



**FINAL INVESTIGATION REPORT ON SERIOUS
INCIDENT TO M/S SPICEJET BOMBARDIER
DHC8-400 AIRCRAFT VT-SUM AT NAGPUR ON
24.11.2017**

**GOVERNMENT OF INDIA
MINISTRY OF CIVIL AVIATION
AIRCRAFT ACCIDENT INVESTIGATION BUREAU**

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 this investigation is prevention of accidents/ incidents and not to apportion blame or liability.

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

<u>INDEX</u>		
<u>CONTENTS</u>		<u>PAGE No.</u>
1	FACTUAL INFORMATION	02
1.1	HISTORY OF THE FLIGHT	02
1.2	INJURIES TO PERSONS	04
1.3	DAMAGE TO AIRCRAFT	04
1.4	OTHER DAMAGE	04
1.5	PERSONNEL INFORMATION	04
1.6	AIRCRAFT INFORMATION	07
1.7	METEOROLOGICAL INFORMATION	17
1.8	AIDS TO NAVIGATION	17
1.9	COMMUNICATIONS	17
1.10	AERODROME INFORMATION	18
1.11	FLIGHT RECORDERS	18
1.12	WRECKAGE AND IMPACT INFORMATION	19
1.13	MEDICAL AND PATHOLOGICAL INFORMATION	19
1.14	FIRE	19
1.15	SURVIVAL ASPECTS	19
1.16	TESTS AND RESEARCH	19
1.17	ORGANISATIONAL & MANAGEMENT INFORMATION	23
1.18	ADDITIONAL INFORMATION	23
1.19	USEFUL AND EFFECTIVE TECHNIQUES	27
2	ANALYSIS	27
2.1	GENERAL	27
2.2	SERVICE BULLETINS ON BEARING COMPARTMENTS SEALS	28
2.3	SUBJECT INCIDENT	28
2.4	OTHER SIMILAR INCIDENTS	29
2.5	ACTIONS TAKEN BY OPERATOR TO AVOID RECURRENCE	29
3	CONCLUSIONS	30
3.1	FINDINGS	30
3.2	PROBABLE CAUSE OF THE INCIDENT	32
4	SAFETY RECOMMENDATIONS	32

GLOSSARIES

APD	Advanced Pneumatic Detector
ARP	Aerodrome Reference Point
ARSR	Air Route Surveillance Radar
ATPL	Airline Transport Pilot Licence
CAR	Civil Aviation Requirements
CFT	Crash Fire Tender
CPL	Commercial Pilot Licence
DGCA	Directorate General of Civil Aviation
DME	Distance Measuring Equipment.
DVOR	Doppler VHF Omni Directional Range
FL	Flight Level
ILS	Instrument Landing System
MSN	Manufacturer Serial Number
MSSR	Mono-Pulse Secondary Surveillance Radar
NDB	Non-Directional Beacon
OEM	Original Equipment Manufacturer
PSIA	Pounds per Square Inch Absolute
TOBI	Tangential On Board Injector
UTC	Co-ordinated Universal Time

**INVESTIGATION REPORT ON SERIOUS INCIDENT TO M/S SPICEJET
BOMBARDIER DHC8-400 AIRCRAFT VT-SUM AT NAGPUR ON 24.11.2017.**

1.	Aircraft		Bombardier
		Type	DHC - 8 - 402 (Q-400)
		Nationality	Indian
		Registration	VT-SUM
2.	Owner		Maple Leaf Financing Limited
3.	Operator		Spice Jet Limited
4.	Pilot - in -Command		ATPL Holder
	Extent of Injuries		None
5.	Co-pilot		CPL Holder
	Extent of Injuries		None
6.	No. of Passengers on board		59
	Extent of Injuries		None
7.	Last point of Departure		Hyderabad Airport
8.	Intended landing place		Jabalpur Airport
9.	Place of incident		En-route
10.	Date & Time of incident		24.11.2017 & 0830 UTC
11.	Phase of operation		Cruise
12.	Type of incident		Smoke in Cockpit & Cabin.

(ALL TIMINGS IN THE REPORT ARE IN UTC)

1. FACTUAL INFORMATION.

1.1 History of the flight

On 24th November 2017, a DHC 8 - 402 aircraft was involved in a serious incident of smoke in cabin & cockpit while operating scheduled flight from Hyderabad to Jabalpur resulting in diversion to Nagpur. The flight was under command of an ATPL holder on type as Pilot - In -Command (Pilot Flying) with a CPL holder on type as Co-pilot (Pilot Monitoring). There were a total of 59 passengers and 02 Cabin Crew members on board the aircraft. On the day of incident prior to the incident flight, the aircraft had operated 05 flights i.e. Hyderabad - Chennai - Bengaluru - Hyderabad - Rajahmundry - Hyderabad. No snag was reported by the crew and these flights were uneventful.

The aircraft was then scheduled to operate flight Hyderabad - Jabalpur. The aircraft took-off from Hyderabad at 0753 UTC for Jabalpur. At 0830 UTC, while cruising at FL 250 and about 140 Nm from Hyderabad cabin crew reported to PIC that there is smoke in cabin. The PIC asked co-pilot to verify the smoke and the same was later confirmed by him. The PIC instructed the cabin crew to check the cabin for any source of fire. The cabin crew checked the whole cabin but did not find any source of fire. The cockpit crew then decided to divert to Nagpur which was around 80 Nm from their position. At around 0833 UTC, the cockpit crew contacted Nagpur ATC and informed that they are making priority landing at Nagpur due to smoke in cockpit. Crew also asked for emergency descent and safety services on arrival. Accordingly, at 0837 UTC full emergency was declared at Nagpur airport. The aircraft was then cleared by ATC for landing at Nagpur with visibility 3200 meters and winds calm. During descent, aft baggage cargo smoke warning along

with fire detected warning light came ON at master warning panel in cockpit and the aft cargo fire extinguisher was operated from the cockpit. Thereafter, the smoke was also felt in the cockpit and as per the statement of PIC they have donned the oxygen mask. PIC then asked co-pilot to carry out QRH (Quick Reference Handbook) actions for fuselage fire, smoke or fumes. The crew heard the aural warning (smoke detector) for lavatory and the forward cargo baggage extinguisher was operated from the cockpit. Accordingly, PIC instructed them to secure the cabin and informed that they are going to land at Nagpur. During approach, low oil pressure warning for engine # 2 came ON. At 0856 UTC, the aircraft landed safely on runway 32 and taxied to the main isolation bay with follow me service and CFT's. After reaching bay, the PIC shut down the engine and instructed cabin crew to evacuate passengers from the left side. All passengers were evacuated from the left side. As per the statement of the cabin crew, post evacuation while carrying out the cabin search they observed some inflated life vests lying in the cabin. There was no injury to passengers during evacuation. The crew also evacuated the aircraft from the left side. At 0923 UTC, full emergency was withdrawn by ATC. There was no injury to any occupant on board the aircraft.

On ground, engine oil level was checked, but nothing was visible in sight glass. "Chip detector" message was found in "Eng health history". Test was carried out for chip detection wherein few metallic particles were found which were out of limits. Engine was removed for further investigation at OEM facilities.

1.2 Injuries to persons.

INJURIES	CREW	PASSENGERS	OTHERS
FATAL	Nil	Nil	Nil
SERIOUS	Nil	Nil	Nil
MINOR/None	04	59	

1.3 Damage to aircraft.

The aircraft sustained damages confined to engine No. 2. After removal the engine was sent to OEM facility for investigation. The investigation team participated in the strip examination and the details are covered in Para 1.16.

1.4 Other damage

Nil

1.5 Personnel information:

1.5.1 Pilot- in- Command:

AGE	27 Years
License	ATPL
Date of License Issue and Validity	04-08-2016 & Valid
Category	Aeroplane
Class	Multi Engine, Land
Endorsements as PIC	PA-34, DHC-8 402
Date of Joining Company	23-Apr-12
Date of Endorsement as PIC on type	17-02-2017
Instrument Rating	23-Dec-2016 & Valid
Date of RTR Issue and Valid up to	17-Apr-17 valid upto 16-Apr-19

Date of FRTOL issue & validity	22-Mar-15 valid upto 21-Mar-20
Date of Med. Exam & validity	27-Jun-17 valid upto 05-Jul-18
Date of Route Check	18-Feb-17
Date of Last Proficiency Check	13-Jun-17
Date of English language Proficiency	05-Mar-16 & valid
Date of last CRM	06-Oct-17
Date of last Monsoon training	06-Oct-17
Date of Dangerous Goods Awareness Training	22-Apr-16
Date of last Refresher/Simulator	06 - Oct 2017
Simulator Training for Critical Emergencies	06 - Oct 2017
Familiarity with Route/ Airport flown for last 12 months and since joining the company.	25-Jun-2017
Total flying experience	4150
Total Experience on type	1550
Total Experience as PIC on type	1300
Last flown on type	23-Nov-2017 (DHC 8 Q400)
Total flying experience during last 01 Year	918:56
Total flying experience during last 180 days	520:46
Total flying experience during last 90 days	239:34
Total flying experience during last 30 days	72:45

1.5.2 Co- Pilot:

AGE	28 Years
License	CPL-11254
Date of License Issue and Valid up to	13-Dec-11 valid upto 12-Dec-21
Category	Aeroplane
Class	Multi Engine, Land
Endorsements as PIC	Cessna 152, Piper Seneca PA-34
Date of Joining Company	10 th March 2016
Instrument Rating	28 th April 2017
Date of RTR Issue and Valid up to	27-Jun-11 valid upto 05-Jun-19
Date of FRTOL issue & validity	13-Dec-11 valid upto 12-Dec-21
Date of Med. Exam & validity	06-Mar-17 valid upto 16-Mar-18
Date of Route Check	24-Aug-17
Date of Last Proficiency Check	27-Oct-17
Date of English language Proficiency & Valid up to	08-May-13& valid upto 07-May-19
Date of last CRM	06-Jul-17
Date of last Monsoon training	06-Jul-17
Date of Dangerous Goods Awareness Training	20-Jun-16
Date of last Refresher/Simulator	06 - Oct 2017
Simulator Training for Critical Emergencies	06 - Oct 2017
Familiarity with Route/ Airport flown for last 12 months and since joining the company.	18-Nov-2017
Total flying experience	1472 Hrs
Total Experience on type	1214:25 Hrs
Total Experience as PIC on type	NIL

Last flown on type	23-Nov-2017 (DHC 8 Q400)
Total flying experience during last 01 Year	917:31 Hrs
Total flying experience during last 180 days	455:31 Hrs
Total flying experience during last 90 days	188:54 Hrs
Total flying experience during last 30 days	85:23

1.6 Aircraft information:

1.6.1 General Information

The aircraft bearing MSN 4402 was manufactured in the year 2012 and was registered under category 'A' with Certificate of Registration Number 4336. The Certificate of Airworthiness Number 6445 under "Normal category" subdivision Passenger / Mail / Goods was issued by DGCA on 30.06.2012. The specified minimum operating crew is two and the maximum all up weight is 29,257 Kgs. At the time of incident, the Certificate of Airworthiness and Aero Mobile License No. A-010/049/RLO was valid. As on 24.11.2017, the aircraft had logged 15888:53 Airframe hours and 15421 cycles.

The aircraft was fitted with two PW150A engines. As on 24.11.2017, the left Engine (PCE-FA0890) had logged 13063:41 hrs and 12640 cycles and the right Engine (PCE-FA0807) had logged 11328:53 hrs and 10871 cycles. There was no snag pending rectification.

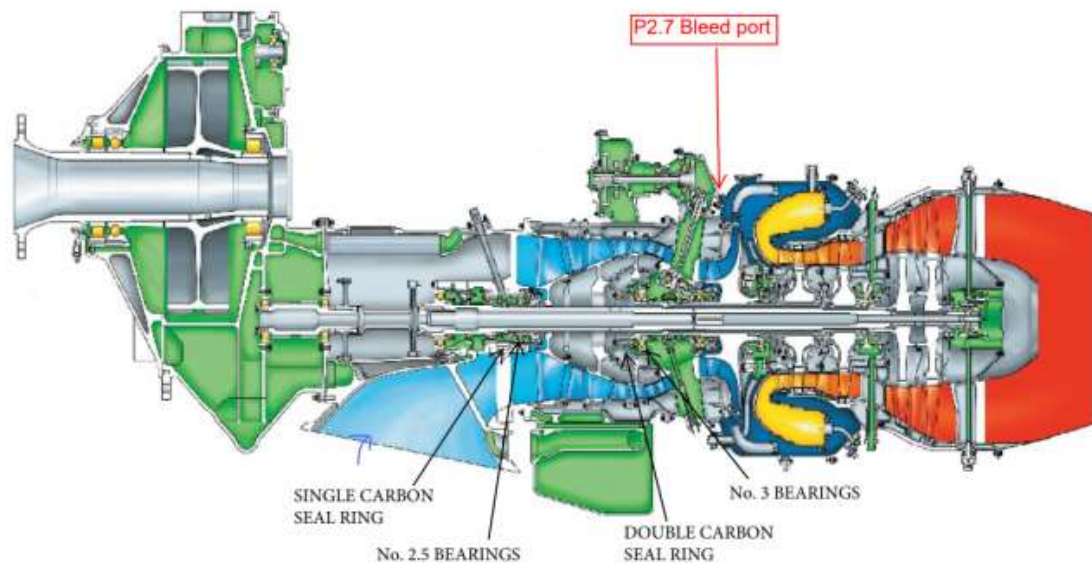
The aircraft and its engines are maintained as per the Maintenance Programme consisting of calendar period / flying hours or Cycles based maintenance as per maintenance programme approved by DGCA.

The last major inspection was carried out at 11653:39 Airframe hours / 11196 cycles on 05.07.2016. Subsequently, all lower inspections were carried out as and when due before the incident.

The aircraft was last weighed on 26.02.2017 and the weight schedule was approved by DGCA. There was no major modification effecting weight & balance since last weighing. Prior to the incident flight, the weight and balance of the aircraft was well within the operating limits.

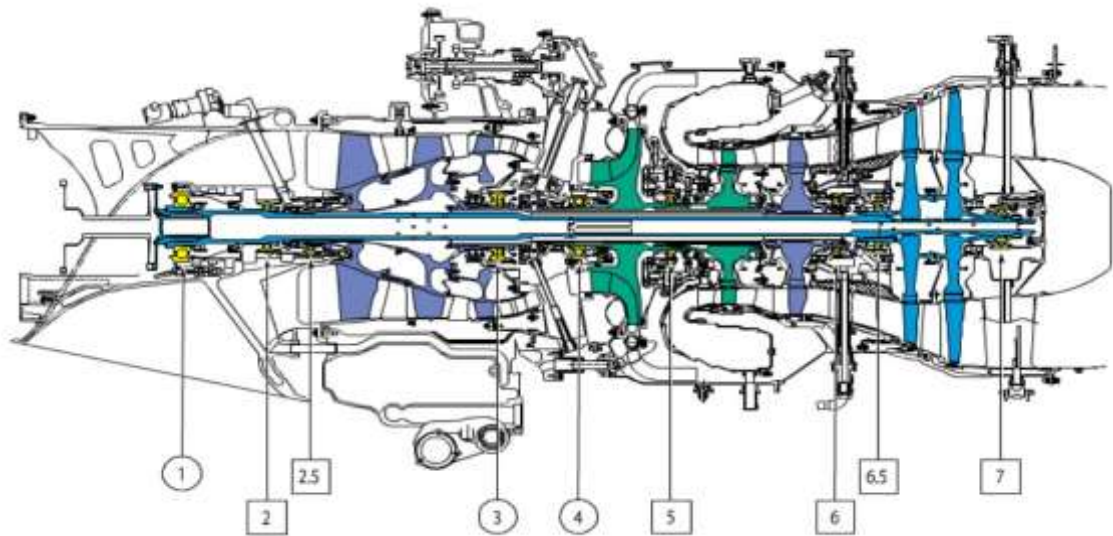
All concerned Airworthiness Directive, mandatory Service Bulletins, DGCA Mandatory Modification on this aircraft and engines have been complied with as on date of incident. The last fuel microbiological test was done on 19.07.2017 and the microbiological growth was negligible.

1.6.2 PW150A Engine Description:



The engine has a low pressure (first stage) axial compressor and a high pressure (second stage) centrifugal compressor, each attached to separate single stage turbines. A two-stage power turbine drives a third shaft to turn the propeller through a reduction gearbox. The high-pressure compressor also drives the accessory gearbox.

1.6.3 Bearings



There are nine main bearing on the engine: six roller bearings and three ball bearings. The ball bearings No. 1, 3 & 4 withstand the following thrusts:

No.1 bearing: Power turbine shaft thrust (Rearward)

No.3 bearing: Low pressure spool thrust (Forward)

No.4 bearing: High pressure spool thrust (Forward)

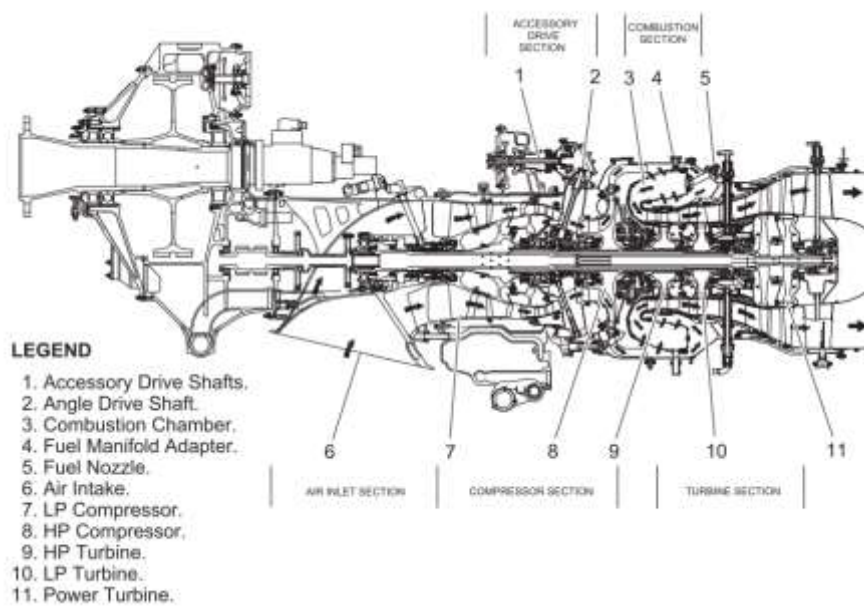
Bearings number 2, 2.5, 5, 6, 6.5 and 7 are roller bearings. They support radial loading and permit axial movement caused by thermal expansion. The following table gives the direction of rotation of bearing along with the shaft which these support.

Power Turbine Shaft	Low Pressure Shaft	High Pressure Shaft
No. 1 Ball	No. 2.5 Roller	No. 4 Ball
No. 2 Roller	No. 3 Ball	No. 5 Roller
No. 6.5 Roller	No. 6 Roller	
No. 7 Roller		
Clockwise	Counter-Clockwise	Clockwise

The forward end of the HP (High Pressure) shaft is located longitudinally and radially by a ball bearing at the No 4 position, in front of the impeller. The aft end of the shaft is held radially by a roller bearing (No 5), positioned forward of the HP turbine and enclosed by the reverse flow combustor.

A number of parts of the HP spool rotate in close proximity to fixed parts of the engine structure in the vicinity of the No 5 bearing. Their operating clearance is assured by the No 4 bearing, preventing forward movement of the HP spool.

1.6.4 Air/Gas Flow:



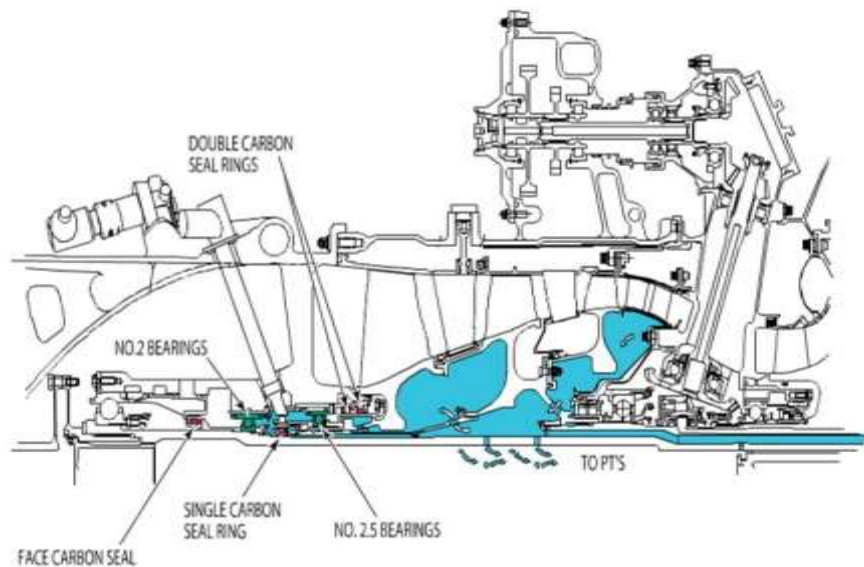
Air entering at the engine inlet is directed rearward and compressed. Two compressors carry out compression for combustion and bleed extraction purposes. Air is first ducted to the low-pressure axial compressor and then to the high pressure centrifugal compressor where it undergoes a second stage of compression. The compressed air then enters internal ducts, and is discharged into the combustion chamber where fuel is added and ignited.

1.6.5 Bearing Compartments Sealing:

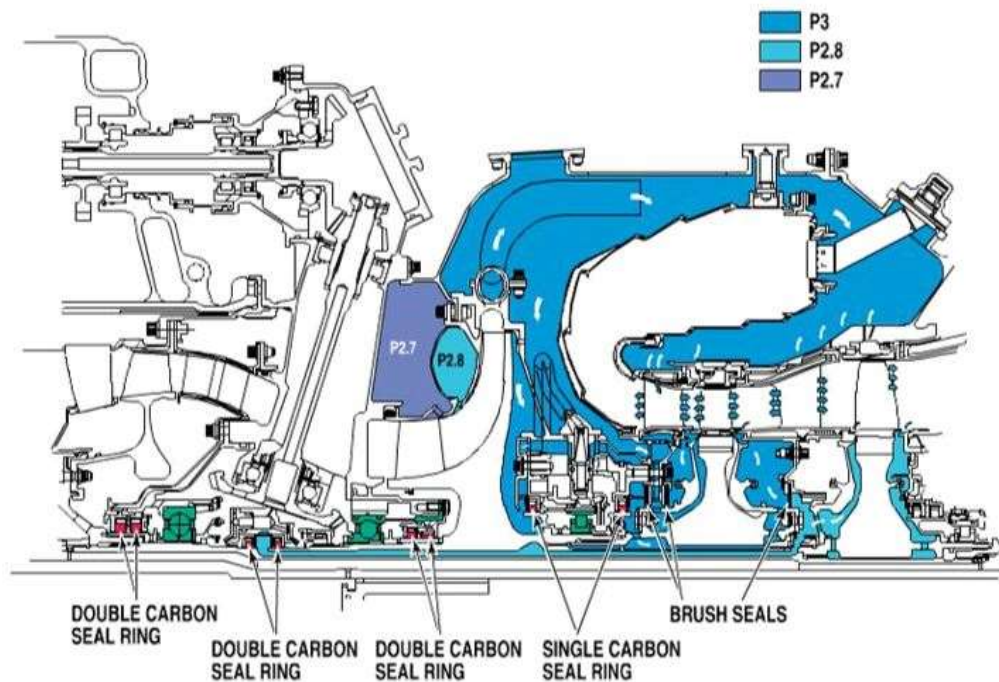
- The No. 2 and 2.5 bearing cavity is sealed using 2 different types of seals. The front end is sealed by a face carbon seal, the rear end is sealed by a double carbon seal ring and the clearance left between the PT (Power Turbine) shaft and the LP (Low Pressure) shaft is sealed by a single carbon seal ring mounted in the LPC rotor. The 2 carbon seal rings are pressurized with P2.5 (LP compressor outlet) directed through internal passages in the LP compressor section.
- The No. 3 and 4 bearing cavity is sealed on each end using a double carbon seal ring and the clearance left between the LP and the HP shafts is sealed by 2 single element carbon seal ring. All seals are pressurized with P2.8 (HP compressor split vane impeller level) directed through internal passages in the inter-compressor case.
- The No. 5 bearing cavity is sealed on each end using a single carbon seal ring. These seals are pressurized with P3 (after HP impeller) directed through internal passages in the gas generator case.
- The No. 6 and 6.5 bearing cavity is sealed on each end using a double carbon seal ring and the clearance left between the LP shaft and the PT shaft is sealed by 2 single carbon seal rings. All seals are pressurized with P2.5 (LP compressor outlet) directed through internal passages in the turbine support case.
- The No. 7 bearing cavity is sealed on the front end using a double carbon seal ring. The seal is pressurized with P2.5 (LP compressor outlet) directed through the PT shaft.

Brush Seals:

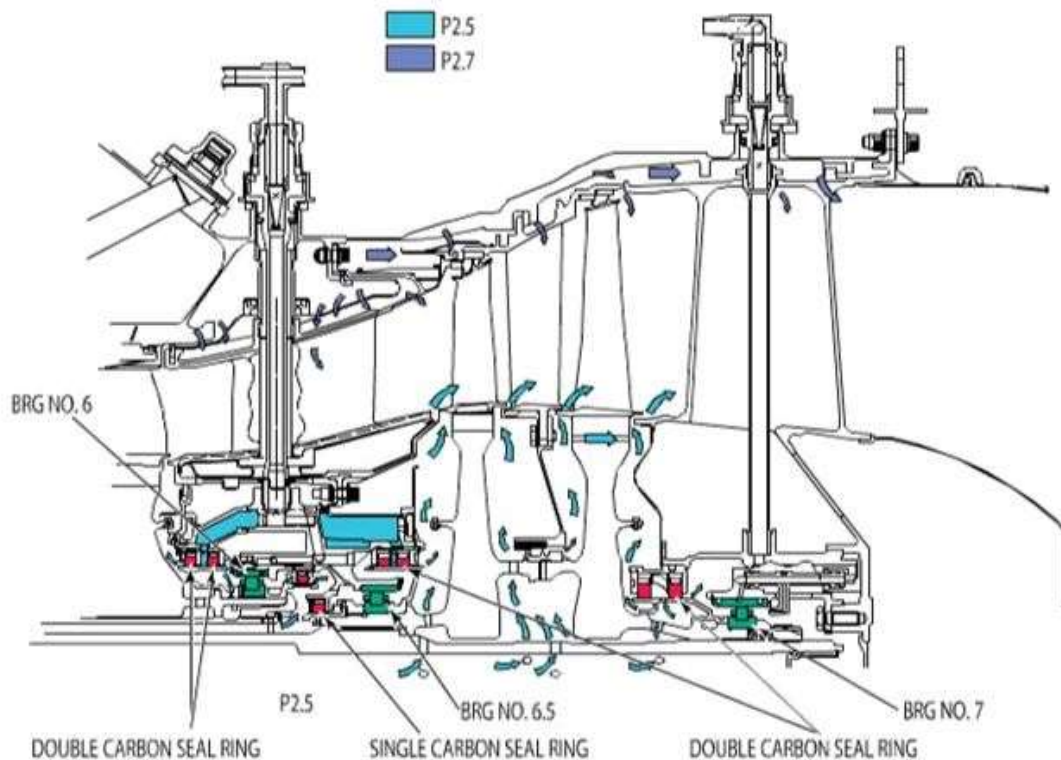
Wire type air restrictors, ensure proper air distribution between turbine stages. Also ensure proper air distribution to cool HP turbine disk and blades from the TOBI nozzle housing.



Bearing Area # 1, 2 & 2.5



Bearing Cavities # 3, 4 & 5



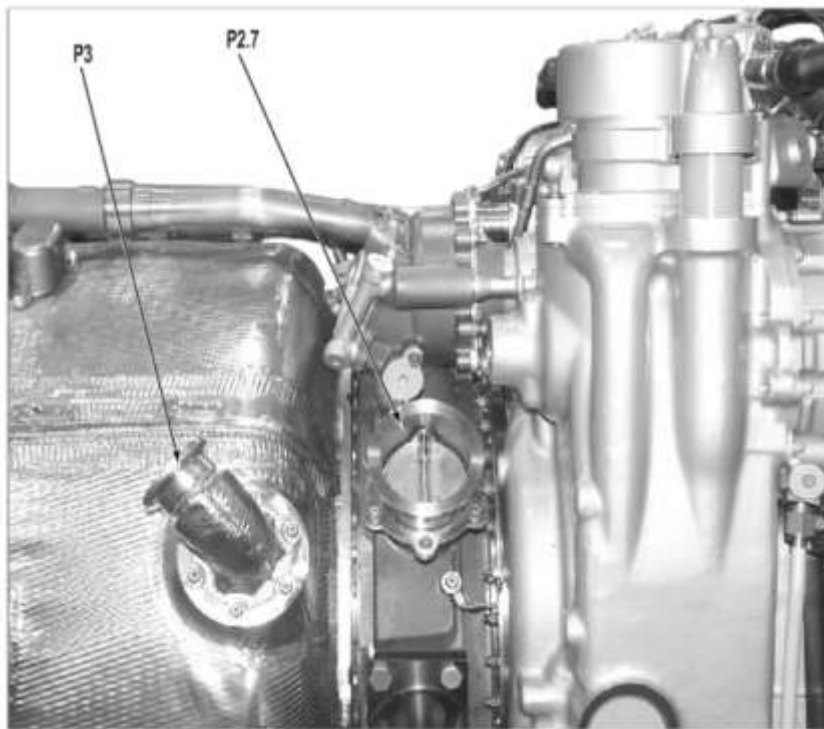
Bearing Cavities # 6, 6.5 & 7

1.6.2.4 PW150A CABIN BLEED SYSTEM

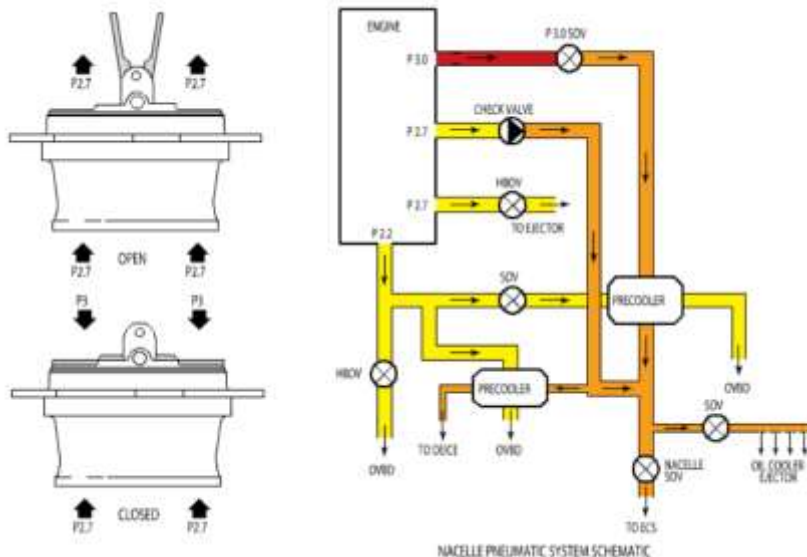
The environmental control system (ECS) of PW150 engine provides bleed air for the various aircraft systems including pneumatic system, the air conditioning system, de-icing systems, etc.

- The engine provides air bleed extraction ports from both compressors, the low pressure (LP/P2.7) and the high pressure (HP/P3). As the two bleed ports are connected to the same duct, a P2.7 check valve is installed in the low pressure port to prevent back flow from the high pressure (P3) to the low pressure (P2.7)
- In general, the ECS is supplied with low pressure air (P2.7). At low engine power, the LP or HP pressure switch (airframe supplied) opens allowing P3 air to feed the airframe system. At a pre-determined pressure (P3), the pressure switch (airframe device) closes the P3

supply allowing the P2.7 check valve to open and feed the airframe air system with P2.7 air pressure.



Cabin Bleed Piping



Operation:

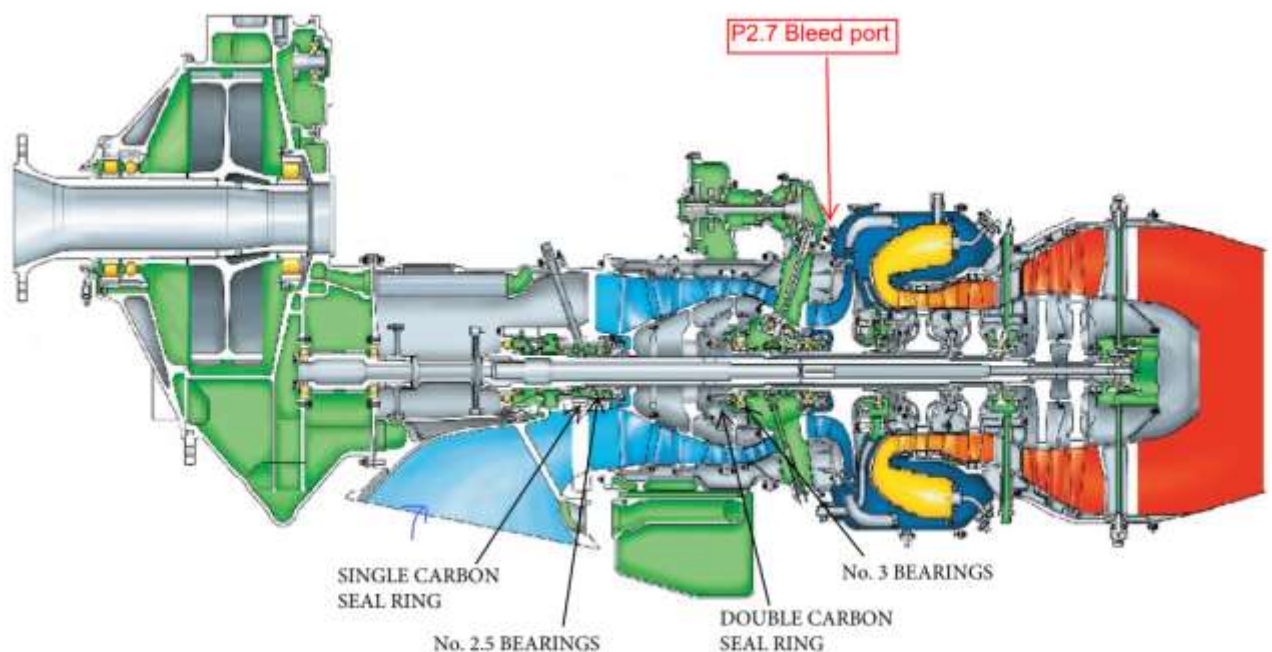
During low power setting, the bleed air is extracted from the high pressure port P3 and during high power setting the bleed air is extracted from low pressure port P2.7. The P2.7 check valve is installed on the inter-

compressor case in order to prevent back flow from high pressure bleed air P3 to low pressure port P2.7.

When power is reduced i.e. when P3 pressure is less than 77 PSIA, the P3 Shut-Off Valve opens allowing P3 port to feed the bleed air to ECS. The P3 air also flows back to P2.7 check valve and since its pressure is higher than that of the P2.7, the two flappers on the P2.7 check valve are moved down causing the valve to close.

When power is increased i.e. P3 pressure is greater than 80 PSIA, the P3 Shut off valve closes making P3 to stop feeding the bleed air to ECS. Hence, the bleed air from P2.7 is the only pressure force applied on the flappers causing the valve to open. The bleed air from P2.7 now takes over P3 and feeds to ECS.

1.6.3 ENGINE OIL SYSTEM



Green colour is oil system

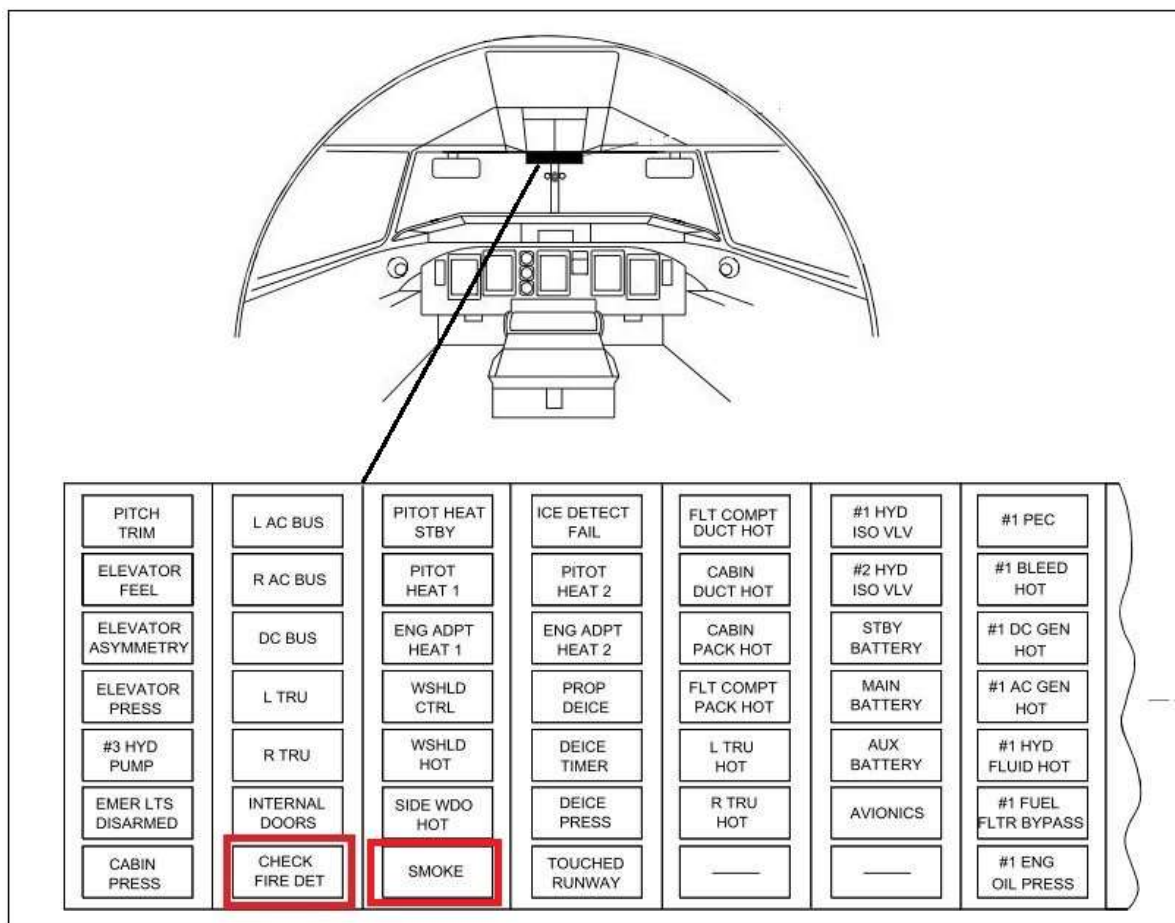
1.6.4 CHECK FIRE DET warning light and Smoke Warning Light

CHECK FIRE DET warning light

When a fire overheat condition occurs, the alarm signals are processed by the Control Amplifier then sent to the Fire Protection Panel in the flight compartment.

If a fire or overheat condition occurs in either engine, this will cause the gas within the APD to expand and turn ON the following lights in the flight compartment:

- Applicable PULL FUEL / HYD OFF T-handle light (red) comes ON
- Both ENGINE FIRE warnings PRESS TO RESET lights (red) flash
- CHECK FIRE DET warning light (red) flashes.



As per the "Non Normal Procedures", in the event of fire, smoke or fumes, the flight crew is required to land the aircraft without, delay

while completing fire suppression and / or smoke or fumes evacuation procedures.

If it cannot be visually verified that the fire has been completely extinguished, (whether the smoke or fumes have cleared or not), land immediately at the nearest suitable airfield or landing site.

1.7 Meteorological information:

The following is the Met report of Nagpur Airport on the date of incident between 0800UTC to 0930 UTC.

Time (UTC)	Winds (°/Knots)	Visibility (Meters)	Weather	Clouds	QNH (hPa)	Temp (°C)	Dew Point (°C)	Trend
0800	10/03	3000	HZ	No Significant Cloud (NSC)	1014	29	14	NOSIG =
0830	Calm	3000	HZ	NSC	1014	30	15	NOSIG =
0900	Calm	3000	HZ	NSC	1013	30	14	NOSIG =
0930	Calm	3000	HZ	NSC	1013	29	14	NOSIG =

1.8 Aids to navigation:

The Dr. Babasaheb Ambedkar International Airport, Nagpur has 01 runway and is equipped with NDB, DVOR/DME, ILS CAT-I, ARSR/MSSR.

1.9 Communication:

There was always two-way communication between the ATC and the aircraft. At the time of incident, the aircraft was under the control of Nagpur ATC.

1.10 Aerodrome Information:

Dr. Babasaheb Ambedkar International Airport, Nagpur is owned and operated by Mihan International. ARP co-ordinates are N 21° 05' 31" & E 079° 02' 54" with elevation of 1033 feet. Aerodrome Rescue & Fire Fighting Category (ARFF) available is CAT-VII.

1.11 Flight recorders:

The Cockpit Voice Recorder (CVR) and the Digital Flight Data Recorder (DFDR) were downloaded and the information has been used for investigation purposes.

As per the DFDR data:

- At 083448 UTC while operating at 24152 feet (pressure altitude), the aircraft started descent.
- At 083627 UTC while operating at 21164 feet, Smoke warning came ON in Centralized Warning Panel (CWP) with master warning for 4 seconds. The smoke warning remained till the engines were shut down after landing.
- At 083645 UTC, while operating at 20474 feet Check Fire Detect warning came ON with master warning for 3 seconds. The Check Fire Detect warning remained till the engines were shut down after landing.
- Between 084724 and 085134, the master warning came ON intermittently till the altitude of 2444 feet.
- At 084725 UTC at an altitude of 4616 feet, Right Engine Oil Pressure warning came ON for 01 sec.
- At 084802 UTC at an altitude of 3664 feet, the right engine oil pressure warning again came ON.
- At 084831 UTC, the aircraft leveled off at flight level 031.

- At 084856 UTC at an altitude of 3086 feet, the right engine oil pressure warning again came ON and it came intermittently till the altitude of 2570 feet.
- At 085012 UTC, the aircraft started descending again.
- At 085052 UTC, the right engine oil pressure warning came again and remained till engine shut down after the aircraft was parked.
- At 085530 UTC, the aircraft landed with flap 15, power lever left at 32.6, power lever right at 27.2, torque left of 0.5% and torque right of 4.5 %.
- The master caution again came ON at 085729 UTC & 085810 UTC for 01 second & 04 seconds respectively.

1.12 Wreckage and impact information.

The aircraft sustained internal damages confined to engine # 2.

1.13 Medical and pathological Information:

Both pilots had undergone preflight medical check prior to the first flight.

The BA test for both of them was negative.

1.14 Fire:

There was no fire after the incident.

1.15 Survival aspects:

The incident was survivable.

1.16 Tests and research:

The involved engine was removed from the aircraft after the incident for detailed examination. The tear down inspection was carried out at OEM designated overhaul facility. The relevant extract and findings made at the

OEM designated overhaul facility during the teardown inspection are as below.

Externally, there were no signs of oil leaking. The magnetic Chip Detectors were found to have a little metal pickup. Some parts like the 2.2 and 2.7 Bleed off Valve (BOV) showed oil wetting on the internal passages. The 2.7 BOV (Blow-Off Valve) was wet on the external surface. Externally visible oil lines were found to be satisfactory with no obvious leak areas. The Low Pressure (LP) Compressor, High Pressure (HP) compressor and Power Turbines assemblies were rotating freely.





The o-rings of the RGB (Reduction Gear Box) main oil filter housing were found to be cut. The magnetic Chip Detectors of the TM Module, RGB Module and A/C Generator were found with little metal pick up.

The oil screen at the Inter Compressor Case was found to have carbon like material, which became powder when handled.



After disassembly of the hot section, the area outside No. 7 bearing compartment was found dry and the carbon seals were found in satisfactory condition.

The oil staining was observed in the gas path indicating that the oil leak was upstream. There was sooting or white discoloration throughout the gas path.



No. 1 Brg. - Flaking at cage



No.2.5 Brg. Dents on Roller Elements

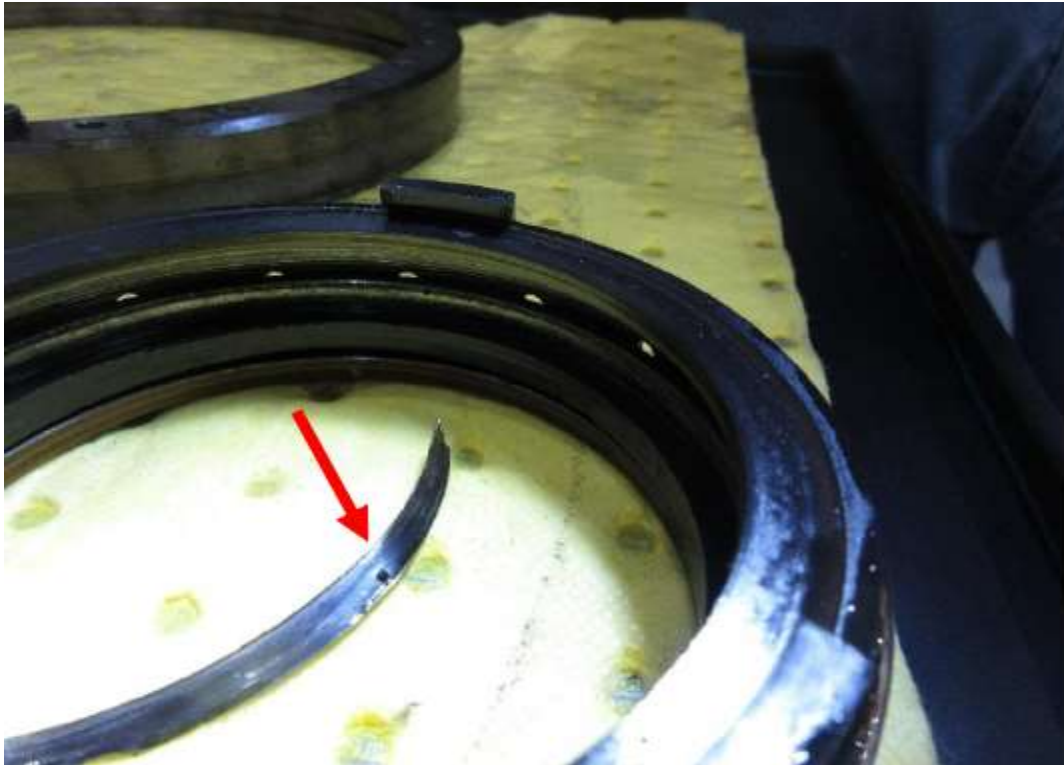


No.3 Brg. -Flaking of inner diameter of cage.



No.4 Brg: Corrosion on more than 30% of Area 1

No.	DESCRIPTION	REMARK
1.	BEARING NO.1	FLAKING FOUND ON CAGE POCKET.
3.	BEARING NO.2.5	DENT ON ROLLERS ELEMENT, CAN BE FELT WITH DESIGNATED SCRIBER.
4.	BEARING NO.3	FLAKING FOUND ON INNER DIAMETER OF CAGE AND CAGE POCKET.
5.	BEARING NO.4	CORROSION FOUND ON 30 PERCENT OF SURFACE AREA 1. FRETTING CORROSTION FOUND ON INNER RING



Wave spring of No. 3 bearing carbon seal assembly had broken

1.17 Organizational and management information:

The airline is a scheduled airline and were having a fleet of 35 Boeing 737s aircraft and 17 Bombardier Q-400 aircraft on the date of incident, operating flights on domestic and international sectors. The Air operator permit (S-16) of the Airlines was valid till 30/06/2018. The Company is headed by Chief Executive Officer. The Flight Safety Department is headed by Chief of Flight Safety approved by DGCA and reports directly to the CEO.

The airline has in-house maintenance facility and maintenance activities are carried out under CAR 145 issued by DGCA.

1.18 Additional Information:

There were two similar occurrences (though engines were removed as a precaution) involving Dash 8, Q400 aircraft during the course of this investigation. Details are as follows:

1.18.1 On 08.04.2018, during cruise, No. 2 engine of one of the other Bombardier Dash-8 Q400 aircraft of the same operator made diversion from its intended flight due to pungent oil smell and smoke in cabin with an alarm from the lavatory smoke detector.

The smoke soon disappeared but the pungent smell continued without any smoke. On ground during maintenance, waste leak was observed in lavatory. There was no abnormality or warning as far as engine was concerned. During maintenance on ground, engine inspection was carried out as a preventive measure and a small amount of oil traces were observed on No. 2 engine turbine blades. As a precautionary measure, the engine was replaced and investigation was carried out at OEM facility. Extract from the report covering failure of bearing seals is given below.

The examination of the engine revealed oil wetness from P2.2, P2.7 and P3 bleed ports. Internal inspection was carried out through P2.2 bleed port after removal of the bleed valve. Presence of oil at the bottom of the LPC case internal surface was observed. The high pressure turbine (HPT), low pressure turbine (LPT) and power turbine (PT) could be rotated freely. The main oil filter, the RGB scavenge filter were found dirty/darkened and displayed some carbon debris. The main oil tank strainer was found clean, but showed some carbon debris/fragments.

The turbo machinery (T/M) magnetic chip detector (MCD) showed some debris. The reduction gearbox (RGB) scavenge MCD and the RGB Air conditioner generator MCD were however clean. T/M & RGB Oil samples showed some carbon fragments.

As per the report of OEM, the reported smoke in the cabin was caused by the distressed No. 2.5 and No. 3 bearing carbon seals that resulted in internal oil leakage into the compressor secondary air systems and engine bleed air system. The carbon 2.5 seal was axially reduced of its original thickness because of rubbing / rotation of the carbon element. The damages observed on the No. 3 bearing front carbon element caused excessive seal clearance and a loss of air pressurized sealing. The loss of sealing subsequently resulted in oil leakage which contaminated the engine primary and secondary air systems.

1.18.2 On 11.04.2018, a Dash8 Q 400 aircraft of the same operator, while operating flight from Coimbatore to Bangalore was involved in an incident of smoke in the cabin and in the flight compartment. When the flight was 20 nm away from Bangalore and at 10000 ft, a mild smoke was observed along with smell in cabin. The non normal checklist actions were carried out by the PIC. ATC was also informed.

When the aircraft was at about 6 nm from Bangalore, the Front baggage Compartment smoke warning came ON. QRH actions were carried out by the crew. Thereafter, there was no smoke in Cabin or flight compartment, but the smell was still present. The Aircraft landed safely at Bangalore. Rapid deplaning of passengers was carried out and all passengers and crew deplaned safely. The passengers were taken to the terminal building. Post flight, no fire was observed in the baggage compartment, but mild smoke was observed in rear baggage compartment.

The subject engine was removed and was stripped at OEM Centre. Relevant extract from the report is reproduced below:

External examination of the engine revealed oil wetness from the P2.2, P2.7 and P3 bleed ports. Inspection through P2.2 bleed port after removal of the bleed valve displayed presence of oil at the bottom of the LPC case internal surface. The high pressure turbine (HPT), low pressure turbine (LPT) and power turbine (PT) could be rotated freely. The main oil filter and the RGB scavenge filter had carbon debris. T/M and RGB Oil samples were dark, and the RGB samples also displayed some debris.

As per the report of OEM, the presence of oil leakage at the P 2.2 valve in this case was confirmed. The reported smoke in the cabin was caused by the distressed No. 2.5 and No. 3 bearing carbon seals that resulted in internal oil leakage into the compressor secondary air system and engine bleed air system.

The tension spring of no. 2.5 bearing carbon seal displayed fretting wear and was axially reduced of its original thickness because of rubbing / rotation of the carbon element.

The damages observed on the No. 3 bearing front carbon element caused excessive seal clearance and a loss of air pressurized sealing. The loss of sealing subsequently resulted in oil leakage which contaminated the engine primary and secondary air systems.

1.18.3 Replacement of carbon seals:

1.18.3.1 Special Instructions

In Nov 2013, the manufacturer of the engine has given 'Special Instructions' to remove carbon seals from service before reaching 10,000 hours. This was to be carried out whenever engine is sent in shop for a Hot Section Inspection (HSI) or Hot Section Restoration (HSR) work scope, irrespective of any work scope that may be planned additional to the HSI.

1.18.3.2 Service Bulletin (SB) 35341

The manufacturer observed that on PW150A engines exudation and oxidation can occur on No. 3 bearing carbon seal while operating under high temperatures and humid environments which can cause oil leakage from No. 3 bearing carbon seal. To obviate the problem, SB No. 35341 was issued for all the PW150A engines on 6/10/2016 having S.No. PCE - FA1238 or earlier.

As per this SB, the existing carbon seal was to be replaced with a new one (as and when sub assembly is disassembled and access was available to the necessary part).

1.18.3.3 Service Bulletin (SB) 35342R1

As the manufacturer has observed that the spring load range of no. 2.5 bearing seal is not optimal and can be improved, an SB No. 35342R1 was issued on 24/1/2018 which required that No. 2.5 bearing seal be replaced with new one that has an increased minimum spring load to prevent potential spinning of the air/oil bearing seal ring (as and when sub assembly is disassembled and access was available to the necessary part).

1.19 Useful or effective investigation techniques:

NIL

2. ANALYSIS

2.1 General:

The aircraft was having valid Certificate of Airworthiness and Certificate of Registration. The certificate of flight release was valid on the day of incident. All concerned Airworthiness Directive, Service Bulletins, DGCA Mandatory Modifications of this aircraft and its engines were found complied with. There was no snag reported prior to the incident flight.

Both pilots were appropriately qualified to operate the flight. The weather was fine. The aircraft was always under positive control of ATC units.

2.2 Service Bulletins on Bearing Compartments Seals

The manufacturer had issued two service bulletins for PW150A engines for No. 3 bearing carbon seal and No. 2.5 bearing seal. Both these SBs required hardware replacement and was to be carried out as and when the assembly was disassembled and access was available.

Service Bulletin 35341 replaces the #3 Brg. carbon seal with one made from a carbon grade that is more resistant to high temperatures and humid environments. Similarly, the SB No. 35342R1 requires that No. 2.5 bearing seal be replaced with new one that has an increased minimum spring load to prevent potential spinning of the air/oil bearing seal ring.

2.3 Subject Incident

Scrutiny of the engine records revealed that though the engine had a shop visit earlier, No. 3 bearing compartment Carbon Seal was of pre Service Bulletin 35341 configuration. The reason for the non-replacement of seal during that shop visit was that the area of the engine required for replacement could not be accessed which is in line with the SB No. 35341 issued by manufacturer on the subject.

In the present case, the #1, #2.5, #3 and #4 bearings had all suffered some form of damage resulting in generation of metal chips. The damage could be attributed to a combination of lack of lubrication as well as vibrations due to imbalance seen in the LPC.

To conclude, the aircraft incident is attributed to the #3 Bearing Carbon Seal that had failed in service and caused oil to leak into the gas path. This

caused oil fumes to be released into the aircraft cabin through the Bleed Off Valves. Eventually enough oil was lost to cause the engine to lose oil pressure and trigger the Low Oil Pressure indication in the cockpit.

2.4 Other Similar Incidents

During the investigation, there were two engine removals as mentioned above due to oil smell by flight crew/ maintenance crew. The reason in both these cases was No. 2.5 & 3 Bearing Carbon seal distress for which the manufacturer has already issued Service Bulletins. According to these SBs, the existing carbon seals were to be replaced with new ones as and when sub assembly is disassembled and access was available to the necessary part.

2.5 Actions taken by operator to avoid recurrence.

The replacement was to be done during the shop visits subject to the condition that access to the concerned area was available. As this could have taken certain time, the operator has taken proactive measures in coordination with Pratt and Whitney for early detection of degradation of carbon seal in oil system installed on pre-modified engines such as

- Periodic Oil sampling and analysis for contamination on effected engines.
- Staggering of engines to avoid both engines to be pre-modified on same aircraft.
- Reduction in water washes frequency to avoid water contamination to carbon seal.
- Accelerated removal of pre-modified engines from fleet to get them modified. The operator intends to remove and return all un-modified rental engines from its fleet before December 2018. These engines (pre

SB) are being monitored at repeat weekly oil sampling program with Pratt & Whitney OIL AT (Analysis Technology) program.

In the meantime, the operator advised its flight crew and engineers about the cabin smoke issue due to internal oil leak on the engines where the modified seals are not installed.

3. CONCLUSIONS:

3.1 Findings:

- a) The Certificate of Airworthiness, Certificate of Registration and the certificate of flight release of the aircraft was valid on the date of incident.
- b) Both Pilots were appropriately qualified to operate the flight.
- c) All concerned Airworthiness Directive, Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engines were found complied with.
- d) On the day of incident prior to the incident flight, the aircraft had operated 05 flights. No snag was reported by the crew and these flights were uneventful.
- e) During the incident flight, while cruising at FL 250 and about 140 Nm from Hyderabad cabin crew reported to PIC that there is smoke in cabin. The same was later confirmed by the co-pilot also.
- f) Source of smoke/fire could not be established during flight.
- g) The cockpit crew then decided to divert to Nagpur which was around 80 Nm from their position and asked for priority landing due smoke in cockpit. Crew also asked for emergency descent and safety services on arrival.
- h) During descent, aft baggage cargo smoke warning along with fire detected warning light came ON at master warning panel in cockpit and

the aft cargo fire extinguisher was operated from the cockpit. Thereafter the smoke was also felt in the cockpit.


- i) The crew heard the aural warning (smoke detector) for lavatory and the forward cargo baggage extinguisher was operated from the cockpit.
- j) During approach low oil pressure warning for engine # 2 came ON.
- k) During the tear down inspection at OEM facility, it was observed that the No.3 bearing carbon seal had failed in service.
- l) Failure of No.3 bearing carbon seal in flight caused oil leakage into the gas path and oil fumes released into the aircraft cabin through the Bleed Valves.
- m) As a precaution, the operator advised its flight crew and engineers about the cabin smoke issue due to internal oil leak on the engines.
- n) During the course of subject investigation, there were two more similar occurrence reported. In both the cases the engine was removed due to oil smell on ground by flight crew/ maintenance crew. The reason in both these cases was No. 2.5 & 3 Bearing Carbon seal distress for which the manufacturer has already issued Service Bulletin.
- o) As per these SBs, the replacement was to be done during the shop visits subject to the condition that access to the concerned area was available. As this access to the area could have taken certain time, the operator in the mean time took proactive measures in coordination with the manufacturer for early detection of degradation of carbon seal in oil system installed on pre-modified engines.
- p) The operator intends to remove and return rental engines with unmodified seals from its fleet before December 2018. Till that time, the engines (pre SB) are being monitored at repeat weekly oil sampling program with Pratt & Whitney OIL AT program.

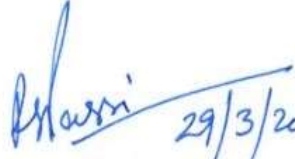
3.2 Probable cause of the incident

The incident occurred as No. 3 Bearing Carbon Seal failed in service resulting in oil leak into the gas path causing oil fumes getting into the aircraft cabin through the Bleed Off Valves.

4. SAFETY RECOMMENDATIONS

In view of the installation of new modified bearing seals introduced by the manufacturer and preventive actions taken by the operator on the recommendation of the manufacturer, no recommendations are being made.


(K Ramachandran) 29/3/2019
Investigator


(R S Passi) 29/3/2019
Investigator - in - Charge

Date: 29th March 2019

Place: New Delhi