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GOVERNMENT OF INDIA

FINAL INVESTIGATION REPORT OF INCIDENT TO M/s SPICEJET LTD. DHC-8-402, AIRCRAFT VT-SQB ON 12.10.2022 AT HYDERABAD

O/o DIRECTOR AIR SAFETY, SOUTHERN REGION, INTERNATIONAL CARGO COMPLEX, MEENAMBAKKAM, CHENNAI-600016

FOREWORD

In accordance with Annex 13 to the International Civil Aviation Organization Convention and the Aircraft (Investigation of Accidents and Incidents) Rules 2017, the sole objective of this investigation is to prevent aviation incidents and accidents in the future. It is not the purpose of the investigation to apportion blame or liability.

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

ABBREVIATIONS

Aircraft	Incident Aircraft
AMM	Aircraft Maintenance Manual
AOC	Air Operator Certificate
ATC	Air Traffic Control
ATPL	Airline Transport Pilot License
CAQ	Cabin Air Quality
CPL	Commercial Pilot Licence
CSN	Cycles Since New
CVR	Cockpit Voice Recorder
DFDR	Digital Flight Data Recorder
ECS	Environmental Control System
ELPL	English Language Proficiency Level
FCOM	Flight Crew Operating Manual
FCTM	Flight Crew Training Manual
FDR	Flight Data Recorder
FDTL	Flight and Duty Time Limitations
FL	Flight Level
FO	Co-Pilot/ First Officer
FRTOL	Flight Radio Telephone Operator's Licence
HBOV	Handling Bleed Off Valve
IATA	International Air Traffic Association
ICAO	International Civil Aviation Organization
ICC	Inter Compressor Case
IFR	Instrument Flight Rules
IR	Instrument Rating
IST	Indian Standard Time
LH	Left Hand
LPC	Low Pressure Compressor
Oil AT	Oil Analysis Technology
Operator	AOP Holder of The Incident Aircraft
PF	Pilot Flying

PIC	Pilot in Command
PM	Pilot Monitoring
PPC	Pilot Proficiency Check
P & WC	Pratt & Witney Canada
RA	Radio Altitude
RECIRC	Recirculating
RH	Right Hand
RWY	Runway
SB	Service Bulletin
SSCVR	Solid State Cockpit Voice Recorder
SSFDR	Solid State Flight Data Recorder
TM	Turbomachinery
TSN	Time Since New
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
WCP	Warning & Caution Panel

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FINAL INVESTIGATION REPORT OF INCIDENT TO M/s SPICEJET LTD. DHC-8-402 AIRCRAFT, VT-SQB ON 12.10.2022 AT HYDERABAD

1	Aircraft	Type	De Havilland Canada/DHC-8-402
		Nationality	India
		Registration	VT-SQB
2	Name of the Owner		M/s Industrial International Aircraft Leasing 1 Ltd.
3	Name of the Operator or Hirer		M/s SpiceJet Ltd.
4	Pilot – in –Command		Valid ATPL holder
	Extent of injuries		Nil
5	First Officer		Valid CPL holder
	Extent of injuries		Nil
6	Date and Time of Incident		12/10/2022, 1718 UTC (12/10/2022, 2248 IST)
7	Place of Incident		Rajiv Gandhi International Airport (VOHS)
8	Last point of Departure		Goa International Airport (VOGO)
9	Intended place of landing		Rajiv Gandhi International Airport (VOHS)
10	Crew on Board		04 (02+02)
11	No. of Passengers on board		86 (65 Males, 17 Females and 04 Child)
12	Type of Operation		Schedule (Passenger) Flight
13	Phase of Operation		Descent
14	Type of Incident		(F-NI: Fire/smoke (non-impact)); SCF-PP (System/Component Failure – Power plant)

(All timings in the report are in UTC)

SYNOPSIS

On 12th October 2022, M/s SpiceJet DASH8 Q400 aircraft registration VT-SQB had operated flight SG -3735 sector Goa - Hyderabad reported smoke in the Cockpit and Cabin and made an emergency landing in Hyderabad at 1728 UTC. There were 90 persons including four crew members on board the aircraft.

Aircraft took off from Goa airport at 1624 UTC. Flight was uneventful till climb. However, while cruising at FL210, Lavatory Smoke Warning got activated without any indications of Smoke inside the Lavatory. Later during descent, the Cabin Crew informed PIC that the cabin was filling with thick Smoke. Crew declared MAYDAY.

Further AFT Baggage smoke warning light got illuminated during approach for which appropriate memory actions were carried out. Aircraft landed safely on Runway 09R and vacated via Rapid Exit Taxiway 'L1' and stopped on taxiway. Evacuation was carried out on taxiway from all the exit doors i.e., L1, R1, L2 and R2. During evacuation, one passenger had minor right knee injury. There was no fire. Later, the aircraft was towed to stand 44.

The incident was reported to DGCA, subsequently the investigation was ordered by DGCA under Rule 13(1) of the Aircraft (Investigation of Accidents and Incidents) Rules, 2017, by appointing the Investigator-in-charge and member vide order no DGCA-15018(07)/43/2022-DAS dated 26.10.2022.

The investigation reveals that, the incident occurred due to the failure of No. 3 Bearing Carbon Seal of ENG#1, which resulted in oil leaking into the gas path and smoke/fumes entering into the aircraft cabin through the bleed air system.

1. Factual Information:

1.1 History of the flight:

On 12th October 2022, M/s SpiceJet, DASH8 Q400 aircraft registration VT-SQB was operating a scheduled flight (SG-3735) sector Goa to Hyderabad. There were 86 passengers and 04 crew members on board the aircraft. There was no abnormality/snag reported on the aircraft during any of the previous flights on said date and previous day.

The flight was under the command of ATPL holder as PIC with First Officer who was holding CPL license. Both the cockpit crew were duly qualified on aircraft type DASH8 Q400. Before the incident flight, crew performed three sectors i.e., Bengaluru-Shirdi, Shirdi-Hyderabad, and Hyderabad-Goa. All three sectors were uneventful. Pilot in Command (PIC) was Pilot Flying (PF) and First Officer (FO) was Pilot Monitoring (PM) for all the sectors. Crew had been provided adequate rest before the flight.

The aircraft was scheduled to operate flight Goa-Hyderabad (4th Sector). The aircraft took off from Goa Airport at 162434 UTC. The take-off was uneventful. At approx. 30 minutes after take-off, while cruising at FL210, Lavatory Smoke Warning got activated without any indication of smoke inside the lavatory. After inspection, the Cabin Crew witnessed no smoke & smell and informed the same to the PIC and reset the smoke detector with the concurrence of PIC.

Further while cruising at the same flight level, approx. after six minutes cabin crew informed the PIC that there is little smoke from cabin ceiling but no smell. PIC instructed cabin crew to secure cabin for landing. At 171237 UTC aircraft contacted Hyderabad ATC and requested for normal descent. ATC instructed to descent to FL170. At this time, crew discussed the QRH checklist items of Fuselage Fire, Smoke or Fumes and PIC turned off Recirculation Fan. Cabin crew informed PIC that cabin is secured for landing. On inquiry by PIC, cabin crew informed that the situation is ok now.

On further descent request by FO, Hyderabad ATC advised aircraft to contact Approach radar on 120.25. On contact, Approach radar instructed to descent to FL110. At 171631 UTC cabin crew informed PIC that the cabin was filling with thick Smoke. Thereafter, the smoke was also felt in the cockpit and as per the statement of PIC they have donned the oxygen mask. At 171758 UTC, the cockpit crew contacted Approach radar and declared MAYDAY due to smoke in the cabin and requested for RWY09. Accordingly, at 1718 UTC full emergency was declared at Hyderabad airport.

During the VOR approach at 4000ft, the SMOKE & CHECK FIRE DET warning came ON along with illumination of SMOKE/EXTG switch on the AFT Baggage panel. PIC immediately operated the fire extinguisher bottles. Subsequently, the aircraft was cleared for landing at Hyderabad with visibility 4000 meters, winds variable 04Kts, and caution with RWY surface wet. Crew performed the memory items for Smoke (recirculation fan-off, donned oxygen masks and smoke goggles and established communication), checklists & call outs as required. Aircraft landed safely at Hyderabad on Runway 09R at 1728 UTC and

vacated RWY via Rapid Exit Taxiway 'L1' and stopped on TWY. PAX evacuation was carried out on taxiway from all the exit doors i.e., L1, R1, L2 and R2 doors. During evacuation, one passenger had minor right knee injury. There was no fire. Later, the aircraft was towed to stand 44. At 1808 UTC, full emergency was withdrawn by ATC.

1.2 Injuries to persons:

Injuries	Crew	Passengers	Others
Fatal	NIL	NIL	NIL
Serious	NIL	NIL	NIL
Minor/None	NIL/04	01/85	

Total personnel on board: 90

1.3 Damage to Aircraft:

There was no damage to the aircraft. However, ENG#1 was replaced due to internal failure.

1.4 Other Damage: NIL

1.5 Personnel information:

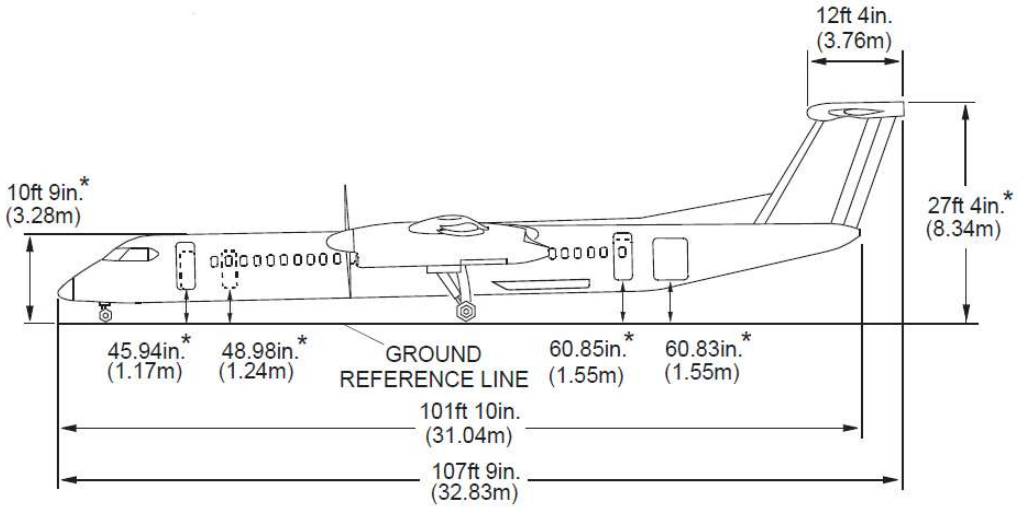
Details	Commander	First Officer
Age/Gender	28 Years/Female	29 Years/Male
Licence type	ATPL	CPL
Date of issue	04-Nov-19	19-Nov-15
Licence Valid up to	03-Nov-24	05-Oct-25
Licence Category	Aeroplane	Aeroplane
Endorsement as PIC	DHC 8 402	C 172, DA 42
Date of Class I/II Medical	22-FEB-22	12-Jan-22
Medical Exam valid up to	01-MAR-23	31-Jan-23
Date of issue of FRTO License	17-Oct-14	19-Nov-15
FRTO Licence Valid up to	16-Oct-24	05-Oct-25
Instrument rating done on	22-Apr-22	17-May-22
Last PPC done on	22-Apr-22	17-May-22
Total Flying Experience	3629:41 Hrs	2538:18 Hrs
Experience on Type	3429 hours 41 Mins	2338 hours 18 Mins
Experience as PIC on Type	724 hours 35 Mins	NA
Last flown on Type	11-Oct-22	11-Oct-22
Total Flying Experience in last 1 year	682:40 Hrs	244:25 Hrs

Total Flying Experience in last 6 months	316:30 Hrs	233:11 Hrs
Total Flying Experience in last 30 days	45:55 Hrs	50:13 Hrs
Total flying experience in last 7 days	11:35 Hrs	13:45 Hrs
Total flying experience in last 24 Hrs	04:00 Hrs	04:00 Hrs
Duty time last 24 Hrs	8:46 Hrs	8:46 Hrs
Rest before the flight	24hrs 36min	24hrs 36min
English Language Proficiency Level	LEVEL 5	LEVEL 4
Valid till	09-Aug-26	23-FEB-24

Both the operating crew were current in all training and were not involved in any serious incident/accident in the past. The licenses of both the cockpit crew and all the ratings were valid. Both the crew had adequate rest prior to roster for the incident flight. Both the cockpit crew had submitted the self-declaration certificate for non-consumption of alcohol in compliance to DGCA order no: DGCA-15031/4/2020- DAS dated 29.03.2022 which was in force due covid pandemic.

1.6 <u>Aircraft information</u>:

The Dash 8-Q400 is a high wing airplane manufactured by Bombardier Aerospace. It is powered by two 5071 shaft horsepower PW 150A turboprop engines manufactured by Pratt & Whitney Canada. Each engine drives a 6 bladed propeller. The Dash 8 is a 2-pilot transport category airplane approved for instrument flight and operation to a maximum altitude of 25000 ft. The aircraft length is 32.83 m, wingspan is 28.42 m and height of this aircraft is 8.34 m. The distance between main wheel centers is 8.80m and has an engine to ground distance clearance of 0.98m.



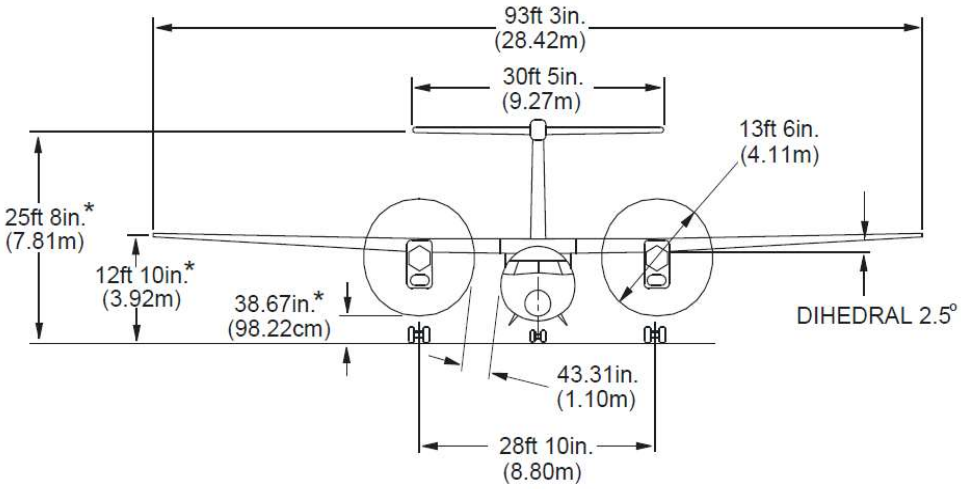


Figure 1: PLAN VIEW DHC 8-Q400 SERIES

1.6.1 Brief Description of PW150A Engine

The DHC-8 Series 400 is powered by 2 Pratt & Whitney Canada model PW150A turboprop engines. Each engine drives a 6 bladed, constant speed, variable pitch, fully feathering Dowty Aerospace model R408 propeller through the engine gearbox. The power plant develops 4580 SHP (Shaft Horse Power) under normal take-off conditions. An automatic uptrim on a manual MTOP rating selection allows either engine, to develop a maximum take-off power of 5071 SHP, for a brief period of time, if an engine failure occurs during take-off.

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 gear box. The high-pressure compressor also drives the accessory gear box.

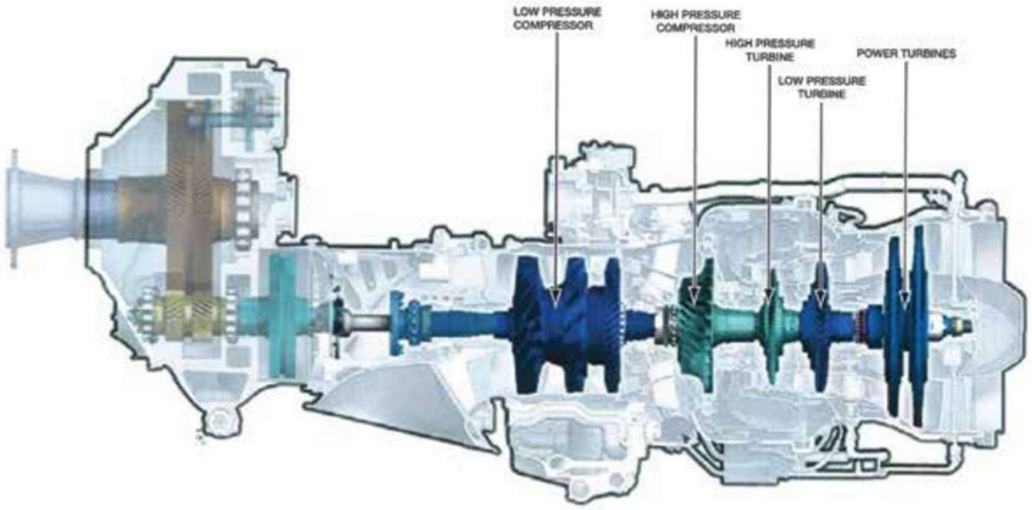


Figure 2: Major rotating assemblies in turbo-machinery and reduction gearbox

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.

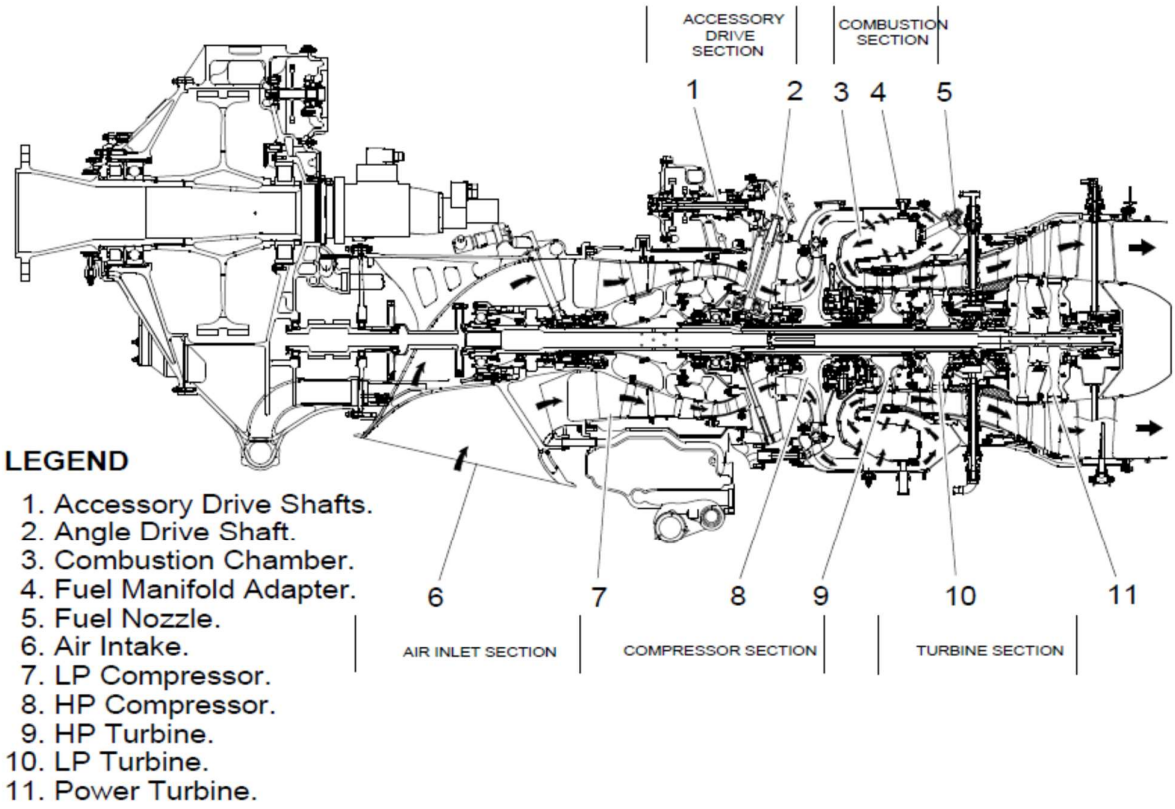


Figure 3: Engine Cross Section

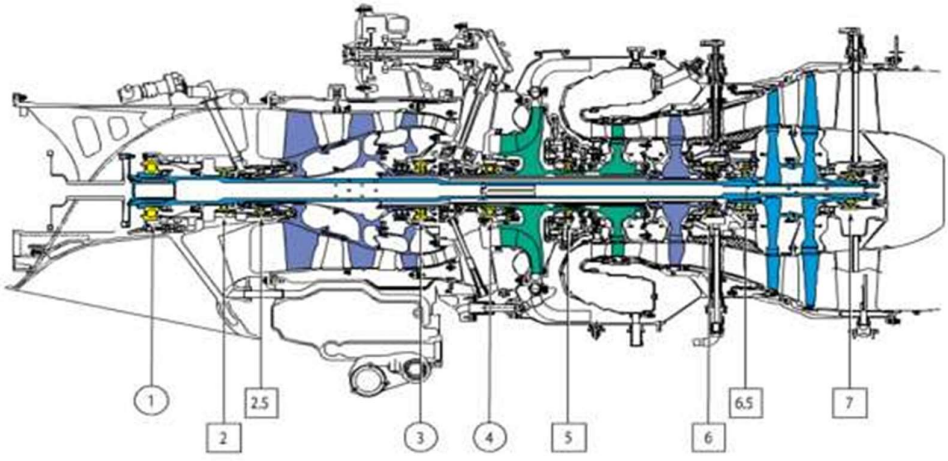


Figure 4: Layout of Bearings

There are nine main bearings 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 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.

Cabin Bleed Air System:

Air for pressurization and air-conditioning is sucked through the air intake at each engine and is compressed by the engines' compressors. At the compressor section, the low pressure (LP) compressor supplies bleed air at higher RPM settings, while the high pressure (HP) compressor opens supply at lower RPM. A portion of compressed air passes through P2.7 LP port and P3 HP port. This compressed air is then ducted into the Air Conditioning System and Environment Control System (ECS). The hot compressed air from the engine is then conditioned to a pre-set temperature and pressure and distributed throughout the aircraft.

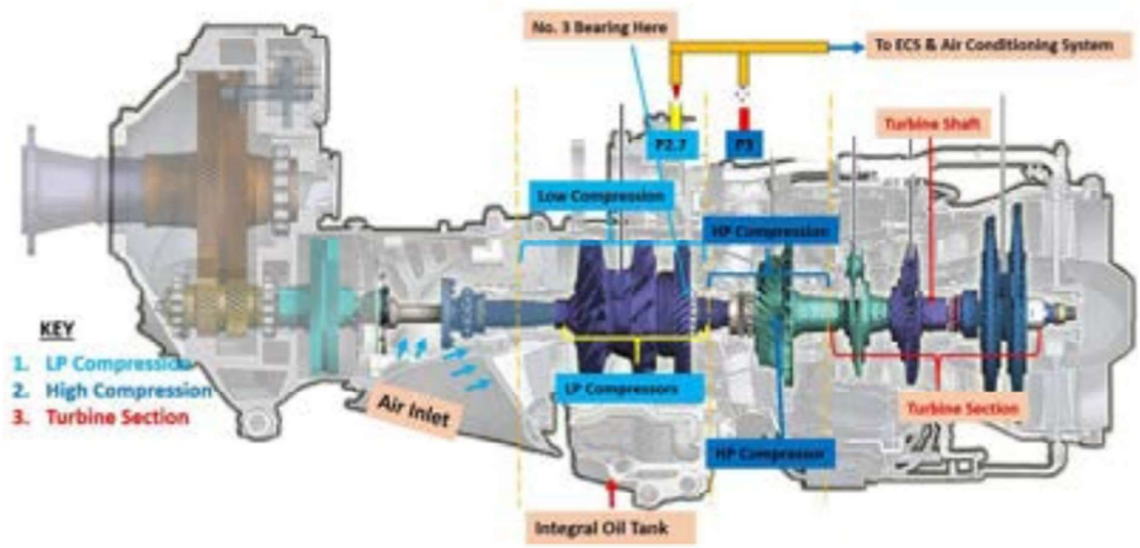
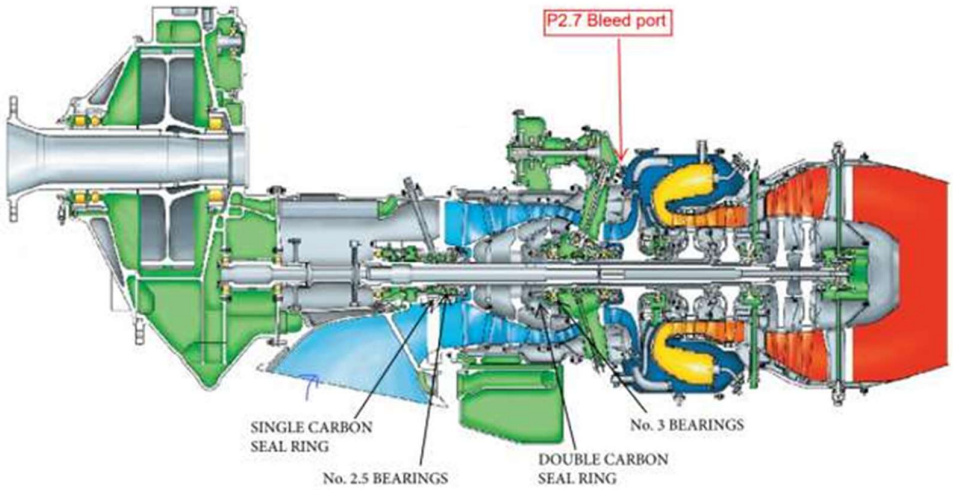


Figure 5: Bleed Air System

Low pressure air (P2.5) cools the axial flow compressor internally. This cooling air flows through the drilled passages into the turbine shaft and seal the bearing cavities of No.3, 4 and 5 bearing. It then flows to cool the discs and roots of the power turbines. The LP compressor is mounted to the LP shaft. The LP compressor case acts as the integral oil tank at the bottom and contains the No.3 bearing which supports the low-pressure shaft and holds the No.3 and No.4 bearing cavities that support the LP and HP compressor.

The carbon seal of these bearings prevent oil from leaking onto the gas path or cabin bleed system.



The oil from the main integral tank goes to the cooling systems and cools down before being distributed for cooling and lubrication. This cool oil is pumped to the bearings and shafts and oil scavenged from them goes into a cavity of the bottom of the Reduction Gear Box (RGB) housing. From there, it goes through filtering and metal chip identification stages and the clean filtered oil goes back to the oil tank for reuse. Green color in the above figure is the engine oil system.

Recirculating Fan

The recirculation fan, draws cabin air through the recirculation filter mounted behind the AFT class "C" baggage compartment. The air is routed aft, where it is mixed with pack conditioned air. The recirculation fan switch on the AIR CONDITIONING control panel controls the on / off operation of the recirculation fan. When the switch is selected to the RECIRC position, the fan starts at low speed (to reduce initial current draw), then switches to high speed. Operating conditions determine the automatic control of the recirculation fan speed. The fan operates at low speed if one pack is turned off.

1.6.2 Aircraft details:

Aircraft Details –	
Aircraft Registration	VT-SQB
Type of Aircraft	DHC-8-402
Manufacture Serial No.	4584
State of Manufacturing	CANADA
Manufacturing year	2018
Certificate of Registration	4974/2 (w.e.f. 23.10.2018)

Certificate of Airworthiness number and issue date	Number 7077, issued on 30.10.2018	
Category	'A'	
Airworthiness Review Certificate number and Validity	SJ/ARC/2021/20, valid till 29.10.2023	
Aircraft TSN / CSN	10153:42 / 8232	
Minimum crew necessary	TWO	
Maxi. Aircraft Take-off Weight	29574 kg	
Maxi. Aircraft Landing Weight	28123 Kg	
Type of fuel	JET A1	
Fuel On-board before Flight	2000 Kgs	
Aero mobile Licence	A-010/099/RLO(NR) Valid upto 31.12.2023	
Engine Details -		
Engine -	**LH**	**RH**
Engine Manufacturer	Pratt & Whitney, Canada	Pratt & Whitney, Canada
Engine Model	PW150A	PW150A
Engine S.no	PCE-FA0910	PCE-FA0875
Date of Manufacture	11.02.2012	05.09.2011
Total Engine Hours/Cycles RH	18871:11 Hr / 17'584	21873:21 Hr / 19'972
Engine Time since Last Shop Visit	840:08 Hrs	4758:19 Hr
Last major check carried out	Shop Visit (22.05.2022) Hot Section Inspection (HIS) and repair.	Shop Visit (04. 12.2019) Engine Overhaul
Last minor check carried out (including the BSI details)	22.Feb.2021 (Last BSI before Shop Visit)	21.Sep.2022 (Last BSI)
Failed Part/ Component in flight	**ENGINE#1 Serial Number PCE-FA0910**	

The aircraft was last weighed on 18th September 2018 at Bombardier Inc. Toronto, Canada and the Weight Schedule was prepared and duly approved by the office of the Director of Airworthiness, DGCA New Delhi. Prior to the incident flight the weight and balance of the aircraft was well within the operating limits.

All the concerned Airworthiness Directive, mandatory Service Bulletins, Mandatory Modifications on the aircraft and its engine had been complied with.

The defect record of the aircraft (30 days prior to the incident flight) was scrutinized on the date of occurrence of the incident and no defect was pending on the aircraft prior to the incident flight.

1.6.3 Post incident details:

On arrival of aircraft to the bay, during initial inspection, the following observations were made by the engineering team:

a. For initial evaluation, Cabin Air Quality (CAQ), unusual electrical fumes in the cabin, galley/lavatory were checked and **observed oil fumes smell in the cabin**.
b. General visual inspection of the engines carried out and **observed oil coming from the LH Engine drains**.
c. Engine oil level check and **found low oil quantity on LH Engine. (**The oil was uplifted to level FULL on both Engines & APU on 12.10.2022 before issuing CRS for the first flight of that day.**)**
d. Inspection of P2.2 & P2.7 HBOV outlet ports and the P2.2, P3.0 & P2.7 airframe bleed air ducts carried out and found evidence of oil wetness and accumulation. **ECS compartment inspected, observed oil wetness/accumulation on cabin ACM compressor discharge port.**
e. Operational test for engine fault code indications carried out and found fault code 938 on both channels of LH Engine. **Metal chips found on the turbo-machinery chip detector.**
f. Further, Boroscopic inspection of HP impeller was carried out and observed oil on the impeller and borescope inspection of Inter Compressor Case (ICC) Strut was found crack in the ICC Strut area.
g. **LH ENGINE replaced (WO# 6038907) as per approved schedule** Q400/72/EC/03 Issue 1 Rev 2.

Figure 6: TM Magnetic Chip Detector

Figure 7: ICC Struct

1.6.4 Service Bulletin:

M/s Pratt & Witney stated that carbon seal failure events had been reported on the PW150A fleet in the past. The common elements or trends identified of the fracture of the carbon seal are -

1. No.3 Bearing carbon seal wear characterized as wear-out at TSN 8,500hrs plus.
2. The air side carbon element gets disintegrated during the event flight and leads to oil leak outside No.3 bearing cavity and into the gas path.
3. Wear-out believed to be caused by exudation of salt and oxidation of the air side carbon element, processes dependent of the high operating temperatures and humid environments.

M/s Pratt & Witney issued a Service Bulletin (SB), number 35341, on 6th October 2016, to operators and owners of aircraft fitted with the PW150A engines which are before and include serial number PCE-FA1238. In the SB, the Manufacturer required the replacement of No.3 bearing carbon seals with carbon seals made of a carbon grade more resistant to high temperatures and humid environments. 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).

M/s SpiceJet has carried out the above replacement of no. 3 bearing carbon seal during the shop visit in 2018 for overhaul at TSN – 11647:36 hrs. The replaced upgraded carbon seal has failed on the incident flight after approx. 7224 hrs.

On inquiry with OEM, it was mentioned that there were 03 events of no. 3 bearing upgraded carbon seal failures during flight (including M/s SpiceJet) reported till Dec 2022 and stated that they have initiated the long-term mitigation action in design improvement activity. And also advised the operators to carry out the short-term mitigation action i.e. Oil Analysis Technology (Oil AT) sampling to be done at 250-300 hours intervals and monitoring of Fault Code 938 (Check for faults every 65 hours), which is being complied by M/s SpiceJet.

1.7 Meteorological Information:

The following is the Met report of Hyderabad Airport on the date of incident 12.10.2022 between 1700 Hrs to 1830 Hrs:

Time (UTC)	Wind Direction /Speed	Visibility	Weather	Trend	Temp/Dew	Cloud
1700	VRB/ 04Kts	4000m	TS	NO SIG	22/21	SCT1500FT FEWCB 3200FT BKN 8000FT
1730	VRB/ 04Kts	4000m	FBL TSRA	NO SIG	22/21	SCT1500FT FEWCB 3200FT BKN8000FT
1800	340/0 6Kts	4000m	FBL TSRA	NO SIG	22/21	SCT1500FT FEW CB 3200FT BKN8000FT
1830	360/0 4Kts	4000m	FBL TSRA	NO SIG	22/21	SCT1500FT FEW CB 3200FT BKN8000FT

1.8 Aids to navigation:

All Navigational Aids available at Hyderabad airport were serviceable. The aircraft was equipped with standard navigational equipment.

1.9 Communications:

Aircraft is equipped with Very High Frequency transmitter and receiver set and High Frequency transmitter and receiver set. There was always two-way radio communications available between the ATC and aircraft.

1.10 Aerodrome information:

Rajiv Gandhi International Airport, Hyderabad. It is located in Shamshabad about 20KM from Hussain Sagar Lake on a radial of 210° and from HHY R192/12 NM (22 Km). It is operated by GMR Hyderabad International Airport Ltd (GHIAL). The IATA Location Identifier Code is HYD and ICAO Location Indicator Code is VOHS. The airport has two runways with orientation 09R/27L and 09L/27R. Runway 09R/27L is the primary runway. The Airport Co-ordinates are 17°14'26" N, 78°25'43.94" E and Aerodrome Elevation is 618.7M/ 2030ft AMSL.

1.11 Flight recorders:

The aircraft was fitted with SSCVR and SSFDR. After the incident at Hyderabad, both were replaced and downloaded. The data was retrieved and utilized in the investigation.

1.11.1 Flight Data Recorder (SSCVR):

CVR details:

Make	: Universal Avionics.
Model	: CVR-120R
Part Number	:1606-01-01
Serial Number	:1979

The following observations are made from the data (in relative time):

a. Aircraft took off safely and normal checklist actions in respect of 'After take-off' and 'Cruise' were carried out as per the SOP.
b. At 01:15:11hrs aircraft was cruising at FL210 and the PIC made a PA announcement by giving general information i.e., shall commence descent 15mins from now, land 35mins from now and details of temperature, Speed etc... After the announcement, there was high pitch horn in the cabin which was due to lavatory smoke indicator ON. After inspection, the cabin crew witnessed no smoke & smell and informed the same to PIC and switched it off with the concurrence of PIC.
c. At 01:21:23hrs, crew carried out descent checklist. At the same time, Cabin Crew informed PIC that there is a little smoke from the cabin ceiling but no smell. With the information, at 01:24:22 hrs, crew

discussed the memory items of QRH and PIC turned off Recirculation Fan.

d. Meanwhile, at 01:24:08hrs, Radar instructed to descent FL170 on request for descent by FO and at 01:27:04hrs, Radar given further descent to FL160.
e. At 01:28:22hrs, Cabin Crew informed that cabin is secured for landing and on enquiry by PIC, it was informed that there is no smoke now.
f. At 01:34:24hrs, approach radar instructed to descent FL110 on request by FO.
g. At 01:37:51hrs, once again the high pitch alarm was ON. At 01:38:09, a further descent to FL100 was approved by ATC. At 01:38:33, on enquiry by PIC, Cabin Crew has informed that there is thick smoke inside the cabin. PIC asked CC to follow their drill.
h. At 01:38:47hrs, cockpit crew started donning the oxygen mask and PIC asked FO to declare MAYDAY due smoke in cabin. At 01:39:43hrs, FO declared MAYDAY and coordinated with ATC for further descent and vectoring for RWY09R.
i. At 01:41:32hrs, CC informed PIC that there is thick black smoke in cabin and they are not able to breath properly. PIC asked the CC to use portable oxygen if required and secure in 5 mins. At the same time, ATC has given descent to 3600ft.
j. At 01:44:41hrs, PIC asked FO to do the memory items. FO carried the memory items i.e. Oxygen mask on, Smoke goggles on, MIC switch mic, Recirc fan off and read the para "Prepare to land the aircraft without delay while completing fire suppression and /or smoke fumes evacuation procedures. Known smoke of fire" and then PIC told "okay okay that enough" and started discussing about vacating the RWY after landing.
k. At 01:46:15hrs, the landing checklist was carried out.
l. At **01:49:36hrs**, the aircraft landed safely and vacated via TWY L1. Later, the PAX evacuation was carried out on the TWY L1.

1.11.2 Flight Data Recorder (SSDFDR):

FDR details:

Make : Universal Avionics.
Model : FDR-125
Part number : 1607-00-00
Serial Number : 1831

The observations made from the provided data are:

Time (UTC)	Sequence of events
16:16:20	Engine #2 Start
16:16:34	Bleed position R: Normal
16:17:04	Engine #1 start
16:17:10	Bleed position L: Normal

16:17:32	Flap 10 selected
16:18:41	Aircraft started Taxi
16:23:49	Bleeds Off
16:24:34	Aircraft Airborne Selected Altitude: 20992
16:24:45	MLG and NLG Up and Locked, Altitude: 100 ft(radio), CAS: 154 knots
16:25:17	Bleed position L and R: Normal
16:25:29	Flaps Up, Altitude: 1679 ft(radio), CAS: 169 knots
16:42:34	Aircraft Levelled off at FL 210
17:02:13	Selected Altitude: 16992, Altitude: 21000 ft(baro)
17:02:25	Aircraft commenced descent, Bleed position L and R: Normal
17:05:09	Selected Altitude: 16000, Altitude: 19012 ft(baro)
17:11:40	Aircraft Levelled off at FL 160
17:12:32	Selected Altitude: 10992, Altitude: 15994 ft(baro)
17:12:42	Aircraft commenced descent, Bleed position L and R: Normal
17:16:26	Selected Altitude: 10000, Altitude: 13242 ft(baro)
17:18:16	Selected Altitude: 8000, Altitude: 10100 ft(baro)
17:19:29	Selected Altitude: 3600, Altitude: 9304 ft(baro)
17:22:26	Master Warning for 8 sec intermittently WCP Smoke: Warning (till the engine shutdown)
17:23:47	Aircraft Levelled off at 3600 ft
17:23:50	Selected Altitude: 4592, Altitude: 3616 ft(baro)
17:24:02	MLG & NLG Down and Locked, Altitude: 3646 ft(baro), CAS: 172 Kts
17:24:06	Flaps 15 selected, Altitude: 3604 ft(baro), CAS: 163 knots
17:25:09	Aircraft commenced final descent
17:26:34	Bleed position L: Min, Bleed position R: Off, Altitude: 2626 ft(baro)
17:26:38	Bleed position L: Off, Bleed position R: Off, Altitude: 2580 ft(baro)
17:27:37	Aircraft landed with vertical acceleration of 0.966g., Bleed position L and R: Off
17:29:02	Both Engine Shutoff

1.12 Wreckage and Impact Information: NIL.

1.13 Medical and pathological Information: NIL.

1.14 Fire:

There was no fire.

1.15 Survival aspects:

The incident was survivable. One passenger had minor right knee injury during evacuation and after diagnosis it was confirmed that there was ligament tear of fibula. PAX were discharged after treatment.

1.16 Tests and research:

The involved engine was removed from the aircraft after the incident for detailed examination. The powerplant investigation was performed at OEM Investigation Facility. The relevant extract and findings made at the OEM designated overhaul facility during the teardown inspection are as below -

- The high pressure (HP) spool, low pressure (LP) spool and power turbine (PT) spool rotated freely. A view through the engine inlet showed oil streaks near the bottom dead center. The main oil strainer showed several black particles and a several metallic flakes. The RGB scavenge oil filter was dark with a few non-metallic particles.

Figure 8: Main Oil Strainer

Figure 9: TM & RGB Oil Filters

- The P2.7 handling bleed valve showed oil residue and the P3 air bleed port was dry. The P2.2 interstage bleed valve and adaptor showed oil residue in the inner passage. The P2.2 bleed valve was removed, and oil accumulation was observed in the low-pressure case (LPC) P.2.2 cavity.

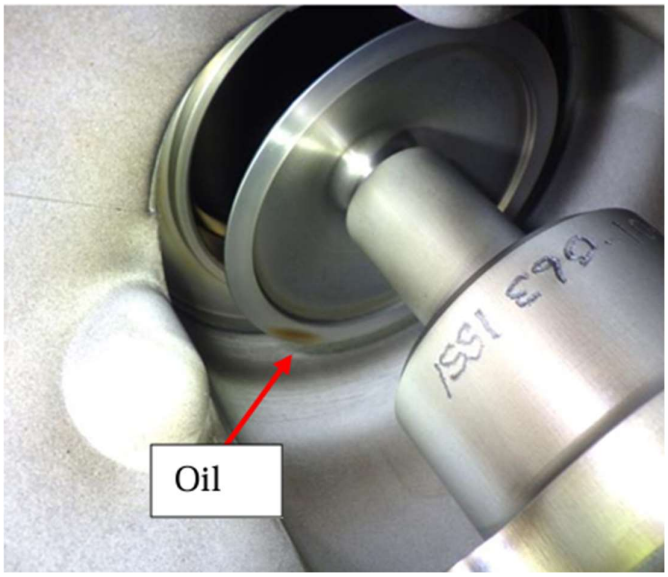


Figure 10: P2.7 Handling Bleed Valve

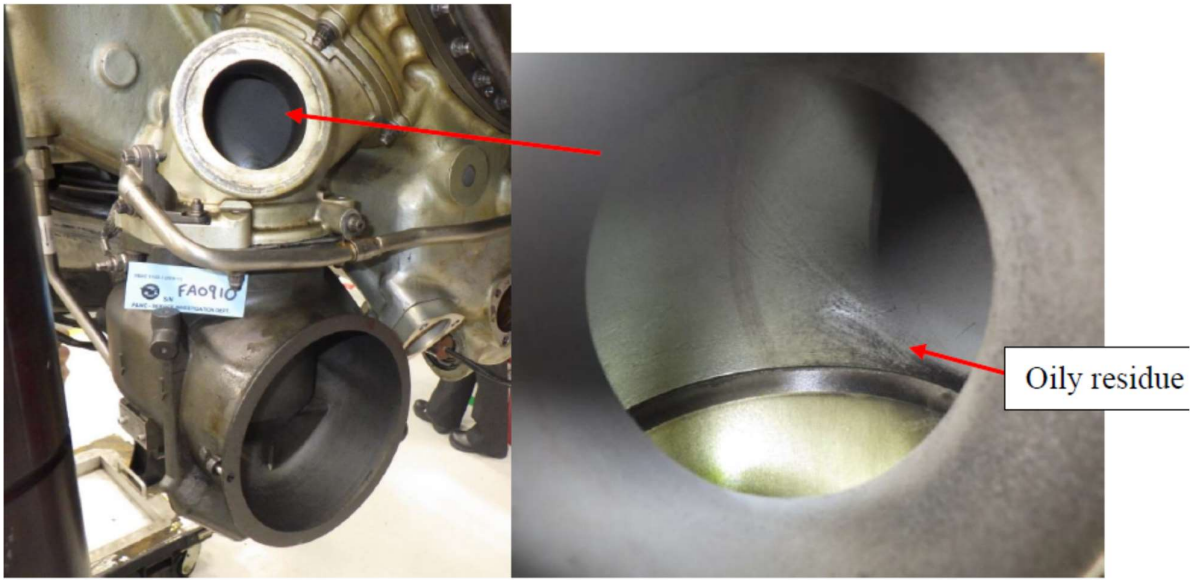


Figure 11: Oily P2.2 Interstage Bleed Valve

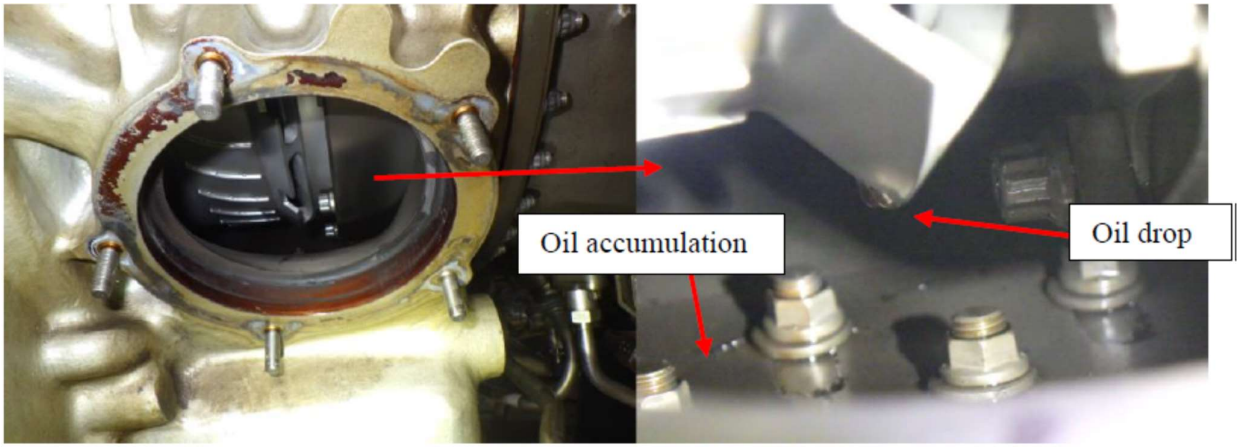


Figure 12: LPC P2.2 Cavity

- The hot section was removed, and no primary distress was observed. The PT shaft exhibited oil and carbon streaks near the P2.5 air holes.

- Examination of the axial compressor showed oil accumulation in all of the rotor bores. The No. 3 bearing housing and cover showed oil leakage and carbon deposits. Several metallic fragments were found on the No. 3 bearing housing cover.

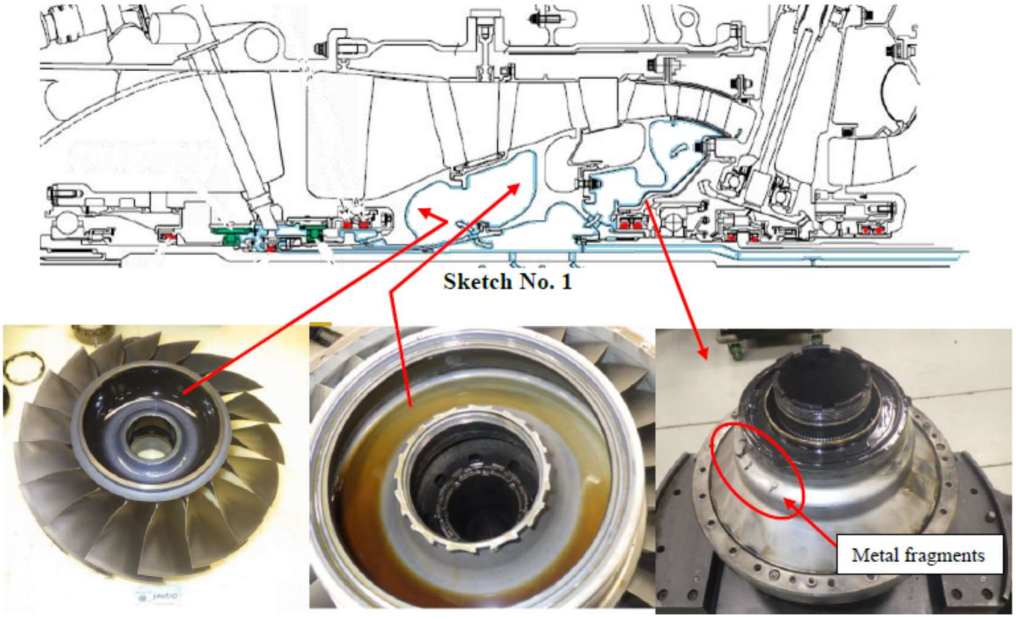


Figure 13: Axial Compressor

- The No.3 carbon seal runner was worn including scratches and grooving along the entire circumference. Dimensional measurement of the No.3 carbon seal runner showed that the diameters (carbon seal running land, air side and oil side) were within limits.

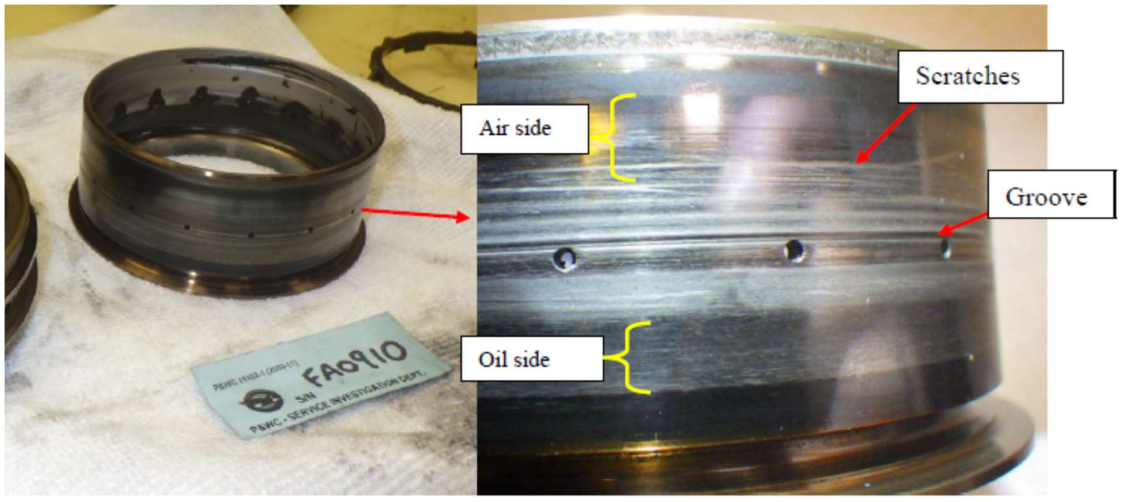


Figure 14: No.3 Carbon seal runner

- Examination of the No.3 carbon seal revealed that the wave spring and oil side washer were worn down to thin fragments, some of which were collected on the No. 3 bearing housing cover and other from behind the carbon elements.

Figure 15: No.3 Carbon Seal wave spring & washer fragments

- The No.3 carbon seal oil side carbon element was worn down axially (approximately 30 % of the carbon material was missing) exposing the retaining band as shown in Photo No. 11. Dimensional measurement of the carbon elements showed that the average diameters were 0.0251 inches (air side) and 0.0261 inches (oil side) over the maximum limit.

Figure 16: No.3 Carbon Seal

- The Inter Compressor Case (ICC) showed oil wetting in the P2.7 cavity and the ICC struts (P2.8 air passages) were fractured.

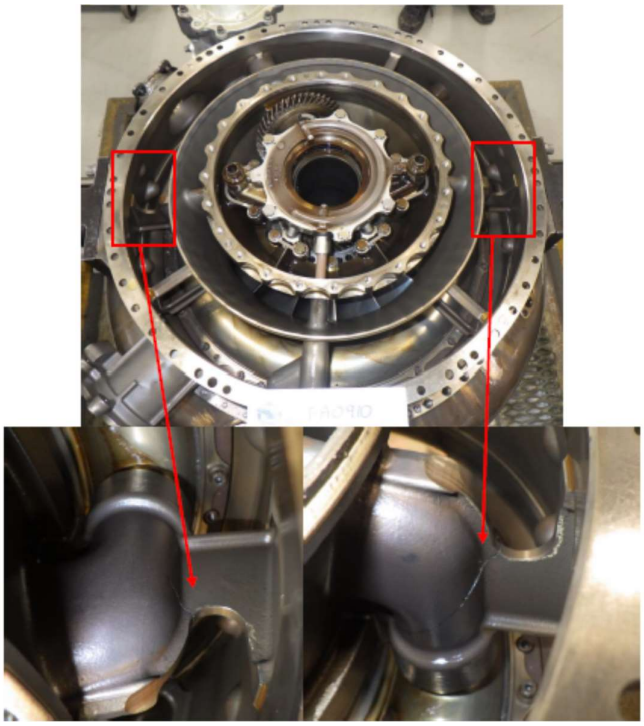


Figure 17: Inter Compressor Case (ICC) strut

Further, the OEM concluded in the engine strip report that, the engine internal oil leak was caused by a deteriorated No. 3 Bearing Carbon Seal. Review of the No.3 carbon seal internal elements revealed evidence that the oil side washer and wave spring spun wore down to thin fragments. The exact cause of the wave spring and washer spinning within the housing was not established. The No. 3 carbon seal was a Post SB35341 configuration. Service Bulletin SB35341 (CAT 6) was introduced in October 2016 to improve the carbon grade used in the carbon seal. The distress mechanism of the carbon seal detailed herein does not show the same degradation characteristic of the Pre SB35341 configuration.

1.17 Organizational and management information:

M/s SpiceJet Ltd.:

SpiceJet is scheduled airline based in Delhi, India and operates domestic and international destinations. The airline is holding a valid Air Operator Certificate no. S-16 issued by DGCA valid up to 16.05.2023. The airline has in-house maintenance facility and maintenance activities are carried out under CAR 145 issued by DGCA.
The organization commenced its operations with the fleet of three Boeing 737-800 aircraft and is consistently expanding its fleet since start of the operations in May 2005. SpiceJet current fleet is a composition of 47 Boeing B737 (Passenger & Freighter), 32 DHC-8 Q400 and 13 Boeing B737-8 MAX aircraft. Total fleet of 92 as on date.

1.18 Additional information: NIL.

1.19 Useful or effective investigation techniques: NIL.

2. ANALYSIS

2.1 Operational aspect of aircraft:

Both the crew members were medically fit, had valid license, provided adequate rest, and found to be within FDTL limits before they operated flight SJ 3735 (Goa-Hyderabad) on 12.10.2022. Flight SG-3735 was the sixth flight of the day by VT-SQB aircraft and for both the flight crew it was fourth flight of the day. The Pilot in Command (PIC) performed the duties of the Pilot Flying (PF) and First Officer (FO) performed the duties of Pilot Monitoring (PM) in all the four sectors.

The aircraft took-off from Goa at time 162434 UTC without any event. On completion of approx. 30 minutes of flight and while cruising at FL210, Lavatory Smoke Warning got activated and the Cabin Crew witnessed no smoke & smell after inspection. Cabin crew informed the same to the PIC and reset the smoke detector with the concurrence of PIC.

Further while cruising at the same flight level after approx. 6 minutes, crew carried out descent checklist. At the same time, cabin crew informed the PIC that there is little smoke from cabin ceiling but no smell, PIC said ok and instructed cabin crew to secure cabin for landing. At 171237 UTC, as FO requested for descent, Hyderabad ATC instructed to descent to FL170. At this time, crew discussed the QRH checklist items of Fuselage Fire, Smoke or Fumes and PIC turned off Recirculation Fan. Meanwhile, cabin crew informed PIC that cabin is secured for landing and also informed that the situation is ok now.

On further descent request by FO with Approach radar, it instructed the aircraft to descent to FL110. At 171631 UTC cabin crew informed PIC that the cabin was filling with thick Smoke, with that PIC instructed to follow the drill. As the smoke was also felt in the cockpit, crew donned oxygen masks, smoke goggles and established communication. At 171758 UTC, the cockpit crew contacted Approach radar and declared MAYDAY due to smoke in the cabin and requested for RWY09. ATC approved and vectored for RWY09R.

During the VOR approach at 4000ft, the SMOKE & CHECK FIRE DET warning came ON along with SMOKE/EXTG switch on the AFT Baggage panel illuminated for which PIC immediately operated the fire extinguisher bottles. At 172250UTC, the aircraft was cleared by ATC for landing at Hyderabad with visibility 4000 meters, winds variable 04Kts, and caution with RWY surface wet. The crew carried out the checklists and all call outs as required and carried out safe landing at Hyderabad on Runway 09R at 1728 UTC, with vertical acceleration of 0.966g, (which is not a hard landing) and vacated RWY via Rapid Exit Taxiway 'L1' and stopped on TWY. PAX evacuation was carried out on taxiway from all the exit doors i.e., L1, R1, L2 and R2 doors. During evacuation, one passenger had minor right knee injury. There was no fire. Later, the aircraft was towed to stand 44. At 1808 UTC, full emergency was withdrawn by ATC.

From the above it is inferred that the crew actions were in line with the standard operating procedures as per FCOM/Checklists.

2.2 Weather:

The aircraft took off from Goa at around 162434 UTC and weather reported for Hyderabad was within the crew operating minima. The weather reported was fine with visibility reported 4000 meters with winds variable 04Kts and feeble rain & thunderstorm with caution runway surface wet. Hence, the weather is not a factor to the incident.

2.3 Engineering aspect of the aircraft:

M/s SpiceJet Bombardier DHC-8-402 aircraft MSN 4584, Indian Registration VT-SQB with PW150A Engines, was registered with DGCA under the ownership of M/s Industrial International Aircraft Leasing 1 Ltd. on 23rd October 2018. The aircraft is registered under Category 'A' and the Certificate of Registration No is 4974/2. As on 12th October 2022, the aircraft had logged 10153:42 Airframe Hours and 8232 Cycles. The aircraft was operated under Scheduled Operator's Permit No S-16 which was valid as on date.

Bombardier DHC-8-402 aircraft and its engines are being maintained as per the maintenance program approved by the Regional Airworthiness Office, O/o DGCA, New Delhi. The aircraft weight and Center of Gravity (CG) were within limits.

Transit inspections are carried out as per approved Transit Inspection schedules and all the higher inspection schedules include checks/ inspection as per the manufacturer's guidelines as specified in the Maintenance Program and are approved by the Continuing Airworthiness Manager (CAMO) — post holder for Continuous Airworthiness.

All the concerned Airworthiness Directive, Mandatory Service Bulletins, DGCA Mandatory Modifications on this aircraft and its engines has been complied with as on day of the event. There were no abnormal observations noticed by airline engineering during the compliance of the ADs & SBs.

Post incident, the engineering found the following observations during initial inspection:

1. There were oil fumes smell in the cabin and oil coming from the LH engine drains. Low oil quantity on LH engine was observed.
2. Found evidence of oil wetness and accumulation on P2.2 and P2.7 HBOV (Handling Bleed-off Valves) outlet ports and the P2.2, P3.0 and P2.7 airframe bleed air ducts. ECS compartment was observed with oil wetness/accumulation on cabin ACM compressor discharge port.
3. Metal chips found on the Turbo-Machinery (TM) chip detector.
4. Boroscopic inspection of HP impeller, observed oil on the impeller. Boroscope Inspection of the Inter Compressor Case (ICC) Strut was found crack in the ICC Strut area.

The defect record of the aircraft (30 days prior to the incident flight) was scrutinized on the date of occurrence of the incident and no defect was pending on the aircraft prior to the incident flight.

Engine Shop Report

The involved ENG#1 S.no PCE-FA0910 was sent to manufacturer facility for investigation.

During detailed examination, it was identified that the engine internal oil leak was caused by a deteriorated No. 3 Bearing Carbon Seal. Review of the No.3 Bearing carbon seal internal elements observed that the oil side washer and wave spring spun wore down to thin fragments. The exact cause of the wave spring and washer spinning within the housing could not be established.

The No. 3 Bearing carbon seal was a Post Service Bulletin SB35341 configuration. Service Bulletin SB35341 (CAT 6) was introduced in October 2016 to improve the carbon grade used in the carbon seal. M/s SpiceJet has carried out the replacement of no. 3 bearing carbon seal during the shop visit in 2018 for overhaul at TSN – 11647:36 hrs. The replaced upgraded carbon seal has failed on the incident flight after approx. 7224 hrs. The OEM stated that, the distress mechanism of the carbon seal detailed herein does not show the same degradation characteristic of the Pre SB35341 configuration.

Further, the OEM has initiated the long-term mitigation action in design improvement activity and advised the operators to carry out the short-term mitigation action i.e., Oil Analysis Technology sampling to be done at 250-300 hours intervals and monitoring of Fault Code 938 (Check for faults every 65 hours), the same is being complied by M/s SpiceJet.

From the above it is inferred that the ENG#1 internal oil leak was caused by a deteriorated No. 3 Bearing Carbon Seal, which got in contact with hot surfaces inside the engine, causing fumes/smoke and enter into the cabin through the bleed air system.

3. CONCLUSIONS

3.1 Findings:

1. The Certificate of Airworthiness and the Certificate of Registration of the aircraft was valid on the date of incident.
2. The certificate of flight release was valid on the day of incident.
3. All the concerned Airworthiness Directive, mandatory Service Bulletins, mandatory modifications on this aircraft and its engine have been complied with as and when due.
4. The aircraft was cleared by engineering at Goa and from the defect record of the aircraft it was observed that no defect was pending on the aircraft prior to the incident flight.
5. The aircraft weight and CG were within limits.
6. Both crew members were appropriately qualified to operate the flight. The PIC was PF (Pilot Flying) and FO was PM (Pilot Monitoring).
7. Prior to the incident flight (GOI-HYD) the same crew had operated three sectors (BLR-SAG, SAG-HYD, and HYD-GOI) and there was no snag reported on the aircraft. All the three sectors were uneventful.
8. The cockpit crew contacted Approach radar and declared MAYDAY due to smoke in

the cabin and requested for RWY09.

9. Crew carried out a safe landing at Hyderabad on Runway 09R at 1728 UTC and vacated RWY via Rapid Exit Taxiway 'L1' and stopped on TWY. PAX evacuation was carried out on taxiway from all the exit doors. During evacuation, one passenger had minor right knee injury. There was no fire.
10. No external damage to the aircraft.
11. The recorded landing g-value was 0.966g, which is within the AMM limits and it is not a hard landing.
12. Crew actions were satisfactory and in compliance of the FCOM procedure/checklists.
13. Both the cockpit crew had submitted the BA self-declaration form (for non-consumption of alcohol) prior to undertaking the first flight for the day as per the existing guidelines at that period.
14. Weather was not a factor to the incident.
15. The engine strip inspection was carried out at manufacture facility and the shop report reveals that the engine#1 internal oil leak was caused by a deteriorated No. 3 Bearing Carbon Seal.
16. 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 air system.
17. The No. 3 Bearing Carbon Seal was a Post Service Bulletin SB35341 configuration. Service Bulletin SB35341 (CAT 6) was introduced in October 2016 to improve the carbon grade used in the carbon seal. The replaced upgraded carbon seal has failed on the incident flight after approx. 7224 hrs.
18. The OEM has initiated the long-term mitigation action in design improvement activity and advised the operators to carry out the short-term mitigation action i.e., Oil Analysis Technology sampling to be done at 250-300 hours intervals and monitoring of Fault Code 938 (Check for faults every 65 hours), the same is being complied by M/s SpiceJet.

3.2 Probable Cause:

The incident occurred due to the failure of No. 3 Bearing Carbon Seal of ENG#1, which resulted in oil leaking into the gas path and smoke/fumes entering into the aircraft cabin through the bleed air system.

4. Safety Recommendations: NIL.

(Sahithi D)
Asst. Director of Air Safety
Member

(Preetham Reddy N)
Asst. Director of Air Safety
Investigator-in-Charge

Place: Chennai
Dated: 10.11.2023

------END OF THE REPORT------