Air Accident Investigation Unit Ireland

FACTUAL REPORT

SERIOUS INCIDENT
Bombardier DHC 8-402 G-FLBB
Shannon FIR, near point OLAPO
31 July 2015

An Roinn Iompair Turasóireachta agus Spóirt
Department of Transport, Tourism and Sport

Foreword

This safety investigation is exclusively of a technical nature and the Final Report reflects the determination of the AAIU regarding the circumstances of this occurrence and its probable causes.

In accordance with the provisions of Annex 13[1] to the Convention on International Civil Aviation, Regulation (EU) No 996/2010[2] and Statutory Instrument No. 460 of 2009[3], safety investigations are in no case concerned with apportioning blame or liability. They are independent of, separate from and without prejudice to any judicial or administrative proceedings to apportion blame or liability. The sole objective of this safety investigation and Final Report is the prevention of accidents and incidents.

Accordingly, it is inappropriate that AAIU Reports should be used to assign fault or blame or determine liability, since neither the safety investigation nor the reporting process has been undertaken for that purpose.

Extracts from this Report may be published providing that the source is acknowledged, the material is accurately reproduced and that it is not used in a derogatory or misleading context.

[1] **Annex 13**: International Civil Aviation Organization (ICAO), Annex 13, Aircraft Accident and Incident Investigation.
[2] **Regulation (EU) No 996/2010** of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation.
[3] **Statutory Instrument (SI) No. 460 of 2009**: Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulations 2009.

AAIU Report No: 2016 - 009
State File No: IRL00915051
Report Format: Synoptic Report
Published: 20 June 2016

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No 996/2010 and the provisions of SI 460 of 2009, the Chief Inspector of Air Accidents on 31 July 2015, appointed Mr Leo Murray as the Investigator-in-Charge to carry out an Investigation into this Serious Incident and prepare a Report.

Aircraft Type and Registration:	Bombardier DHC 8-402	
No. and Type of Engines:	2 x Pratt & Whitney Canada PW150A	
Aircraft Serial Number:	4255	
Year of Manufacture:	2009	
Date and Time (UTC)[4]:	31 July 2015 @16.22 hrs	
Location:	Shannon FIR[5] near reporting point OLAPO[6]	
Type of Operation:	Commercial Air Transport	
Persons on Board:	Crew - 4	Passengers - 74
Injuries:	Crew - Nil	Passengers - Nil
Nature of Damage:	Minor (engine, internal)	
Commander's Licence:	Airline Transport Pilot Licence (Aeroplanes) Issued by the UK Civil Aviation Authority	
Commander's Details:	Female, aged 63 years	
Commander's Flying Experience:	7,264 hours, of which 2,354 were on type	
Notification Source:	ATC[7] Station Manager, Dublin Airport	
Information Source:	AAIU Field Investigation. AAIU Report Form submitted by the Commander	

[4] **UTC**: Coordinated Universal Time. All timings in this report are UTC; to obtain the local time add one hour.
[5] **FIR**: Flight Information Region.
[6] **OLAPO**: Reporting point at position N53 46.82' W007 17.68'.
[7] **ATC**: Air Traffic Control.

SYNOPSIS

The aircraft had departed Ireland West Airport (EIKN) and was climbing through 17,000 ft when the Flight Crew were alerted by a strange odour/fumes on the flight deck followed by activation of the forward toilet smoke alarm. With smoke becoming visible in both the cabin and flight deck, the Flight Crew donned their oxygen masks. The flight diverted to Dublin Airport (EIDW) where it landed at 17.41 hrs, without further incident. There were no injuries.

Subsequent trouble-shooting by maintenance personnel revealed the presence of oil in the Handling Bleed-Off Valve (HBOV) caused by failure of carbon seals due to distress and rupture of the No. 4 Bearing Key washer in the No. 1 engine. Contamination of the secondary oil system due to the damaged seals caused fumes to enter the cabin and flight deck.

The AAIU was notified by the Air Traffic Control (ATC) Station Manager at Dublin Airport at 16.34 hrs while the aircraft was still airborne. One Inspector of Air Accidents travelled to Dublin Airport and spoke with the aircraft crew.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft was engaged on a scheduled passenger service from Ireland West Airport (EIKN) to Manchester (EGCC), United Kingdom with the Co-Pilot acting as Pilot Flying (PF). When climbing through 17,000 ft (FL[8] 170) in the vicinity of reporting point OLAPO[9], the Flight Crew detected a strange odour/ fumes on the flight deck. A review of the engine instrumentation showed that the No. 1 Inter-Turbine Temperature (ITT) was significantly higher than that of the No. 2 engine, but it was still within acceptable limits.

The Flight Crew were then alerted by the senior Cabin Crew member (CC1) that the toilet smoke alarm had activated. They reported that there was visible smoke near the ceiling in the aircraft cabin. The Flight Crew levelled the aircraft at FL 190 and donned crew oxygen[10] masks. Smoke was also now evident on the flight deck, observed to be emanating from panels to the left of the Commander's seat. Following a PAN (Urgency) call to ATC, an immediate descent was made to FL 100.

The Commander requested ATC to provide details of the nearest suitable airfields and following evaluation, informed ATC of their intention to proceed for an immediate landing at EIDW. The Commander kept in communication with CC1 regarding the intensity of the smoke in the cabin and whether it was worsening.

[8] **FL**: Flight level, a three-digit representation of aircraft altitude referenced to standard pressure.
[9] **OLAPO:** Reporting Point N534649 W0071441W.
[10] **Crew oxygen**: A dedicated 100% oxygen supply for emergency use by the flight crew.

The aircraft landed at 17.41 hrs without further incident. After landing, the Commander judged that an immediate evacuation was not necessary. The Airport Fire Service (AFS) made a visual check of the aircraft exterior before it proceeded to park on stand 205R. The passengers deplaned normally. The AFS then boarded and inspected the aircraft interior; however, the source of the smoke/fumes could not be readily identified. The AFS stood down at 18.08 hrs.

1.2 Subsequent Maintenance Actions

Two days later, on 2 August 2015, one of the Operator's Engineers attended the aircraft with the intention of performing troubleshooting. On start-up of the No. 1 engine for a low-power engine run, he was alerted to a large amount of smoke coming from an engine vent and the drain mast. The engine was shut down immediately. On inspection, a large quantity of oil was found in the engine ducting. The oil quantity indication was also observed to be very low. Borescope inspections were performed which traced the fault to oil leaking from a HBOV on the No. 1 engine. The No. 1 engine was removed and sent for overhaul.

1.3 Engine Information

The removed engine, Serial Number FA0492 had been installed in the No. 1 position on G-FLBB in March 2011. At installation, the engine had accumulated 4,820 hours (TSN[11]) and 5,233 cycles. At the time of the event, the engine had been operated for 13,001 hours TSN and 14,583 cycles.

Following this event, the engine and its associated modules were sent to an approved maintenance facility in Hamburg for overhaul, Service Bulletin compliance and replacement of the Life-Limited Parts (LLPs). The approved maintenance facility provided a full strip report on completion of the work. Inspection of the engine identified No. 4 Bearing Key washer distress (**Photo No. 1**) and the following finding was made: '*high unbalance of the HP rotor resulted in distress of the carbon seals resulting in oil leak into the gas path'*.

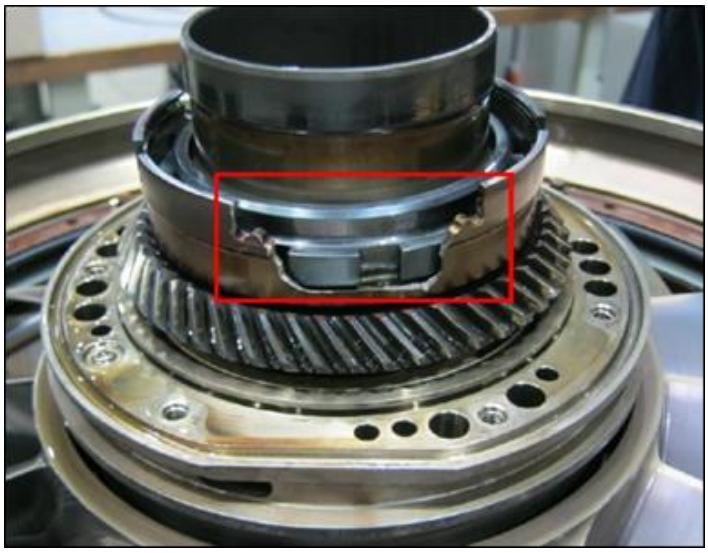


Photo No. 1: No. 4 Bearing Key washer from Engine S/N FA0492 exhibiting distress and fracture (*Pratt & Whitney Canada*)

[11] **TSN**: Time Since New.

A diagram from the PW150A *Illustrated Parts Catalog* showing the High Pressure (HP) Turbine assembly and the No. 4 Bearing Key washer is reproduced in **Appendix A**.

1.4 Other Events Reported by the Operator

Including this event, the Operator undertook four unscheduled engine removals on its fleet in 2015 due to oil smell/fumes and six due to No. 4 Bearing Key washer fracture, two of which were associated with smoke and fumes. The Operator continued to monitor and track components as part of its reliability programme.

1.5 Actions taken by the Engine Manufacturer

The Engine Manufacturer reported to the Investigation that, since December 2014, operators had experienced a total of 19 occurrences following distress of the No. 4 Bearing Key washer. In most cases the engine was subject to an unscheduled removal. Four of the occurrences involved an in-flight shutdown (IFSD) of the affected engine; in one case the shutdown was uncommanded. Because of the history of such events the Engine Manufacturer undertook the following preventative/corrective actions (**Table No. 1**):

Discard the No. 4 bearing washer (Engineering task)	February 2015
Replace washer each shop visit (SB35326)	December 2015
Inspection Service Bulletin (SB A35325)	December 2015
Service Information Letter (SIL PW150-058)	January 2016
Design improvements – infinite life, field hardware	February 2016

Table No. 1: Preventative/Corrective actions taken

On 26 January 2016, the Engine Manufacturer issued a Service Information Letter (SIL No. PW150-058) to all operators highlighting the root cause and preventative action to be taken. The Engine Manufacturer identified that:

> '*The distress condition of some washers, had resulted in metal chips being released into the oil system with possible symptoms being reported as loss of oil sealing, loss of oil pressure, cabin air contamination and in some cases In Flight Shut Down (IFSD) of the affected engine*'

The cause of the washer wear (distress) was identified as stress in the filet radius of the key washer which may initiate cracks that could propagate until there is material release.

An improved key washer with an 'infinite life' was designed by the Engine Manufacturer and was made available from 29 February 2016. In the interim period until such replacements were made, the Engine Manufacturer developed and implemented several actions aimed to reduce the incidence of events related to the distress of the Key washer component.

2.0 AAIU Comment

The event occurred in the latter stages of the climb from the departure aerodrome when the Flight Crew detected a strange odour/ fumes on the flight deck. At this time the CC1 alerted the Commander that the toilet smoke alarm had activated and that there was smoke evident at the cabin ceiling. The Commander requested an immediate level off and both Flight crew donned oxygen masks which remained on for the duration of the flight. A PAN (urgency) call was made to ATC and an immediate descent made to FL100.

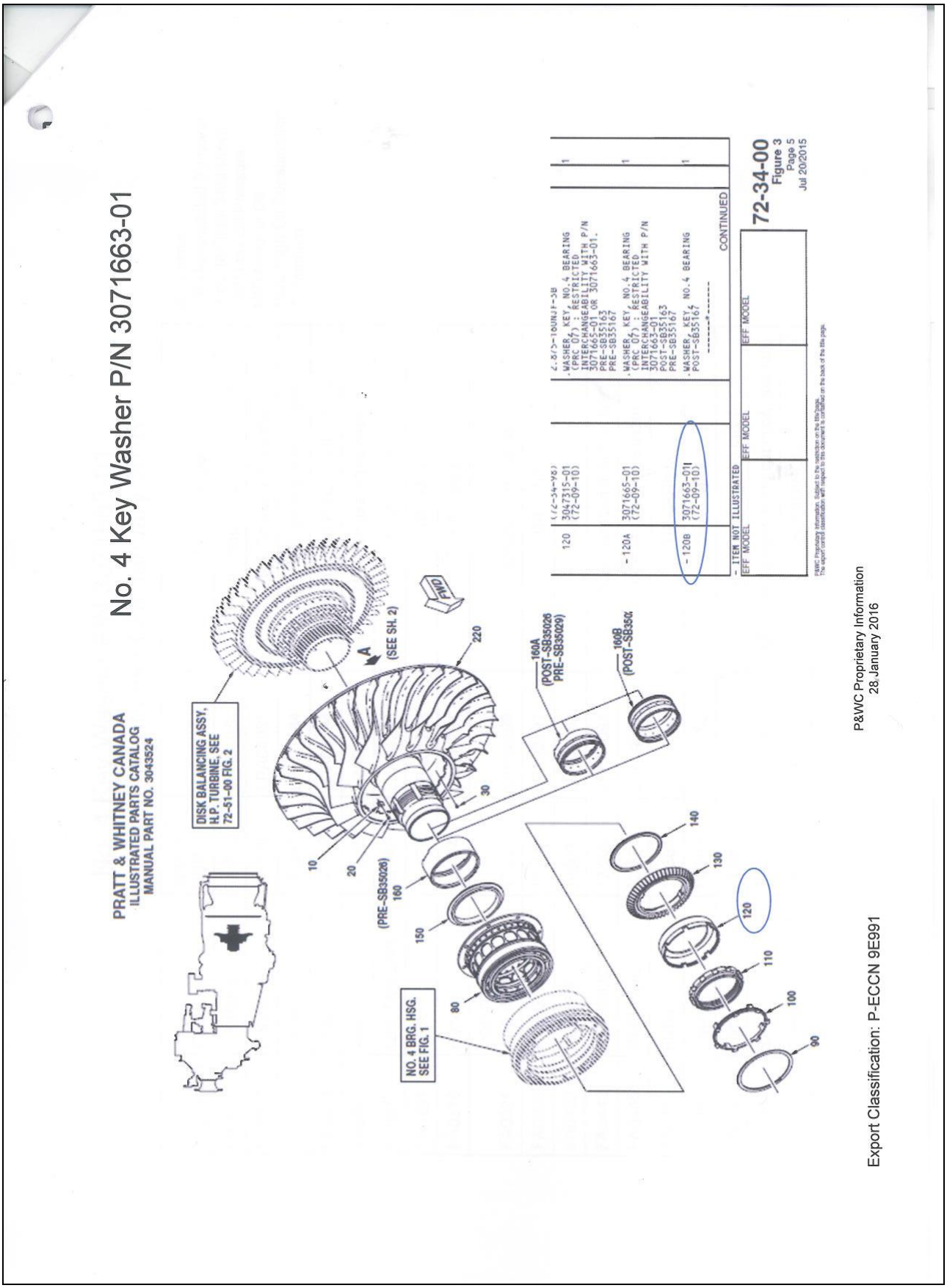
At this stage smoke became evident in the flight deck. With workload high, the Commander requested information from ATC regarding the nearest available aerodromes and EIDW was selected as the most appropriate for a diversion. The Commander kept in communication with CC1 regarding the intensity of the smoke in the cabin and whether it was increasing.

As the situation appeared to have stabilized, the Flight Crew concentrated on diverting to the nearest suitable aerodrome and continued with the non-normal drills as time permitted. The Co-pilot continued to act as PF and landed at EIDW without further incident. The Commander judged that an evacuation was not necessary and after the AFS made an external inspection, the aircraft was taxied to stand. Following disembarkation, the AFS inspected the aircraft. However, the source of the smoke was not apparent.

The Commander made appropriate decisions and took necessary actions during the event.

The Engine Manufacturer has identified the cause of the No. 4 Bearing Key washer distress and issued guidance for inspection and replacement of the part. In addition, the part has been redesigned for an 'infinite life' on replacement and accordingly this Investigation does not sustain any Safety Recommendations.

Appendix A



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In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No 996/2010, and Statutory Instrument No. 460 of 2009, Air Navigation (Notification and Investigation of Accidents, Serious Incidents and Incidents) Regulation, 2009, the sole purpose of this investigation is to prevent aviation accidents and serious incidents. It is not the purpose of any such investigation and the associated investigation report to apportion blame or liability.

A safety recommendation shall in no case create a presumption of blame or liability for an occurrence.

Produced by the Air Accident Investigation Unit

AAIU Reports are available on the Unit website at www.aaiu.ie

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