FINAL INVESTIGATION REPORT ON UN-COMMANDED IN-FLIGHT SHUT DOWN OF ENGINE #1 OF BOEING B787-8 AIRCRAFT VT-ANW AT MUMBAI ON 04.08.2023

GOVERNMENT OF INDIA
O/o, DIRECTOR AIR SAFETY, WESTERN REGION,
NEW INTEGRATED OPERATIONAL OFFICE COMPLEX,
SAHAR ROAD, VILE PARLE (EAST), MUMBAI

OBJECTIVE

This investigation is performed in accordance with The Aircraft (Investigation of Accidents and Incidents) Rules 2017 of India.

The sole objective of this investigation is to prevent aircraft accidents and incidents. It is not the purpose of this investigation to apportion blame or liability.

FOREWORD

This document has been prepared based on the evidence collected during the investigation, opinions 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 accidents or incidents could lead to erroneous interpretations.

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FINAL INVESTIGATION REPORT ON THE INCIDENT TO M/s AIR INDIA, BOEING B787-8 AIRCRAFT VT-ANW ON 04.08.2023 AT MUMBAI

1.	**Aircraft Type**	Boeing B787-8
2.	**Nationality**	Indian
3.	**Registration**	VT-ANW
4.	**Owner**	M/s Air India
5.	**Operator**	M/s Air India
6.	**Pilot In-Command**	Airline Transport Pilot's License Holder
7.	**Co-pilot**	Airline Transport Pilot's License Holder
8.	**Extent of Injuries**	NIL
9.	**Date and Time of Incident**	04.08.2023, 14:47 hrs
10.	**Place of Incident**	Mumbai, India
11.	**The geographical location of the site of Occurrence**	19° 05' 29" N; 072° 51' 57" E
12.	**Last point of Departure**	Chatrapathi Shivaji Maharaj International Airport, Mumbai
13.	**Intended Place of Landing**	Heathrow Airport, London
14.	**No. of Persons On-Board**	267
15.	**Type of Operation**	Scheduled Commercial Operation
16.	**Phase of Operation**	Initial Climb
17.	**Type of Incident**	Un-commanded In-Flight Engine Shut Down

All Timings in the report are in IST

SYNOPSIS:

On 04th August 2023, M/s Air India Ltd Boeing B787-8 aircraft VT-ANW was involved in air turn back incident due to In-Flight Shutdown of Engine# 1 during climb while operating flight AI-131, Chatrapathi Shivaji Maharaj International Airport, Mumbai to Heathrow Airport, London.

Aircraft was released without any MEL on any of the Engine systems to operate flight AI-131. Both engines were started normally and the taxi was also normal. The aircraft got airborne at 1437hrs IST. While climbing passing FL170 at 14:46hrs, the crew heard a loud thud noise which was followed by EICAS caution ENGINE SURGE L.

As part of memory actions the corresponding thrust lever was retarded and it was observed that the ENGINE SURGE message had disappeared. As per the QRH abnormal and emergency procedures, when the advancement of throttle lever of Eng# 1 was initiated ENG FAIL L was shown on EICAS which was followed by engine flameout.

PIC declared PAN-PAN, decided not to jettison fuel and carried out an overweight landing with single engine uneventfully. No human injury was reported in the incident. The incident was investigated as per the order of Director General of Civil Aviation and it was found that one of the HPC stage 10 blade got liberated due to improper installation of locking lugs which led to Engine Surge and subsequent un-commanded shut down in-flight.

1. FACTUAL INFORMATION

1.1 History of Flight

M/s Air India Ltd Boeing B787-8 aircraft VT-ANW, was scheduled to operate flight no. AI-131 from Chatrapathi Shivaji Maharaj International Airport, Mumbai to Heathrow Airport, London on 04th August 2023 with 256 passengers and 02 cockpit crew and 09 cabin crew. The aircraft was under the command of PIC (ATPL holder). PIC was the pilot flying and First Officer was the pilot monitoring. It was the first flight of the day for PIC and Co-pilot. AME released the aircraft for departure of the flight AI-131 with no relevant MEL on any of the Engine systems.

PIC reported for flight duty at 1230hrs IST for flight and completed pre-flight external checks wherein no abnormality was observed. PIC accepted the aircraft. Both the engines were started normally. No abnormalities were observed during taxi and engine parameters were observed normal during taxi and take-off. The aircraft got airborne at 1437hrs IST. During the climb phase, passing FL170 at 14:46hrs, the crew heard a loud thud noise, followed by an EICAS caution ENGINE SURGE L. PIC then declared PAN-PAN to the ATC

As part of the memory actions, the corresponding thrust lever was retarded by the crew and it was observed that the ENGINE SURGE message had disappeared. In the process of execution of QRH abnormal and emergency procedures, when the advancement of throttle lever of ENG #1 was initiated by the crew, ENG FAIL L was shown on the EICAS display followed by engine flameout. The execution of the checklist was put on hold and it was noticed by the crew the Auto-relight function on the affected engine was automatically initiated.

Crew carried out a FOR-DEC discussion and then decided to return to Mumbai. Further the crew discussed company circular and guidelines for conducting an overweight landing and decided not to jettison fuel post which the crew completed the execution of ENGINE SURGE and ENGINE FAIL checklists which were partially carried out earlier. Subsequently, the crew carried out an overweight landing and the aircraft landed safely. No human injury was reported in the incident.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	0	0	0
Minor	0	0	0
None	11	256	-

1.3 Damage to Aircraft

Upon arrival in Mumbai, VT-ANW was inspected by the AME, who determined that the damage was confined solely to the affected engine, with no other damages caused to any other part of the aircraft's structure during the incident.

During the exterior inspection of the affected engine, debris / fine particles were found in the LH engine exhaust. The LH engine was replaced and the affected engine was subjected to Borescope inspection at the operator’s facility and the following observations were made.

- N1 and N2 rotor were found free to rotate and there was no noise during manual rotation

- Qty (1) HPC Stage 10 blades found liberated and missing between loading and locking slot, causing damage to all the blades. Both the locking and loading slot grub screws were found to be in place.
- All HPC Stage 9 blades were found with severe damage of missing material, bent, tear, dent and cracks on T/E.
- All HPT Stage 1 blades noticed with missing TBC, damage on L/E and convex area along with dents and missing material in L/E tip area.
- Quantity (1) HPC stage 10 blade found liberated and missing from the loading slot, causing damage to all blades, beyond AMM Limits.
- TBC material powder/ Metal powder was found on LPT stage 4,5 & 6 Blades, Tip shorted area/ concave side (Powder was found in loose condition).

Below are the images indicating the missing blade and other damages.


10/8/2023 10:11 AM


10/8/2023 10:17 AM

1.4 Other Damage

Nil

1.5 Personnel Information

Details	**PIC**	**FO**
Age / Sex	47/Male	34/ Male
License	ATPL	ATPL
Date of Issue	28.04.2007	12.08.2014
Valid up to	15.07.2025	28.09.2026
Category	Aeroplanes	Aeroplanes
Date of Class I Medical Exam	16.11.2022	20/05/2023
Class I Medical Valid up to	15.11.2023	19/05/2024
Date of Issue of FRTO License	14.07.2000	26/11/2018
FRTO License Valid up to	13.04.2055	25/11/2023
Total Flying Experience	11458:28 hrs	7135:00 hrs
Total Flying Experience as PIC	7697:28 hrs	704:16 hrs
Total Flying Experience on Type	4305:03 hrs	4306:35 hrs
Total Flying Experience as PIC on Type	3854:13 hrs	603:26 hrs
Total Flying Experience in last 1year	621:17 hrs	627:05 hrs
Total Flying Experience in last 6 months	304:02 hrs	305:34 hrs
Total Flying Experience in last 30 days	56:43 hrs	55:22 hrs
Total Flying Experience in last 7 days	08:33 hrs	18:29 hrs
Total Flying Experience in last 24 hours	00:00 hrs	00:00 hrs
Duty Time last 24 hours	00:00 hrs	00:00 hrs
Rest before the incident flight	54:31hrs	93 hrs

Ratings	PIC: B787, B737-800, Cessna 152A, King Air C-90A, TB-20 Co-pilot: A310-300, B777-200	PIC B787, BE 90/99/100/120, TB20 P2 B737 300-900
Pilot Proficiency Check (PPC) done on	19.05.2023	06/06/2023
PPC due on	18.11.2023	05/12/2023
IR Test done on	19.05.2023	26/12/2022
IR Test valid till	18.05.2024	25/12/2023
Line Check done on	07.01.2023	08/06/2023
Line Check valid till	06.01.2024	07/06/2024

All the training and credentials of both the crew were found to be valid and as per the requirements of CAR. Both the crew members were subjected to Pre-Flight Medical Examination and they were found negative.

PIC and First Officer had adequate rest before they operated the incident flight. Upon scrutiny of the records, PIC and First Officer were found to be within limits of FDTL. Performance of PIC and First Officer was found satisfactory during IR/PPC checks carried out in last one year. No adverse remarks were found to be recorded in their respective assessment forms. They did not have any past incident history with the operator.

1.6 Aircraft Information

1.6.1 General Information

The details provided below are as of before the incident flight.

Aircraft Registration	VT-ANW	
Type of Aircraft	Boeing B787-8	
Aircraft Serial No.	36294	
Manufacturing year	2016	
Owner	M/s Air India Limited	
Operator	M/s Air India Limited	
Certificate of Airworthiness number and issue date	6820 15.11.2016	
ARC number and Validity	ANW/6820/ARC 3RD/AIWB/2022017 14.11.2023	
A/c TSN	24175 hrs	
Maximum All Up Weight authorized	227930 kgs	
Minimum crew necessary	02	
Engine Type	GEnx-1B	LH # 956-126
Engine Sl no.		RH # 956-876
Aircraft All up Weight	201340 kgs	
Fuel On-board before Flight	49717 kgs	
Max Landing Weight	172365	
Incident sector Landing Weight	197000 (approx.)	

Engine History

Engine Serial number	956-126
TSN/CSN(As on 04 AUG 23)	31070/6143(Approximate)
Date of installation	10 MAY 2023
TSLV/CSLV	1117/179
Reason for last shop visit	HPT stage 1 blade distress Repair.
Work done on LH engine since installation.	During engine installation, traces of oil leak noticed, BSI of HPC stage 1, 2 & 3 blades carried out and found satisfactory. NIL fresh oil traces were found. (Callout No: 23S0355/ANW dated 16 MAY 23)

The affected engine of the aircraft was upgraded to PIP2 configuration in 2015 and the HPC rotor was rebuilt with 6th to 10th stage locking lugs installed as per SB 72-0157 and 72-0130. Further to the above the HPC stage 10 blades were replaced with EM72-00-00 special procedure 014 in 2018 at M/s GE Evergreen Engine Services (”GEEVES”), Taiwan, and the HPC has accumulated 2287 cycles till the day of the event. The most recent shop visit in October 2022 was for repair of HPT Stage 1 distress and there was no work scope on HPC Stage 10 blades after 2018.

There was no snag or defect on the LH engine in the previous 5 sectors of operation and prior to departure of the aircraft there was no MEL invoked for any of the LH engine systems.

The aircraft made an overweight landing at Mumbai, however there was no hard landing and the overweight landing inspection revealed no damages or abnormalities. During physical inspection debris/fine particles were found on the exhaust and the following maintenance messages were observed in the central maintenance computer.

a) At 1446 hrs a Flight Deck Effect ENGINE THRUST L was found generated with maintenance message MM 73-33941 (Left engine thrust is lower than commanded)
b) At 1447 hrs a Flight Deck Effect ENGINE SURGE L was found generated with maintenance message MM 73-32871 (Left engine assembly had continuous or multiple stalls)
c) At 1448 hrs a Flight Deck Effect ENGINE FAIL L was found generated with maintenance message MM 73-32901 (Left engine assembly speed is below idle with fuel switch on)

Based on the above the engine was replaced with a serviceable engine bearing serial number 956-265. The removed engine was transported to OEM facility for investigation and repair. In view of the maintenance message 73-32901, Engine fuel control relay and Engine fuel time - delay relay were replaced as a precautionary measure. The removed relays were sent for investigation and on testing of the same they were found to be performing satisfactorily.

1.7 Meteorological Information

The weather was conducive for flying operations.

1.8 Aids to Navigation

Aircraft is equipped with navigation aids such as ADF, ILS, GPS, VOR, DME, ATC Transponder Mode S and Weather Radar, Radio Altimeter, TCAS & ELT. All navigational aids were reported to be available. Runway 27 at Mumbai Airport is equipped with Cat IIIB ILS (Localizer and Glide path) & Approach Lighting System. Other navigation aids installed at Mumbai Airport include NDB, DVOR and DME with Precision and Non-Precision approach procedures. It has also a secondary surveillance RADAR for providing route navigation services. There were no known navigation aid difficulties reported by the crew.

1.9 Communication

Aircraft is equipped with Very High Frequency transmitter & receiver set, High Frequency transmitter & receiver set and Satellite transmitter & receiver set. There was always two-way communication established between the ATC and aircraft. The crew promptly declared PAN-PAN through radio telephony while dealing with the In Flight Shut Down situation.

1.10 Aerodrome Information

Chhatrapati Shivaji Maharaj International Airport is a licensed international airport for both IFR and VFR traffic with IATA location identifier as BOM and location indicator code as VABB. CSMIA is operated, managed and developed by Mumbai International Airport Limited. The Airports Authority of India manages the Air Traffic. The Airport is equipped with Advanced Surface Movement Guidance and Control System. The elevation of the airport is 40ft and it has two cross runways made of asphalt with orientation 09/27 and 14/ 32.

1.11 Flight Recorders

The aircraft is fitted with two Enhanced Airborne Flight Recorder units. After the incident, the CVR and the DFDR data were milked by the engineering department of the organization.

1.11.1 CVR Transcript

The CVR was downloaded after the incident and recording of the complete incident flight was available. The details of the readout are as follows.

- The crew performed all briefings, pre-flight checklist and takeoff checklist and takeoff and initial climb was satisfactory.
- At elapsed time 01:02:33, while aircraft climbing, "ENG THRUST L" followed by "ENG SURGE L" EICAS messages illuminated along with

annunciation. PAN-PAN call was made to ATC and requested to maintain FL170 followed by memory actions for left engine surge.

- In about a minute, the crew completed readout and execution of the Engine Thrust Left checklist and started to execute the Engine Surge Left checklist.
- However at 01:04:34, as the power lever of the left engine was being advanced from Idle Engine Fail Left message appeared on EICAS. Crew decide to hold the Engine Surge checklist and notice that the Auto-relight had started.
- At 01:05:52, ATC called the crew and asked them to confirm if the issue was on left engine. Crew requested ATC to standby and later requested to descend to FL 160. The same was cleared by the ATC.
- The crew then started to discuss a FOR-DEC and then decided to return back to Mumbai Airport which they informed to ATC and over a period of 3 minutes, the crew decide to return back to Mumbai.
- At 01:10:00, the crew started to read the company circular and guidelines for conducting an Overweight Landing and decide to jettison fuel or not. The crew then call the cabin crew and brief them about the situation and informs them about returning to Mumbai.
- At elapsed time 01:11:31, the crew finished discussion on the overweight landing circular and decided to do an overweight landing without any fuel jettison.
- At 01:17:15, the crew checked braking performance calculations for overweight landing for the available runway at Mumbai and also start completing the ENGINE SURGE and ENGINE FAIL checklists which were left midway due FOR-DEC and other decisions.
- At elapsed time 01:20:08, while executing the ENGINE FAIL checklist the crew identified that automatic re-lights were unsuccessful and then the Left Fuel Control Switch is put to CUT-OFF.

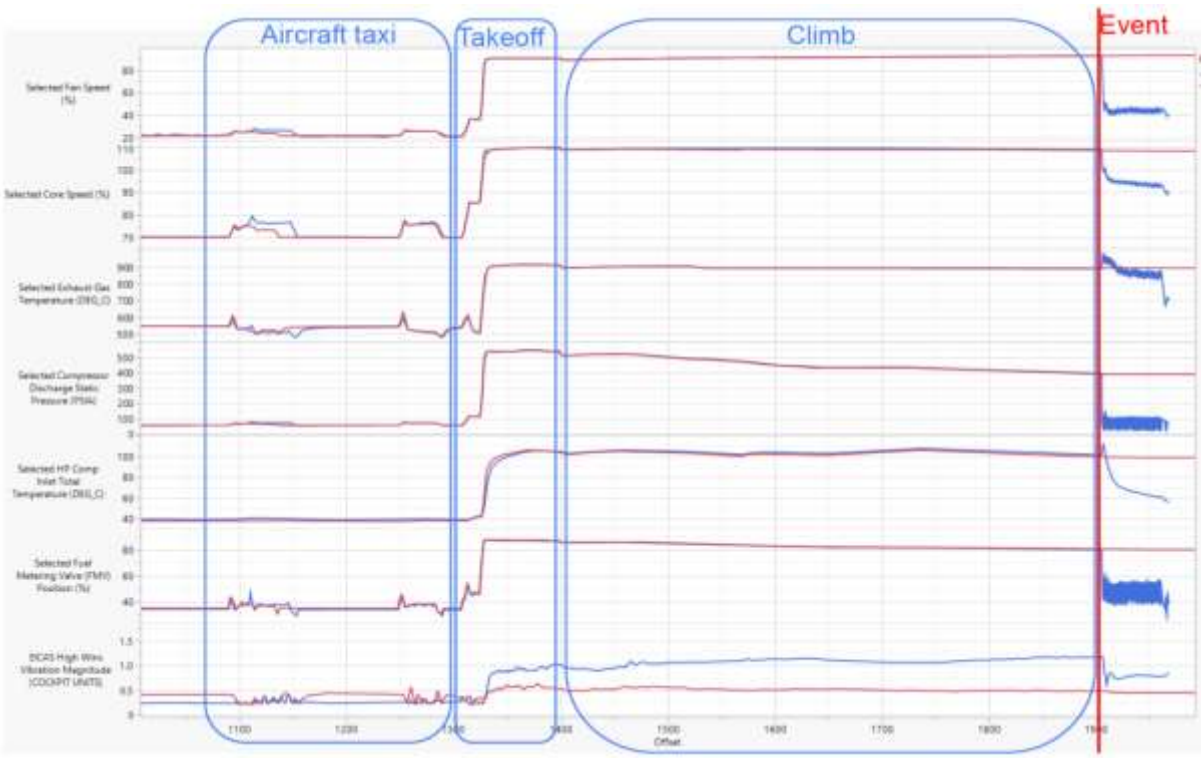
- At elapsed time 01:21:05, the crew discussed and decided to attempt re-light once again and at 01:24:27 after unsuccessful restart attempt, the crew set the put the fuel control switch to Cut-off position and started the APU.
- At 01:32:16, approach briefing was completed and Passenger announcement was made by the PIC. And further continued approach and requested last available exit-November taxiway.
- Further approach and landing was uneventful and the aircraft touchdown at 01:45:19 and vacated RWY 27 at taxiway November. Crew carried out the checklist and call outs as required.

1.11.2 DFDR Readout

Event (Time)	Parameters	Values
Take Off & Initial Climb DFDR (09:07:08 to 09:08:02)	Altitude	0 to 550 fts
	Auto Throttle	Active
	Gross Take-off Weight	202 tons
	Fuel flow	13687 lbs/hr
	Throttle Angle	33.81 to 71.2 degrees
	Engine Fuel Control switch	RUN mode
EICAS Msg: Eng#01 'Eng. Thrust L' & 'Eng. Surge L' DFDR (09:16:44 to 09:17:51)	Altitude	16736 fts
	Auto Throttle	Active
	Eng#01 N1	93% reduced to 41 %
	EGT (Max at this event)	957 degrees to 570 degrees
	Fuel flow	12169 reduced to 1208 lbs/hr
	Throttle Angle	68.87 reduced to 33.92 degrees
	Engine Fuel Control switch	RUN mode
	Altitude	16906 fts

EICAS Msg: Eng#01 Engine Fail DFDR (09:18:21)	Auto Throttle	Active
	N1	41% reduced to 33.9 %
	Fuel flow	1208 reduced to 655 lbs/hr
	EGT	832.65 degrees
	Throttle Angle	34.05 degrees
	Engine Fuel Control switch	RUN mode
EICAS Msg: Eng#01 Engine cut -off DFDR (09:35:01)	Altitude	14080 fts
	Auto Throttle	Active
	Engine Fuel Control switch	RUN mode to CUT-OFF mode
	EGT	514 degrees
	N1	19.30%
	Throttle Angle	34.02 degrees
Eng#01 Manual Restart Attempt DFDR (09:35:31)	Altitude	13403 fts
	Auto Throttle	Active
	Fuel flow	478 lbs/hr
	EGT	193.14 degrees
	Throttle Angle	34.04 degrees
	N1	18.40%
	Engine Fuel Control switch	CUT-OFF mode to RUN mode and again to CUT-OFF mode
Eng#01 Approach phase DFDR (09:58:16 to 09:60:18)	Altitude	1000fts to 0ft
	Auto Throttle	Active
	Fuel flow	0 lbs/hr
	Rate of descent	855 to 720 fts/min
	Vref landing	160kts
	Engine Fuel Control switch	CUT-OFF mode
	Throttle Angle	33.85 degrees
	Gross weight of a/c during Landing	197 tons

As provided by the OEM, the FDR Data comparison of both the engines indicate that both the engines were operating normal until the In-Flight Shut Down event occurred



1.12 Wreckage and impact information

Nil

1.13 Medical and pathological information

There was no post-flight breath analyzer medical examination conducted on the crew after the incident. Both the crew had undergone a Pre-flight medical examination before operating the incident flight and tested negative for consumption of alcohol.

1.14 Fire

There was no fire before or after the incident.

1.15 Survival Aspects

No human injuries were reported in the incident.

1.16 Tests and research

The affected engine S/no 956126 was removed from VT-ANW after the incident and sent to OEM facility for investigation and necessary repair purposes. OEM had concluded that the engine had experienced a surge followed by un-commanded In-Flight Shut down event. There were no abnormal trends with regards to EGT's, hot day margins, Fuel flows and Core speeds. The release of the HPC Stage 10 blade was the cause of the un-commanded In-Flight Shut down and EEC auto-restart attempts were unsuccessful due to distress from HPC Stage 10 blade release.

The root cause investigation for the release of HPC Stage 10 blade was conducted by the OEM and the disassembly investigation revealed that the LH locking lug was installed out of the lock slot and the RH locking lug was installed partially inside the lock slot and the improper installation of lugs caused the release of the blade.

Above are the pictures of the LH locking lugs which have experienced severe damage on upper lug shoulder indicating lug installed out of lock slot and not proper.

Above are the pictures of the RH locking lugs which have experienced abnormal wear on one side of the shoulder and pressure face indicating that the installation was partially inside the lock slot and not proper.

1.17 Organizational and Management Information

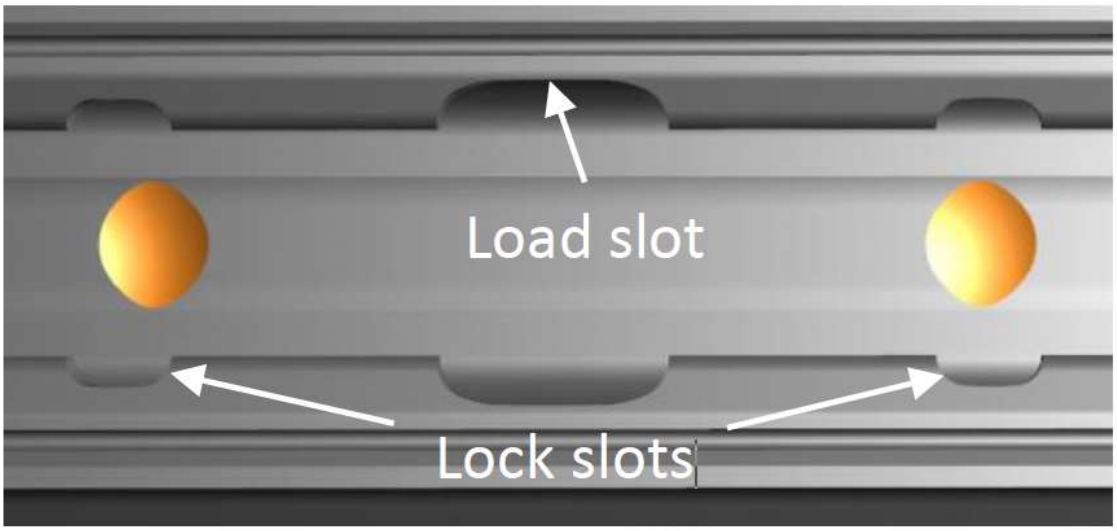
Air India is a scheduled airline owned by Tata Group. Air India operates its flights on domestic and international sectors. Air India operates its flights on domestic and international destinations with a fleet of Boeing 777, Boeing 787, Airbus 319, Airbus 320 and Airbus 321 aircraft. M/s Air India Limited is

headquartered at New Delhi. Air India is the largest international carrier of India. Over 40 international destinations are served by Air India spanning cities in Europe, USA, UK, Africa, the Gulf, Asia and Australia.

1.18 Additional Information

1.18.1 HPC Blade design / Assembly Overview

There are two locking lugs for each stage and these locking lugs secure the blades in a circumferential fashion to prevent blade release from the load slot.



During installation a set screw placed on top of lug is torqued, raising the locking lug into the locking slot in the spool.

Improper installation

Proper installation

1.19 Useful or Effective Investigation Techniques

Nil

2. ANALYSIS

2.1 Operational Aspects

Both the flight crew members (ATPL holders) were medically fit, had valid license, provided adequate rest, and found to be within FDTL limits before they operated flight AI-131(Mumbai-London) on 04.08.2023. Medical fitness and FDTL of the crew was not a factor to the incident.

It was the first flight for both the flight crew. Appropriate briefing was carried out by cockpit crew while preparing the aircraft for sector AI-639. During climb at around 16736fts, 1446 hrs, EICAS message 'Engine Thrust L' followed by 'Engine Surge L' came on. The crew made a PAN-PAN call to ATC, requesting to maintain FL170 and levelled off immediately. Memory actions for 'Engine Surge L' were performed. Meanwhile, at 1448 hrs, an EICAS message for 'Engine Fail L' appeared, indicating engine flameout. The above mentioned immediate actions of the crew were found to be satisfactory.

After the crew noticed the engine had spooled down and the auto-relight function by the EEC was initiated, the crew started discussing about further action with regards to execution of the flight. The crew conducted FOR-DEC and decided that they would return back to Mumbai. The cabin crew were briefed about the situation and the decision. Following this, the crew discussed the company circular and guidelines regarding an overweight landing. Based on their review, they decided against jettisoning fuel and opted for an overweight landing in Mumbai. However, these discussions and decisions were made before completing the abnormal checklists for ENGINE SURGE and ENGINE FAIL. The checklists were fully executed after the discussions concluded, and then the fuel switch was set to the CUT-OFF position. Throughout this period, the automatic relight function continued to attempt restarts, though these attempts were unsuccessful.

The above discussed deviation from execution of checklist and all the other satisfactory crew actions are not a contributory factor to the incident.

2.2 Engineering Aspects

The aircraft had a valid Certificate of Airworthiness and the ARC was valid as on the date of the incident. The review of previous 5 sectors of the aircraft operations did not reveal any snags with regards to the LH engine or any of its systems. Load & Trim sheet was prepared. The calculated take-off weight, landing weight and Centre of Gravity were found within limits. The aircraft departed with a valid certificate of release to service. The Scheduled and unscheduled maintenance activities conducted as per the scope and approval of the airline are not a contributory factor to the incident.

The affected engine in the incident was installed on the aircraft on 10/05/2023 and during the installation there were oil traces noticed. A BSI was carried out for HPC Stage 1, 2 and 3 and no abnormalities were found. Post

installation the engine did 179 cycles till the day of the incident and no abnormalities in the operation were found. This was also confirmed by the OEM that there were no abnormal trends in EGT, fuel flow and core speeds of the engine till the day of the incident.

The last shop visit of the affected LH engine (Sr.no. 956-126) was to address the HPT stage 1 blade distress. Repairs for the same were performed and no work was carried out on the HPC Stage 10 of the engine. As per the history of the engine the HPC stage 10 blades were replaced with EM 72-00-00 special procedure 014 in 2018 and the HPC has accumulated 2287 cycles till the day of the event and no other work was carried out the HPC Stage 10 ever since 2018. The OEM concluded that the un-commanded In-Flight Shut down of the engine was caused by the release of a HPC Stage 10 blade and the disassembly investigation of the engine revealed that this release had occurred due to improper installation of locking lugs of HPC Stage 10. The LH locking lug was installed out of the locking slot and the RH locking lug was partially inside the locking slot.

3. CONCLUSION

3.1 Findings

i. Airworthiness Review Certificate of the aircraft was valid. The calculated takeoff weight, landing weight and Centre of Gravity were found within limits. Aircraft departed with valid Certificate of Release to Service.
ii. Both crew members had valid licenses while operating incident flight. Medical fitness & FDTL was not a factor to this incident.
iii. Weather was not a factor in this incident.
iv. The engine was maintained in accordance with the OEM guidelines and approved maintenance programme. The OEM report of the engine also did not indicate any abnormal deviation of engine parameters till the incident flight.

v. No abnormalities were observed by the crew while starting both the engines and engine parameters were normal during taxi and take-off

vi. The crew did not execute the QRH checklists completely but gave priority to FOR-DEC procedures and company guidelines.

vii. Crew actions in the complete event were not a contributory factor to the incident.

viii. The aircraft landed uneventfully with single operating engine.

ix. OEM has concluded that the un-commanded In-Flight Shutdown of the engine was due to the release of the HPC Stage 10 blade.

x. During the disassembly investigation, it was established that the release of HPC Stage 10 blade was due to improper installation of the locking lugs in 2018.

3.2 Causes of the Incident

HPC stage 10 blade got liberated due to improper installation of locking lugs which led to Engine Surge and subsequent un-commanded shut down in-flight.

4. SAFETY RECOMMENDATIONS

4.1 Action deemed fit by DGCA, i.r.o finding no 3.1(x) may be taken.

Rohith Mitai
Investigator – in – Charge

Yogesh Kakde
Member