FINAL REPORT

AIC 20 - 2001

Qantas Airways Limited

VH-QOE

DHC-8-402

In-flight smoke event

About 22 nautical miles South of Jacksons International Airport

Port Moresby

PAPUA NEW GUINEA

16 March 2020

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About the AIC

The Accident Investigation Commission (AIC) is an independent statutory agency within Papua New Guinea (PNG). The AIC is governed by a Commission and is entirely separate from the judiciary, transport regulators, policy makers and service providers. The AIC's function is to improve safety and public confidence in the aviation mode of transport through excellence in: independent investigation of aviation accidents and other safety occurrences within the aviation system; safety data recording and analysis; and fostering safety awareness, knowledge and action.

The AIC is responsible for investigating accidents and other transport safety matters involving civil aviation in PNG, as well as participating in overseas investigations involving PNG registered aircraft. A primary concern is the safety of commercial transport, with particular regard to fare-paying passenger operations.

The AIC performs its functions in accordance with the provisions of the *PNG Civil Aviation Act 2000 (As Amended)*, and the *Commissions of Inquiry Act 1951*, and in accordance with *Annex 13* to the *Convention on International Civil Aviation*.

The object of a safety investigation is to identify and reduce safety-related risk. AIC investigations determine and communicate the safety factors related to the transport safety matter being investigated.

It is not a function of the AIC to apportion blame or determine liability. At the same time, an investigation report must include relevant material of sufficient weight to support the analysis and findings. At all times the AIC endeavours to balance the use of material that could imply adverse comment with the need to properly explain what happened, and why it happened, in a fair and unbiased manner.

About this report

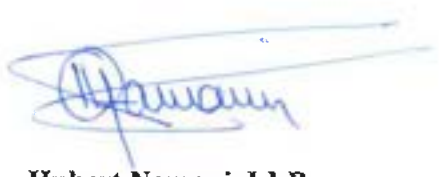
On 16 March 2020 at 03:43 UTC (13:43 local time), the Civil Aviation Safety Authority of PNG (CASA PNG) notified the PNG AIC via email of the serious incident that occurred earlier that day, involving a Bombardier DHC-8-402 aircraft, registered VH-QOE, owned by Qantas Airways Limited and operated by Sunstate Airlines (QLD) Pty Ltd. The AIC immediately commenced an investigation and dispatched a team of investigators to perform on-site activities.

This *Final Report* has been produced by the AIC pursuant to *ICAO Annex 13* and has been approved for public release.

The report is based on the investigation carried out by the AIC under the Papua New Guinea *Civil Aviation Act 2000 (As Amended),* and *Annex 13* to the *Convention on International Civil Aviation*. It contains factual information, analysis of that information, findings and contributing (causal) factors, other factors, safety actions and safety recommendations.

Although AIC investigations explore the areas surrounding an occurrence, emphasis is placed on those facts that are relevant to understanding how and why the accident occurred are included in the report. The report may also contain other non-contributing factors which have been identified as safety deficiencies for the purpose of improving safety.

Readers are advised that in accordance with *Annex 13 to the Convention on International Civil Aviation*, it is not the purpose of an AIC aircraft accident investigation to apportion blame or liability. The sole objective of the investigation and the final report is the prevention of accidents and incidents (Reference*: ICAO Annex 13, Chapter 3, paragraph 3.1*). Consequently, AIC reports are confined to matters of safety significance and may be misleading if used for any other purpose.



Hubert Namani, LLB
Chief Commissioner
21 September 2021

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GLOSSARY OF ABBREVIATION

AFTN	**:** Aeronautical Fixed Telecommunication Network
AMSL	: Above Mean Sea Level
AOC	: Air Operator Certificate
ARFF	: Aviation Rescue and Fire Fighting
ASL	: Air Services Limited
ATC	: Air Traffic Control
ATS	: Air Traffic Services
CAR	: Civil Aviation Rules
CASA	: Civil Aviation Safety Authority
CPL	: Commercial Pilot License
CVR	: Cockpit Voice Recorder
ELT	: Emergency Locator Transmitter
ERP	: Emergency Response Plan
ETA	: Estimated Time of Arrival/Estimating Arrival
FCOM	: Flight Crew Operating Manual
FDR	: Flight Data Recorder
FIS	: Flight Information Service
FM	: Flight Manual
Ft	: Foot (Feet)
GPS	: Global Positioning System
H	: Hour(S)
HF	: High Frequency (3 000 To 30 000 Khz)
hPa	: Hectopascal
IFR	: Instrument Flight Rules
Kt	: Knot(S)
M	: Metre(S)
MEL	: Minimum Equipment List
MH_z	: Megahertz
Min	: Minute(S)
Mt	: Mount
NAC	: National Airport Cooperation
Nm	: Nautical Miles
NW	: North West
P&WC	: Pratt & Whitney Canada
PIC	: Pilot-In Command
RPM	: Revolutions Per Minute
S	: Second(S)
SMS	: Safety Management System
SOP	: Standard Operating Procedure(S)
TAF	: Terminal Aerodrome Forecast
TSBC	: Transportation Safety Board of Canada
TSN	: Time Since New
UTC	: Coordinated Universal Time
VFR	: Visual Flight Rules
VHF	: Very High Frequency (30 To 300 Mhz)

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INTRODUCTION

SYNOPSIS

On 16 March 2020, at about 11:29 local, the flight crew of a Bombardier DHC-8-402, registered VH-QOE, owned by Qantas Airways Ltd and operated by Sunstate Airlines (QLD) Pty Ltd enroute from Jacksons International Airport, Port Moresby, Papua New Guinea to Cairns International Airport, Queensland, Australia on a scheduled passenger flight, declared a PAN as a result of an in-flight smoke/fumes event.

The flight crew identified an unusual smell entering the cockpit which intensified as the aircraft continued climbing. After passing 10,000 ft, the cabin crew confirmed that the unusual smell extended to the cabin. At 11:28:23 the flight crew commenced the QRH procedure for *"Smoke (Warning Light) or Fuselage Fire, Smoke or Fumes"* by actioning the *RECALL ACTION* items, donning their oxygen masks, and broadcasting a PAN, to then request ATC for a priority return to Port Moresby.

Moresby Radar instructed the crew to track to Jacksons International Airport and plan for an approach to land on runway 32R.

As soon as the aircraft was established on the approach at about 4,000 ft, the smoke alarm in the toilet activated. The crew continued the approach and requested for ARFF to be available upon landing. The control tower then notified the ARFF and a team was sent to a stand by position at taxiway Golf to assist the aircraft as necessary.

The aircraft landed at 11:47:08. After completing the landing roll, the flight crew called the cabin crew to check on the status of the smoke and condition of the passengers. The cabin crew confirmed that the smoke was still present in the cabin and passengers were having trouble breathing.

After exiting the runway, the flight crew stopped the aircraft and shut down the engines at taxiway Foxtrot. The cabin crew conducted a precautionary disembarkation with the assistance of ARFF who were accompanying the aircraft by then. Passengers were later transported to the airport terminal.

There were 12 persons on board the aircraft: 2 flight crew, 2 cabin crew and 8 passengers. No injuries were reported.

The smoke/fume event occurred due to burning oil in the No.2 engine. The oil was found to have leaked from a fractured No.3 bearing carbon seal element.

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1 FACTUAL INFORMATION

1.1 History of the flight

On 16 March 2020, at about 11:29 local (01:29 UTC[1]), the crew of a Bombardier DHC-8-402 aircraft, registered VH-QOE, owned by Qantas Airways Ltd and operated by Sunstate Airlines (Qld) Pty Ltd, on a passenger flight scheduled as QLink 192D from Jacksons International Airport, Port Moresby, Papua New Guinea to Cairns International Airport, Queensland, Australia, declared a PAN[2] about 22 nm South of Jacksons due to an in-flight fumes/smoke emergency event and subsequently returned and landed at Jacksons.

The Pilot in Command (PIC) was the designated pilot flying and the co-pilot was the pilot monitoring.

Before the aircraft took off from Jacksons runway 32R at about 11:19, according to the Cabin Crew 2 (CC2), a smell similar to *dirty socks* was identified and she could not relate the smell to a source. According to the flight crew, during the initial climb and as the aircraft turned left to intercept the planned southbound track at about 3 nm West of Jacksons, they noticed an unusual smell entering the cockpit that they referred to as a smell similar to *dirty socks*. As the smell did not appear strong to them at the time, they initially decided to continue with the flight as planned. The PIC stated in his interview that as the aircraft passed 10,000 ft, he noticed that the smell commenced to intensify.

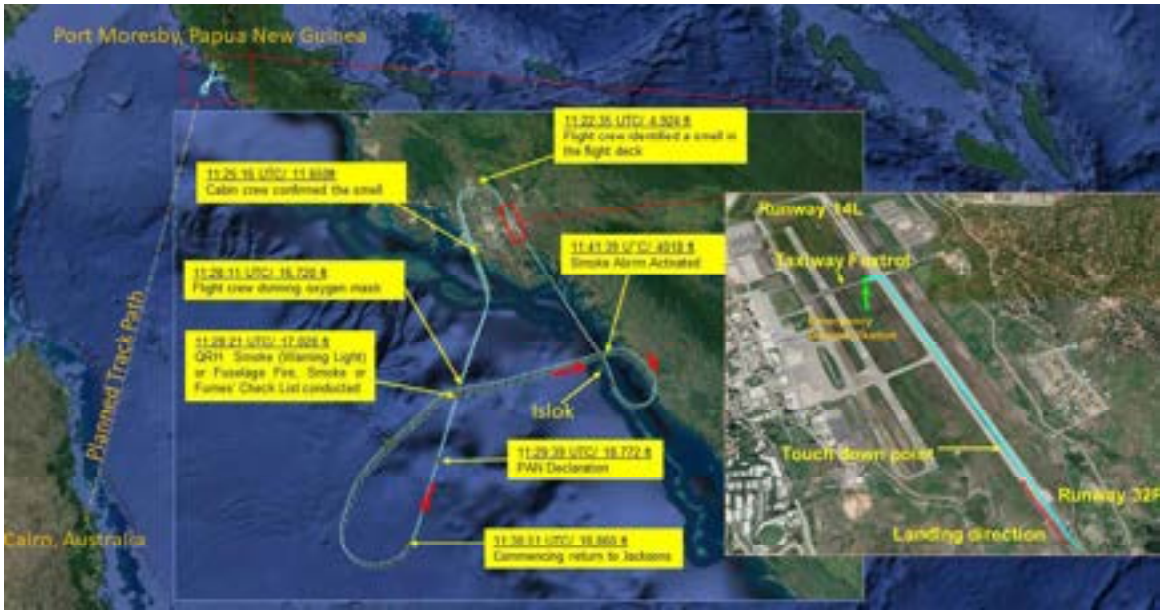

Figure 1. Flight path of VH-QOE

At 11:25:16 as the aircraft was climbing through about 12,000 ft, after being asked by the PIC, both cabin crew confirmed the presence of the unusual smell inside the cabin.

The PIC subsequently instructed the cabin crew to standby while the flight crew assessed the situation and to expect a return to Port Moresby.

At 11:28:11, as the aircraft passed 17,000 ft, just over 15 nm from Port Moresby, the flight crew donned their oxygen masks. The crew then levelled the aircraft off just under 19,000 ft. The crew subsequently

1 The 24-hour clock, in Coordinated Universal Time (UTC), is used in this report to describe the local time as specific events occurred. Local time in the area of the serious incident, Papua New Guinea Time (Pacific/Port Moresby Time) is UTC + 10 hours.

2 Is the international standard urgency signal that someone aboard a boat, ship, aircraft, or other vehicle uses to declare that they have a situation that is urgent, but for the time being, does not pose an immediate danger to anyone's life or to the vessel itself (Source: Wikipedia).

actioned the *RECALL ACTIONS* items of the *Quick Reference Handbook (QRH) 'Smoke (Warning Light) or Fuselage Fire, Smoke or Fumes'* checklist *(see Appendix A, 5.1.2).*

At 11:29:39, about 22 nm from Port Moresby, while maintaining the outbound track, the co-pilot declared a PAN and requested for a priority return to Port Moresby. Moresby Radar subsequently instructed the crew to make a right turn, track towards Port Moresby, and descend to 10,000 ft. At 11:31:28 the crew referred to and continued the *'Smoke (Warning Light) or Fuselage Fire, Smoke or Fumes'* checklist and began at the *'Known Source Fire, Smoke or Fumes'* section. The crew read out but did not action the two action items for the removal of smoke or fumes as they agreed that there was no smoke. The PIC then handed control of the aircraft over to the co-pilot and subsequently informed the cabin crew that they were going to return to Port Moresby due to the fumes, and to expect a normal approach and landing. Subsequently, the PIC instructed the cabin crew to brief the passengers about the emergency situation and the intention to return to Port Moresby.

At 11:32:30, Moresby Radar instructed VH-QOE to contact Jacksons Radar on radio frequency 125.5MHz at that time. The flight crew acknowledged and continued the descent.

The co-pilot initiated a right turn and a descent at about 32 nm from Port Moresby. The PIC took back control from the co-pilot as the aircraft tracked back towards Port Moresby. At 11:34:02, the co-pilot requested Jacksons Radar to track for Bayview[3] to further descend in the *holding pattern*[4] and further requested to conduct a RNAV[5] approach for runway 32R. Moresby Radar instructed the flight crew to track to ISLOK[6] for further descent to 6,000 ft.

The aircraft was established over ISLOK at 11:34:41 as it passed 15,000 ft. The flight crew continued the descent in the holding pattern.
At 11:37:26 while descending through about 12,000 ft, the flight crew commenced the items of the *QRH 'Smoke (Warning Light) or Fuselage Fire, Smoke or Fumes'* checklist referred to *'Unknown Source of Fire, Smoke or Fumes'* section, specifically to *'Bleed Source or Air Conditioning Suspected'* and switched off *Bleed Air 1*. They then waited for about one minute. While waiting, the PIC advised the co-pilot to refer back to *'Known Source of Fire, Smoke or Fumes'* section of the checklist and carried out the two action items for removing smoke or fumes which they had earlier skipped. Subsequently they were called and informed by cabin crew that there was smoke entering the cabin.

The flight crew continued with the checklist, which requires to turn *Bleed Air 1* on and then switch *Bleed Air 2* off. However, the flight crew did not turn *Bleed Air 1* back on and went straight into turning *Bleed Air 2* off.

At 11:40:08, while descending in the hold pattern, passing 8,000 ft, Jacksons Radar called and instructed the crew to further descend to 4,000 ft. The co-pilot acknowledged Jacksons Radar's instructions and advised that they were turning inbound for the approach to runway 32R.

At 11:40:24, while passing through 6,000 ft, turning inbound for the approach, Jacksons Radar called and asked the flight crew if they could accept a speed reduction as there was another ATR aircraft (P2-ATF) on right downwind. The flight crew did not accept and requested to be given priority for landing. Jacksons Radar acknowledged and requested the flight crew to stand by. Subsequently, Jacksons Radar coordinated with Jacksons Tower to have P2-ATF, about to join mid-downwind to give way. Jacksons Tower subsequently instructed P2-ATF to maintain downwind and contact Jacksons Radar. After establishing contact with Jacksons Radar, P2-ATF was asked by Jacksons Radar if they could continue outbound on downwind or if they required a climb. P2-ATF confirmed that they could extend downwind. They continued downwind giving way to VH-QOE.

3 Located 9 miles South East of Jacksons runway 32R.
4 A predetermined maneuver which keeps an aircraft within a specific airspace while awaiting further clearance. *(Source: PNG MATS*)
5 Area Navigation.
6 Runway 32R RNAV Approach Initial Approach Fix

At 11:41:18, VH-QOE's co-pilot called Jacksons Radar and reiterated the request for priority for landing due to smoke and fumes in the cabin and asked for further descent. Jacksons Radar cleared VH-QOE for a visual approach for runway 32R.

At 11:42:08, established overhead ISLOK at about 4,000 ft, in the approach for runway 32R, the Senior Cabin Crew (SCC)[7] opened the lavatory door to identify if the smoke was coming from that area. In doing so, smoke went from the cabin into the lavatory and activated the smoke aural alarm. The flight crew continued the approach and, by then, Jacksons Radar advised VH-QOE to call Jacksons Tower on the frequency 118.1 MHz.

At 11:42:48, VH-QOE was cleared to land by Jacksons Tower. Subsequently, the crew configured the aircraft for landing and conducted a normal visual approach, landing at 11:47:08.

The aircraft exited the runway via taxiway Foxtrot. ATC requested for the crew's intentions and were subsequently informed by the PIC that they would conduct a precautionary disembarkation at that position due to smoke in the cabin. At 11:48:21, the crew shut down the engines. The passengers were then requested by the cabin crew to disembark through the main exit door and were led away from the aircraft where according to the cabin crew, about 30 minutes later they were picked up and transported with their luggage to the terminal. The ARFF remained at taxiway Foxtrot until the aircraft was towed to Bay 23.

1.2 Injuries to persons

Injuries	Crew	Passengers	Total in Aircraft	Others
Fatal	-	-	-	-
Serious	-	-	-	-
Minor	-	-	-	Not applicable
Nil Injuries	4	8	12	Not applicable
TOTAL	4	8	12	-

Table 1: Injuries to persons

1.3 Damage to the aircraft

There was no damage sustained by the aircraft.

1.4 Other Damage

Not applicable.

7 In charge cabin crew member. ICAO DOC 10062 definition: Cabin crew leader who has overall responsibility for the conduct and coordination of cabin procedures applicable during operation and during abnormal and emergency situations for flights operated with more than one cabin crew member.

1.5 Personnel information

1.5.1 Pilot in command

Age	: 35 years
Gender	: Male
Nationality	: Australian
Position	: Line Pilot
Type of license	: ATPL (Australian)
Type rating	: DHC8-Q400
Route Competency Check valid to	: 09 November 2020
Total flying time	: 7,366.21 hours
Total on DHC8-Q400	: 2,289.15 hours
Total hours last 7 days	: 6.02 hours
Total hours last 24 hours	: 2.37 hours
Medical Class	: One
Valid to	: 29 July 2021
Medical limitations	: Nil

1.5.2 Co-pilot

Age	: 29
Gender	: Male
Nationality	: Australian
Position	: Line Pilot
Type of license	: CPL (Australian)
Type rating	: DHC8-Q400
Total flying time	: 1,614.41 hours
Total DHC-8-Q400	: 363.49 hours
Total hours last 7 days	: 22.46 hours
Total hours last 24 hours	: 2.37 hours
Medical class	: One
Valid to	: 09 Jan 2021
Medical limitations	: Nil

1.5.3 Senior Cabin Crew (SCC)

Age	: 45 years
Gender	: Female
Nationality	: Australian
Type rating	: DHC-8
Type of certificate	: Emergency Procedures Training
Valid to	: 29 March 2020
Competency Line Check Valid	: 30 September 2020
Total flying experience	: 14.5 years
Total hours last 90 days	: 91.7 hours
Total hours last 7 days	: 12.5 hours
Total hours last 24 hours	: 2.50 hours

1.5.4 Cabin Crew 2 (CC2)

Age	: 50 years
Gender	: Female
Nationality	: Japanese
Type rating	: DHC-8
Type of certificate	: Emergency Procedures Training
Valid to	: 06 May 2020
Competency Line Check Valid	: 31 May 2020
Total flying experience	: 12.9 years
Total hours last 90 days	: 183.00 hours
Total hours last 7 days	: 18.00 hours
Total hours last 24 hours	: 2.50 hours

1.6 Aircraft Information

1.6.1 Aircraft data

Aircraft manufacturer	: Bombardier Inc.
Type and Model	: DHC-8-402
Serial number	: 4125
Year of manufacture	: 2006
Registration	: VH-QOE
Name of the owner	: Qantas Airways Ltd
Name of the Operator	: Sunstate Airlines Pty Ltd
Certificate of Airworthiness number	: PLH/064
Certificate of Airworthiness issued	: 22 June 2006
Valid to	: Non-terminating
Certificate of Registration number	: Not Applicable
Certificate of Registration issued	: 6 February 2012
Certificate of Registration valid to	: Non-terminating
Total airframe hours	: 29,011.15 hours
Total airframe cycles	: 30,557 cycles

1.6.2 Engine Data

Engine type	: Turboprop
Manufacturer	: Pratt and Whitney Canada (P&WC)
Model	: PW150A

Engine No. 1

Serial number	: PCE-FA0273
Date of manufacture	: November 2005
Total time since new	: 21,835.6 hours
Cycles since new	: 23,910
Time since Hot Section Inspection	: 3,444.54 hours
Cycles since Hot Section Inspection	: 3,522
Cycle since last Overhaul	: 7,515
Time since last Overhaul	: 7,202.11 hours

Engine No. 2

Serial number	: PCE-FA1139
Date of manufacture	: July 2015
Total time since new	: 9,218.11 hours
Cycles since new	: 9,656
Time since Hot Section Inspection	: Not applicable
Cycles since Hot Section Inspection	: Not applicable
Time since last Overhaul	: Not applicable
Cycles since last Overhaul	: Not applicable

1.6.3 Propeller

Manufacturer	: Dowty Aerospace Propellers
Type and Model	: R408/6-123-F/17

Propeller No. 1 (Left)

Serial Number	: DAP0300
Total time	: 24,161.08 hours
Total cycles	: 26,408
Total time since Overhaul	: 3,806.08 hours
Cycles since Overhaul	: 3,838

Propeller No. 2 (Right)

Serial Number	: DAP0638
Total time	: 20,214.56 hours
Total cycles	: 21,288
Total time since Overhaul	: 9,422.15 hours
Cycles since Overhaul	: 9,887

1.6.4 Smoke Detection System

The aircraft has a smoke detection system installed at the forward and aft baggage compartments and at the lavatory to detect smoke. The devices installed in each compartment are photosensitive devices.

Smoke detectors in the baggage compartments turn on indications on the Fire Protection Panel (FPP), Glareshield Panel, and Caution and Warning Panel in the cockpit.

Presence of smoke in the lavatory compartment causes the repeater lights in the passenger compartment ceiling to turn on, and a single audible warning (high chime) in the passenger address system to sound, followed by an audio alert on the smoke detector. There is no indication in the cockpit of smoke events in the lavatory.

During the interviews, the flight crew did not indicate any smoke detector alert observations. According to the CVR data, at 11:42:08 an audible loud chime alert was sounded followed by a sound of an audible alert. According to the SCC, the activation of the smoke alarm was caused by smoke entering the lavatory as she opened the lavatory door to identify if the smoke was coming from there.

1.6.5 Bleed Air System

Air for pressurisation 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.

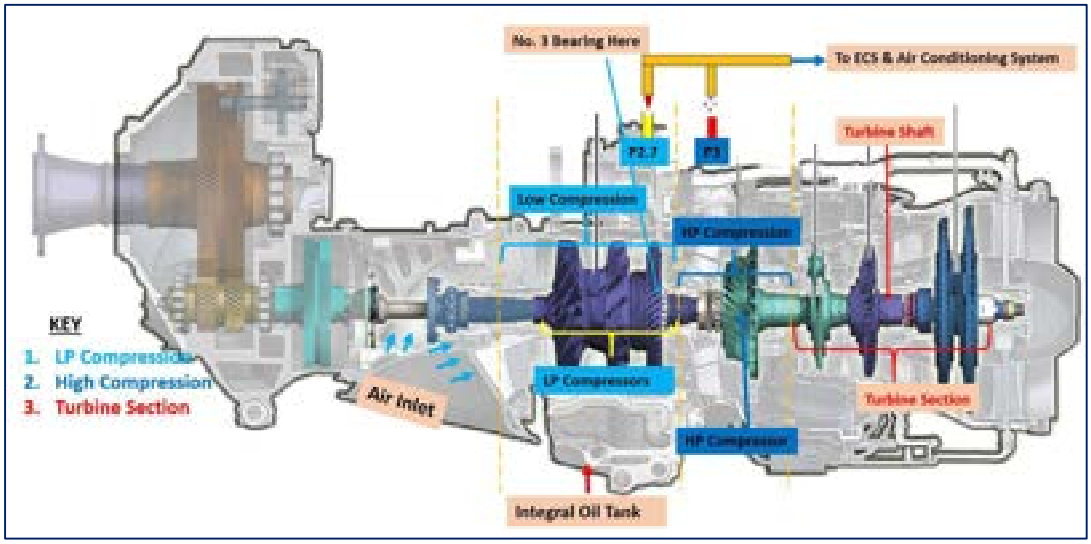

Figure 2. Bleed Air extraction

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.

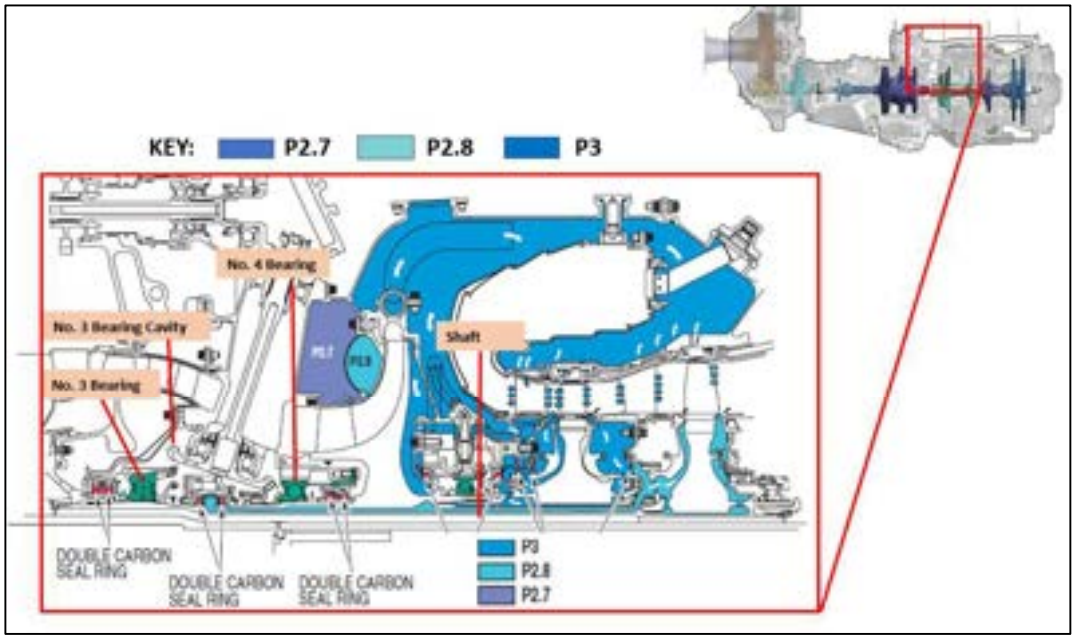

Figure 3. Bearing and Carbon seal location

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.

1.6.6 Right Engine Inspection/Examination

1.6.6.1 Right Engine Inspection and Examination

On 18 March 2020, the AIC together with engineers from Air Niugini, conducted a preliminary borescope inspection on the No.2 engine and observed evidence of oil in the inter compressor.

The engine was recommended for further examination. It was then subsequently removed and sent to P&WC Service Centre in St-Hubert, Quebec, Canada for a detailed inspection, arriving on 23 June 2020, where it remained in quarantine due to the Covid-19 pandemic restrictions. Between 21 and 23 September 2020, the engine was subject to a disassembly and a detailed examination under the supervision of the Accredited Representative to the investigation from the Transportation Safety Board of Canada (TSBC).

On 1 February 2021, P&WC provided an *Engine/Component Investigation Report* to the AIC.

NOTE: The AIC report focuses only on findings and analysis from the P&WC report that were identified as being relevant to the AIC investigation.

Refer to the *Appendix B, 5.2* for the findings from P&WC.

According to P&WC *Engine/Component Investigation Report*, the removal of the turbomachine (TM) magnetic chip detector (MCD) showed fuzz material while the reduction gearbox (RGB) and the AC generator MCD were clean. The P2.2 bleed air adapter and the P2.7/P3 check-valve revealed greasy surfaces during the examination.

Figure 4. Chip Detectors, bleed air adapter and Check valve

Upon the removal of P2.2 bleed air adapter, an oil puddle was observed at the bottom of the low pressure compressor case (LPC). Coked oil was observed at the bottom of the turbine support case, *see Figure 5.*

Figure 5. LP compressor(1) and turbine support case(2)

Removal of the Power Turbine 2 (PT2) disk assembly showed that there was coked oil at the bottom of the PT vane ring (1) and PT1 disk assembly was greasy *(see figure 6).*

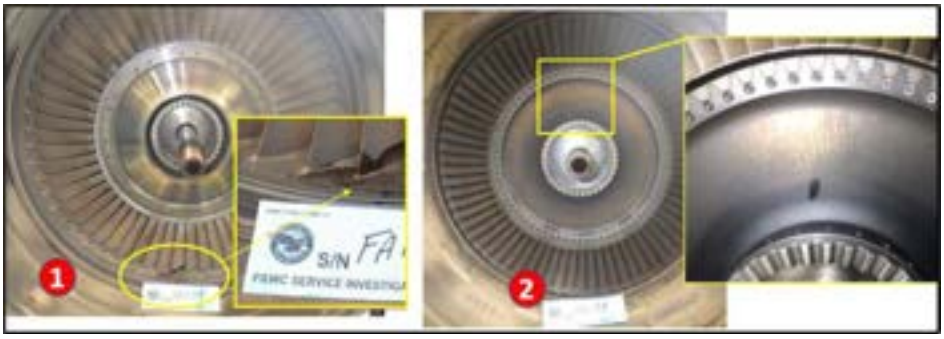

Figure 6. PT vane ring and PT1 assembly

The turbine support case (TSC) revealed oil puddle at the bottom of the gas generator case. A minimum amount of oil was noticed in the 1st stage compressor stator *(see figure 7)*.

Figure 7. Oil evidence

When the LPC and 3rd stage bottom half stator were removed, there was oil puddle observed in the respective component (*see figure 8).* There was oil wetness observed next to the No.6.5 bearing carbon seals and next to the secondary air passage hole on the PT shaft.

Figure 8. No.6.5 Bearing seal, 3rd Stage rotor case and PT Shaft

When the 1st stage LPC rotor was removed, oil wetness associated with debris on its hub back face was observed. Also, on the 2nd stage LPC rotor hub, oil puddle and rubbing on the LPC stator was also observed.

Figure 9. 1st LPC stator and rotor hub

After the removal of the LPC assembly, oil wetness was observed in the inter compressor case (ICC) and cracks at the two air boss.

Figure 10. LPC Assembly

The 1st stage LPC stator showed 2 rubbing marks and the 2nd and 3rd stages LPC rotor exhibited rubbing on all blade tips (*see figure 11*).

Figure 11. 2nd stage LPC stator and rotor hub and 1st stage LPC rotor hub back face

When the No. 3 bearing carbon seal was removed, the carbon element on the air side was found fractured in multiple pieces. The retaining band and the wave spring remained in their respective positions (*see figure 12*).

Figure 12. No. 3 bearing carbon seal

When the No.5 bearing flex was removed from the diffuser case, coked oil was found in the heat shield air core (*see figure 13*).

Figure 13. No. 3 bearing carbon seal and the No.5 bearing flex

1.6.6.2 No.3 Bearing Carbon Seal

The carbon seal fitted in the engine had the part number (P/N) 3053630-01. According to the *PW150 SERIES CIR (Cleaning, Inspection and Repair) MANUAL (PART NO. 3043526)*, the carbon seal has a service limit (soft time[8]) of 10,000 hours since new or since last overhaul and shall be replaced with a new one when the component reaches the limit if the next on-wing interval period can result in more than this limit. The Manufacturer further stated, however, that the design intent for the carbon seals was not to have a specific 'wear-out' life, but rather to have no significant wear in-between normal engine inspection intervals. The carbon seals were intended to be replaced during scheduled inspections due to minor 'wear and tear'

1.6.6.2.1 No.3 Bearing Carbon Seal Issue Trends

According to P&WC, regarding carbon seal P/N 3053630-01, it was established that the local operating temperatures were such that the normal design intent was not met which meant there was a probability that the carbon seal could experience a rather sudden mode of fracture not necessarily preventable by scheduled inspection.

The P&WC also stated that carbon seal failure events had been reported on the PW150A fleet in the past. Certain common elements or trends identified by the report that characterize fracture of the carbon seal included:

- *No.3 carbon seal wear characterized as wear-out, at TSN[9] 8,500hrs+*
- *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.*
- *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.*

8 soft time interval is one that is chosen by an operator to be done at a specific interval but may be adjusted to fit their operational schedule. This interval may or may not be recommended by the manufacturer (Ref: http://www.faa-aircraft-certification.com/soft-time-hard-time-and-oc-cm-components.html).

9 Time Since New

P&WC later clarified that 8,500 hrs referred to the earliest reported time (TSN) on their record for an engine to have had a No.3 bearing carbon seal fail. According to P&WC, proactive actions to limit the rate of No. 3 bearing carbon seal driven events had been implemented in two phases:

(1) proactive replacement of the carbon seal at engine shop visit starting in Jan 2013 (replacement with new or overhauled seal, same configuration)

(2) proactive upgrade to SB35341 of the carbon seal at engine shop visit starting in Oct 2016.

According to their records, the rate of events had been reduced from 4 events per year in 2012 (rate of 0.0028events per 1000hrs) to less than 2 events per year from 2013 onwards (rate lower than 0.001events/1000hrs) and zero events since March 2020.

At the time of the occurrence, the affected engine had clocked more than 9,200 hours without a disassembly and was scheduled for a planned removal from the aircraft on 31 July 2020.

1.6.6.3 Service Bulletin SB 35341

In an email response to the AIC's queries, the Manufacturer stated that a trend was established from their investigations into past engine issue reports, specifically related to the No.3 bearing carbon seal PN: 3053630-01 wear out and failure. They believe that the wear-out is because of the process of exudation of salt and oxidation of the air side carbon element, resulting from high operating temperatures and humid environments. They also stated that similar events had been reported on carbon seals with time since new higher than 8,500hrs (with 85% of these events being on carbon seal with time since new above 10,000 hrs).

On 6 October 2016, P&WC issued a Service Bulletin (SB), number 35341, to operators and owners of aircraft fitted with the PW150A engine serial numbers PCE-FA1238 and before (*see Appendix C, 5.3)*, which included the engine involved in this serious incident.

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, at engine shop visits.

1.6.7 Airworthiness and maintenance

1.6.7.1 Regulatory Requirements

At the time of the serious incident the aircraft had a current Certificate of Airworthiness (CoA) and Certificate of Registration (CoR).

1.6.7.2 Scheduled Maintenance and Engine Logbook

The AIC reviewed the maintenance records of the six months prior to the occurrence. No outstanding scheduled tasks or pending defects were found, and the aircraft was deemed to be serviceable at the time of the serious incident.

The review of the Engine Logbooks also revealed that the involved engine did not visit any overhaul facilities.

In the context of this occurrence, SB 35341 was to be implemented when the engine sub-assembly had been disassembled, and access became available to the seal. At the time of the serious incident, engine 2 had a total time of 9,218.11 hours since new. According to the information initially provided by the Operator, the engine would go for shop visit depending on the engine performance read out given by the engine conditions trend monitoring (ECTM) or borescope inspection. According to records provided during the comment period, the initial scheduled shop visit date was 22 May 2020 and was rescheduled to 31 July 2020.

Because no specific information regarding the scope of the engine work after removal was provided to the AIC, the investigation could not determine the work scope of the schedule visit and whether the No. 3 bearing carbon seal was one of the components subject for removal and replacement.

1.6.7.3 Minimum Equipment List

There was no outstanding *Minimum Equipment List (MEL)* item at the time of the serious incident.

1.6.8 Fuel information

The fuel type used was JET-A1. The total fuel on board before departure was 4,496.55 litres (3,610 Kg). The investigation determined that fuel was not a contributing factor in this serious incident.

1.6.9 Weight and Balance

The weight and cargo distribution information provided by the Operator showed that the aircraft was within its weight and centre of gravity limits.

1.6.10 Collision Avoidance Systems

The aircraft was fitted with a Traffic Alert and Collision Avoidance System (TCAS) and Enhanced Ground Proximity Warning System (EGPWS). Collision avoidance system was not a factor in this serious incident.

1.7 Metrological Information

1.7.1 Weather Forecast

The Weather Forecast that was provided by the National Weather Service was valid from 04:00 on 16 March 2020 to 04:00 on 17 March 2020, and was as follows:

Wind	: Variable winds blowing at 3kt
Weather	: Good visibility
Cloud	: Broken clouds at 3,500 ft

A slight change in weather expected between 05:00 and 07:00 on 16 March 2020 was as follows:

Weather	: visibility up to 700 m with fog
Temperature	: 25°C, 25°C, 29°C and 28°C (six-hourly interval between 04:00 on 16 March 2020 to 04:00 on 17 March 2020)
QNH	: 1007 hPa, 1008 hPa, 1010 hPa and 1009 hPa (six-hourly interval between 04:00 on 16 March 2020 to 04:00 on 17 March 2020)

1.7.2 Terminal Aerodrome Forecast

The Terminal Aerodrome Forecast for Port Moresby that was provided by the National Weather Service was valid from 10:00 on 16 March 2020 to 10:00 on 17 March 2020, and was as follows:

Wind	: Blowing 340° at 10 kt
Weather	: Good visibility
Cloud	: Scattered clouds at 1,800 ft and Broken clouds at 3,000 ft
Temperature	: 29°C between 10:00 and 16:00 on 16 March 2020
QNH	: 1011 between 10:00 and 16:00 on 16 March 2020

1.8 Aids to navigation

Ground-based navigation aids, on-board navigation aids, and aerodrome visual ground aids and their serviceability were not a factor in this serious incident.

1.9 Communications

1.9.1 Communication Equipment

The aircraft was equipped with a High Frequency (HF) radio and two Very High Frequency (VHF) two-way communication radio. Both communication systems were serviceable during the time of the serious incident. The communication between the flight crew and ATC was clearly readable.

1.9.2 Ground coordination

According to ATC audio recordings, Moresby Radar contacted Jacksons Radar and advised them that VH-QOE had declared a PAN and was returning with reported fumes in the cabin. Jacksons Radar acknowledged.

Jacksons Radar subsequently informed Jacksons Tower that VH-QOE was returning due to a cabin fume event but did not inform Jacksons Tower about the number of persons on board and that VH-QOE had declared a PAN. Jacksons Tower queried Jacksons Radar on whether it was fumes or smoke and further asked if VH-QOE expected a normal approach and landing. Jacksons Radar responded telling Jacksons Tower to wait and standby. However, Jacksons Tower did not receive the requested information until VH-QOE was transferred to them.

Jacksons Tower subsequently called Airport Rescue and Fire Fighting Services (ARFF) and instructed them to standby at Taxiway Golf. Jacksons Tower also provided information related to the smoke event to ARFF. However, ARFF were not provided the number of persons onboard. Jacksons Tower then called Jacksons Radar expressing concern about not receiving information requested earlier.

1.10 Aerodrome information

Name of aerodrome	: Jacksons International Airport
Location indicator	: AYPY
Airport operator	: National Airports Corporation (NAC)
Latitude	: 09 26.509 S
Longitude	: 147 13.144 E
Elevation	: 129 ft AMSL
Runway length	: 2,750 m
Runway Width	: 45 m

Jacksons International Airport has a Category 8[10] Rescue and Fire Fighting services available and has three fire tenders on stand-by at the station. The operational hours begin at 03:00 and end at 19:00 and can extended as required to cater for late flights.

10 The highest category for Jacksons International Airport, where it can cater for a Boeing 767 aircraft. SOURCE: ICAO DOC 9137 PART 1 _ AEROPLANE CLASSIFICATION BY AIRPORT CATERGORY

1.11 Flight Recorders

The aircraft was fitted with a Cockpit Voice Recorder (CVR) and a separate Flight Data Recorder (FDR).

The FDR identifying information:

- Manufacturer: Honeywell
- Model: SSFDR
- Part Number: 980-4700-027
- Serial Number: 11530
- Recording Duration: At least 25 hours

The CVR identifying information:

- Manufacturer: Honeywell
- Model: SSCVR
- Part Number: 980-6022-011
- Serial Number: 10001
- Recording Duration: At least 2 hours

This SSCVR inputs five channels of cockpit audio including: Command, First Officer, Passenger Address (PA)/Third Crew, Cockpit Area Microphone (CAM), Combination (Command, First Officer and PA/Third Crew Member's communication. The manufacturer refers to the CAM channel as the wide band (WB) channel and Combination of the 3 channels as the Mixed Band channel. The Mixed Band and the CAM are recorded to two 120-minutes duration channels and the most recent 30 minutes of the Command, First Officer and the PA/Third Crew member's communication to three separate channels.

1.12 Wreckage and impact information

There was no wreckage nor impact in this occurrence.

1.13 Medical and pathological information

No medical or pathological investigations were conducted because of this serious incident, nor were they required.

1.14 Fire

There was no evidence of pre- or post-impact fire.

1.15 Survival aspects

1.15.1 Cabin Crew Action

The cabin crew did not associate the unusual smell that they identified to oil contaminated bleed air and only informed the flight crew about it when they were asked by them in the context of the occurrence.

The Qantas Link *Aircrew Emergency Procedure Manual* subsection *2.8.2 Cabin Fumes* states;

> *Fumes caused by oil contaminated bleed air have been described as having a strong odour similar to 'dirty socks', and possibly visually a blue smoke, haze or mist.*

During the events and as the smoke intensified in the cabin, three passengers requested for masks to the cabin crew. The cabin crew distributed surgical masks they had on board for other purposes to those passengers and also distributed some wet towelettes to all the passengers, in accordance with the smoke inhalation prevention procedures in their *Aircrew Emergency Procedures Manual*.

After landing, the cabin crew conducted a precautionary disembarkation at the PIC's command and moved all passengers upwind of the aircraft where they conducted a headcount and checked on the passengers' condition. The cabin crew stated that none of the passengers appeared injured or physically affected by the inflight fumes and smoke.

1.15.2 Aviation Rescue and Fire Fighting Services (ARFF)

At about 11:43, the Aviation Rescue and Fire Fighting (ARFF) service was alerted by Jacksons Tower about VH-QOE's emergency and asked them to initiate their Aerodrome Emergency Plan (AEP).

The ARFF subsequently deployed its three tenders to their standby position at the aerodrome and followed the aircraft during its landing and taxi until it came to a complete stop at taxiway Foxtrot.

As part of their tactical plan, once the engines were shutdown, ARFF personnel took standby positions in front of the aircraft. After the passengers and crew disembarked, two ARFF officers equipped with PPE, in consultation with the crew, boarded the aircraft. They stated that they identified the presence of smoke in the cabin and cockpit, without identifying its cause.

After the manoeuvre was completed, Tender One stood by with the aircraft until it was towed to Bay 23 while Tender Two and Tender Three returned to the station.

1.15.3 Emergency Response

The AIC reviewed the operator's *Station Emergency Response Plan (SERP)* for Port Moresby, *Aircrew Emergency Procedures Manual*, *Operations Manual*, the *Management System Manual* and the *Airports Ground Handling Agreement* Sections 12 Emergency Planning, subsections 12.1 to 12.9 of the *Qantas Link Supplementary Details to Specification for Airports Ground Handling agreement.*

The preamble states *"This section deals with the Carriers expectations of the Handling Company in the event of an aircraft accident, serious incident or other crisis involving the Carrier. It is a mandatory requirement that the Carrier has in place a plan to respond to such an event and thus where the services of a Handling Company are utilised, this plan must incorporate that Handling company. No section or clause supersedes the relevant airport authority's own Crisis Plan."*

Section 12.1 - *The Handling Company must without delay and without waiting for instructions from the Carrier, take all reasonable and possible measures to assist customers and crew and safeguard and protect from loss or damage any baggage, cargo and mail carried in the aircraft. The handling company will be reimbursed at cost for any extra expenses incurred in rendering such assistance*.

Section 12.3 - *The Handling Company, if the first to be aware or notified of an aircraft accident, serious incident or other crisis involving the Carrier, will immediately report this to the Carrier via Operations Control.*

According to the interview, Air Niugini ground handling staff were notified by their operations division about the emergency when the aircraft was returning to Port Moresby and remained at the airport on standby. They also informed AIC that during that time, they liaised with the Qantas office at the airport. They were able to see when the aircraft came to a stop at taxiway Foxtrot and the subsequent disembarkation. Once ARFF actions on the aircraft were completed, and after they had a safety briefing with the flight crew, the ground staff accessed the aircraft accompanied by a National Airport Corporation's (NAC) authorised vehicle to transport the crew and passengers to the terminal building.

On the day of the occurrence, the Qantas Customer Services Coordinator at Jacksons Airport office stated that she remained in the office to monitor calls and to liaise with Jacksons Emergency Operations Centre (EOC), the PIC and Qantas Head Office in Sydney regarding the serious incident.

1.16 Tests and research

The engine was received at P&WC Service Centre St-Hubert, Quebec, where a disassembly investigation was performed between 21 and 24 September 2020, under the direct supervision of the Accredited Representative for Canada reporting to the AIC. The *Engine/Component Investigation Report* from P&WC was sent to the PNG AIC through the Accredited Representative.

No tests were conducted apart from the engine examination conducted by P&WC, refer to *Section 1.6.1.4 and Appendix B, 5.2*

1.17 Organisation and Management Information

1.17.1 The Operator

Sunstate Airways Pty Ltd is a subsidiary of Qantas Airways Ltd. The Operator is authorised by CASA PNG under a Foreign Air Operator's Certificate (FAOC) to operate Australian registered aircraft in regular and non-regular Public Transport Passenger and Cargo operations between Port Moresby and any point outside of Papua New Guinea where approval has been granted by the National Aviation Authority of that country.

Sunstate Airways Pty Ltd Head Office is located at 10 Bourke Road, Mascot,2020, NSW, Australia, and at the time of the occurrence, it had a Foreign Air Operator Certificate number 129/025 issued on 01 August 2018, valid until 31 July 2021. The Operator is authorised to perform commercial air operations in accordance with its exposition.

1.18 Additional Information

During the investigation, it was found out that similar occurrences had happened in the past. In particular, the investigation referenced an investigation report that was released by the *Aircraft Accident Investigation Bureau of India (AAIBI)* on 29 March 2019, about a serious incident occurred on 24 November 2017, involving a Bombardier DHC-8-402 (Q-400) aircraft that sustained smoke in the cabin and in-flight.

According to the AAIBI, the aircraft was equipped with two PW150A engines (same type as the engine involved in this occurrence) and No. 2 engine (the engine involved in that case), had logged 11,328:53 hours and 10,871 cycles on the date of that occurrence.

In its investigation, the AAIBI identified 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".*

The AAIBI report established as probable cause of the serious incident that *"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."*

The AAIBI report also stated that *"during the course of subject investigation, there were two more similar occurrences 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."*

1.19 Useful or effective investigation techniques

The investigation was conducted in accordance with the Papua New Guinea *Civil Aviation Act 2000 (As Amended)*, and the Accident Investigation Commission's approved policies and procedures, and in accordance with the Standards and Recommended Practices of *Annex 13* to the *Chicago Convention on International Civil Aviation.*

2 ANALYSIS

2.1 General

The analysis section of this report discusses relevant facts which contributed to the serous incident.

The investigation determined that there were no issues with the aircraft and its systems apart from the engine involved in the smoke/fume event. The analysis will therefore focus on the following issues but not necessary under separate headings:

- Operational aspects,
- Aircraft engine defects,
- Communication, and
- Survival aspects.

2.2 Flight Operations

2.2.1 Operational procedures

The investigation determined that even when the Qantas Link *Aircrew Emergency Procedure Manual and Operations Manual* clearly specifies that fumes caused by oil contaminated bleed air have been described as having a strong odour similar to 'dirty socks', the cabin crew did not make the right association between the odour and its origin. As the emergency procedures applicable for smoke and fumes in the cabin and in the cockpit ultimately require landing as soon as possible, if the cabin crew had identified correctly the origin of the odour and reported it when they initially perceived it, the flight crew would have had more time available for decision making and, possibly, a chance to cancel the flight even before take-off.

The crew identified that the fumes/smoke was entering through the bleed system, however, they were unable to identify whether it was associated with the No.1 (left) or No.2 (right) engine. The investigation could not identify any abnormal parameters from the FDR associated with operation of either engine for the flight and emergency. The No.2 engine, the actual source of fume/smoke, was operating within the normal parameters. This indicated that the cockpit engine gauge readings gave no reasonable abnormal readings that would have helped the crew to positively identify that the fumes/smoke were entering from the No.2 engine.

Additionally, at the onset of the emergency, the flight crew carried out the *QRH* specific procedure for *"Bleed Source or Air Conditioning Suspected"*. The procedure initially requires turning *Bleed Air 1 off*, and then to wait up to one minute for improvement. As the issue was in effect associated to *Bleed Air 2*, there was no improvement. Under these conditions, the flight crew is expected, as per the procedure, to turn *Bleed Air 1* back on and then to turn *Bleed Air 2* off, and subsequently to wait up to one minute for improvement. However, the PIC decided not to turn *Bleed Air 1* back on, which in the end caused that the flight crew was not able to isolate the origin of the fault to continue with the applicable steps required by the checklist to avoid unnecessary effects on safety.

2.2.2 Communication

VH-QOE had declared a PAN and requested for *priority* return to the Jacksons International Airport. Moresby Radar contacted Jacksons Radar and advised them that VH-QOE had declared a PAN and was returning with reported fumes in the cabin. Jacksons Radar acknowledged. However, Jacksons Radar, relaying the message to Jacksons Tower, did not provide information about the PAN. Following the query from Jacksons Tower regarding more information about the emergency situations, Jacksons Radar did not provide the clarification requested.

Following transfer of VH-QOE, Jacksons Tower called ARFF and instructed them to stand by at Taxiway Golf. Jacksons Tower called Jacksons Radar expressing concern about not receiving pertinent information requested.

Jacksons Radar asked if VH-QOE could accept a speed reduction to allow another aircraft, P2-ATF, about to join downwind, to approach ahead. The investigation determined that in the event of a potential conflict between aircraft, right of way should have been given to the emergency aircraft unless it was impracticable to do so.

When the flight crew of the emergency aircraft insisted that they required priority due to smoke and fume, the Jacksons Radar advised them to stand by. The crew called back just under a minute later as they had not heard back from Jacksons Radar, and it was then that they received clearance to approach.

The fact that Jacksons Radar was able to appropriately have P2-ATF safely give way, following VH-QOE flight crew's counter-request (request to be number 1), showed that there were available options for ATC to initially allow VH-QOE to be given right of way to approach ahead of the other non-emergency traffic. The investigation determined that the request for VH-QOE to accept a speed reduction was not necessary or appropriate. This circumstance did not cause any delay or deviation to VH-QOE's flight path.

The investigation recognises that any unnecessary distraction or diversion of attention has the potential to affect the ability of the flight crew to effectively manage time critical situations such as an urgency or emergency situations. Although it was to no significant detriment, the flight crew of VH-QOE had their attention diverted intermittently for a period of just under a minute during the approach, following Jacksons Radar's speed reduction request.

2.3 Aircraft

2.3.1 No.2 Engine.

The status of the chip detectors and free rotations of the PT, LP turbine and HP turbine spool showed that engine was operative, and the flight crew did not report any abnormal indications related to No. 2 engine parameters. According to P&WC, the No.3 bearing carbon seal was believed to be due to wear-out caused by exudation of salt and oxidation of the air side carbon element

The evidence of oil found on other components of the engine was an indication that, as a result of the failure of the carbon element, oil leaked through the bearing seal and went into engine's air passage. As the oil encountered hot surfaces, it released fumes/smoke that entered the aircraft cabin through the bleed air system.

2.3.2 No.3 Bearing Carbon Seal (No.2 Engine)

According to P&WC, proactive actions to limit the rate of No.3 bearing carbon seal driven events had been implemented (refer to section 1.6.3). Consequently, the rate of events had reportedly been reduced.

The AIC recognises that 10% percent of the PW150A fleet are still in the pre-SB35341 configuration and remain exposed to the same risk of a smoke/fume event similar to that involving VH-QOE and other reported No.3 bearing carbon seal related smoke events.

P&WC also stated that events similar to the VH-QOE smoke/fume event had been reported on carbon seals with time since new higher than 8,500 hours, with 85% of these events being on carbon seal with time since new above 10,000 hours.

The investigation noted that with No.3 bearing carbon seal wear-out time may vary from engine to engine based on amount of exposure to high temperatures and humidity. However, the known trend identified the least amount of time for failure for the No.3 bearing carbon seal as 8,500 hours. It is a concern that operators are operating the engine even past No.3 bearing carbon seal times in excess of 10,000 hours.

The risk of engine performance deterioration from the No.3 bearing carbon seal oil leak may be detected prior to it having an impact on engine performance. However, one of the main indicators for such an oil leak is smoke/fumes in-flight. The engine oil smoke/fumes is considered a health and safety hazard to persons onboard. Furthermore, depending on pilot procedures and distance from nearest suitable landing area, the exposure time for persons onboard may have serious health effects.

The *PW150 Series CIR Manual Part No. 3043526* established a service limit (soft time) for carbon seals of 10,000 hours since new or since last overhaul although the design intent as discussed by P&WC was for the component not to have a life limit.

The concern that the AIC has is that the operating conditions cannot be monitored, that is, the amount and intensity of exposure to environmental conditions cannot be monitored or measured. The AIC also raises concern that the mode of failure represented by the term 'wear-out' as stated by P&WC actually refers to the sudden fracture of the carbon seal. As the No.3 seal wear-out or fracture will result in an oil leak into the air path, the initial indicators of the seal failure are likely to be fumes and smoke entering the cabin in-flight as was the case for this occurrence and other reported similar events.

Furthermore, according to the Service Bulletin, the conditions for the replacement of the carbon seal were:

- when the engine subassembly is dissembled, and
- if the component is accessible.

Therefore, subassembly disassembly can occur at an overhaul shop facility without having access to the No.3 bearing carbon seal. In such instances, the Service Bulletin provides allowance for the seal to continue to be used without implementing the Service Bulletin.

At the time of the occurrence, the affected engine had clocked more than 9,200 hours without a disassembly of the engine or an engine shop visit. It had initially been scheduled for a shop visit on 22 May 2020 and later rescheduled for 31 July 2020. The investigation noted that engine shop visits are determined and scheduled by operators. It is, therefore, the view of the AIC that the information related to the earliest likely failure time, approximately 8,500 hours is relevant for operators to take into consideration when scheduling shop visits.

The investigation found that the SB35341 addressed the replacement of the No.3 bearing carbon seal. However, the failure time was not included as information or as a condition for replacement of the seal.

3 CONCLUSIONS

3.1 Findings

3.1.1 Aircraft

a) The aircraft was certified, equipped and maintained in accordance with existing regulations and approved procedures.

b) The aircraft was airworthy when dispatched for the flight.

c) The mass and the centre of gravity of the aircraft were not factors in this serious incident.

d) The No.3 bearing carbon seal of No.2 engine failed as a result of being exposed to high operating temperatures and humid environments during its lifetime.

e) The fracture in No.3 bearing carbon seal caused the leakage of oil to other components and surfaces of No.2 engine.

f) Oil leaked through No.3 bearing carbon seal got in contact with hot surfaces inside the engine, causing fumes/smoke, that entered the cabin through the bleed air system.

g) The failure of the No. 3 bearing carbon seal occurred at 9,218.11 hours. The engine removal had been planned to occur on 31 July 2020, about four months from the occurrence.

h) The earliest known failure of the No. 3 bearing carbon seal was at about 8,500 hours.

i) The smoke alarm in the lavatory was activated by smoke entering from the cabin when the cabin crew opened the lavatory door.

3.1.2 Flight crew/Cabin Crew

a) The flight crew were properly licensed, medically fit and adequately rested to operate the flight.

b) The flight crew were in compliance with the flight and duty time regulations.

c) The flight crew carried out normal radio communications with the relevant ATC units.

d) The cabin crew did not report the strange smell noticed before take-off and after take-off.

e) Flight crew and cabin crew did not associate the unusual odour identified as conditions that could indicate that oil contaminated bleed air was entering the cabin, as described by their Aircrew Emergency Manual and Operations Manual.

3.1.3 Flight operations

a) Flight crew initially did not action the two action items for the removal of smoke or fumes as they agreed that there was no smoke, and they completed those outstanding items later, after smoke was effectively identified.

b) At the onset of the emergency, the flight crew did not follow the "*Smoke (Warning Light) or Fuselage Fire, Smoke or Fumes"* QRH procedure, with regard to *"Unknown Source of Fire, Smoke or Fumes"*, switching off *Bleed Air 2* without turning *Bleed Air 1* back on.

c) By not adequately following the applicable QRH procedures, the flight crew was unable to isolate and identify the source of the fumes/smoke entering the cabin.

3.1.4 Air Traffic Services

a) Jacksons Radar's request to VH-QOE to accept a speed reduction was not appropriate and not necessary to reduce speed to allow another aircraft to approach and land, even after ATC acknowledged the PAN call broadcast by the emergency aircraft.

b) At two different instances, the flight crew requested for priority return and priority over other aircrafts respectively.

c) Moresby Radar did not transfer the accurate information regarding priority return as stated by the flight crew to Jacksons Radar when declaring the PAN.

d) Jacksons Radar did not provide appropriate information regarding VH-QOE's emergency situation when queried by Jacksons Tower.

e) The number of persons on board was not provided to the ARFF team on the ground.

3.1.5 Flight Recorders

a) The aircraft was equipped with a flight data recorder (FDR) and a cockpit voice recorder (CVR); as required by regulation.

3.1.6 Medical

a) There was no evidence that a member of the flight crew suffered any sudden illness or incapacity which might have affected their ability to perform their duties.

3.1.7 Survivability

a) The flight crew donned their oxygen masks at the onset of the emergency.

b) The cabin crew assisted 3 passengers with surgical masks and provided wet towelettes to all the passengers to place over their nose and mouth during the emergency.

c) There were no reported injuries.

d) ARFF were on standby prior to VH-QOE landing. They stood down their services after assisting VH-QOE in its final position.

3.2 Causes [Contributing factors]

The smoke/fumes that entered the cabin through the bleed air system was produced by the oil liberated at the No.3 bearing carbon seal coming in contact with hot surfaces inside the engine.

The wear-out and early fracture of the airside carbon element was 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.

The manufacturer of the engine had noted that No. 3 bearing carbon seal is likely to fracture earlier than its first overhaul shop visit as the earliest failure case reported was about 8,500 hours. At the time of the occurrence, the seal had 9,218.11 hours and had not reached the time for its first engine overhaul shop visit. The 718.11 hours more than the wear trend.

Service bulletin SB35341, issued by the manufacturer with regard to the conditions for replacement of No. 3 bearing carbon seal, did not include the wear trend of the component determined by the manufacturer as a condition or consideration for its replacement.

4 AFETY RECOMMENDATIONS

4.1 Recommendations

As a result of the investigation into the serious incident involving the Bombardier DHC-8-402 aircraft, registered VH-QOE which sustained an inflight fumes/smoke event, 22 nm South-West of Jacksons, Papua New Guinea, the Accident Investigation Commission issued the following recommendations to address concerns identified in this report.

4.1.1 AIC 21-R01/20-2001 to Pratt & Whitney Canada

The PNG Accident Investigation Commission recommends that Pratt & Whitney Canada ensure that operators of aircraft fitted with the engine PW150A which have the No.3 bearing carbon seal, PN: 3053630-01, are fully aware of the sudden failure trend of the seal and that the earliest probable fracture time can be earlier (as early as about 8,500 hours) than its first overhaul shop visit.

Action requested

The AIC requests that Pratt & Whitney Canada note recommendation AIC 21-R01/20-2001, and provide a response to the AIC within 90 days, but no later than 28 September 2021, and explain including evidence how Pratt & Whitney Canada has addressed the safety deficiency identified in the safety recommendation.

Pratt & Whitney Canada Response to Safety Recommendation

Pratt & Whitney Canada informed the AIC on 23 August 2021 in response to the safety recommendation that the preventive action had already been implemented.

4.1.2 AIC 21-R02/21-2001 to Sunstate Airlines (QLD) Pty Ltd

The PNG Accident Investigation Commission recommends that Sunstate Airlines Pty Ltd ensure that its flight and cabin crews are fully aware of the relevant information relating to unusual odours that can be indications of potential sources of smoke/fumes in the cabin and the applicable company procedures in place, to timely and adequately identify, report and react to such conditions, facilitating the adequate administration of the inflight operation.

Action Requested

The AIC requests that Sunstate Airlines (QLD) Pty Ltd note recommendation AIC 21-R02/20-2001, and provide a response to the AIC within 90 days, but no later than 28 September 2021, and explain including evidence how Sunstate Airlines (QLD) Pty Ltd has addressed the safety deficiency identified in the safety recommendation.

Sunstate Airlines (QLD) Pty Ltd

Sunstate Airlines (QLD) Pty Ltd informed the AIC on 9 September 2021 in response to the safety recommendation that they recognise the opportunity for safety improvement, and they would include it in their next cyclic training to ensure Crew are fully aware of relevant information relating to unusual odours that can be indications of potential sources of smoke/fumes in the cabin.

4.1.3 AIC 21-R03/21-2001 to NiuSky Pacific Limited

The PNG Accident Investigation Commission recommends that NiuSky Pacific Limited should ensure that effective and appropriate communication and coordination is maintained with aircraft in an emergency or urgency situation.

Action requested.

The PNG Accident Investigation Commission requests that NiuSky Pacific Limited note recommendation AIC 21-R03/20-2001 and provide a response to the AIC within 90 days, but no later than 28 September 2021, and explain including evidence about how NiuSky Pacific Limited has addressed the safety deficiency identified in the safety recommendation.

NiuSky Pacific Response

NiuSky Pacific Limited informed the AIC on 02 September 2021 in response to the safety recommendation that they would update refresher training to ensure that all Air Traffic Services operational staff fully understand the nature of these types of incidents to ensure that inappropriate questions are not asked of crew of emergency aircraft in future.

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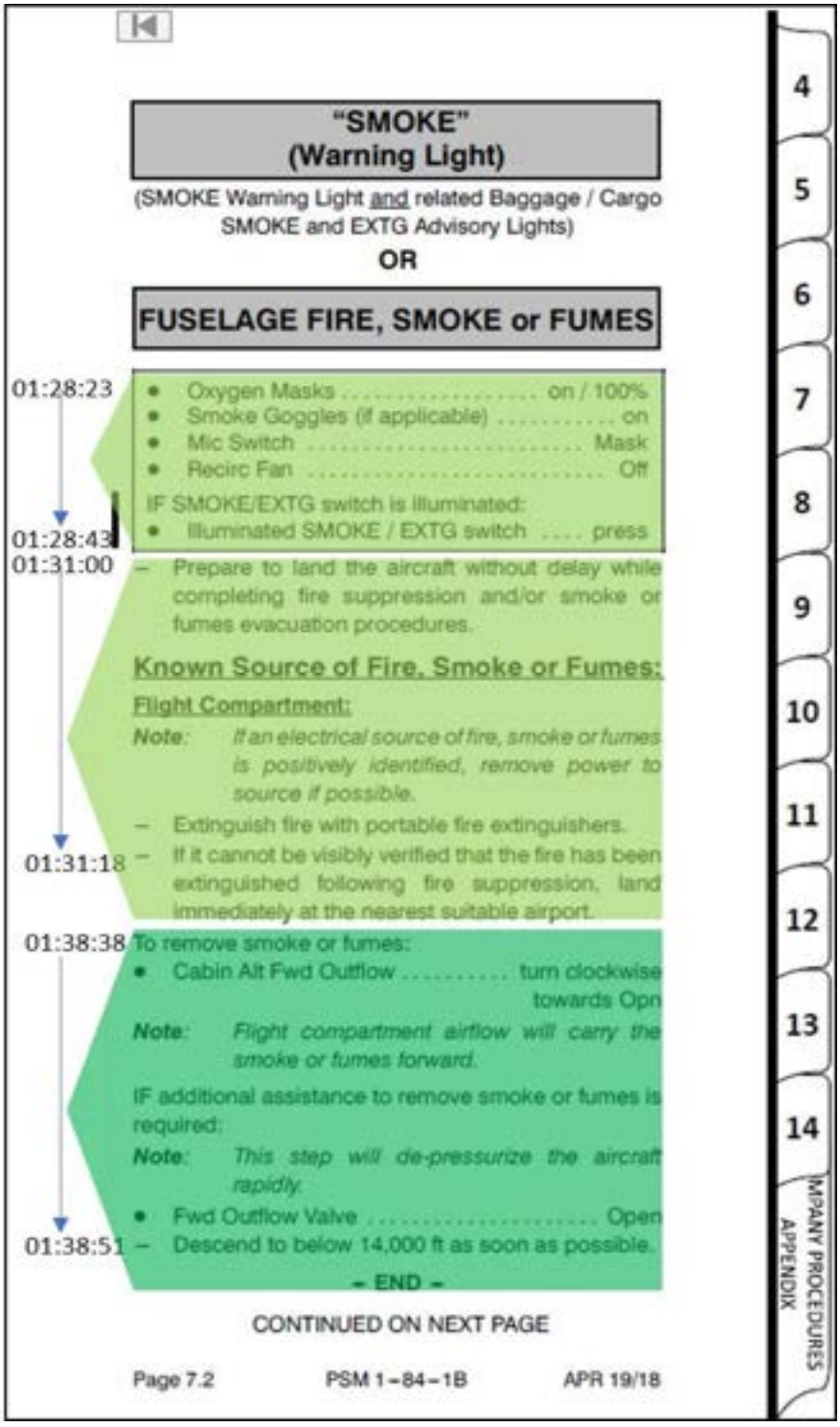
5 APPENDIX

5.1 Appendix A: QANTAS Link QRH Non-Normal Procedures

5.1.1 Key

5.1.2 SMOKE (Warning Light) or FUSELAGE FIRE, SMOKE or FUMES



"SMOKE"
(Warning Light)

(SMOKE Warning Light and related Baggage / Cargo SMOKE and EXTG Advisory Lights)

OR

FUSELAGE FIRE, SMOKE or FUMES

01:28:23

- Oxygen Masks ..... on / 100%
- Smoke Goggles (if applicable) ..... on
- Mic Switch ..... Mask
- Recirc Fan ..... Off

IF SMOKE/EXTG switch is illuminated:

- Illuminated SMOKE / EXTG switch .... press

01:28:43

01:31:00

– Prepare to land the aircraft without delay while completing fire suppression and/or smoke or fumes evacuation procedures.

Known Source of Fire, Smoke or Fumes:

Flight Compartment:

Note: *If an electrical source of fire, smoke or fumes is positively identified, remove power to source if possible.*

– Extinguish fire with portable fire extinguishers.

01:31:18 – If it cannot be visibly verified that the fire has been extinguished following fire suppression, land immediately at the nearest suitable airport.

01:38:38 To remove smoke or fumes:

- Cabin Alt Fwd Outflow ..... turn clockwise towards Opn

Note: *Flight compartment airflow will carry the smoke or fumes forward.*

IF additional assistance to remove smoke or fumes is required:

Note: *This step will de-pressurize the aircraft rapidly.*

- Fwd Outflow Valve ..... Open

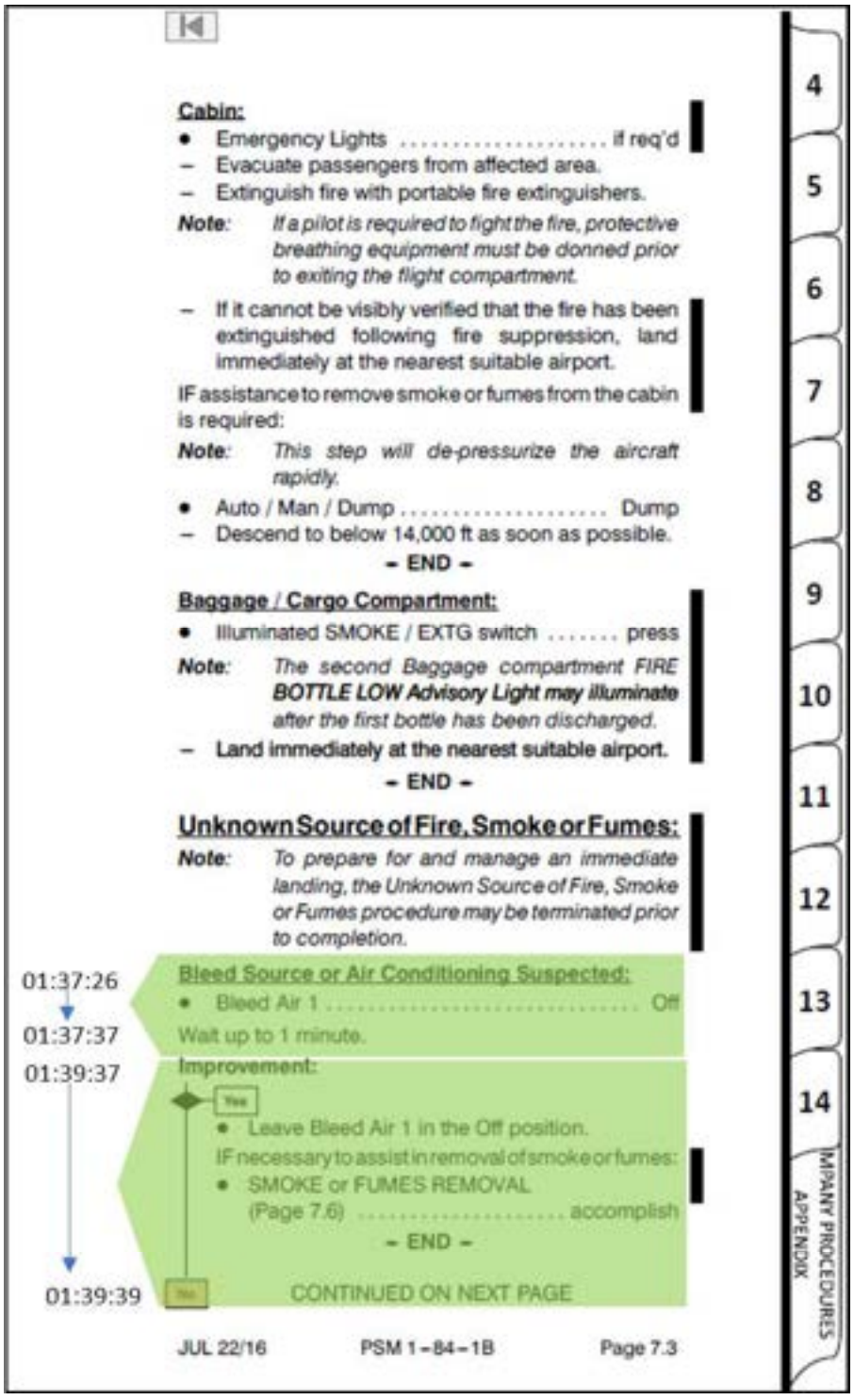
01:38:51 – Descend to below 14,000 ft as soon as possible.

– END –

CONTINUED ON NEXT PAGE

Page 7.2 PSM 1-84-1B APR 19/18

4 5 6 7 8 9 10 11 12 13 14 COMPANY PROCEDURES APPENDIX



Cabin:

- Emergency Lights ..... if req'd
- Evacuate passengers from affected area.
- Extinguish fire with portable fire extinguishers.

Note: *If a pilot is required to fight the fire, protective breathing equipment must be donned prior to exiting the flight compartment.*

- If it cannot be visibly verified that the fire has been extinguished following fire suppression, land immediately at the nearest suitable airport.

IF assistance to remove smoke or fumes from the cabin is required:

Note: *This step will de-pressurize the aircraft rapidly.*

- Auto / Man / Dump ..... Dump
- Descend to below 14,000 ft as soon as possible.

– END –

Baggage / Cargo Compartment:

- Illuminated SMOKE / EXTG switch ..... press

Note: *The second Baggage compartment FIRE **BOTTLE LOW Advisory Light may illuminate** after the first bottle has been discharged.*

- **Land immediately at the nearest suitable airport.**

– END –

Unknown Source of Fire, Smoke or Fumes:

Note: *To prepare for and manage an immediate landing, the Unknown Source of Fire, Smoke or Fumes procedure may be terminated prior to completion.*

01:37:26

Bleed Source or Air Conditioning Suspected:

- Bleed Air 1 ..... Off

01:37:37

Wait up to 1 minute.

01:39:37

Improvement:

Yes

- Leave Bleed Air 1 in the Off position.

IF necessary to assist in removal of smoke or fumes:

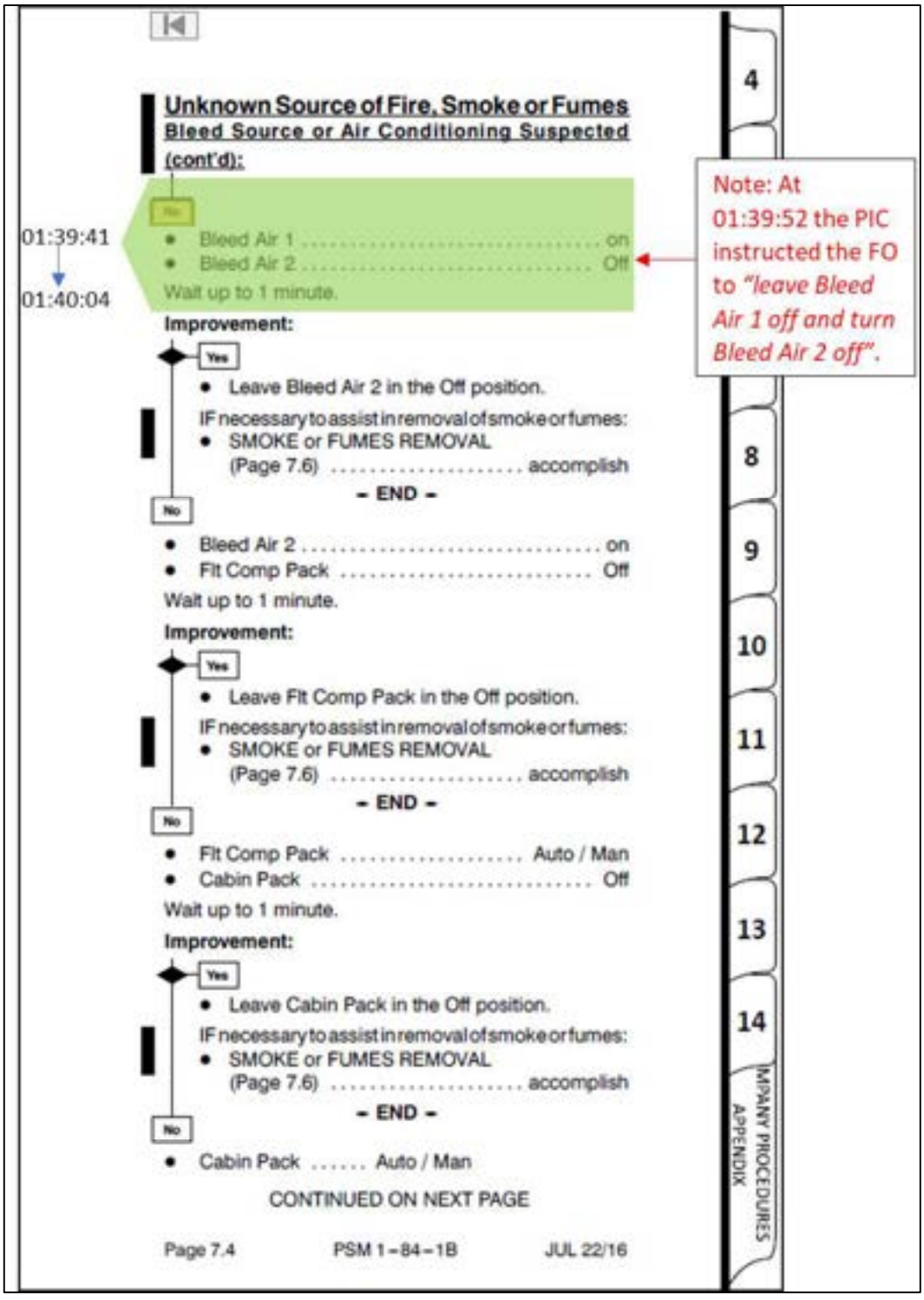
- SMOKE or FUMES REMOVAL (Page 7.6) ..... accomplish

– END –

01:39:39

No

CONTINUED ON NEXT PAGE



Unknown Source of Fire, Smoke or Fumes
Bleed Source or Air Conditioning Suspected (cont'd):

01:39:41 ↓ 01:40:04

- Bleed Air 1 ..... on
- Bleed Air 2 ..... Off

Wait up to 1 minute.

Improvement:

Yes

- Leave Bleed Air 2 in the Off position.

IF necessary to assist in removal of smoke or fumes:

- SMOKE or FUMES REMOVAL (Page 7.6) ..... accomplish

– END –

No

- Bleed Air 2 ..... on
- Flt Comp Pack ..... Off

Wait up to 1 minute.

Improvement:

Yes

- Leave Flt Comp Pack in the Off position.

IF necessary to assist in removal of smoke or fumes:

- SMOKE or FUMES REMOVAL (Page 7.6) ..... accomplish

– END –

No

- Flt Comp Pack ..... Auto / Man
- Cabin Pack ..... Off

Wait up to 1 minute.

Improvement:

Yes

- Leave Cabin Pack in the Off position.

IF necessary to assist in removal of smoke or fumes:

- SMOKE or FUMES REMOVAL (Page 7.6) ..... accomplish

– END –

No

- Cabin Pack ..... Auto / Man

CONTINUED ON NEXT PAGE

Page 7.4 PSM 1-84-1B JUL 22/16

4 8 9 10 11 12 13 14 COMPANY PROCEDURES APPENDIX

Note: At 01:39:52 the PIC instructed the FO to *"leave Bleed Air 1 off and turn Bleed Air 2 off"*.

5.2 Appendix B: P&WC Engine Teardown Report

GO BEYOND

Service Investigation

Engine / Component Investigation Report

Report No.: 20SIE00232
S/O: 219500

Customer / Operator: Qantas Link

Engine Model: PW150A

Investigation Date: September 2020

Serial No.: FA1139

Time Since New (TSN): 9,218.18

Cycles Since New (CSN): 9,656

Time Since Overhaul (TSO): N/A

Cycles Since Overhaul (CSO): N/A

Time Since Repair (TSR): N/A

Cycles Since Repair (CSR): N/A

Previous Overhaul by: N/A

Previous Repair by: N/A

Reason for Previous Shop Visit: N/A

Engine / Component Disassembly by: Pratt & Whitney Canada (P&WC) St-Hubert Service Center

Reason for Engine Removal: Smoke in the cabin

Major Part(s) Affected

Part No./Serial No.	Description	Condition	Time/Cycles
3053630-01/ N/A	No. 3 Bearing carbon seal	Fractured	9,218.18 / 9,656

1.0 Synopsis

1.1 It was reported that on March 16th 2020, the flight crew from a De Havilland DHC 8Q/400, registration No. VH-QOE, reported a slight oil smell in front of the cabin during take-off. The pilots elected to return to the airport. Within few minutes, smoke started to fill the cabin and oxygen mask were used. The subject engine was sent to P&WC, St-Hubert Service Center for further investigation.

EXPORT CONTROL CLASSIFICATION		LOCATION	U.S. REGULATION	
			EAR	ITAR
		U.S.	9E991	NSR
		OUTSIDE U.S.	NSR	NSR
			LOCAL REGULATION	
		CANADA	EPA (ECL)	DPA (CG)
Date of marking	2021-01-05		NSR	No

2.0 Investigation

2.1 The engine was received at P&WC St-Hubert Service Centre, where a disassembly investigation was performed from the 21st to 23rd September 2020 with the following attendees:

- Transport Safety Board (TSB) of Canada
- Pratt & Whitney Canada (P&WC)

2.2 As received, the engine cradle was in normal condition (Photo No. 1).

Photo No. 1

2.3 General view of the engine external showed normal operational visual conditions (Photo No. 2). The power turbines (PT), low pressure (LP) turbine and high pressure (HP) turbine spool could all be rotated freely.

Photo No. 2

2.4 The turbomachine (TM) magnetic chip detector (MCD) showed fuzz material while the reduction gearbox (RGB) and the AC generator MCD were clean (Photos No. 3 to 5).

Photo No. 3
TM MCD

Photo No. 4
RGB MCD

Photo No. 5
AC Gen MCD

2.5 Visual examination of the oil pump strainer showed non-metallic debris (Photos No. 6 & 7).

Photo No. 6

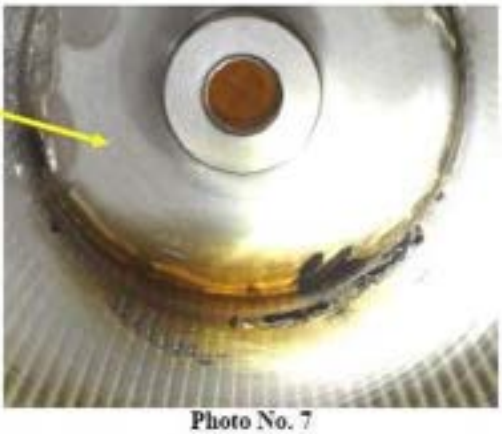


Photo No. 7

2.6 Visual examination of the P2.2 bleed air adapter and the P2.7/P3 check-valve revealed greasy surfaces (Photos No. 8 & 9). The P2.7 bleed-off valve was not received with the engine.

Photo No. 8
P2.2 bleed air adapter

Photo No. 9
P2.7/P3 Check valve

2.7 Visual examination of the RGB oil filter showed small amount of metallic silver and black particles (yellow arrow, Photos No. 10 & 11).

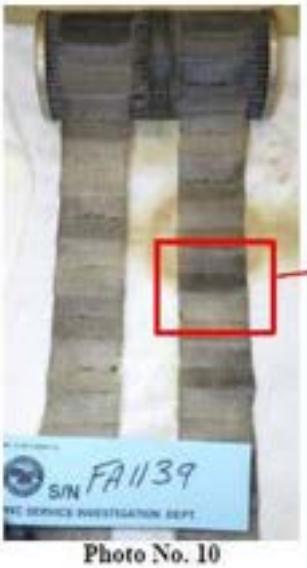


Photo No. 10

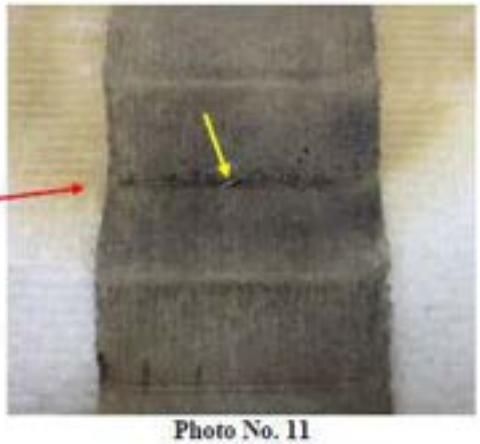


Photo No. 11

2.8 Visual examination of the TM oil filter showed small amount of non-metallic particles (Photos No. 12 & 13).

Photo No. 12

Photo No. 13

2.9 Removal of the fuel inlet filter showed organic and metallic debris (Photo No. 14).

Photo No. 14

2.10 Removal of the P2.2 bleed air adapter showed oil puddle at the bottom of the low pressure compressor (LPC) case (yellow arrow and oval, Photos No. 15 & 16).

Photo No. 15

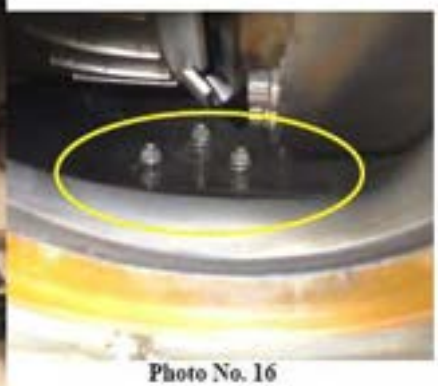


Photo No. 16

2.11 The RGB was split from the TM and the housing packing was in good condition (yellow arrow, Photo No. 17).

Photo No. 17

2.12 Removal of the exhaust duct showed no obvious damage to the PT2 disk assembly. Coked oil was observed at the bottom of the turbine support case (yellow arrow, Photos No. 18 & 19).

Photo No. 18

Photo No. 19

2.13 Removal of the PT2 disk assembly showed coked oil at the bottom of the PT vane ring (yellow arrow, Photo No. 20)

Photo No. 20

2.14 The PT1 disk assembly was greasy (Photos No. 21 & 22).

Photo No. 21

Photo No. 22

2.15 Removal of the PT1 disk assembly showed the inter turbine vane (ITV) and revealed oil wetness next to the No. 6.5 bearing carbon seal (Photos No. 23 & 24).

Photo No. 23

Photo No. 24

2.16 Removal of the ITV showed the LP disk assembly and revealed no obvious damage (Photo No. 25).

Photo No. 25

2.17 Removal of the LPT disk assembly showed no obvious damage to the LPT vanes. The LPT shroud segments did not exhibit rubbing marks (Photo No. 26)

Photo No. 26

2.18 No obvious damage were observed on the HPT disk assembly (Photo No. 27).

Photo No. 27

2.19 Removal of the PT shaft showed oil wetness next to the secondary air passage holes (red oval, Photos No. 28 & 29).

Photo No. 28

Photo No. 29

2.20 Removal of the turbine support case (TSC) revealed oil puddle at the bottom of the gas generator case (red arrow, Photos No. 30).

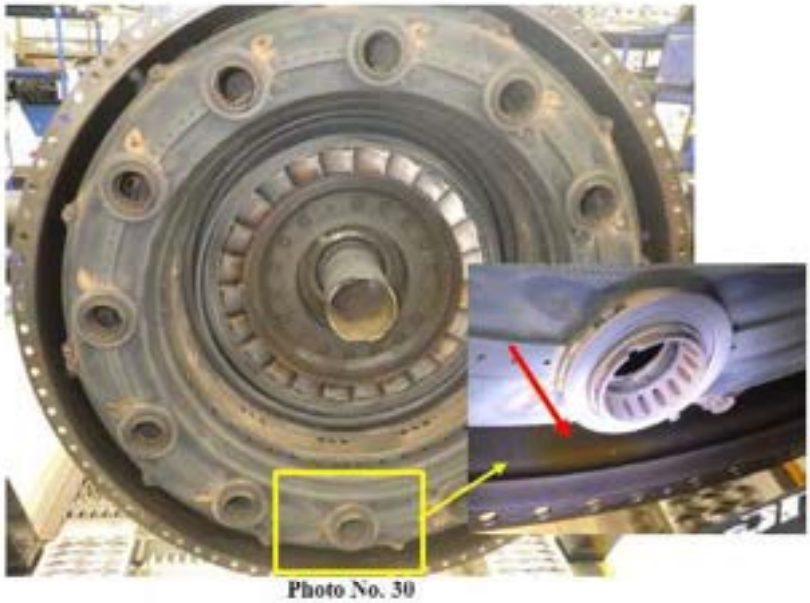


Photo No. 30

2.21 Removal of the combustion chamber showed oil wetness on the entire surface as well as within the diffuser pipe (Photo No. 31).

Photo No. 31

2.22 The front inlet case was removed from the LPC case and provided access to the No. 2.5 bearing carbon seal. Visual examination of the No. 2.5 bearing carbon seal showed no obvious damage (Photo No. 32).

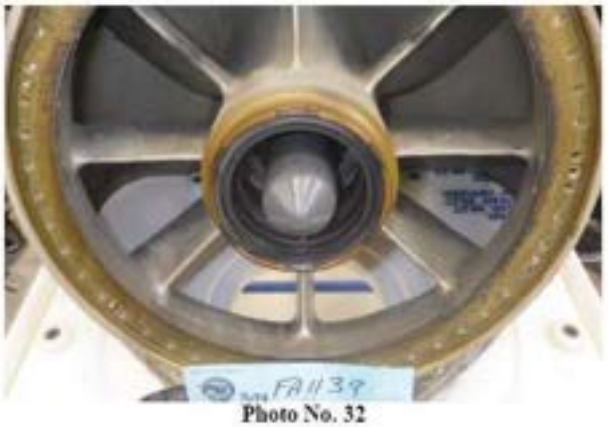


Photo No. 32

2.23 Visual examination of the 1st stage compressor rotor showed no obvious damage. Minimal amount of oil was noticed in the 1st stage compressor stator (red arrow, Photos No. 33 & 34).

Photo No. 33

Photo No. 34

2.24 Removal of the LPC case showed oil puddle at 6 O'clock (red oval, Photo No. 35)

Photo No. 35

2.25 Removal of the 3rd stage bottom half stator showed oil puddle (red oval, Photo No. 36).

Photo No. 36

2.26 Visual examination of the 3rd stage LPC rotor back face showed oil wetness and debris (Photos No. 37 & 38).

Photo No. 37

Photo No. 38

2.27 Removal of the LPC assembly revealed oil wetness in the inter compressor case (ICC) and cracks at the two air boss (yellow arrows, Photos No. 39 to 41).

Photo No. 39

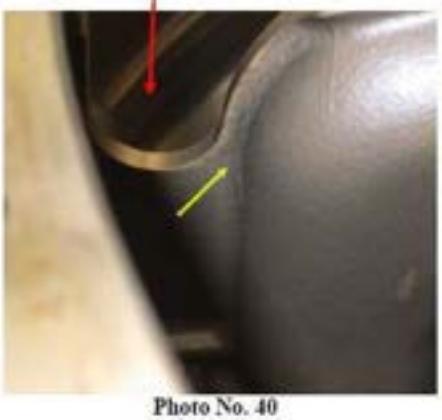


Photo No. 40

Photo No. 41

2.28 Removal of the 1st stage LPC rotor showed oil wetness associated with debris on its hub back face (yellow arrow, Photo No. 42)

Photo No. 42

2.29 The 1st stage LPC stator showed 2 rubbing marks (yellow arrows, Photos No. 43 & 44).

Photo No. 43

Photo No. 44

2.30 Removal of the 1st stage LPC stator showed oil puddle (yellow arrow) in the 2nd stage LPC rotor hub and rubbing in the 2nd stage LPC stator (red arrow, Photo No. 45).

Photo No. 45

2.31 The 2nd and 3rd stage LPC rotor exhibited rubbing on all blades tips (Photos No. 46 & 47).

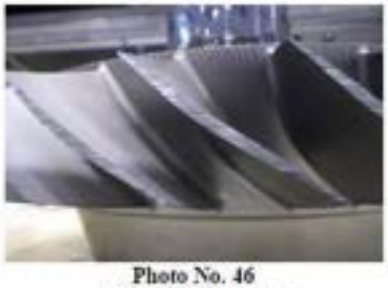


Photo No. 46
2nd stage LPC rotor

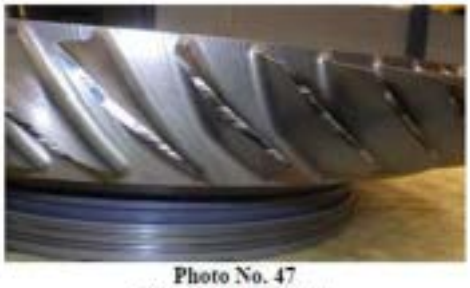


Photo No. 47
3rd stage LPC rotor

2.32 Removal of the No. 3 bearing carbon seal revealed that the carbon element on the air side fractured into multiple pieces. The air side carbon element retaining band stayed in its position. The wave spring and the washer were not fractured (Photos No. 48 & 49).

Photo No. 48

Photo No. 49

2.33 The No. 3 bearing carbon seal was disassembled to visually inspect the internal components (Photo No. 50). The No. 3 bearing carbon seal housing showed scoring in line with the washer on the air side (red arrow, Photo No. 51).

Photo No. 50

Photo No. 51

2.34 Removal of the HP impeller showed no obvious damage (Photo No. 52).

Photo No. 52

2.35 Removal of the No. 5 bearing flex housing from the diffuser case revealed coked oil in the heat shield air core (yellow arrow, Photo No. 53)

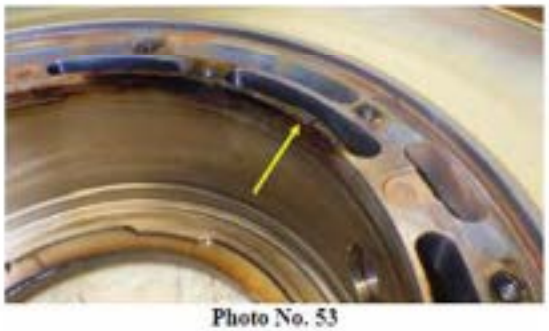


Photo No. 53

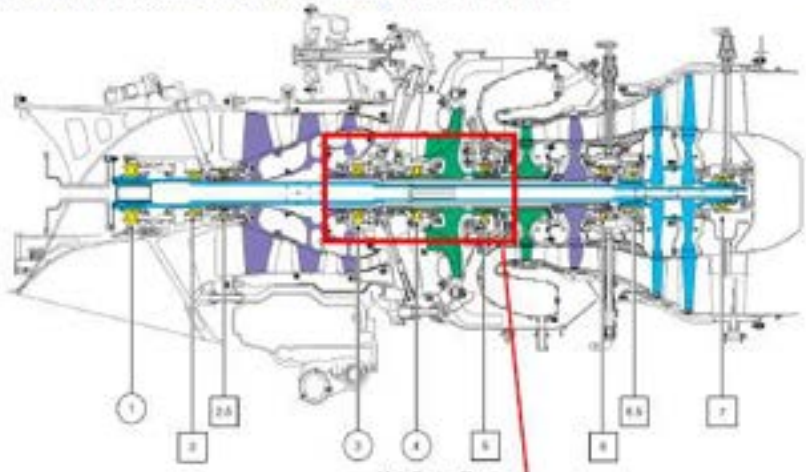
2.36 The carbon seals were measured for fits and clearances. Deviations of over maximum (O/max) by more than 0.001" were found as identified in table No. 1.

	Deviation	Clearance
Fit 4020 – Intershaft carbon seal	0.0054" O/Max	0.0049" O/Max
Fit 5020A – No. 5 bearing seal runner	0.0090" O/Max	0.0085" O/Max

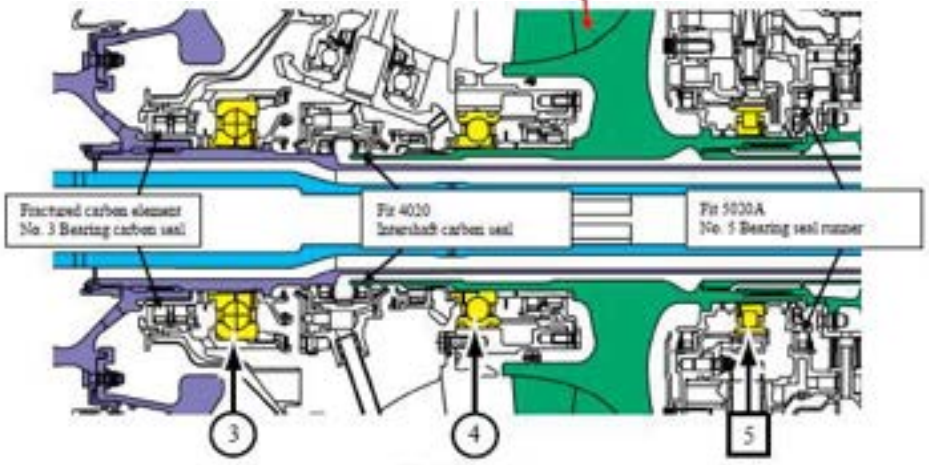
Table No. 1

3.0 Discussion

3.1 The sketch No. 1 & 2 present the location of the fits & clearance deviated over 0.001" and the fractured No. 3 carbon seal. It is believed that the reported deviations were the result of normal wear and tear. They would not have contributed to the event.



Sketch No. 1



Sketch No. 2

3.2 The fractured carbon seal in the No. 3 bearing area liberated oil into the LPC secondary air system and engine bleed air system.

3.3 Previous investigations on the No. 3 bearing carbon seal PN 3053630-01 revealed wear-out at approximately 8,500 hrs. The wear out is 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.

4.0 Conclusions

4.1 The reported smoke in cabin event was a result of the No. 3 bearing carbon seal disintegration that resulted in oil contamination of the gas path.

5.0 Remarks

5.1 The subject No. 3 bearing carbon seal is a pre-SB 35341 (Category 6) which was issued to replace the carbon seal with one made from a carbon grade that is more resistant to high temperatures and humid environment.

Written By: **Service Investigation Department**

Approved By: **Service Investigation Department**

Date of Issue: 29 January 2021

Distribution:

5.3 Appendix C: P&WC Service Bulletin No. 35341

PRATT & WHITNEY CANADA

SERVICE BULLETIN

P&WC S.B. No. 35341

BULLETIN INDEX LOCATOR
72-31-00

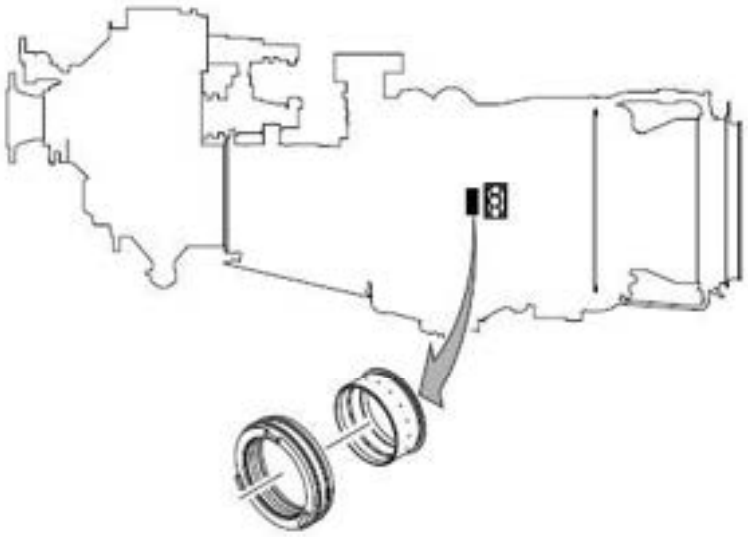
TURBOPROP ENGINE
NO. 3 BEARING CARBON SEAL - REPLACEMENT OF

MODEL APPLICATION

PW150A

Compliance: CATEGORY 6

Summary: There can be oil leakage from the No. 3 bearing carbon seal. Replace the carbon seal with one made from a carbon grade that is more resistant to high temperatures and in a humid environment.



Oct 06/2016

PW150-72-35341
Cover Sheet

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* International Access Code

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Fax 1-450-647-2888
Web Site ..... www.pwc.ca

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Contains no Technical Data			( )
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		EAR	ITAR
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		EIPA (ECL)	DPA (CG)
	Canada	NSR	No

PRATT & WHITNEY CANADA

SERVICE BULLETIN

P&WC S.B. No. 35341

TURBOPROP ENGINE
NO. 3 BEARING CARBON SEAL - REPLACEMENT OF

1. Planning Information

A. Effectivity

PW150A Engines which are before and include Serial No. PCE-FA1238.

B. Concurrent Requirements

None.

C. Reason

(1) Problem

There can be oil leakage from the No. 3 bearing carbon seal.

(2) Cause

Exudation and oxidation can occur on the No. 3 bearing carbon seal in high temperatures and humid environments.

(3) Solution

Replace the carbon seal with one made from a carbon grade that is more resistant to high temperatures and in a humid environment.

D. Description

Replace the No. 3 bearing carbon seal with a new one.

E. Compliance

CATEGORY 6 - P&WC recommend to do this Service Bulletin when the sub-assembly (i.e. module, accessories, components, or build groups) is disassembled and access is available to the necessary part. Do all spare sub-assemblies.

F. Approval

D.O.T./D.A.A . Approved.

G. Manpower

Once you have access to the part, an estimate of 1.5 man-hours is required to include this service bulletin at maintenance.

H. Weight and Balance

None.

1. Planning Information (Cont'd)

I. Electrical Load Data

Not applicable.

J. Software Accomplishment Summary

Not applicable.

K. References

Applicable PW150 Technical Manuals

L. Publications Affected

Applicable PW150 Technical Manuals

M. Interchangeability and Intermixability of Parts

Interchangeability - Refer to Para. 2.C.

Intermixability - Not changed.

2. Material Information

A. Industry Support Information

Not applicable.

B. Material - Price and Availability

You can get the procurable parts listed in Para. 2.C. from any Pratt & Whitney Canada Parts Distribution Center.

The estimated total cost of new parts needed to replace old parts is Quote (US, 2016).

The new parts are available October 2016.

C. Material Necessary for Each Engine

The quantity of materials listed in this section is on a per engine basis.

New P/N	Keyword	Old P/N	Qty	Est. Unit List Price ($US, 2016)	Instructions Dispositions
3127374-01	Seal, Carbon, No. 3 Bearing	3053630-01	1	Quote	(A)(B)

2. Material Information (Cont'd)

New P/N	Keyword	Old P/N	Qty	Est. Unit List Price ($US, 2016)	Instructions Dispositions

(A) ONE WAY INTERCHANGEABLE (ATA200 Explanation Code 01): The old part can only replace the old part; the new part can replace the old and the new part.

(B) Discard the part if it is unserviceable. Return a serviceable part to stock.

D. Reidentified Parts

None.

E. Tooling - Price and Availability

Not Applicable.

3. Accomplishment Instructions

A. Remove the parts in the Old P/N list in Para. 2.C., Material Information. Refer to the instructions in the Engine Manual section(s).

B. Install the parts in the New P/N list in Para. 2.C., Material Information. Refer to the instructions in the Engine Manual section(s).

C. Write the accomplishment of SB35341 in the engine module log book.

4. Appendix

Not applicable.