الهيئة العامة للطيران المدني
GENERAL CIVIL AVIATION AUTHORITY

United Arab Emirates

Air Accident Investigation Sector

Incident

- Summary Report -

AAIS Case Nº: AIFN/0003/2011

Partial Loss of Right Hand Engine Thrust Reverser

(SCF–PP–OTHEM)

Operator: Emirates
Make and model: Boeing 777-200
Nationality and registration: UAE, A6-EMH
Place of occurrence: Moscow Domodedovo Airport
State of Occurrence: Russia
Date of Occurrence: 5 March 2011

Investigation Objective

This Investigation is performed pursuant to the United Arab Emirates (UAE) Federal Act 20 of 1991, promulgating the Civil Aviation Law, Chapter VII, Aircraft Accidents, Article 48. It is in compliance with Part VI, Chapter 3 of the UAE Civil Aviation Regulations, in conformity with *Annex 13 to the Convention on International Civil Aviation* and in adherence to the *Air Accidents and Incidents Investigation Manual*.

The sole objective of this Investigation is to prevent aircraft accidents and incidents. It is not the purpose of this activity to apportion blame or liability.

Investigation Process

The occurrence, involving a Boeing 777–200 passenger Aircraft, registration A6-EMH, was notified to the United Arab Emirates (UAE) General Civil Aviation Authority (GCAA) Air Accident Investigation Sector (AAIS) by phone call to the Duty Investigator (DI) Hotline Number +971 50 641 4667.

The National Transportation Safety Board (NTSB) was notified of the event and assigned an accredited representative. After the Initial/On-Site Investigation phase, the occurrence was classified as 'Serious Incident'; however, when more information became known the occurrence was re-classified as an 'Incident'.

The AAIS requested delegation of the investigation from the State of Occurrence (Russia), and the AAIS performed the Investigation, being the investigation authority of the State of the Operator and Registry.

This Investigation was limited to the events leading up to the occurrence and no in-depth analysis of non-contributing factors was undertaken.

This Summary Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with item 3.1, Annex 13 to the Convention on International Civil Aviation, which was incorporated in the UAE legal system.

The use of this Summary Report for any purpose other than that of preventing future accidents, may induce to erroneous interpretations and conclusions.

All AAIS reports are publicly available from:

http://www.gcaa.gov.ae/en/epublication/pages/investigationreport.aspx

History of the Flight

On 5 March 2011, during darkness at 2210 local time of Russia, Emirates passenger flight number 132, operated by Boeing 777-200ER, registration A6-EMH, took off from runway 32L at Moscow Domodedovo Airport, Russia to Dubai International Airport, the United Arab Emirates.

At approximately 400 feet above ground level, the flight crew received an Engine Indication and Crew Alerting System (EICAS) message of thrust asymmetry. The climb continued to above the minimum sector altitude and the flight crew completed the relevant checklist. Later in the climb, the cabin crew reported that they had heard a loud bang and saw sparks coming from the Aircraft right hand side during the takeoff.

Subsequently, the flight crew received an EICAS message regarding the right engine Electronic Engine Control normal mode, the turbine overheat sensor, the overheat circuit, and the engine fire loop.

The crew performed the abnormal checklist as per the Operator's procedures, which required the selection of the Electronic Engine Control Mode to alternate mode. As per the flight recorder data, two short spikes in exhaust gas temperature were recorded on the takeoff followed by a slightly erratic reading during a four-minute period.

Approximately 8 minutes after takeoff, all recorded engine parameters stabilized and remained normal for the remainder of the flight. The commander called the Air Traffic Control (ATC) and requested a runway inspection and later the co-pilot repeated the request but in Russian. Later, the ATC reported to the flight crew that no debris had been found. However, airport authority inspections later found pieces of the thrust reverser on the runway (see figures 1 and 2 below). The flight crew informed the Operator of the EICAS messages and a decision was made, by the commander, to continue the flight based on the information available to him at the time. On arrival, Dubai ATC reported that small pieces had separated from the Aircraft during landing. The flight crew shut down the right engine immediately after vacating the runway and requested a runway inspection. Following normal passenger disembarkation, the commander was made aware of the missing thrust reverser part (figure 3).

Figure 1. Aft right engine thrust reverser

Figure 2. Detail of the aft thrust reverser

.

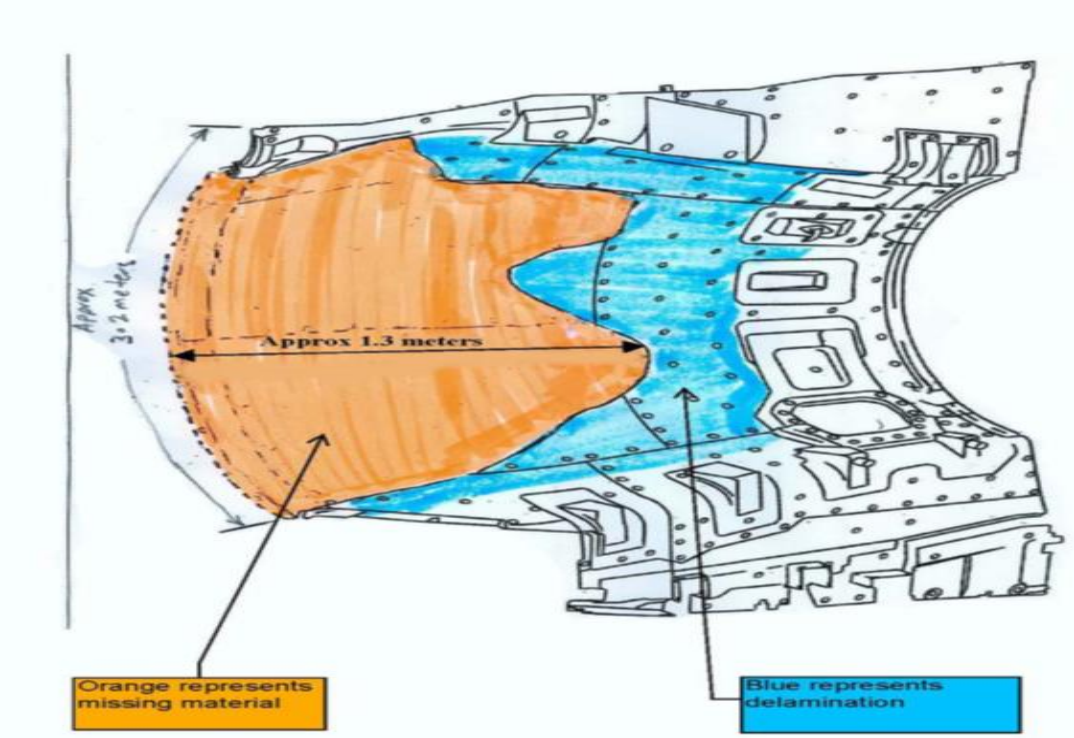

Figure 3. Drawing showing approximate material damage and loss on Left hand reverser's inner of wall of the right hand engine

Aircraft Information

The B777-200 was powered by two RB 211 Trent 800 engines. Each engine thrust reverser has two inner walls (left and right) that surround the aft part of the engine. These inner walls do not move. Reverse thrust is produced when movable doors, which are located aft of the two inner walls open, diverting fan bypass air forward, assisting the aircraft in reducing its speed. The inner wall (Part Number 315W5101-1) that failed was the left hand inner wall of the No.2 engine.

This part number inner wall was one of those delivered to the Operator, on the first sixteen RB 211-powered B777 aircraft. The composite inner wall has a carbon fiber corefor the low density core, and polyacrylonitrile based carbon fiber core for the high density core. The composite wall is protected from heat by a fire blanket. Cytec Metlbond was used as an adhesive.

The composite inner wall was protected from the engine heat by a thermal/fire blanket. If heat penetrated the thermal blanket, the protection of the composite inner wall would be significantly reduced. Therefore, significant effort was concentrated in reducing the possibility of heated air penetrating the blanket, which served as a protection for the composite inner wall.

Tests and Research

The failed inner wall was returned to Boeing for forensic laboratory examination, which was performed under the supervision of the NTSB, at the request of the AAIS. The detailed failure analysis revealed that an earlier repair had suffered some degree of adhesion failure between the adhesive film and the earlier repaired core and concluded that the inner wall failed primarily due to residual thermal damage that was not addressed when the panel was initially inspected and repaired. The repair was not effective due to inadequate cleaning of the core prior to repair and failure to expand the repair sufficiently to remove the thermal damage.

Furthermore, the forensic examination revealed that it was possible that the thrust reverser was mis-rigged, resulting in higher-than-normal loads which could have caused the weakened panel to fail.

Other Information

Boeing had issued two flight operations technical bulletins in May and June 2011. These publications informed airlines operating Rolls-Royce-powered Boeing 777s, of the in-service failures of the thrust reverser inner wall, due to thermal degradation of the composite structure. These failures had been attributed to long exposure of the thrust reverser inner wall to elevated temperatures. The bulletin stated that: “These temperatures are sufficient to degrade the material properties of the inner wall composite construction…..Typically, the thrust reverser failure has occurred at or shortly after airplane take-off rotation”.

In order to minimize the possibility of recurrence, Boeing also issued a series of service bulletins. Furthermore, the Federal Aviation Administration (FAA) issued *Airworthiness Directive 2012-16-04*, effective 3 October 2012 that required replacement of the 8th stage engine bleed valve parts. As the excessive heat downstream of the engine 8th stage bleed valve was the potential initiation point of the thermal damage to the composite thrust reverser, all safety efforts focused on its redesign, to prevent thrust reverser thermal damage.

As a preventive action, the Operator incorporated a set of modifications and pro-actively installed new inner-walls in all RB211 Trent 800 engines to mitigate the risk related to the thermal degradation of the inner-wall. This program started in August 2011 and was completed in December 2012.

Cause(s)

The Air Accident Investigation Sector determines that the failure of the thrust reverser inner wall was primarily due to residual thermal damage that was not correctly inspected and repaired following previous exposure to high temperatures.

Safety Actions Taken

The following Boeing service bulletins were incorporated by the Aircraft Operator. These modifications were performed:

- *Service Bulletin 777-78-0082* and *777-78-0071:*Thermal Protection System (TPS) introduced a new blanket and cooling of the inner wall.
- *Service Bulletin 75-G466*: Engine Bleed Valve modification to address thermal threat to thrust reverser for normal operation.

- *Service Bulletin 75-G765*: Engine Bleed Valve modification to address threat to thrust reverser for intermediate pressure engine bleed valve failure conditions .
- Compliance with FAA *AD 2012-16-04.*

Additionally, the Operator took proactive action to install new thrust reverser inner-walls on RB211 Trent 800 engines which incorporated the above modifications to remove the risk related to a latent degradation of the inner-wall. This program started in August 2011 and was completed in December 2012.

This Report is issued by:
The Air Accident Investigation Sector
General Civil Aviation Authority
United Arab Emirates.