- (f) MCDU was not downloaded before carrying out the troubleshooting and aircraft was released from Amritsar by AME in consultation with the MCC.
- (g) Aircraft tookoff from Amritsar at 1359 UTC. During climb and cruise, ECAM warning "Engine# 2 high N2 vibrations" was generated in the cockpit.
- (h) Crew followed the QRH and accordingly reduced the thrust and speed of the aircraft. FL290 for cruise was selected and aircraft speed was maintained at 250 knots during the Amritsar-Guwahati sector. Crew continued the flight to the destination.
- (i) There was no fire or smoke during the incident.
- (j) Aircraft landed safely in Guwahati at 1637 UTC.
- (k) At Guwahati airport, AME carried out troubleshooting in coordination with the MCC.
- (I) Aircraft was released for operation on 25th March at 0200 UTC and the crew rostered for the next scheduled flight accepted the aircraft at 0208 UTC.
- (m) Analysis of DFDR data showed that engine #2 could not accelerate at line up and vibrations of 10 CU reached on Engine#2.
- (n) MCC decided to ground the aircraft for Engine# 2 replacement at Guwahati.
- (o) Crack in Tie shaft and Ni(Nickel) front hub due HCF as observed during strip examination of Eng #2 at OEM facility.

(p) Detailed snag analysis was not carried out due to non-availability of qualified AME. However, the aircraft was declared serviceable and released for further flight.

3.2 Probable Cause

The cause of the incident was a High Cycle Fatigue crack generated on front Hub / Tie shaft which resulted in excessive rotor whirl and tie shaft imbalance which led to propagation of vibrations at high thrust settings.

4. SAFETY RECOMMENDATIONS

4.1 DGCA

(a) DGCA may advice all operators operating A320 NEO aircraft to pursue short and long term corrective measures as suggested by OEM in a coordinated manner to arrest and resolve the issue of high N2 Engine (NEO) vibrations.

4.2 Aircraft Operator

(a) It is recommended that any defect / PDR entry related to neo engines shall be cleared by an A320 type rated AME only.

Dinesh Kumar Investigator

Investigator In-Charge

Date: 04 May 2020 Place: New Delhi