INCIDENT

Aircraft Type and Registration:	Boeing 757-28A, G-TCBA
No & Type of Engines:	2 Rolls-Royce RB211-535E4-37 turbofan engines
Year of Manufacture:	1998
Date & Time (UTC):	12 June 2010 at 0045 hrs
Location:	Near London Gatwick Airport
Type of Flight:	Commercial Air Transport (Passenger)
Persons on Board:	Crew - 8 Passengers - 226
Injuries:	Crew - None Passengers - None
Nature of Damage:	None
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	16,875 hours (of which 8,134 were on type) Last 90 days - 139 hours Last 28 days - 76 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft began to leak fuel from the left engine while it was cruising at FL360. The flight crew diagnosed the fuel leak and cross-fed fuel to the left wing to correct the imbalance but the fuel leak continued. The commander made a PAN call and the aircraft was cleared to make an approach to Runway 26L at Gatwick Airport with no speed or altitude constraints, following which the aircraft landed normally. Subsequent investigation by the operator's maintenance engineers traced the source of the fuel leak to a pipe coupling at the HP fuel pump on the left engine. Further detailed investigation into the fuel leak was not possible as the seals removed from the aircraft were discarded, rather than being retained as is required by the operator's engineering organisation's procedures.

History of the flight

The aircraft was on a flight from Milas-Bodrum Airport, Turkey, to London Gatwick Airport and was established in the cruise at FL360. Approximately 2 hours and 20 minutes into the flight and shortly after entering French airspace a FUEL CONFIG warning appeared on the EICAS display. The commander consulted the Quick Reference Handbook (QRH) and a lateral fuel imbalance of 800 kg was detected 'right wing heavy'. He then carried out the QRH drill to correct the imbalance, during which it was noted that when the 'fuel consumed' figure from FMC Progress Page 2 was added to the fuel remaining figure, a discrepancy of 800 kg was evident, leading the crew to conclude that fuel was leaking from the aircraft. Fuel flow indications remained equal for both engines.

The commander contacted Maintrol using the aircraft's high frequency link and the symptoms were described to the duty engineer, who considered it possible that they could be caused by water contamination in the fuel uplifted from Milas-Bodrum. Fuel balancing continued, but the discrepancy between fuel used and fuel on board continued to increase to 1,200 kg, confirming a probable fuel leak.

The commander considered diverting to Paris Charles de Gaulle Airport which at this point was approximately 40 nm west of the aircraft, but Runway 09 was in use which would have necessitated additional track miles. As the aircraft was nearing the top of descent for arrival into London Gatwick, where the arrival runway in use was Runway 26L, the commander elected to continue to London Gatwick. He made a PAN call to London ATC who cleared the aircraft for an immediate approach to Runway 26L with no speed or altitude constraints, following which the aircraft landed normally.

Approaching the end of the landing roll the commander shut down the left engine as a fire precaution and parked the aircraft on Runway 08L, to allow the Airfield Fire and Rescue Services (AFRS) to conduct an inspection of the aircraft, and the airfield was closed to all movements. The AFRS fire chief advised, via the commander, that the aircraft be prepared for passenger evacuation using the right-hand slides only, due to the considerable amount of fuel spilled on the runway, taxiway, left engine and brakes.

The commander shut down the right engine and the AFRS hosed the fuel spillage away. Total useable fuel on board at the time the right engine was shutdown was approximately 3,800 kg, which was approximately 478 kg less than the flight planned arrival fuel of 4,278 kg. The commander estimated that approximately 1,300 kg of fuel had leaked from left engine and that the smaller 478 kg discrepancy in the actual-versus-planned arrival fuel quantity was due to the expeditious routeing received resulting from the PAN call.

The aircraft was towed to a remote stand where the passengers were disembarked normally. Following passenger disembarkation the operator's maintenance engineer opened the left engine cowl, resulting in a further fuel spill and it was apparent that the left engine and cowling interior were saturated with fuel.

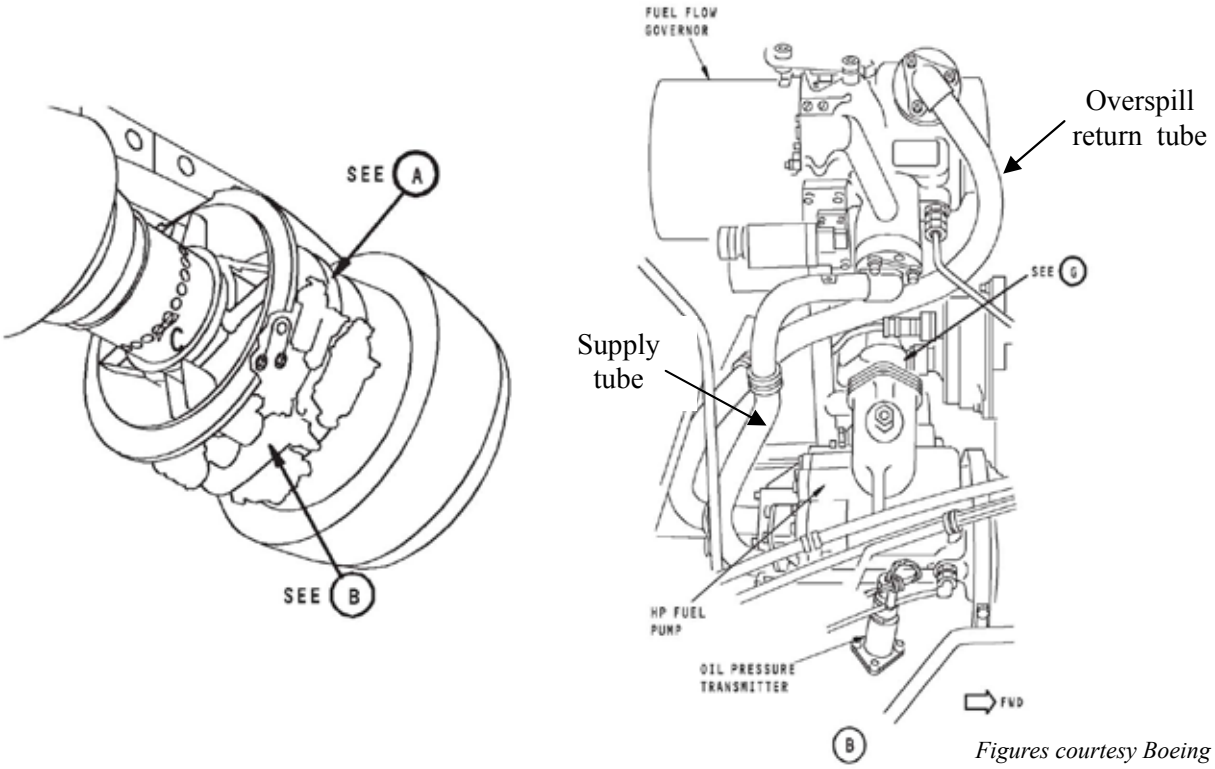
Source of the fuel leak

The operator's maintenance engineer traced the fuel leak to the seal ring between the HP fuel pump and the fuel flow governor (FFG) to HP fuel pump overspill return tube on the left-hand engine (shown in Figures 1 and 2). He therefore replaced this seal ring on both engines in accordance with the aircraft maintenance manual and a second maintenance engineer conducted a duplicate inspection, following which both engines were ground run at maximum static EPR to check for leaks. No fuel leaks were observed during this test and the aircraft was released to service.

The aircraft's maintenance records were reviewed and no record of maintenance activity on the fuel supply tube had been recorded or scheduled since the left engine had been installed, following overhaul, eight months previously in August 2009. Following installation the left engine had accumulated 2,839 flight hours and 812 flight cycles.

Retention of parts involved in occurrences

Following replacement of the HP fuel pump seal ring, the seal ring removed from the aircraft was discarded, preventing further investigation of this item's condition. The operator's engineering organisation is approved



Figures courtesy Boeing

Figure 1

Location of the HP fuel pump and FFG on the RB211-535E4 engine

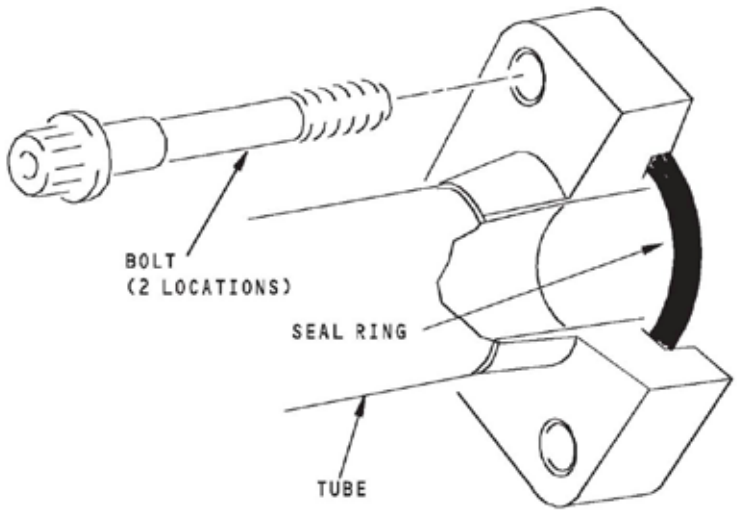


Figure courtesy Boeing

Figure 2

FFG fuel overspill return tube coupling at the HP fuel pump (post SB RB.211-73-B047)

by EASA under EASA Part 145 '*Maintenance Organisation Approval'* procedures. EASA regulation Part 145.A.60(a) states:

> *'The organisation shall report to the competent authority, the state of registry and the organisation responsible for the design of the aircraft or component any condition of the aircraft or component identified by the organisation that has resulted or may result in an unsafe condition that hazards seriously the flight safety.'*

In order to comply with this requirement the engineering organisation's Company Manual contains procedure 02-02-18 *'Reporting of Defects to the NAA/Operator/ Manufacturer'* which provides the following requirement to retain parts involved in occurrences that generate a Mandatory Occurrence Report (MOR) as required by Civil Aviation Publication (CAP) 382 – *'The Mandatory Occurrence Reporting Scheme'*:

> *'3.8 Retention of Parts Involved in Occurrences*
>
> *Any part that is the subject of an occurrence report or involved in or the cause of an incident is to be removed from the aircraft and prominently identified as the subject of an investigation. The part must then be returned to Stores and brought to the attention of Quality Assurance for decisions on further action on the part as the nature of the occurrence dictates.'*

Similar incidents

The CAA's MOR database was searched to identify any previous similar incidents involving leaks from the couplings between the HP fuel pump and the FFG supply and overspill fuel tubes on Rolls-Royce RB211-535E4 series engines. Following introduction of Service Bulletin (SB) RB.211-73-B047 in April 1996, which revised the fuel tube end adapters to feature a rigid two-bolt flanged joint and seal ring at the HP fuel pump coupling, only one occurrence of a fuel leak at this location was listed in the MOR database. However, information supplied by the engine manufacturer recorded 23 other events involving fuel loss from the HP fuel pump fuel tube couplings since January 2008. This statistic was gathered from the worldwide fleet of RB211-535E4 engines and included one precautionary diversion; all the other events were detected during ground checks.

Investigation undertaken by the engine manufacturer determined that the width of the seal ring groove in the fuel tube end adapter was insufficient to allow the seal ring to seat properly in the groove when the joint was compressed during torque tightening of the assembly. If the seal ring did not seat correctly, it was possible for it to become pinched at the corners of the groove. The action of vibration and fuel pressure fluctuations caused portions of the pinched seal ring to erode, resulting in a loss of sealing capability.

In response, the engine manufacturer introduced a further SB, RB.211-73-G230, in November 2009 that increased the width of the seal ring groove from 2.60 mm to 4.15 mm. No engines incorporating this SB have subsequently experienced fuel leaks at the HP fuel pump fuel tube couplings. The engine manufacturer comments that compliance guidance contained in this SB currently recommends embodiment of this modification when the engine is disassembled for refurbishment or overhaul. The modification is currently optional on-wing, when the parts require renewal or when the fuel tube connections are disturbed during maintenance.

Analysis

The source of the fuel leak was correctly identified by the operator's maintenance engineer as the coupling between the left engine HP fuel pump and the fuel overspill return tube from the FFG to the HP fuel pump, because following replacement of the seal ring at that location no further fuel leakage occurred.

No maintenance actions, either scheduled or unscheduled, had been performed on the fuel overspill return tube in the eight months preceding the incident. During this period the aircraft had accumulated 2,839 flight hours and 812 flight cycles without experiencing a similar fuel leak. Previous occurrences of fuel leaks at this location have been caused by trapping of the seal ring between the mating faces of the coupling, leading to erosion of the seal ring and eventual loss of sealing capability. The engine manufacturer introduced SB RB.211-73-G230 to address this problem, but this SB had not yet been embodied on this aircraft when the incident occurred.

As the seal ring removed from the aircraft was discarded following the incident, contrary to the operator's maintenance organisation's procedures, it has not been possible to identify positively the cause of the fuel leak. However, given the recorded history of fuel leaks due to trapping and subsequent erosion of the seal ring on engines without SB RB.211-73-G230 embodied, it is considered that this is the most likely mechanism that caused the fuel leak in this incident.

Safety action

Recent human factors analysis by the engine manufacturer indicates acceptable reliability when tubes are replaced during planned on-wing maintenance. Hence a revision to the Service Bulletin is planned, to recommend on-wing replacement during planned maintenance and during unplanned overhaul shop visits. Hence, it is expected that this modification will be fully implemented into the fleet by the end of 2013 and progress against this target will be monitored.