Air Accident Investigation Unit Ireland

FACTUAL REPORT

INCIDENT
Boeing 777-236, G-VIIK
North Atlantic Oceanic Airspace
2 December 2012

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

AAIU Report No: 2013-015
State File No: IRL00912119
Report Format: Factual Report
Published: 11/11/2013

In accordance with Annex 13 to the Convention on International Civil Aviation, Regulation (EU) No. 996/2010 and the provisions of S.I. 460 of 2009, the Chief Inspector of Air Accidents, on 2 December 2012 , appointed Mr Thomas Moloney as the Investigator-in-Charge to carry out an Investigation into this Incident and prepare a Report. The sole purpose of this Investigation is the prevention of aviation Accidents and Incidents. It is not the purpose of the Investigation to apportion blame or liability.

Aircraft Type and Registration:	BOEING 777-236, G-VIIK
No. and Type of Engines:	2 x GENERAL ELECTRIC GE90-85B
Aircraft Serial Number:	28840
Year of Manufacture:	1998
Date and Time (UTC[1]):	2 December 2012 @ 03:25 hrs
Location:	North Atlantic Oceanic Airspace
Type of Operation:	Commercial Air Transport / Scheduled Passenger
Persons on Board:	Crew 13 Passengers 174
Injuries:	Crew Nil Passengers Nil
Nature of Damage:	Minor
Commander's Licence:	ATPL issued by UK CAA
Commander's Details:	Male, aged 51 years
Commander's Flying Experience:	16,435 hours, of which 2,000 were on type
Notification Source:	Shanwick Duty Manager
Information Source:	AAIU Investigation

[1] **UTC:** Universal Co-ordinated Time. All times in this Report are UTC which was the same as local time in Ireland on the date in question.

SYNOPSIS

The flight crew of G-VIIK experienced a series of smoke events on the flightdeck while in the cruise over mid-Atlantic. They declared an emergency and the First Officer (F/O) donned his oxygen mask. They descended the aircraft to Flight Level (FL) 150 and diverted to Shannon Airport (EINN), Ireland. The cause of the smoke was later identified as a bearing failure of the primary equipment cooling supply fan.

1. FACTUAL INFORMATION

1.1 History of the Flight

G-VIIK departed from Philadelphia (KPHL), USA at 23.21 hrs on 1 December 2012 on a scheduled passenger flight to London Heathrow (EGLL), UK. The F/O was Pilot Flying. The flight proceeded routinely into North Atlantic oceanic airspace, where it was cruising at FL 380 at Mach 0.84. At approximately 03.25 hrs, as the aircraft was approaching the waypoint 50°N 30°W in mid-Atlantic, the flight crew experienced the first of three smoke events on the flightdeck. The Commander described the third event as being *"quite bad"* and he made the decision to declare a MAYDAY and to descend the aircraft to FL 150. The Commander instructed the F/O to don his oxygen mask, while he himself did not do so because he considered that use of the mask might impair radio communications. This action was in accordance with the Operator's QRH[2], which calls for the donning of oxygen masks and smoke goggles, if needed, during such a smoke event. Shanwick Oceanic Control reported that they received the MAYDAY call on HF[3] radio at 04.06 hrs and that the aircraft requested a diversion to EINN.

During the descent, the flight crew carried out the smoke checklist in accordance with the QRH and the smoke cleared. They reported that they received a status message to the effect that the right hand (RH) equipment cooling fan had failed. At 04.34 hrs, the flight crew downgraded the emergency to PAN but, due to higher fuel consumption at FL 150, a diversion to EINN remained necessary. The aircraft landed in EINN at 06.04 hrs without further incident.

1.2 Technical Investigation

The Operator informed the Investigation that the RH equipment cooling supply fan, part number 4100941C, serial number 1453A was isolated at EINN in accordance with the aircraft Minimum Equipment List. The aircraft was ferried to EGLL where the fan was removed and sent to the Operator's workshops. While it was not possible to determine for how many flight hours this fan had been in service, it was established that it had been delivered to the Operator on a different aircraft in May 2000.

Two equipment cooling supply fans are located in the left sidewall of the forward cargo compartment. The fans blow air taken from the cabin through the electronic equipment in the forward part of the aircraft, including the flight deck displays, aisle stand and overhead panels. Any smells or haze emanating from the fans would therefore be evident to the flight crew. The failed RH fan was the primary fan while the left hand (LH) fan was a back-up. The LH fan automatically takes over if the RH fan stops and there is no evidence to suggest that this did not occur as specified.

[2] **QRH:** Quick Reference Handbook
[3] **HF:** High Frequency radio, used for long range communication

On initial inspection it was found that a front end bearing failure of the RH equipment cooling supply fan had occurred, as the fan rotation was poor. The unit was stripped down and it was determined that the front bearing race had collapsed, a common failure mode for rotary fans. The breakdown of the front end bearing assembly allowed contact between internal rotating and stationary parts which caused local overheating and the subsequent smoke/burning smell. A protection logic circuit in the system acted to shut down the RH supply fan and turn on the LH supply fan to ensure continuous cooling to the electronic equipment. This was annunciated to the crew by an EICAS[4] status message reporting that the RH supply fan was not in the commanded state or was overheated. All fan bearings were replaced and the unit rotor was balanced to correct the defect.

1.3 Engineering Solution

The Operator informed the Investigation that, in their experience, equipment cooling fan failures are quite rare, with an approximate failure rate of one per year. However, the subject event was the second such failure in two months and the second related diversion since 2008. Bearing failure is the most common mode of failure for this type of fan. The Operator also reported that *"smell in cabin"* events due to recirculation fan failures were quite common in their fleet, running at about one per month. This information is borne out by several smoke/smell events involving various operator's aircraft overflying Ireland, which have resulted in diversions into Irish airports and which have, on investigation, been attributed to equipment cooling or recirculation fan failures.

The Operator is currently working with a third party vendor to fit vibration monitors to the recirculation fan positions under an STC[5]. It is also working towards the installation of a vibration monitor on the primary (RH) equipment cooling fan position. The proposal is to install this monitor on only one of the two equipment cooling fan positions so that overall system redundancy will not be affected. The purpose of the monitors is to facilitate early detection of abnormal vibration in the fans, thus allowing for their shut-down before a bearing failure results in an in-flight smoke event.

Another approach to resolve the issue, which the aircraft Manufacturer and the OEM[6] have developed and which is now the 777 production configuration, is the addition of a bearing brake to fans. If a bearing begins to fail, the brake stops the fan from turning to prevent excess smoke from being generated.

2. AAIU COMMENT

This occurrence, which developed in mid-Atlantic, was operationally well handled by the flight crew who, when faced with the threat of smoke on the flightdeck, made the prudent decision to declare an emergency, to make an early descent and to set course for the nearest diversion airport. The AAIU is aware of several similar occurrences with other operator's aircraft, which have necessitated diversions into Irish airports. The Operator is working towards the installation of vibration monitors, which should result in early detection of fan issues and thus lead to a reduction in the number of fan failures leading to in-flight smoke events.

– END –

[4] **EICAS:** Engine Indicating and Crew Alerting System
[5] **STC:** Supplementary Type Certificate
[6] **OEM:** Original Equipment Manufacturer

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

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