

No: 6/91 **Ref: EW/G91/02/06** **Category: 1a**

Aircraft Type and Registration: BAe 146-200, G-OLCB
No & Type of Engines: 4 Lycoming ALF 502-R5 turbofan engines
Year of Manufacture: 1988
Date & Time (UTC): 9 February 1991 at 2258 hrs
Location: Manchester International Airport
Type of Flight: Public Transport
Persons on Board: Crew - 2 Passengers - 6
Injuries: Crew - None Passengers - None
Nature of Damage: Both tyres and outer wheel of left main landing gear severely damaged
Commander's Licence: Airline Transport Pilot's Licence
Commander's Age: 45 years
Commander's Flying Experience: 5,500 hours (of which 510 were on type)
Information Source: Aircraft Accident Report Form submitted by the pilot and AAIB inquiries

The aircraft was on a night flight from Geneva to Manchester. The Manchester Airport ATIS reported the relevant weather as wind calm; visibility 2500 metres in haze; cloud 4 oktas at 1000 ft aal; ambient temperature minus 6°C; Runway 24 wet but clear of snow over its whole area. The crew noted after the landing that the runway surface was damp, rather than wet, and with no standing water. Runway 24 available length was 3048 metres, the landing weight was around 28000 kg (Maximum Landing Weight 36740 kg) and touchdown speed was 103 KIAS. Wheel brake anti-skid was selected on, as usual.

The landing, on Runway 24, was executed by the First Officer, and touchdown was reported as smooth, with moderate wheel braking during the ground roll. The handling pilot felt the aircraft settle slightly shortly after main wheel touchdown, before the nose landing gear had touched down. He then felt the aircraft pull somewhat to the left, and at the end of the landing roll the aircraft came quickly to a halt and could not be taxied off the runway. Inspection revealed that both tyres of the left main landing gear had deflated. The passengers were disembarked via the airstairs without injury.

After changing the left main landing gear wheels on the runway the aircraft was towed into a heated hangar. Examination reportedly showed that each tyre had been worn away in one area, including the sidewalls, and that part of both rim flanges of the outer wheel had been abraded away. The damage was consistent with both wheels having failed to rotate during the landing roll.

The BAe 146 has a tricycle landing gear with two wheels on each main landing gear leg. Each main wheel incorporates a carbon multi-disc wheel brake assembly with a duplicated anti-skid system that operates down to around 15 kt ground speed during deceleration. Auxiliary pistons in each brake unit operate to brake the main wheels as landing gear retraction is initiated, in order to reduce retraction loads. The auxiliary braking remains on until the landing gear is extended again. An integral brake cooling electric fan is fitted in each of the four main wheel axles, and the four fans are controlled by a flight deck switch with Auto/On/Off selections. With Auto selected, the operator's standard procedure at the time of the accident, the fans operate all the time that the landing gear is locked down and stop when the landing gear is retracted. A brake temperature indicator (BTI) system (Modification 40049) can be incorporated as a customer option and includes a brake temperature sensor in each of the four main wheel axles and a flight deck indicator.

After G-OLCB had been removed to the hangar the brake system was checked, a number of brake system components were changed, including the anti-skid control unit and the dual adaptive anti-skid valve (DAAV), further brake system inspections and checks were made, high speed taxi runs with heavy braking were conducted, and the aircraft was flown. Throughout these checks no fault was found. Subsequent tests and examination of relevant brake system components by the brake system manufacturer revealed that the anti-skid control valve was out of calibration, although to only a minor degree, and the DAAV failed a Production Acceptance Test item of the scheduling of brake pressure versus valve electrical current. The latter was reportedly the result of severe contamination that was found of hydraulic fluid filters within the unit with a black deposit that was identified as debris from eroded body O-ring seals. The seals were of an original design standard type, DAS2074A-3, that have been changed to type DSR58991-1008. The defect would have reduced brake peak performance, but no evidence was found of a fault in any of the components that could have contributed to this accident.

Other BAe 146 operators have reportedly experienced instances of seized brakes during cold weather operations. It has appeared that brakes which have become wet or slush covered during taxi for takeoff or during the take-off run have frozen after retraction. They have then failed to release when the auxiliary retraction brake cylinders have been depressurised on gear extension for landing. A report has been received of a case in Copenhagen that occurred a few days before the accident to G-OLCB and that was apparently similar. G-OLCB's flight crew reported that at Geneva the aircraft had been required to taxi a considerable distance for take-off and that no hold had been required before the

takeoff. There had not been general snow, ice or standing water on the apron, taxiways or runway, but there had been some patches of water and packed ice. The ambient temperature was +3°C and dew point +1°C, and conditions had been generally damp, with some rain. Brake fans had been selected to Auto throughout both the flight to Geneva, the turnaround and the return flight, in accordance with the operator's standard procedure at the time of the accident. The crew could not positively recall whether the aircraft had been in or out of cloud at the time that the landing gear had been extended on the approach to Manchester.

At least one overseas operator has developed procedures to prevent brakes freezing on after retraction, and in 1989 BAe advised such procedures in BAe 146 Flight Operations Bulletin 13/89 "Winter Operations". This included: "Taxying - Use of Brake Fans: If BTIs are fitted, leave Brake Fans OFF for taxying when BTI indicates less than 200°C on all wheels. Monitor BTI and select Brake Fans ON as appropriate to maintain brake temperatures between 150 and 200°C. Select Brake Fans Auto/ON for landing as per normal procedures." The procedure is aimed at both reducing the entrainment by brake fans of water, snow or ice, and also at maintaining brakes warm enough at the point of retraction to prevent freezing. It is noted that the BTI is not standard equipment and is therefore not fitted to all aircraft. The Bulletin also advises: "After take-off, if climbout performance is not limiting, delay retraction of the landing gear in order to shake off any accumulated slush."

At the time of the accident the operator's Operations Manual was in process of amendment to incorporate these procedures and they had not been promulgated to flight crews. The procedures have now been incorporated into the operator's Operations Manual and Checklists and the operator has revised its methods for taking action on such information.

In addition, the aircraft manufacturer issued a CAA approved Modification, under Service Bulletin No. 32-107-01183A, issued 25 September 1990, to introduce a facility whereby the auxiliary retraction brakes are automatically released 24 seconds after being applied. This Modification was categorised by the manufacturer as recommended. It was not incorporated on G-OLCB.

As a result of the investigation AAIB has recommended that the CAA:

1. Take measures aimed at ensuring that safety relevant operating procedures advised by manufacturers are expeditiously promulgated to the personnel concerned with their application.
2. Require measures to prevent possible brake freezing that are applicable to BAe 146 aircraft not fitted with a brake temperature indicator system, until such aircraft should be modified to incorporate automatic depressurisation of auxiliary retraction brakes.

3. Require mandatory modification to incorporate automatic depressurisation of BAe 146 auxiliary retraction brakes shortly after landing gear retraction.

4. Assess the need for action to prevent deterioration of O-rings in the BAe 146 dual adaptive anti-skid valves from leading to reduction in braking performance capability.