Serious Incident

Aircraft Type and Registration:	Boeing 737-8200 MAX, EI-HEZ	
No & Type of Engines:	2 CFMI LEAP-1B27 engines	
Year of Manufacture:	2019 (Serial no: 62312)	
Date & Time (UTC):	24 April 2025 at 1300 hrs	
Location:	London Stansted Airport	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 6	Passengers - 191
Injuries:	Crew - None	Passengers - None
Nature of Damage:	None reported	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	33 years	
Commander's Flying Experience:	6,700 hours (of which 6,380 were on type) Last 90 days - 184 hours Last 28 days - 40 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

Synopsis

A Boeing 737-8200 MAX experienced a fuel leak on a scheduled flight from Venice to Manchester, resulting in a diversion to London Stansted Airport. The non-normal checklist was not actioned fully, with the pilots deciding not to shut down the affected engine. On landing, the use of thrust reverse with a fuel leak increased the risk of fire.

History of the flight

The crew reported for duty for a flight from Venice Airport to Manchester Airport. Weather across Europe was good and they agreed to accept the standard operational flight plan (OFP) fuel load, which included 637 kg of extra fuel. They positioned out to a remote parking stand to wait for the arrival of the aircraft.

The aircraft was handed over by the off-going crew, the commander conducted an external inspection and a normal refuel took place. The passengers were boarded but aircraft dispatch was delayed by an hour due to a company computer system failure. During this time the APU was running and a fuel imbalance had developed between the main fuel tanks. This was corrected with the fuel balancing procedure being conducted from memory. The aircraft completed a normal pushback with engine start and departed without any further delay.

Shortly after reaching their cruise altitude of FL380, the commander noted a fuel imbalance developing, with the right main tank indicating 250 kg less that the left main fuel tank. The fuel balancing procedure was conducted again from memory, with normal fuel pump configuration restored after seven minutes of fuel cross-feeding.

After another 20 minutes of flight, a fuel imbalance of 170 kg was noticed with the right main fuel tank low. The commander decided to action the fuel '*IMBAL'* non-normal checklist which directed them to the '*Fuel Leak Engine'* non-normal checklist. The pilots noted an increasing fuel imbalance of around 100 kg every 10 minutes, which indicated an engine fuel leak (the QRH stated that a change of fuel imbalance of 228 kg within 30 minutes or less should be classified as a leak). The cabin crew did not observe any signs of fuel spray from the engine or strut.

Based on the current leak rate, continuing to their destination would use all the additional fuel on board, and so a decision was made to initiate a diversion to Stansted Airport. The pilots considered that their leak rate of 300 kg every 30 minutes exceeded the QRH value by only 70 kg, and so they decided not to shut down the engine on the affected side given that the weather at Stansted Airport was good and the diversion was only expected to take about 20 minutes. They stopped the checklist and monitored the fuel consumption.

A normal approach was conducted with the IMBAL alert illuminating during the approach, and the aircraft landed with a fuel imbalance of 586 kg. The aircraft stopped after exiting the runway and was met by the fire service who confirmed there was fuel leaking from the right engine. The aircraft was shutdown and towed to stand for passengers to disembark.

Aircraft fuel system

The Boeing 737-8200 MAX has three main fuel tanks: left wing, right wing and centre. Each fuel tank has two electrically driven fuel pumps that provide pressurised fuel into a fuel manifold associated with each engine. The centre tank fuel pumps produce higher pressure to ensure the centre tank fuel is used before the wing tank fuel. Check valves located throughout the system ensure the proper direction of fuel flow. Fuel shutoff valves are located on the front spar outboard of each engine strut (spar fuel shutoff valve) and at the engine (engine fuel shutoff valve).

The engine fuel manifolds are interconnected by a cross-feed valve. Normally the cross-feed valve is closed, and each engine is independently fed with pressurised fuel from their respective side. If the cross-feed valve is opened, fuel pressure can be provided to both engines from any operating fuel pump.

Fuel imbalance

The Airplane Flight Manual (AFM) and Flight Crew Operations Manual (FCOM)[1] provide a maximum lateral fuel imbalance limitation between main wing tanks of 453 kg for taxi, takeoff, flight or landing.

Footnote

[1] The FCOM is prepared by Boeing for the aircraft operator. It contains operational procedures and information for the flight crew to safely and efficiently operate the aircraft.

The manufacturer states in the Flight Crew Training Manual (FCTM)[2] that the fuel balance limitation is not for aircraft controllability, but to maximise the structural life of the airframe and landing gear. Lateral control is not significantly affected when operating beyond the normal balance limits. The FCTM goes on to say that *'routine fuel balancing when not near the imbalance limit increases the possibility of crew errors and does not significantly improve fuel consumption'*.

An amber IMBAL alert is displayed to the pilots when the lateral fuel imbalance between the wing tanks is greater than 453 kg. Fuel cannot be transferred between wing tanks to correct a fuel imbalance. A fuel imbalance is rectified by burning fuel from the heavier side by using the cross-feed valve. There is an *'IMBAL'* non-normal checklist contained in the Quick Reference Handbook (QRH).

If considering balancing fuel before the limitation is reached, the FCTM refers to the *' Fuel Balancing'* supplementary procedure contained in the FCOM. The FCOM guidance on supplementary procedures states, '*at the discretion of the captain, procedures may be performed by memory, by reviewing the procedure prior to accomplishment, or by reference to the procedure during its accomplishment.'*

Fuel leak

The FCTM states that a fuel leak should be considered as a possibility any time an unexpected fuel quantity indication, Flight Management Computer (FMC) fuel message, or fuel imbalance condition is experienced. This consideration is incorporated at the start of both the QRH *'IMBAL'* non-normal checklist and the FCOM *'Fuel Balancing'* supplementary procedure.

The most common type of fuel leak is between the front spar and the engine as fuel lines are exposed in the strut. This is the assumption of the QRH *'Fuel Leak Engine'* non-normal checklist, which instructs the pilots to shut down the associated engine, closing both the spar fuel shutoff valve and the engine fuel shutoff valve. This stops further loss of fuel and prevents fuel leaking around the hot parts of the engine.

The FCTM offers additional information when fuel is leaking around an operating engine stating, *'the risk of fire increases further when the thrust reverser is used during landing. The thrust reverser significantly changes the flow of air around the engine which can disperse fuel over a wider area.'*

Analysis

Fuel imbalance

On reaching the cruise altitude the commander noted a fuel imbalance during a fuel check and decided to balance the fuel before an IMBAL alert was displayed. The pilots completed

Footnote

[2] The FCTM provides information on manoeuvres and techniques, developed and recommended by Boeing, and recognised by the FAA for use in flight operations. They are provided as guidance and do not prevent the operator from developing equivalent techniques.

fuel balancing from memory, missing the prompt at the start of the FCOM *'Fuel Balancing'* supplementary procedure to consider a possible fuel leak. This delayed the start of the diagnosis process until the second imbalance was noticed, some 35 minutes into the cruise.

Memory 'v' checklist

Boeing encourages the use of the FCOM *'Fuel Balancing'* supplementary procedure with good crew coordination to reduce the possibility of errors. The FCOM guidance on the use of supplementary procedures gives the captain the discretion to accomplish the procedure from memory, by reviewing the procedure prior to accomplishing it, or action the procedure as a checklist. If used as a checklist there is less likelihood of an omission or error occurring and, in this case, it is likely the pilots would have had the opportunity to diagnose a fuel leak on first recognition of the imbalance at around seven minutes into the cruise.

Fuel leak

When the fuel imbalance was addressed for the second time in flight, the commander actioned the QRH *'IMBAL'* non-normal checklist although there was no IMBAL alert. A fuel leak was suspected, leading to the QRH '*Fuel Leak Engine'* non-normal checklist. The pilots confirmed an engine fuel leak but decided not to continue with the non-normal checklist, which would have led them to shut down the affected engine, because they considered the leak rate to be only marginally greater than the trigger value in the QRH. Advice contained in the FCTM did not form part of their decision-making process.

The thrust reversers were used for approximately six seconds on landing. With fuel still leaking around the right engine, the use of thrust reverse would have dispersed fuel vapour around the hot parts of the engine and the risk of a fire would have increased.

Conclusion

In completing fuel balancing from memory, the pilots did not consider the possibility of a fuel leak, delaying diagnosis of the problem. Once the leak was confirmed, they decided not to fully complete the non-normal checklist, which directed them to shut down the affected engine. The subsequent use of thrust reverse on landing increased the potential risk of fire due to disbursement of fuel vapour around hot parts of the engine.