
Apparent fuel leak, Boeing 777-236, G-YMME

Micro-summary: This Boeing 777-236 experienced an apparent fuel leak, prompting a diversion.

Event Date: 2004-06-10 at 1907 UTC

Investigative Body: Aircraft Accident Investigation Board (AAIB), United Kingdom

Investigative Body's Web Site: <http://www.aaib.dft.gov/uk/>

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S2/2004 - Boeing 777-236, G-YMME

AAIB Bulletin No: S2/2004	Ref: EW/C2004/06/01	Category: 1.1
Aircraft Type and Registration:	Boeing 777-236, G-YMME	
Serial Number:	30306	
No & Type of Engines:	2 Rolls-Royce Trent 895-17 turbofan engines	
Year of Manufacture:	2000	
Date & Time (UTC):	10 June 2004 at 1907 hrs	
Location:	London Heathrow Airport	
Type of Flight:	Public Transport (Passenger)	
Persons on Board:	Crew - 15	Passengers - 151
Injuries:	Crew -None	Passengers - None
Nature of Damage:	None	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	50 years	
Commander's Flying Experience:	14,607 hours (of which 2,256 were on type) Last 90 days - 178 hours Last 28 days - 64 hours	
Information Source:	AAIB Field Investigation	

History of the flight

The aircraft was scheduled to fly from London Heathrow to Harare, Zimbabwe and was loaded with 101,100 kg of fuel. After a normal start up and taxi, the aircraft took off from Runway 27L expecting to fly a Midhurst 3G Standard Instrument Departure. Immediately after takeoff, an aircraft at the runway holding point reported a trail of smoke from the rear of the departing aircraft and a smell of fuel vapour. This was acknowledged and the aircraft continued on its planned departure, climbing to 6,000 feet amsl. As there were no abnormal indications on the flight deck and nothing visible from within the aircraft, the crew considered it likely that they were leaking fuel from the centre tank. This was reinforced by further reports from the ground and other aircraft of a two-mile vapour trail from the rear of the aircraft. The pilots decided to dump fuel in order to reduce the aircraft's weight to maximum landing weight and to return to Heathrow. An emergency was declared and the aircraft transferred to a discreet frequency whilst ATC directed the aircraft over the sea during the ensuing 25 minutes of fuel dumping. With approximately 4,000 kg of fuel remaining in the centre tank, an ILS approach was made to Runway 27L. There were no reports of any fuel leaking during the approach and the landing was made with minimum braking in order to keep the brake units as cool as possible. The Airfield Fire and Rescue Service met the aircraft and reported some vapour emanating from the left main landing gear wheel unit but no apparent fuel leaks. As a precaution, the left engine was

shutdown and the aircraft was taxied back to a stand where the passengers were disembarked normally.

Preliminary engineering information

An engineer inspected the aircraft after it arrived at the stand. He noticed a few drips of fuel on the left main landing gear but none on the ground. After opening the left main gear door he detected a distinct smell of fuel. An inspection inside the gear bay revealed that the centre fuel tank purge door was not in place. The purge door was hanging on a lanyard inside the fuel tank and a plastic bag was attached to the purge door opening. The bag contained fuel and it also contained the screws that would normally hold the purge door in place (see Figures 1 and 2).



Figure 1 - View inside left main gear bay looking forward at the rear spar of the centre fuel tank. Purge door opening circled in red.



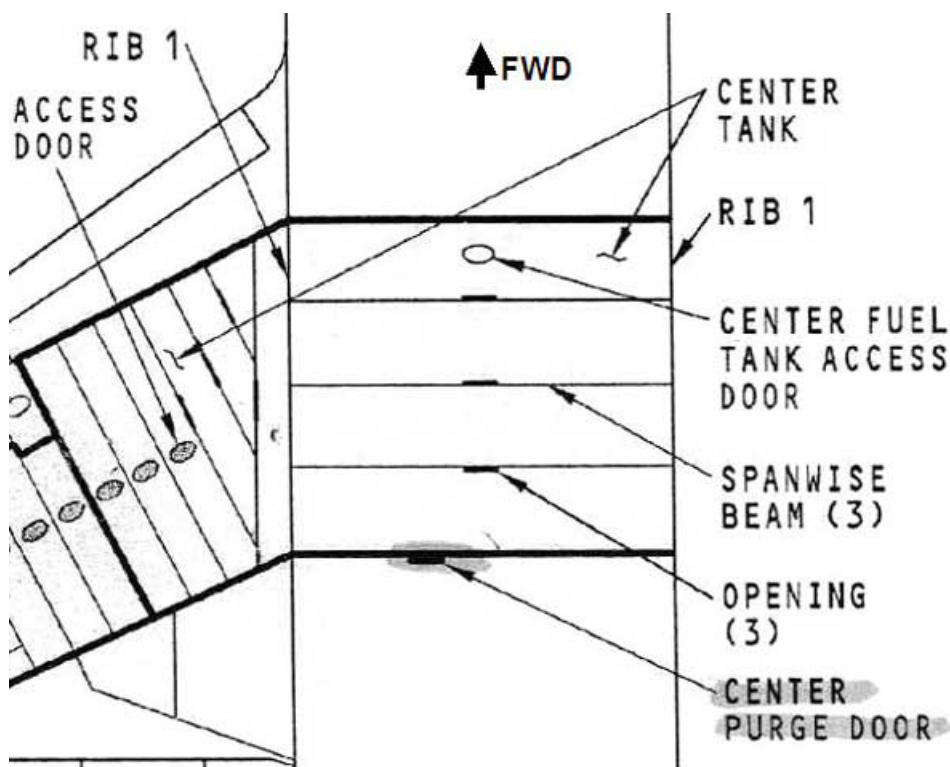
Figure 2 - Purge door opening. Fuel and retaining screws inside plastic bag. Purge door is hanging on lanyard inside the fuel tank. The O-ring seal was removed from the purge door by maintenance staff following the incident.

The Boeing 777-200 ER has a centre fuel tank that occupies the centre wing box and the inboard sections of the wings. It has a capacity of 98,800 litres or approximately 80 tonnes of jet fuel. Before start-up G-YMME had approximately 43 tonnes of fuel in the centre tank which would have reached a level slightly below the purge door opening. The aircraft's pitch attitude during climb-out would have been sufficient for the fuel to start flowing through the purge door opening.

The aircraft had flown 16,696 hours and had completed 1,907 cycles at the time of the incident. Its last heavy maintenance was a 2C check which was carried out during the period between 2 May and 10 May 2004. Between completion of this 2C maintenance and the incident flight, the aircraft had flown 53 sectors; the highest centre fuel tank load during those flights was 28 tonnes. There was no record of any maintenance work requiring access to the centre tank or removal of the centre tank purge door since the 2C check.

The 2C maintenance check required access to the centre fuel tank to carry out an internal structural inspection of the rear spar and to carry out a special check of the bonding of the centre tank float switches. The rear spar inspection required access to the rear of the centre wing section of the centre tank while the bonding check only required access to the left and right inboard wing sections of the centre tank.

The centre fuel tank was drained and purged to permit safe access inside the tank to carry out the inspections. The purge procedure in the Aircraft Maintenance Manual (AMM) called for the removal of the centre tank access door on the belly of the aircraft and the three inboard access doors under each wing (see Figure 3). The AMM contained a stand-alone procedure detailing removal of the purge door which is on the rear spar of the centre tank (and accessible within the left main landing gear bay) but this was not referenced in the purge procedure. The maintenance organisation had raised routine job cards for removal of the centre tank access door and removal of one inboard access door on each wing. No routine job card had been raised for removal of the purge door. In the event that the purge door needed to be removed, standard procedure required that a defect card be raised calling for the purge door to be refitted. No such defect card was raised during the 2C check.



Maintenance personnel involved with the 2C check were interviewed and many stated that they were not aware of the existence or location of the purge door on the Boeing 777. One engineer stated that

he had removed the purge door previously on another aircraft to help ventilate the rear section of the centre tank prior to carrying out the rear spar inspection. On that occasion he raised a defect card to refit the purge door.

A leak check is performed following removal of any fuel tank access doors. The Fuel Leak Detection procedure in the AMM specified the required minimum fuel quantities to leak check the individual access doors to the wing tanks and the centre wing tank. This procedure did not, however, mention the purge door. The previously mentioned stand-alone maintenance procedure for removal and reinstallation of the purge door contained a leak detection procedure for the purge door. The procedure stated that the centre fuel tank should be refuelled to a minimum quantity of 32,000 kg to leak check the purge door. This fuel amount is insufficient to reach the purge door opening. Since this incident the aircraft manufacturer has issued a revised figure of 52,163 kg to leak check the purge door.

During the 2C check, leak checks were carried out on all the fuel tank doors that had been removed as part of routine jobs - this did not include the purge door. The centre tank was refuelled to a maximum of 40 tonnes for an engine run.

The investigation of the open purge door also revealed that the rear spar inspection had not been correctly carried out on G-YMME. The AMM contained a diagram which was incorrect and showed the forward spanwise beam inside the centre fuel tank as the area to be inspected rather than the rear spar. The engineer on G-YMME performed the inspection per the diagram and therefore did not go to the rear of the centre tank to inspect the rear spar. The rear spar inspection diagram had been corrected by the manufacturer and this corrected diagram first appeared in the May 2004 revision of the AMM. This new version of the AMM was not on the maintenance organisation's database at the time of the 2C check. The maintenance organisation has since discovered that two other Boeing 777 aircraft were incorrectly inspected due to the incorrect diagram. A plan for re-inspecting these aircraft is currently being devised by the operator, the aircraft manufacturer and the Civil Aviation Authority.

The diagrams of the centre wing tank in the Boeing 777 AMM show openings within the spanwise beams. These openings permit access to the rear of the tank. On the 777-200 ER these openings are closed off with baffle doors because of the fuel in the centre wing (unlike the basic 777-200 that has a dry centre wing and no baffle doors). The AMM does not show the baffle doors in any of its diagrams of the centre fuel tank. These baffle doors must be removed to gain access to the rear spar. The rear spar inspection procedure does not mention the baffle doors. No routine job cards had been raised by the maintenance organisation to remove the baffle doors on G-YMME.

Further work

The AAIB is in discussion with the aircraft manufacturer concerning issues with the Boeing 777 Maintenance Manual and the hazard associated with flight when the purge door is removed. The AAIB is also investigating relevant processes and procedures at the maintenance organisation.

Formal Report

Under the provision of the Civil Aviation (Investigation of Air Accidents and Incidents) Regulations 1996, the Chief Inspector of Air Accidents has ordered that an Inspector's Investigation be conducted into the circumstances of this serious incident.