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INVESTIGATION REPORT ON INCIDENT TO M/S TATA SIA AIRLINES LTD. (VISTARA) AIRBUS A320-232 AIRCRAFT VT-TTF WHILE OPERATING FLIGHT UK -733 (SECTOR: CHENNAI - KOLKATA) ON 25.02.2019

DIRETORATE GENERAL OF CIVIL AVIATION

GOVERNMENT OF INDIA

NEW DELHI

ABBREVIATIONS

Abbreviation	Expanded Form
ADEM	Advanced Diagnostics and Engine Monitoring
ADF	Automatic Direction Finding
AME	Aircraft Maintenance Engineer
AMM	Aircraft Maintenance Manual
AMSL	Above Mean Sea Level
AOC	Air Operator Certificate
ARC	Airworthiness Review Certificate
ATC	Air traffic control
ATIS	Automatic Terminal Information Service
ATPL	Airline Transport Pilot License
BMOD	Bill of Material Object Damage
BRN	Broken
BSI	Borescope Inspection
°C	Degree Celsius
CAT	Category
CB	Cumulonimbus
CC	Concave
CEO	Chief Executive Officer
CG	Centre of Gravity
C of A	Certificate of Airworthiness
CPL	Commercial Pilot Licence
CSN	Cycles Since New
CV	Convex
DFDR	Digital Flight Data Recorder
DGCA	Directorate General of Civil Aviation
DME	Distance Measuring Equipment
DOD	Domestic Object Damage
DVOR	Doppler Very High Frequency Omni Range
ECAM	Electronic Centralised Aircraft Monitoring
EEC	Electronic Engine Control
EGR	Engine Ground Run
EGT	Exhaust Gas Temperature
ELT	Emergency Locator Transmitter
EM	Engine Manual
ENG	Engine
EPR	Engine Pressure Ratio
ESN	Engine Serial Number
FF	Fuel Flow
FH	Flight Hours
FL	Flight Level
FMU	Fuel Metering Unit
FO	Foreign Object
FOD	Foreign Object Damage
FRTO	Flight Radio Telephoney Operators License
FT	Feet

FWD	Forward
GPS	Global Positioning System
HCF	High Cycle Fatigue
HP	High Pressure
HPC	High Pressure Compressor
HPT	High Pressure Turbine
HRS/hrs	Hours
IAE	International Aero Engines
IFR	Instrument Flight Rules
IFSD	In Flight Shut Down
ILS	Instrument Landing System
IN/in.	Inch
IR	Instrument Rating
I.T.	Information Technology
KG	Kilograms
KG/H	Kilograms/Hour
KT	Knots
LE, L/E	Leading Edge
LP	Low Pressure
LPC	Low Pressure Compressor
MAC	Mean Aerodynamic Chord
MET	Meteorological
MLW	Maximum Landing Weight
MM	Millimetre
MTOW	Maximum Take-Off Weight
MTS	Meters
NM	Nautical Mile
NOSIG	No Significant
NSCBI	Netaji Subhash Chandra Bose International
OPS	Operations
PAPI	Precision Approach Path Indicators
PIC	Pilot In Command
PFR	Post Flight Report
PS3	Compressor Outlet Pressure
PSI	Pounds per square inch
PSIA	Pounds per square inch absolute
P&W	Pratt & Whitney
QTY	Quantity
RA	Radio Altitude
RADAR	Radio Detection and Ranging
SCT	Scattered
SEM	Scanning Electron Microscope
S/N	Serial Number
S/SE	South/South East
SYS	System
TCAS	Traffic Collision Avoidance System
T/E	Trailing Edge
TLA	Throttle Lever Angle
TSAL	Tata Sia Airlines Ltd.

TSM	Troubleshooting Manual
TSN	Time Since New
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VIGV	Variable Inlet Guide Vane
VOR	Very High Frequency Omnidirectional Range
VSV	Variable Stator Valve
ZFW	Zero Fuel Weight

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INVESTIGATION REPORT ON INCIDENT TO M/S TATA SIA AIRLINES LTD. (VISTARA) AIRBUS A320-232 AIRCRAFT VT-TTF WHILE OPERATING FLIGHT UK -733 (CHENNAI - KOLKATA) ON 25.02.2019

1	Aircraft	Type	AIRBUS A320 - 232
		Nationality	INDIAN
		Registration	VT-TTF
2	Owner	M/s WILMINGTON TRUST SP SERVICES (DUBLIN) LIMITED, IRELAND	
	Operator	M/s TATA SIA AIRLINES LTD. (VISTARA), NEW DELHI	
3	Pilot-in-Command	ATPL	
	Extent of injuries	Nil	
4	Date & Time of Incident	25.02.2019 at 0326 hrs	
5	Place of Incident	Enroute	
6	Co-ordinates of Incident site	Latitude: 21° 59' 31" N Longitude: 88° 22' 32" E	
7	Last Point of Departure	Chennai International Airport (VOMM)	
8	Intended place of landing	Netaji Subhash Chandra Bose International Airport , Kolkata (VECC)	
9	No. of Passengers on Board	121	
10	Type of Operation	Scheduled Operation	
11	Phase of Operation	Descent	
14	Type of Incident	Engine #2 IFSD	

(All timings in the report are in UTC)

Synopsis

On 25.02.2019, M/s Tata SIA Airlines Ltd. (Vistara) A320-232 aircraft VT-TTF was operating a schedule passenger flight UK-733 from Chennai to Kolkata. The aircraft was under the command of Pilot in Command holding ATPL with First Officer holding CPL. There were 128 persons on board the aircraft including 07 crew members.

The aircraft took off from Chennai and flew uneventfully till descent to FL150. While levelling at FL150 and turning right heading 020, around 20-25 NM short of Kolkata, at 0326 hrs flight crew heard a loud bang noise. ECAM alert of "Eng # 2 Stall" was triggered and while executing the ECAM actions, another ECAM alert of "Eng # 2 EGT Over limit" triggered. ECAM actions were followed and thrust lever was retarded to idle. EGT still continued to be in RED then Engine # 2 Master was put to OFF. Flight crew declared PAN PAN and landed safely at Kolkata. There were no injuries to any of the crew members and passengers on board the aircraft. There was no fire. The incident occurred during day time.

The incident was notified to the DGCA by M/s Tata SIA Airlines Ltd. (Vistara) and same was investigated by Investigator In-Charge under Rule 13(1) of Aircraft (Investigation of Accidents and Incidents) Rules 2017. It is not the purpose of the investigation to apportion blame or liability. The sole objective of the investigation and the report is the prevention of accidents and incidents.

The conclusive root cause of what promoted blade to fracture for this event could not be determined, however the probable cause of incident is foreign object damage on 3rd stage HPC blade and further High Cycle Fatigue attributed it to fracture and subsequent damage down stream the engine.

1. Factual Information

1.1. History of the flight

On 25.02.2019, M/s Tata SIA Airlines Ltd. (Vistara) A320-232 aircraft VT-TTF was operating a schedule passenger flight UK-733 from Chennai to Kolkata. The aircraft was under the command of Pilot in Command holding ATPL with First Officer holding CPL. There were 128 persons on board the aircraft including 07 crew members (2 Pilots and 5 Flight Attendants).

This was the first flight of the day, both the cockpit crew reported for duty on time and pre-flight self briefing was done before undertaking the flight from Chennai to Kolkata.

There was total 9600 kg of fuel on board the aircraft. Pre-Flight inspection was carried out by the AME and aircraft was released for flight. The aircraft took off from Chennai runway 25 at 01:47 UTC and flew uneventfully till descent to FL150.

While levelling at FL150 and turning right heading 020, around 20-25 NM short of Kolkata, at 0326 hrs flight crew heard a loud bang noise. ECAM alert of "Eng # 2 Stall" was triggered and while executing the ECAM actions, another ECAM alert of "Eng # 2 EGT Over limit" triggered. ECAM actions were followed and thrust lever was retarded to idle. EGT still continued to be in RED then Engine # 2 Master was put to OFF. Flight crew declared PAN PAN and landed safely at Kolkata.

There were no injuries to any of the crew members and passengers on board the aircraft. There was no fire. The incident occurred during day time.

1.2. Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	Nil	Nil	Nil
Serious	Nil	Nil	Nil
Minor/None	07	121	

1.3. Damage to Aircraft

Engine #2 HPC was damaged.

1.4. Other Damage

There was no other damage.

1.5. Personal Information

1.5.1. Cockpit Crew Details

Pilot in Command:

Age	: 31 Years / Male
License	: ATPL
Category	: Aeroplane
Date of License Issue and validity	: 05/12/2016 and valid up to 04/12/2021
Date of Class I medical examination and validity	: 04/01/2019 and valid up to 18/01/2020
FRTO license renewal and validity	: 27/02/2017 and valid up to 26/02/2022
IR Check and validity	: 23/09/2018 and valid up to 22/09/2019
Total flying experience	: 5752:43 hours
Total Experience on type	: 4297:50 hours
Total Flying experience during last 1 year	: 888:40 hours
Total Flying experience during last 6 months	: 386:54 hours
Total flying experience during last 30 days	: 42:30 hours
Total flying experience during last 07 Days	: 08:08 hours

Total flying experience during last 24 Hours	: 00:00 hours
Duty time last 24 Hours	: 02:44 hours
Rest before flight	: 18 hours (Approx)

First Officer:

Age	: 21 Years / Female
License	: CPL
Category	: Aeroplane
Date of License Issue and validity	: 16/06/2017 and valid up to 15/06/2022
Date of Class I medical examination and validity	: 24/05/2018 and valid up to 27/05/2019
FRTO license issue and validity	: 16/06/2017 and valid up to 15/06/2022
IR Check	: 19/02/2019 and valid up to 18/02/2020
Total flying experience	: 897:56 hours
Total Experience on type	: 683:51 hours
Total Flying experience during last 1 year	: 683:51 hours
Total Flying experience during last 6 months	: 363:27 hours
Total flying experience during last 30 Days	: 34:38 hours
Total flying experience during last 07 Days	: 12:41 hours
Total flying experience during last 24 Hours	: 00:00 hours
Duty time last 24 Hours	: 00:00 hours
Rest before flight	: 24 hours

1.6. Aircraft Information

1.6.1. General

Registration Mark	: VT-TTF
Manufacturer	: Airbus Industry
Country of Manufacturer	: France
Type/Model	: A320-232

Serial Number	: 6388
Year of Manufacture	: 2014

Certificate of Airworthiness:-

Number	: 6658
Issued	: 09/01/2015
Category	: Normal
Sub- Division	: Passenger/Mail/Goods

Airworthiness Review Certificate:-

ARC ReferenceNumber	: TSAL/ARC/01/18
Approval Reference Number	: TSAL/F-APP/DDG/NR/MG/100
Date of issue	: 05.01.2019
Date of expiry	: 08.01.2020

Certificate of Registration:-

Number	: 4548
Issued	: 06/01/2015
Validity	: 17/12/2020
Category	: 'A'
Time Since New	: 13436:36 hours
Cycles Since New	: 8113 cycles

1.6.2. Engines

Manufacturer	: International Aero Engines (IAE)
Type/Model	: V2500 / V2527-A5
Part Number	: 4W5198E01
Serial Number- 1 engine	: V12038

- Time Since New : 28017:50 hours
- Cycles Since New : 17591 cycles

Serial Number- 2 engine : V17533

- Time Since New : 13436:36 hours
- Cycles Since New : 8113 cycles

1.6.3. Maintenance History of Engine #2:

On 21-05-2016, borescope inspection of LP stage 1.5 & 2.5 and HP stage 3 & 6 carried out due bird hit, bird feathers were found in LP stage 1.5 and 2.5, nil damage was observed. Hence HPC stage 3 clapper must be inspected at the next letter check and at each 750 flight cycles thereafter for a total of 2250 flight cycles. On 17.09.2016, 28.01.2017 & 26.05.2017, repeat borescope inspections of HPC stage 3 clapper carried out. Nil abnormality observed.

On 12-06-2018, reduced borescope inspection at 300 FH due damage on the HPT 1 blade – Carried out boroscope inspection of HPT blades (STAGE 1 & 2) aerofoils & duct segments. One blade damage with higher dimension recorded & this blade remains fall under criteria of 300 FH repetitive inspections. However other 03 blades of HPT stage 1 with leading edge holes recorded. HPT stage 2 blade aerofoils & ducts segments inspection found satisfactory. Inspected both ignitor plugs A & B for erosion (missing material), found satisfactory.

On 12-07-2018, reduced borescope inspection at 300 FH – Carried out boroscope inspection of HPT blades (STAGE 1 & 2) aerofoils & duct segments. Found erosion/burn on leading edge of HPT stage 1 – QTY 06 blades. All damage is in outer 50% span, falling under 300FH reduced inspection criteria. In the reference of previous damages observed, two more HPT 1 blades are affected. All are mapped and no further reduction of interval required. Igniter plugs (A and B) removal/installation and inspection carried out, found satisfactory. EGR carried out for leak check, found satisfactory.

On 01-08-2018, P&W informed operator regarding potential T2 sensing issue which started from 23.07.2018. On 25.07.2018, inspection of P2T2 carried out and found satisfactory. Cleaning of P2T2 probe carried out, observed dust particles same removed. EGR carried out and found satisfactory. P2T2 sensor panel screw damaged, same replaced. P&W has observed that there is no recovery in Delta T2 parameters after the above troubleshooting and recommended replacing the P2/T2 probe next first, and if no recovery is noted, the replacement of the EEC for fault isolation. On 01.08.2018, P2/T2 probe has been replaced. P&W observed recovery in parameters starting 04.08.2018.

On 08-08-2018, reduced borescope inspection at 300 FH – Carried out boroscope inspection of HPT blades (STAGE 1 & 2) aerofoils & duct segments. Erosion / burn found on L.E of HPT 1 blades of outer 50 % span and damage recorded. Both igniter plugs (A & B) inspected, igniter plug B found eroded (erosion value found = 8.71 MM) hence igniter plug B replaced. Post plug replacement ignition SYS B OPS check carried out, found satisfactory.

On 08-09-2018, reduced borescope inspection at 300 FH – Carried out boroscope inspection of HPT blades (STAGE 1 & 2) aerofoils & duct segments. Found damage on 6 HPT stage 1 blades in outer-50% maximum burn on L.E. As per AMM engine remains at 300 FH repeat inspection interval. Ignite plug B inspected, found satisfactory.

On 12-10-2018, reduced borescope inspection at 300 FH – Carried out boroscope inspection of HPT blades (STAGE 1 & 2) aerofoils & duct segments. Found erosion/burn on L/E of 6 blades & remains at 300 FH repeat inspection interval.

On 14-11-2018, reduced borescope inspection at 300 FH – Carried out boroscope inspection of HPT blades (STAGE 1 & 2) aerofoils & duct segments. Found erosion burn on L/E of 8 blades in outer 50%. As per AMM engine remains at 300 FH repeat inspection interval.

On 15-12-2018, reduced borescope inspection at 300 FH – Carried out boroscope inspection of HPT blades (STAGE 1 & 2) aerofoils & duct segments. Found erosion/burn on L/E of 8 blades. As per AMM engine remains at 300 FH repeat inspection interval.

On 01.01.2019, fuel metering unit (FMU) replaced due leak from base of electrical connector of FMU.

On 29-01-2019, reduced borescope inspection at 300 FH – Carried out boroscope inspection of HPT blades (STAGE 1 & 2) aerofoils & duct segments. Damage was observed (L.E hole) on qty - 11 HPT stage 1 blades with maximum dimensions & due to these findings, HPT stage 1 to remain under 300 FH repeat inspection.

Engine combustion chamber inspection reduced to 300 FH due edge burn back on OBL & IBL row 2,3,4.

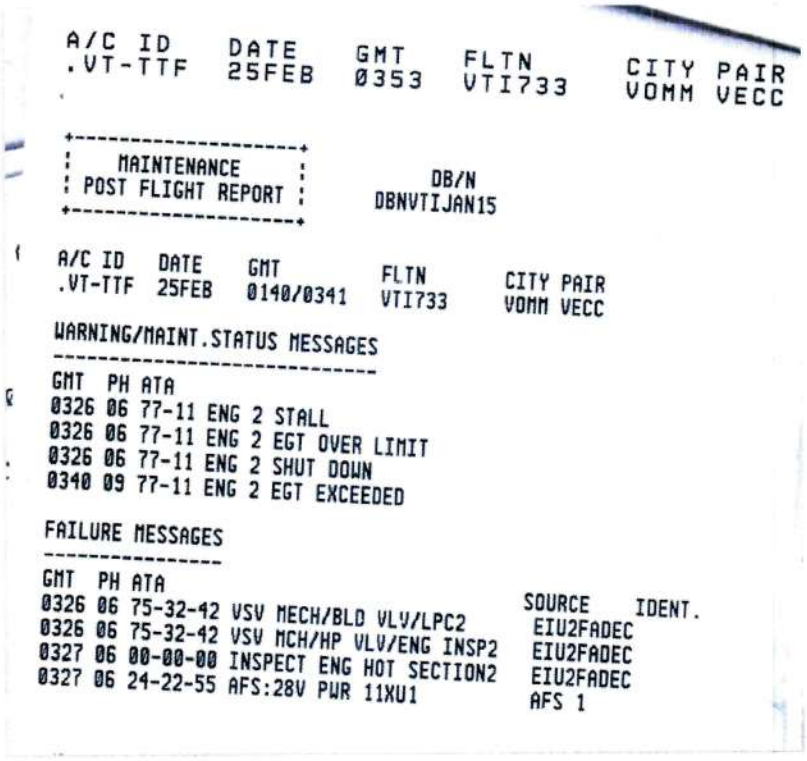
From the above maintenance history, there was no damage recorded on fan blade, LPC and HPC before this incident.

1.6.4. Engine #2 Health Monitoring: There were no significant adverse trend shifts observed on the steady state data processed in Advanced Diagnostics and Engine Monitoring (ADEM) by Pratt Whitney Engine Health Monitoring for the period of last six months i.e. August 2018 to February 2019.

1.6.5. Technical Log Book: The PIC recorded the following defect/event in technical logbook:-

During descent through FL160 & FL170, Engine #2 stall followed by Engine #2 EGT over limit, ECAM actions followed, Thrust Lever retracted, Engine #2 Master to OFF, declared 'PAN PAN'. After Engine #2 was shut, Engine #2 shut down ECAM triggered. Landed safely. EGT was continuously in RED despite bringing Thrust Lever to idle.

1.6.6. Post Flight Report (PFR): The following Warning/Maintenance Status Messages and Failure Messages were printed in PFR (Figure I).



```
A/C ID    DATE    GMT    FLTN      CITY PAIR
.VT-TTF   25FEB   0353   VTI733    VOMM VECC

+--------------------+
!   MAINTENANCE      !        DB/N
! POST FLIGHT REPORT !    DBNVTIJAN15
+--------------------+

A/C ID   DATE    GMT          FLTN      CITY PAIR
.VT-TTF  25FEB   0140/0341   VTI733    VOMM VECC

WARNING/MAINT.STATUS MESSAGES
-----------------------------
GMT  PH ATA
0326 06 77-11 ENG 2 STALL
0326 06 77-11 ENG 2 EGT OVER LIMIT
0326 06 77-11 ENG 2 SHUT DOWN
0340 09 77-11 ENG 2 EGT EXCEEDED

FAILURE MESSAGES
----------------
GMT  PH ATA
0326 06 75-32-42 VSV MECH/BLD VLV/LPC2      SOURCE    IDENT.
0326 06 75-32-42 VSV MCH/HP VLV/ENG INSP2   EIU2FADEC
0327 06 00-00-00 INSPECT ENG HOT SECTION2   EIU2FADEC
0327 06 24-22-55 AFS:28V PWR 11XU1          EIU2FADEC
                                            AFS 1
```

Fig. I. Printed Post Flight Report (PFR)

1.6.7. Action taken by AME:

Vide Work Order CC2200000934, carried out troubleshooting as per TSM task - EGT higher than limit on Engine #2 (Above idle).

Visual inspection of the EGT harness, junction box and EGT thermocouples were carried out, found satisfactory.

Functional test of the EGT harness, junction box and EGT thermocouples were carried out, found satisfactory.

Borescope Inspection of HPC was carried out and found damage outside of AMM Limits.

Borescope Inspection of inside of Combustion Chamber & HP Turbine Stage 1 Vanes was carried out, found attachment post 100% visible & partially attached on OBL Row-3.

Borescope inspection of HP Turbine blade aerofoils was carried out, found damage within AMM limits in stage 1 blades & stage 2 blades.

Checked Master Magnetic Chip Detector, found satisfactory.

Igniter Plugs inspection carried out, found satisfactory. Ignition Lead removal / installation carried out to facilitate BSI along with inspection.

Details of Borescope Inspection are given below:

AREA/PORT	PARTS INSPECTED	VIEW	QTY	REMARKS
A. HIGH PRESSURE COMPRESSOR				
A	STAGE -3	Leading Edge	31	Qty. 1 Blade broken near root and damages on rest of blades
B		Trailing Edge		Tear, Tip curl beyond AMM Limit
B	STAGE-4	Leading Edge	38	All blades damages beyond limit
C	STAGE-5	Trailing Edge	64	All blades damages beyond limit
C	STAGE-6	Leading Edge	79	All blades damages beyond limit
D	STAGE-7	Trailing Edge	93	All blades damages beyond limit
D	STAGE-8	Leading Edge	84	All blades damages beyond limit
E		Trailing Edge		
E	STAGE-9	Leading Edge	89	All blades damages beyond limit
F		Trailing Edge		
F	STAGE-10	Leading Edge	85	All blades damages beyond limit
G	STAGE-11	Trailing Edge	78	All blades damages beyond limit
G	STAGE-12	Leading Edge	71	All blades damages beyond limit
OBSERVATIONS / NOTES : • Due to STAGE 3 Blade broken & Ingestion inside HPC, All STAGES got damaged beyond Limit. • Type of Damages – Broken Blades, Tear & Burnt • No Bird Debris Found.				

AREA/PORT	PARTS INSPECTED	REMARKS
B. COMBUSTION CHAMBER		
B1 TO B6	COMBUSTION CHAMBER	Satisfactory
IP 1	COMBUSTION CHAMBER	Attachment Post 100 % Visible & Partially attached, OBL-3
IP 2	COMBUSTION CHAMBER	Attachment Post 100 % Visible & Partially attached, OBL-3
OBSERVATIONS / NOTES : • One Attachment Post 100 % Visible & Partially attached on OBL-3		

AREA/PORT	PARTS INSPECTED	VIEW	QTY	REMARKS
C. HIGH PRESSURE TURBINE				
IP1/IP2	STAGE -1	Leading Edge	64	Damages – Leading edge burn through hole with in AMM limit
T1/2L or T1/2R		Trailing Edge		Satisfactory
T1/2L or T1/2R	STAGE-2	Leading Edge	72	Satisfactory
T2/3L or T2/3R		Trailing Edge		Satisfactory
OBSERVATIONS / NOTES : • NIL				

As per the above observations/findings & AMM, Engine #2 - S/N V17533 was withdrawn from service.

1.6.8. Load and Trim sheet

Load and trim sheet of flight contain the following data:-

- Total Traffic Load: 12029
- Zero Fuel Weight: 55223 kg (Maximum 61000 kg)
- Fuel on Board: 9600 kg
- Take-off Weight: 64523 kg (Maximum 69450 kg)
- Trip Fuel: 4950 kg
- Landing Weight: 59573 kg (Maximum 64500 kg)

The maximum take of weight (MTOW) and Maximum Landing weight (MLW) are 73500 kg and 64500 kg respectively, the allowed weight for the flight for take-off was 69450 kg.

The actual take-off weight was 64523 kilogram and the actual landing weight was 59573 kilogram.

The take-off centre of gravity (CG) was 36.6% of the mean aerodynamic chord (MAC) and the pitch trim was -1.8 down and the MAC of zero fuel weight (ZFW) was 40.2% of the MAC. The CG of the aircraft was within limits.

1.6.9. Aircraft Station License

The License is issued by Ministry of Communications & I.T. – Department of Telecommunications, New Delhi.

- License No. : A-139/003- RLO(NR)
- Issued on: 09-02-2015
- Valid up to: 17-12-2020

1.7. Meteorological Information:

1.7.1. Indian Metrological Department- MET Report of Kolkata (VECC) on 25.02.2019 at 0300 UTC:

Wind 12003 KT, Visibility 2600 M, Weather FBL RA, Cloud 1: SCT 2000 feet (600 MTS), Cloud 2: FEW CB 3000 FT (900 MTS), Cloud 3: BKN 9000 FT (2700 MTS), Temperature 16 °C, Dew point 15 °C, Trend: NOSIG, Remarks: CB TO S/SE.

1.7.2. The incident occurred during day time.

1.8. Aids to Navigation

Kolkata airport is equipped with DVOR, CAT IIIB ILS, PAPI and high power DME. It has also secondary surveillance RADAR for providing route navigation services.
Navigational aids fitted in aircraft were ADF, ILS, VOR Receiver, DME Interrogator, ATC Transponder MODE S, Weather Radar, Radio Altimeter, GPS, TCAS and ELT.

1.9. Communications

All the communications between the pilot and the Air Traffic Services (Chennai ATC and Kolkata ATC) were normal as recorded by the aircraft Cockpit Voice Recorder (CVR). The qualities of the recorded transmissions were good.

1.10. Aerodrome Information

Netaji Subhash Chandra Bose International (NSCBI) Airport (VECC) is an international airport located in Kolkata, West Bengal. The elevation AMSL of airport is 7.2M (23 FT) and reference temperature is 36° C. The airport is licensed by DGCA for both IFR and VFR traffic. The airport reference code is 4E. The airport has two parallel runways made of Asphalt.

- 01L/19R, 2839 m × 45 m
- 01R/19L, 3,628 m × 45 m

The Airport Reference point is 223914.2N, 0882648.18E. Runway has marking for Designation, Threshold, Touchdown Zone, Centre line, runway edge and is lighted for Threshold, Edge, End, Touchdown Zone, and Centre line. The Airport Rescue and Fire Fighting Services is Category '9' (Nine).

1.11. Flight Recorders

The aircraft was equipped with Digital Flight Data Recorder (DFDR) and Cockpit Voice Recorder (CVR).

1.11.1. Cockpit Voice Recorder (CVR)

The significant observations from the CVR are as follows:

Time (UTC)	From	To	Details
03:05	ATC	Aircraft	Report for Descend
03:12	-	-	ATIS forecast- Aerodrome warning 0300-1500 thunderstorms with rain
03:22	ATC	Aircraft	Contact Radar 127.3
03:25	FO	PIC	This is not even there when we entered
03:25	ATC	Aircraft	Descent & maintain FL150 standby
03:25	PIC	ATC	We are maintaining 150 & turning right heading 020 to avoid sir
03:26	ATC	Aircraft	Roger that
03:26	FO	PIC	Ok heading 020
03:26	PIC	FO	Yeah, just avoid yellow part of it, really can't go. Avoid it we will have to go through
03:26	FO	PIC	Yeah, heading 020
03:26	Cockpit		Sound observed like increase in spool speed
03:26	Cockpit		Sound heard in cockpit like drop (thud)
03:26	FO	PIC	Master Caution
03:26	PIC	FO	Engine #2 stall
03:26	ATC	Aircraft	Reduce to minimum speed
03:26	PIC	ATC	Minimum speed
03:26	PIC	FO	ECAM actions
03:26	FO	PIC	Engine #2 EGT over limit, Thrust Lever to below limit
	PIC	FO	OK
	FO	PIC	If unsuccessful, Engine #2 Master OFF
03:26	PIC	FO	OK, EGT not successful. Engine #2 MASTER OFF. ECAM actions please
03:26	FO	PIC	Engine #2 EGT over limit, if unsuccessful Engine #2 Master OFF
03:26	PIC	FO	Engine #2 Master OFF
03:26	FO	PIC	Confirm Engine #2
03:26	ATC	Aircraft	Descend to FL140
03:26	FO	PIC	Engine #2 Master OFF
03:26	ATC	Aircraft	Descend to FL140
03:27	PIC	ATC	We are declaring PAN PAN, we have Engine no. #2 failure and request further descent

1.11.2. Digital Flight Data Recorder (DFDR)

The significant observations from the DFDR are as follows:

Time (hrs)	Altitude (feet)	Details
03:24:19	17332	During descent, Engine #1 & #2 Anti Ice was switched ON at 03:24:19 Hrs from altitude 17332 feet to 9796 feet at 03:30:47 HRS.
03:26:06	14996	While levelling to FL150, Engine #1 & #2 – N1 started increasing slowly from 65 to 78% (77% at 03:26:15 HRS); N2 increase from 82 to 87 % (87% at 03:26:15 HRS)
03:26:16	15000	After levelling aircraft at FL150, sudden drop in Eng #2 EPR from 1.213 to 0.884 psi
03:26:18	15000	Sudden drop in Eng #2 – N1 (78 to 50 %), N2 (83 to 79 %)
03:26:20 to 03:26:22	15000	Sudden drop in Engine #2 PS3 (214 to 21 PSIA) and FF (2253 to 220 KG/h), Master Caution of PIC and FO triggered and Engine #2 exhaust gas temperature (EGT) started increasing from 466 °C
03:26:38	15004	Engine #2 TLA brought to zero and Engine #2 EGT recorded 703 °C
03:26:55	14988	Engine #2 EGT recorded maximum 740 degree Celsius.
03:26:56	14988	Engine #2 Master put to OFF and Fuel flow closed, Master Caution of PIC and FO alert stopped
03:38:59	0	Aircraft Touchdown at Kolkata Airport.

1.12. Wreckage and Impact Information

There was no impact and there was no wreckage.

1.13. Medical and Pathological Information

There was no injury to any crew or passenger and no injury to any person on ground.

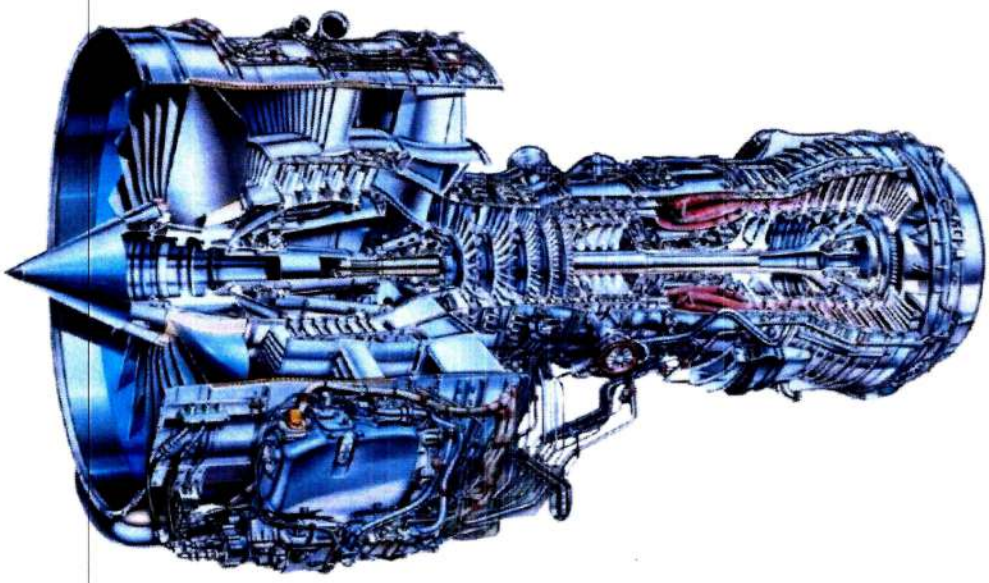
1.14. Fire

There was no fire.

1.15. Survival Aspects

The incident was survival.

1.16.Test and Research



IAE Engine V2527-A5

The involved engine V2527–A5 (S/N V17533) was sent to IAE by the operator for investigation. Further the engine was sent by IAE to Turbine Services & Solutions in Abu Dhabi, United Arab Emirates for disassembly. The findings and conclusion of IAE investigation report are detailed below:

1.16.1.Investigation findings during engine teardown

Shop reported the below concerning teardown findings:

Items looked at during engine teardown	Shop's response
Check LPC for any missing hardware/lock plates-bill of material object damage (BMOD)	No missing parts
Check to see if there are any missing Lock/Retaining Plates	No missing plates
Check for organic material via black light	No organic material found with black light
Check for any irregularities with the actuation hardware for VIGV or Stg 3	Nothing found
Check & confirm if there is any signs of damage forward of the HPC 3rd	Some damage on the LPC and 1 off fan blade displayed damage beyond engine manual limits

NOTE: When IAE inquired further about the damaged LPC fan blade IAE was informed that the hardware was at the vendor (Lufthansa Technic AG) and no longer available for further investigation. Also there is no evidence of bird strike being reported for this engine.

1.16.2. Details of Examination: The following hardware was analyzed:

Part Name	Part No.	Count
HPC Stg 3 Blade	6A8688	31
HPC Stg 3 Retaining Plate	6A1028 6A3597	7 2
HPC Variable Inlet Guide Vane (VIGV)	6B1269 6B1270	38 2
HPC VIGV Lever Arm	6B1287	17
HPC Stg 3 Variable Vane (VSV)	6B1271 6B1272 6B1273	27 2 3
HPC Stg 3 VSV Lever Arm	6B1288	1
HPC Stg 4 Variable Vane	6B1274 6B1275	45 5
HPC Stg 5 Variable Vane	6B1276 6B1277	28 30

HPC Stage 3 Blades

No repair markings were observed on the 3rd stage blade set; which is an indication that these are first run blades. Visual examination of the blades revealed widespread impact damage and one blade fractured above the root platform. Contact damage and deformation was observed on the mid-span shrouds (clappers) of the blade set. Three typical intact blades were imaged (Figure 1-5). When the other blades in the blade set were viewed at a similar span location as the fractured blade, no additional cracking was observed on the leading edges (L/Es).

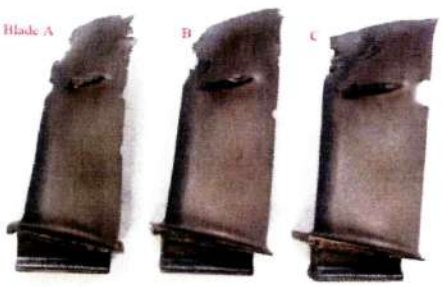


Fig. 1: Stage 3 blades, concave side

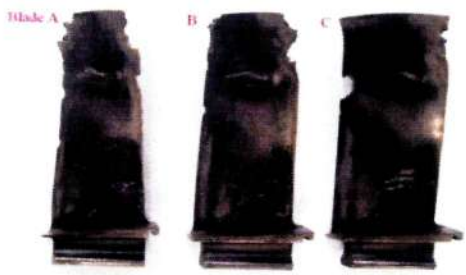


Fig. 2: Stage 3 blades condition

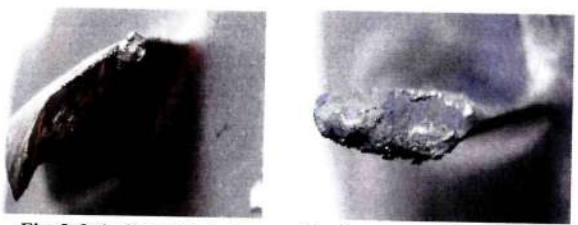


Fig. 3 & 4: Concave & convex side clapper surface of blade A clappers showing deformation and damage

Fig. 5: Inboard-looking of blade A

In regards to the fractured HPC 3rd stage blade specifically, secondary impact damage obscured the origin area. Rub damage smeared the fracture site on the blade where crack initiation began. No material or processing anomalies were observed at the fracture site. Examination of the fracture site beyond the early stages of fatigue revealed a mixture of striations and cleavage-like features, indicative of a high-amplitude HCF mode.

- The 3rd stage blade fracture occurred approximately 0.87 in. above root platform on the L/E of the airfoil and 0.44 in. above root platform on the T/E of the airfoil (Figure 6-8).

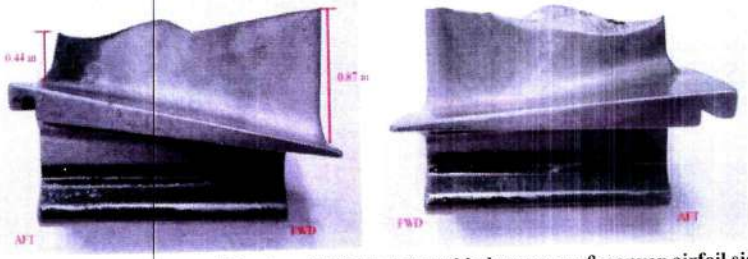


Fig. 6&7: Overall image of fractured HPC 3rd stage blade concave & convex airfoil side.

Fig. 8: Image of fractured HPC 3rd stage blade part markings

- Binocular examination revealed fatigue originating from the concave (CC) side L/E and extending towards the trailing edge (T/E) approximately 0.91 in. before transitioning to overstress (Figure 9-10).

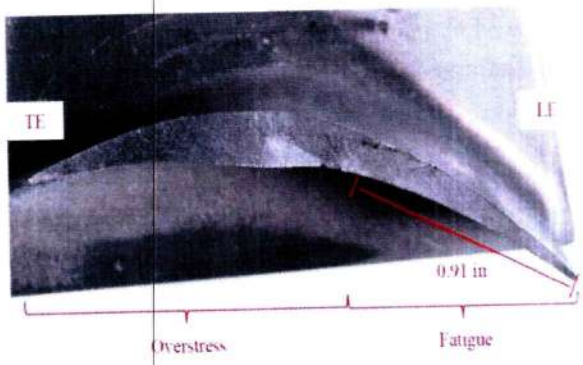


Fig. 9: Overall image of HPC 3rd blade fracture surface. Fatigue progressed from L/E towards the T/E

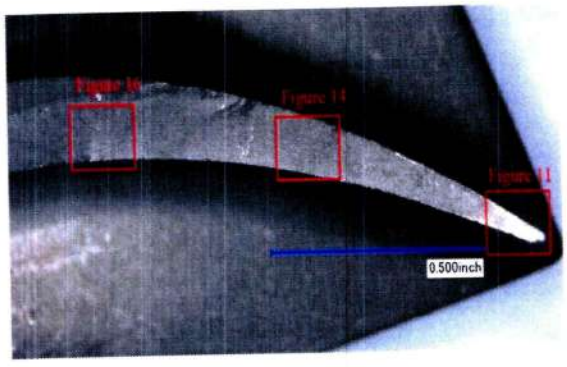


Fig. 10: Close-up image of fatigue

- Scanning electron microscope (SEM) examination of the fatigue progression revealed cleavage features indicative of high cycle fatigue (HCF) (Figure 10-16).

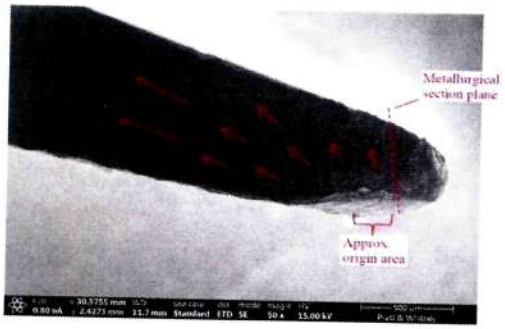


Fig. 11: SEM image of origin area, ~50x magnification Arrows denoting fracture progression direction and reference location of metallurgical section shown.

Fig. 12: SEM image of origin area, ~150x magnification. Large area of secondary impact damage smeared over approximate origin.

Fig. 13 SEM image adjacent to origin area, ~2500x magnification. Surface appeared rub-damaged

Fig. 14: SEM image of fracture progression, ~150x magnification

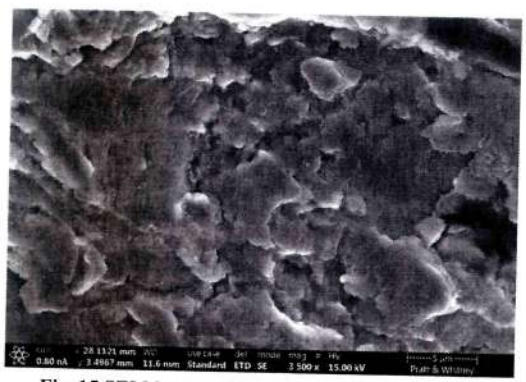


Fig. 15 SEM image of fracture progression, ~3500x magnification. Surface appeared to show a mixture of striations and cleavage-like features

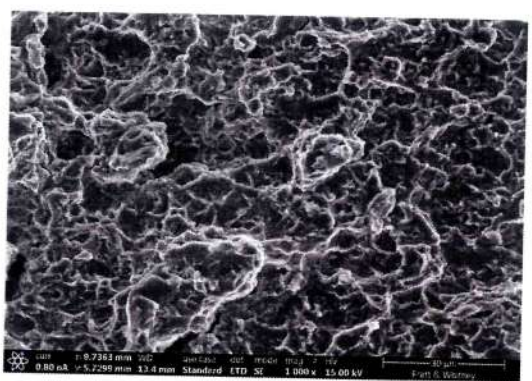


Fig. 16: SEM image of fracture transition to overstress, ~1000x magnification

- A radial metallographic section was prepared into the approximate origin area (Figure 17). Bulk microstructure and composition of the blade appeared consistent with manufacturing forging requirements hence no material or processing anomalies were observed on the fractured blade.

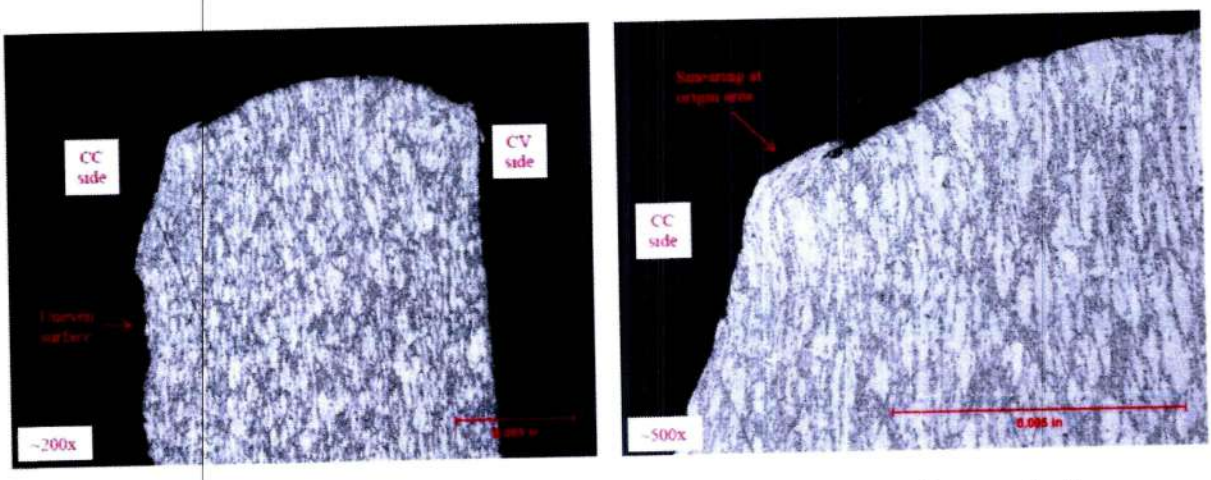


Fig. 17: Metallographs of the fractured blade radial L/E section at approximate origin area. Uneven erosion-like appearance of concave (CC) airfoil surface was exaggerated due to the section plane through the L/E radius

- The radial metallographic section was ground down past the origin/LE radius to examine erosion damage at the concave leading edge (Figure 18). The observed maximum depth of erosion damage was approx. 0.0011in.

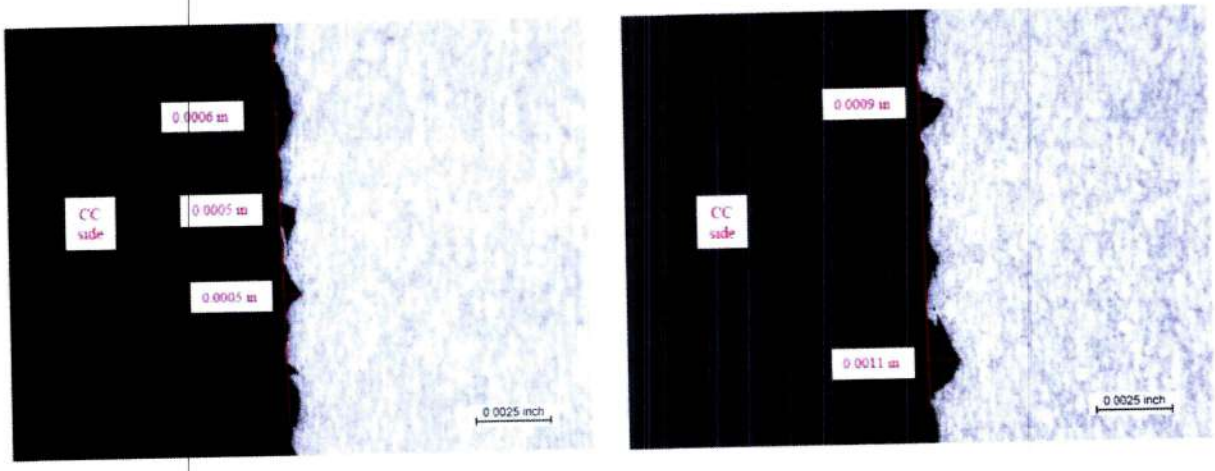


Fig. 18: Metallographs of the fractured blade radial L/E section at approximate origin area to show erosion on the concave (CC) airfoil surface. Typical surface condition (top) and maximum depth observed (bottom).

HPC Stage 3 Retaining plates

Visual examination of the stage 3 blade retaining plates revealed a polished surface and deformation likely due to removal. Polished surfaces indicated retaining plates may have been partially refurnished following removal. Retaining plate edges showed contact wear (Figure 19).

Fig. 19: Overall images of typical 3rd stage blade retaining plate forward side (top), aft side (middle), and retaining plate edge wear/deformation (bottom).

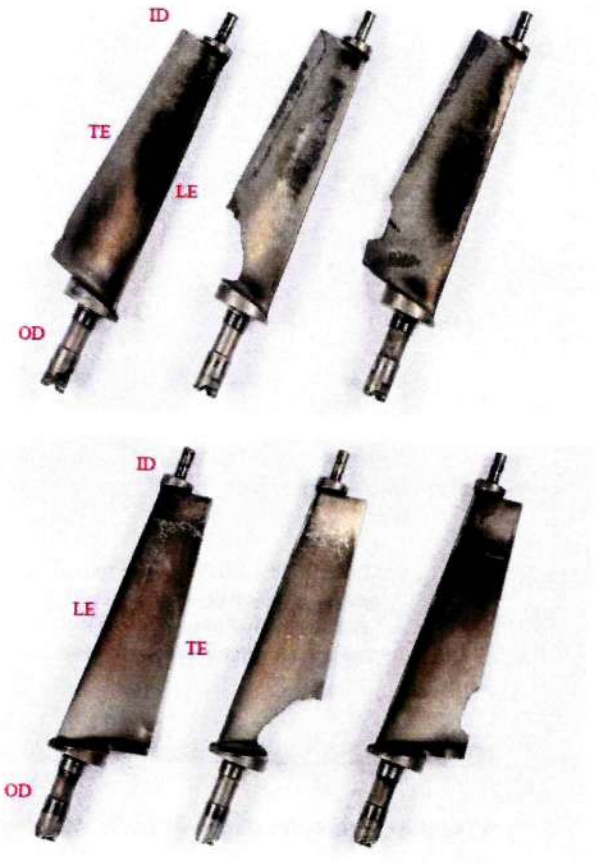


Fig. 20: HPC Variable Inlet Guide Vane overall images concave side (top) and convex side (bottom). No evidence of leading edge erosion was found.

HPC Variable Inlet Guide Vanes (VIGV)/VIGV Lever Arms

Visual examination of the HPC VIGV set revealed varying degrees of outboard T/E impact damage and cracking. VIGV cracking location and appearance was consistent with overstress fracture due to impact. There was no L/E erosion found (Figure 20).

VIGV lever arms showed significant torsional deformation as well as cracked lever arm balls (Figure 21).

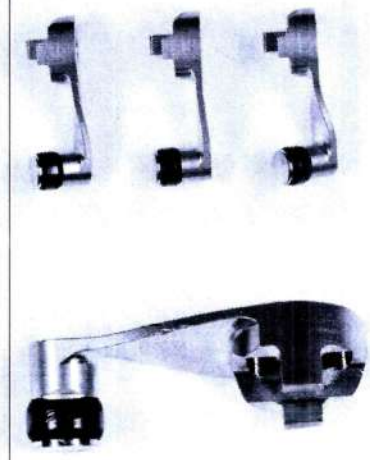


Fig. 21: HPC VIGV Lever Arm images of typical deformation (top) and a close-up image of lever arm ball cracking/deformation (bottom)

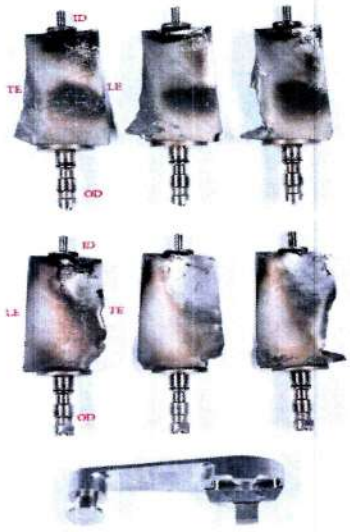


Fig. 22: HPC stage 3 Variable vane overall images concave side (top), convex side (middle), and lever arm (bottom). Heavy trailing edge damage and cracking from impact with liberated blade. Lever arm showed no discernable deformation.

HPC Stage 3-5 Variable Vanes

Visual examination of the 3rd – 5th stages of variable vanes revealed extensive secondary L/E and T/E impact damage. The singular 3rd stage variable vane lever arm did not appear to have damage or deformation, however, the lever arm ball was missing (figures 22-24).

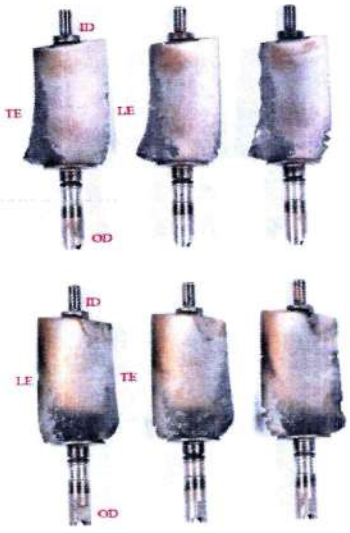


Fig. 23: HPC stage 4 Variable Vane overall images concave side (top) and convex side (bottom). Impact damage was observed on both the leading and trailing edges.

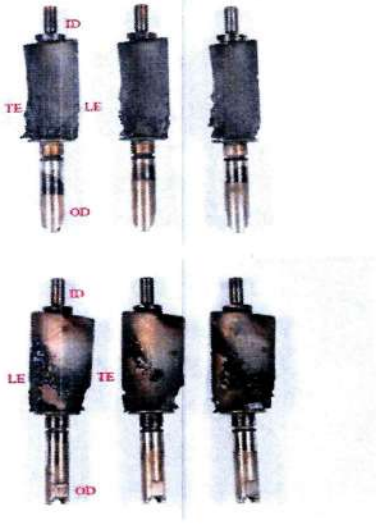


Fig. 24: HPC stage 5 Variable vane overall images concave side (top), convex side (middle), and lvere arm (bottom). Heat and impact damage observed.

1.16.3.IAE Conclusion:

High cycle fatigue (HCF) attributed to the above platform fracture of the HPC Stage 3 Blade. HCF is classified as occurring many times over a short timeframe of engine operation. Crack progression as a result of HCF can be linked to stresses exacerbated by vibratory loads experienced during engine operation.

The exact crack initiation site on the 3rd stage fractured blade could not be determined due to secondary damage to the origin area. Analysis of the blade revealed the crack progressed from the concave side of the leading edge (L/E) of the blade airfoil and extended up to approximately 0.91 in. towards the trailing edge (T/E).

The root cause of what promoted the blade to fracture in regards to this event is inconclusive. However service experience with this particular type of blade fracture has revealed some potential root causes.

Potential root causes for HPC 3rd stage blade fractures:

- Impact damage to the L/E.
- Misalignment of the 3rd stage blades leading to shingling of the clapper faces and exciting a vibratory mode.
- Off-schedule Variable Guide Vanes (VIGVs) leading to wake vibratory excitement of the 3rd stage blades.

The fractured site sustained secondary damage which obscured the origin area, hence impact damage due to foreign object damage (FOD) or domestic object damage (DOD) cannot be ruled out as a potential cause for blade fracture. Due to the blade set not being indexed, it could not be determined if misalignment/shingling occurred previous to the blade fracture. Also the severity of the damage caused by the event hindered the determination if the VIGVs were off schedule on the applicable engine. Off scheduled VIGVs could lead to a vibratory wake on the HPC 3rd stage and possibly cause fracture to the blades.

Since June 2005 there has been sixteen (16) reported above platform fractures on the HPC Stage 3 Blade. A majority of the fractures were attributed to bird strike, FOD or clapper misalignment/material release. At this time IAE does not recommend fleet action for this type of event.

1.16.4. IAE further informed on investigation :

The evidence provided in eagle net case CAS-114361-X4C6G3 suggests that Foreign Object (FO) was ingested. FO ingestion can lead to damage to the fan, LPC and HPC blades. Foreign object damage can be the reason of the fractured HPC stage 3 blade and damage to the fan and LPC stage 2.5 blade on ESN V17533.

During engine disassembly and inspection, no foreign object (FO) was reported that led to engine event. In the induction report, signs of FOD on fan blade were observed and one fan blade with

impact damage on leading edge was noted (Figure II & III). Impact damage was also observed on LPC 2.5 blades. Damage to fan and LPC blades suggests that object impacted fan blade then it was ingested in to engine flow path impacting LPC 2.5 blades and likely impacted HPC stage 3 blade. Fractured stage 3 blade tumbled in the engine resulting in secondary damage (Figure VI & VII). Portion of the blade that was intact with the root of the blade also has secondary damage limiting possibility of determining exact crack initiation site. Conclusive root cause of what promoted blade to fracture for this event cannot be determined. However, likely cause for stage 3 blade fracture based on what can be observed on fan and LPC blades is impact damage to the Leading edge due to FO ingestion.

Damage on the fan blade:

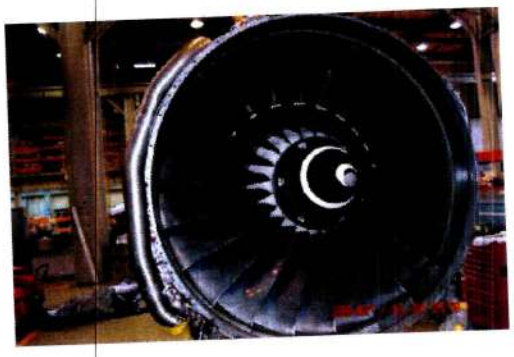


Fig. II: Fan blades before removal

Fig. III: Damaged fan blade (bend on leading edge)

Damage on LPC:

During BSI 2.5 Blades (QTY 04) were noted with dent/bend with deflection on Zone 'C', the worst measured approx. 0.019" depth (noted defect acceptable as per EM limit) (Figures IV & V)

Fig. IV: LPC Stage 2.5 blades with dent

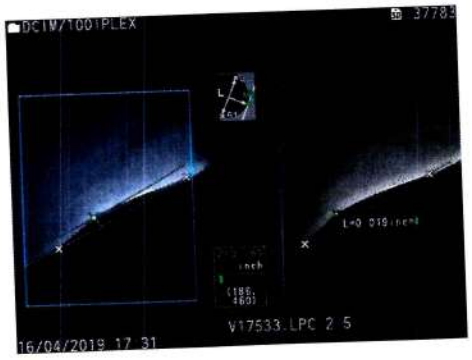


Fig. V: LPC Stage 2.5 blades with bend

Damage on HPC:

Fig. VI: HPC rotor blades with distortions

Fig. VII: HPC rotor blades with distortions/and quantity 01 blade broken off.

1.17. Organizational and Management Information:

Tata SIA Airlines Ltd. (Vistara) is a scheduled airline, holding AOC Number S-27 (Passenger & Cargo) and operating domestic and international flights with fleet Airbus A320, Airbus A321neo, Boeing 787-9 and Boeing 737-800NG aircraft. The Company is headed by CEO assisted by a leadership team of professional of various departments.

1.18. Additional Information

High Cycle Fatigue (HCF): High Cycle Fatigue occurs many times over a short period of engine operation. There may be hundreds or thousands of cycles for each flight depending on what is generating the cyclic stress. HCF cycles can be generated by either vibratory loads, or wakes created in the flow path from airfoils. There is usually steady stress imposed on top of the fatigue stress, with the part life related to both the cyclic and steady stress levels. One or more HCF cycles can occur, for example, at each revolution of a high pressure rotor, low pressure rotor, or an air pulsation generated as one or more compressor blades pass stationary vanes. Most common example of the HCF failure in the aircraft engine is airfoil failures.

1.19. Useful or Effective Investigation Techniques:

NIL

2. ANALYSIS

On 25.02.2019, M/s Tata SIA Airlines Ltd. (Vistara) A320-232 aircraft VT-TTF was operating a schedule passenger flight UK-733 from Chennai to Kolkata. The aircraft was under the command of Pilot in Command holding valid ATPL with First Officer holding valid CPL.

This was the first flight of the day. Pre-Flight inspection was carried out by the qualified AME and aircraft was released for flight. The actual take-off weight was 64523 kilogram and the actual landing weight was 59573 kilogram. The CG of the aircraft was within limits.

The aircraft took off from Chennai and flew uneventfully till descent to FL150. While levelling at FL150 and turning right heading 020, around 20-25 NM short of Kolkata, flight crew heard a loud bang noise, ECAM alert of Eng # 2 Stall and after that ECAM alert of Eng # 2 EGT Over limit were triggered. The Flight crew action for Eng #2 STALL & Eng #2 EGT OVER LIMIT was appropriate. Aircraft landed safely at Kolkata.

After the incident, borescope inspection on Engine #2 was performed by AME and observed that one of the HPC stage 3 blade was broken near root and damaged the rest of the blades of stage and got ingested inside HPC, blades of all stages of HPC were damaged beyond AMM limits. No bird debris found.

There was no maintenance history of any fan blade, LPC and HPC damage recoded on engine #2 before this incident. Engine health monitoring was analyzed by Pratt Whitney for the period of last six months and there were no significant adverse trend shifts observed.

The involved engine was sent to IAE by the operator for investigation. IAE investigation revealed that one of fan blade damaged beyond engine manual limits and no organic material found during black light inspection. During borescope inspection, LPC stage 2.5 blades (QTY 04) were noted with dent/bend with deflection on Zone C and same was within engine manual limit. Damage to fan and

LPC blades suggests that object impacted fan blade then it was ingested into engine flow path impacting LPC stage 2.5 blades and likely impacted HPC stage 3 blade, which further caused High Cycle Fatigue attributed HPC stage 3 blade to fracture. The fractured stage 3 blade tumbled in the engine resulting in secondary damage. Portion of the blade that was intact with the root of the HPC stage 3 blade also has secondary damage limiting possibility of determining exact crack initiation site, hence conclusive root cause of what promoted HPC stage 3 blade to fracture for this event could not be determined. However likely cause for HPC stage 3 blade damage is Foreign Object and further High Cycle Fatigue attributed HPC stage 3 blade fracture.

Since June 2005 there has been sixteen (16) reported above platform fractures on the HPC Stage 3 Blade. The majority of the fractures on the HPC Stage 3 Blade were attributed to bird strike, FOD or clapper misalignment/material release. At this time IAE does not recommend fleet action for this type of event.

3. CONCLUSIONS

3.1. Findings

3.1.1. The flight crew were duly qualified to operate the flight.

3.1.2. The aircraft had valid C of A with valid ARC.

3.1.3. Pre-Flight inspection was carried out by the qualified AME and aircraft was released for flight.

3.1.4. There was no snag prior to the incident flight.

3.1.5. The CG of the aircraft was within limits.

3.1.6. Flight crew action for Eng #2 STALL & Eng #2 EGT OVER LIMIT was appropriate.

3.1.7. One of the HPC stage 3 blade was found broken near root and damaged the rest of the blades of stage and got ingested inside HPC, blades of all stages of HPC were damaged beyond AMM limits. No bird debris found.

3.1.8. There was no maintenance history of any fan blade or LPC damage on Engine #2 before this incident.

3.1.9. No significant adverse trend shifts were found from Engine health monitoring.

3.1.10. One of fan blade was damaged beyond engine manual limits and no organic material found during black light inspection. LPC stage 2.5 blades (QTY 04) were noted with dent/bend with deflection on Zone C during borescope inspection and same was within engine manual limit.

3.1.11. Foreign object impacted fan blade, LPC stage 2.5 blades and likely impacted HPC stage 3 blade, which further caused High Cycle Fatigue attributed HPC stage 3 blade to fracture.

3.1.12. The fractured HPC stage 3 blade tumbled in the engine resulting in secondary damage, portion of the HPC stage 3 blade that was intact with the root of the blade also has secondary damage limiting possibility of determining exact crack initiation site.

3.1.13. Conclusive root cause of what promoted HPC stage 3 blade to fracture for this event could not be determined.

3.1.14. Likely cause for HPC stage 3 blade damage is Foreign Object and further High Cycle Fatigue attributed HPC stage 3 blade fracture and subsequent damage downstream the engine.

3.1.15. Since June 2005 there has been sixteen (16) reported above platform fractures on the HPC Stage 3 Blade. The majority of the fractures on the HPC Stage 3 Blade were attributed to bird strike, FOD or clapper misalignment/material release. At this time IAE does not recommend fleet action for this type of event.

3.2. Probable Cause of the Incident

The conclusive root cause of what promoted blade to fracture for this event could not be determined, however the probable cause of incident is foreign object damage on 3rd stage HPC blade and further High Cycle Fatigue attributed it to fracture and subsequent damage down stream the engine.

4. SAFETY RECOMMENDATIONS

In light of para 3.1, there is no safety recommendation.

27/05/2022

(K.L. MEENA)
Dy. Director Air Safety
Investigator In-Charge, VT-TTF

Date: 27.05.2022
Place: New Delhi