Loss of System B hydraulics, Boeing 737-448, EI-BXB

Micro-summary: This Boeing 737-448 experienced a partial loss of System B hydraulics, landed normally, and then evacuated when smoke was seen coming from the aft fuselage.

Event Date: 1998-08-28 at 1225 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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1. Accident reports can be and sometimes are revised. Be sure to consult the investigative agency for the latest version before basing anything significant on content (e.g., thesis, research, etc).

2. Readers are advised that each report is a glimpse of events at specific points in time. While broad themes permeate the causal events leading up to crashes, and we can learn from those, the specific regulatory and technological environments can and do change. ***Your company's flight operations manual is the final authority as to the safe operation of your aircraft!***

3. Reports may or may not represent reality. Many many non-scientific factors go into an investigation, including the magnitude of the event, the experience of the investigator, the political climate, relationship with the regulatory authority, technological and recovery capabilities, etc. It is recommended that the reader review all reports analytically. Even a "bad" report can be a very useful launching point for learning.

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Boeing 737-448, EI-BXB

AAIB Bulletin No: 6/99 Ref: EW/G98/08/42 Category: 1.1

Aircraft Type and Registration:	Boeing 737-448, EI-BXB
No & Type of Engines:	2 CFM56 turbofan engines
Year of Manufacture:	1989
Date & Time (UTC):	28 August 1998 at 1225 hrs
Location:	Runway 27L, London Heathrow Airport
Type of Flight:	Public Transport (Passenger)
Persons on Board:	Crew - 7 - Passengers - 152
Injuries:	Crew - None - Passengers - 2 (minor)
Nature of Damage:	B System hydraulic pump failed
Commander's Licence:	Airline Transport Pilots Licence (Irish)
Commander's Age:	46 years
Commander's Flying Experience:	12,292 hours (of which 6,182 were on type)
	Last 90 days - 190 hours
	Last 28 days - 68 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and comprehensive Incident Investigation Report prepared by the operator

History of the Flight

The flight had proceeded uneventfully from Cork to London Heathrow when, approaching the Ockham VOR, the Hydraulic and Master Caution lights flickered and extinguished. They then flickered again and the first officer informed the commander that the System B quantity was indicating 39%. The crew, despite having already acknowledged an outbound heading from Ockham towards the approach requested from ATC permission to take up a hold in order to assess the situation. Whilst the flight was holding, ATC were informed that the problem was associated with one hydraulic system. The appropriate checklist was completed. Flap 5 was selected and speed reduced to 180 kt. The crew had decided that the procedure was an abnormal one, as opposed to an emergency situation and therefore neither a 'Pan' nor 'Mayday' was declared. The Senior Cabin Crew Member (SCCM) was called to the flight deck and briefed that the landing would be normal, but at a slightly faster speed, and that the emergency services would be in attendance.

Having briefed the SCCM the commander made a Public Address (PA) to the passengers informing them that part of the hydraulic system had failed and, as a consequence, the landing would be at a faster speed than normal. Furthermore, after landing, the aircraft would be attended by emergency vehicles. The crew informed ATC that they were ready for the approach and, in response to an ATC inquiry as to the range at which they wished to join the final approach, the crew requested 10 miles. Two aircraft were vectored to Runway 27L ahead of the flight and none behind it, in anticipation of the possibility of a blocked runway.

The crew were advised of a discrete frequency of 121.6 MHz for direct communication with the Rescue and Fire Fighting Services (RFSS). Following an auto coupled approach an uneventful landing was completed and 80% N_1 reverse thrust used with manual braking to bring the aircraft to a stop slightly beyond the normal turn-off point. With the aircraft at a stop the commander made a PA for passengers to 'remain in your seats, remain in your seats' (indicating to the cabin crew that an evacuation was not necessary). The first officer requested a thorough check of the landing gear and aircraft by the RFSS. The commander decided to shut down both engines and secure the aircraft as Fire Service personnel approached from many directions to carry out the inspection.

The crew were then informed by the RFSS of some smoke coming from the left side of the aircraft. The commander requested the first officer to confirm 'smoke' coming from the aircraft and the Fire Chief confirmed smoke coming from right side also. Based on this information the commander made the decision to evacuate the aircraft and informed the first officer of this decision. At the same time the SCCM came into the flight deck and, hearing the word evacuate, asked the commander if he wanted the aircraft evacuated. The commander said that he did and returned to completing the checklist, while the SCCM returned to the cabin and made the following PA 'cabin crew evacuate the aircraft'. (CCMs in the aft cabin area could smell and see smoke before the senior made the PA announcement). The commander did not initiate the 'Evac Alert' system as, by the time he came to it as a checklist item, the evacuation was well under way. In their operator's report the flight deck crew were highly complimentary of ATC, having found them exceptionally understanding and considerate of their situation in a high density traffic environment.

The evacuation

All doors were used except door 1 Right, the galley service door, where the slide inflated fully but was tilted towards the front of the aircraft such that it was not usable. The overwing exits were used initially but the passengers were confronted by a considerable drop to the ground since the flaps were only set at the Flap 15 position. This setting had been used for landing in accordance with the Quick Reference Handbook for a 'B' system hydraulic failure and therefore full flap had not been deployed. The RFSS, assessing there to be no immediate danger, redirected the passengers back into the aircraft and to the slide exits. The cabin crew and flight deck crew checked the entire cabin and toilets before they themselves left the aircraft using the slides.

One of two children, being carried by one passenger, was found to have stopped breathing on arrival at the end of the slide but the infant was revived by mouth and nose resuscitation given by one of the airport Fire Officers in attendance, and recovered quickly. Another passenger received slight back injuries on exiting the end of the slide. Both were taken to hospital but were not detained having been examined by medical personnel.

All the passengers were moved away from the aircraft and assembled in groups of ten. Young passengers and unaccompanied minors were kept together, along with a young girl who had been

separated from her mother when she exited the aircraft through the opposite door. Buses were brought to the aircraft and the passengers and crew were brought to the passenger terminal.

The hydraulic failure

Technical examination showed the hydraulic 'B' system pump [P/N 5718F03] to have failed. Examination of this unit revealed damage to a plug and bleeder 'O' ring seal P/N NAS1612-4. The damaged 'O' ring exhibited one obvious defect in that it had flattened on the side which faces the belleville washer P/N 57446. Another pump was inspected because it had an 'O' ring installed which came from the same batch as the failed 'O' ring. The 'O' ring was removed and exhibited the same characteristics (flat side) as the failed 'O' ring, however overnight the 'O' ring resumed its original shape.

Six 'O' rings were sent to RAPRA Technology for testing, including the failed 'O' ring, the 'O' ring which was removed from the serviceable pump, an 'O' ring from the 'bad batch' and three 'O' rings from batch 1034521 for comparison purposes.

The maintenance organisation arranged for analysis of the 'O' rings. The defective 'O' ring was found to have failed because of mould misforming. The 'O' ring which was from the same batch as the failed 'O' ring and removed from the serviceable pump was found to have been heavily buffed to remove excess flash. Also the third 'O' ring from batch 1034562 was found to have been buffed. The three 'O' Rings from batch number 1034521 showed no defects. The exact cause of failure was either a seal pinched on assembly or a manufacturing fault due to buffing to remove excess flash. As either of these defects could have caused the hydraulic leak the complete batch of 'O' rings was withdrawn from service.

Failure of slide at door 1 right to deploy correctly

The failure of door 1 right (1R) slide to deploy correctly was fully investigated. The slide was repacked by the individual who had previously packed it and was refitted to door 1R on the subject aircraft. A CCM opened the door and the slide deployed faultlessly. It was considered that the procedure whereby the manual inflation handle was to be pulled, regardless of the functioning of the automatic inflation system, could hazard the safety of cabin crew due to common system parts in both the manual and automatic sequences.

Safety actions

Amongst several follow up actions taken by the operator the following are of interest to operators and maintenance organisations of similar types of aircraft

1 All stock in stores, and aircraft fitted 'O' rings P/N NAS1612-4, of batch number 1034562, were to be purged from the system.

2 The maintenance organisation issued instructions to all personnel involved in the fitting of 'O' ring seal P/N NAS1612-4 emphasising the need for particular attention to avoid pinching of the seal on assembly.

3 Training of all relevant personnel, stressed the requirement for a single movement when opening of the door to guarantee correct slide operation.

4 The procedure whereby cabin crew members immediately pull the manual inflation handle of escape slides, regardless of the functioning of the automatic inflation system, was to be re-examined.