

No: 10/92

Ref: EW/C92/3/6

Category: 1a

Aircraft Type and Registration: BAe 146-300, G-UKHP

No & Type of Engines: 4 Lycoming ALF 502-R5 turbofan engines

Year of Manufacture: 1989

Date & Time (UTC): 31 March 1992 at 1130 hrs

Location: Aberdeen Airport

Type of Flight: Public Transport

Persons on Board: Crew - 6 Passengers - 75

Injuries: Crew - Nil Passengers - Nil

Nature of Damage: Mud contamination of wheels, brakes and mud ingestion by power plants

Commander's Licence: Airline Transport Pilot's Licence

Commander's Age: 59 years

Commander's Flying Experience: 12,298 hours (of which 1,444 hours were on type)
Last 90 days - 150 hours
Last 28 days - 42 hours

Information Source: AAIB Field Investigation

The crew of the BAe 146-300 aircraft reported for duty at 0505 hrs to operate 4 sectors departing from, and returning to, Aberdeen. The incident occurred on the final sector from Edinburgh to Aberdeen, with the commander as the handling pilot. The three earlier sectors had been operated satisfactorily.

The crew received a terminal airfield forecast for Aberdeen, prior to their departure from Edinburgh, which did not differ significantly from the actual weather copied by the crew from the Aberdeen Automatic Terminal Information Service (ATIS) prior to their approach. The ATIS recording, timed at 1050 hrs, gave a surface wind of 070°/19 kt variable between 040° and 110°, gusting between 12 kt and 30 kt. Visibility was given as 10 km in rain with 2 octas of cloud at 800 feet, 6 octas at 1000 feet, 7 octas at 1500 feet, and with water patches on the runway, 1mm to 2mm deep. Wind shear of ± 15 kt was reported at 400 feet. Since runway 34 was in use, these conditions resulted in a strong gusting wind from the right during the final approach and landing.

The aircraft was radar vectored for an ILS approach to runway 34. Prior to the approach the crew had correctly calculated the Vref speed for a 33° flap landing to be 119 kt at their landing weight of 37,444 kg and, in accordance with the operations manual, an additional 10 kt was set on the ASI 'bugs' to allow for the gusty conditions on finals. The autopilot, which had been used during the cruise and descent, was disengaged at 1400 feet agl, and 33° flap was selected at 1000 feet agl. Turbulence and speed fluctuations during the later stages of the approach were not as much as had been expected by the commander and he later stated that the reported windshear at 400 ft did not occur. Drift during the final stages of the approach was such, however, that the commander was only able to see the runway through the area of the windscreen outside the normal sweep of the windscreen wipers. This did not give rise to any problems and after selecting the airbrakes to the AIRBRAKE OUT position at approximately 50 ft agl, the aircraft touched down firmly in the centre of the runway at 120 kt.

Once on the runway it is normal procedure for the commander to move the airbrake lever through from the AIRBRAKE OUT position to the LIFT SPOILER position and for the first officer to confirm that the engine thrust is at "ground idle", that the lift spoilers have operated by noting correct operation of the associated indicator lights and calling "yellow over green". * However, on this occasion the first officer reminded the commander of the need to prevent the 'into wind' wing from lifting but did not make the "ground idle/yellow over green" calls. (The flight data recorder (FDR) subsequently showed that the spoilers had not deployed. The warning captions, marked "LIFT SPLR", located on the coaming in front of each pilot, which should illuminate 6 seconds after touchdown if the lever is not selected to LIFT SPLR, did not illuminate).

Runway 34 at Aberdeen is 1829 metres long and 46 metres wide. Several witnesses, positioned outside the fire station, saw the aircraft's main landing gear make initial runway contact just inside runway block 3 (560 metres into the runway). From this initial touchdown position, the aircraft would have had 1269 metres of runway remaining. Witnesses then described the aircraft as "bouncing on its main wheels, touching down a second time 'nose-wheel-first' and then bouncing twice more in a level attitude". By runway block 4, adjacent to runway light 13, the aircraft had travelled 375 metres with 894 metres of runway remaining, and witnesses described it as having been firmly on all three landing gears, with water spray visible behind the tyres. The FDR recorded the IAS at this point as being 112 kt. The area of noticeable spray from the tyres was observed by witnesses to be limited to between runway blocks 4 and 5.

*Pressure switches, one in the deploy line of each selection valve, activate flight mode annunciators "SPLR Y" and "SPLR G" on both pilot's instrument panels when spoilers are deployed.

As soon as all wheels were on the runway the commander commenced braking. Although the aircraft had touched down further into the runway than intended, the commander was not unduly concerned. However, it soon became apparent that the brakes were not effective and so pressure to the brake pedals was increased. Realising that he was not obtaining sufficient braking, and even though there were no warnings of a system malfunction, the commander decided to switch from the GREEN to the alternate YELLOW system. This involved a momentary release of brake pressure during the system changeover. The commander, now assisted by the first officer, applied maximum pressure to the foot brakes. Both pilots reported that the brakes felt "normal" but this, however, still did not produce the expected retardation. The commander considered selecting the EMERGENCY YELLOW system but as this would have deprived him of anti-skid protection, and in the absence of any malfunction indications, he decided to remain with the YELLOW system selected. The crew realised at this stage that the aircraft would overrun the runway. The first officer transmitted "TOWER, THERE'S NO BRAKES WE'RE GOING OFF THE RUNWAY" and the commander steered the aircraft slightly to the right to avoid the runway 16 approach lights. The aircraft left the paved surface at a recorded speed of 69 kt and overran an area of very wet grass and soft mud, which was some two feet deep. It became apparent to the commander that the aircraft was not going to hit any obstructions and he therefore decided against warning the passengers to 'brace'. As the aircraft came to rest, with its nose wheel some 146 metres from the runway end, the commander made an initial assessment of the situation. Since there were no signs of fire, or anything to endanger the passengers, he shut down the engines and advised the passengers to remain seated to await transport to the terminal.

A senior fire officer who, at the time of the incident, had been waiting in his car at the threshold of runway 16, arrived quickly alongside the aircraft and advised the commander that there were no signs of fire, apart from smoke or 'steam' from the wheel brakes which were partly buried in the mud. By this time the cabin crew had lowered the airstairs allowing the fire officer to enter the aircraft and reassure the passengers.

Airport fire services, which were being held on "weather standby", responded immediately to the crash alarm which had been sounded by the duty ATC supervisor before the aircraft had left the runway. With no immediate sign of fire, however, the fire vehicles stayed clear of the aircraft and remained on the runway threshold to avoid the soft surface. A driver of one of the fire vehicles which followed the aircraft's path down the runway reported that the centre portion of the runway was very wet, with large puddles on which there was a tendency for his vehicle to skid.

The passengers, none of whom were injured, were eventually deplaned and transported to the terminal.

Immediately after the incident the airport authority conducted a check of the runway braking action using a standard Mu-meter. The recorded readings were .71 / .78 / .71, indicating that the braking action was good.

On site inspection

The overrun area beyond the northern end of Runway 34 consisted of a soft overlay of grassed, peaty soil about 12 to 18 inches thick, over a hard stony substrate. At the time of the incident the top layer had been rendered very soft and waterlogged by heavy rain. An examination of the overrun before the aircraft was recovered showed that the aircraft wheels had left no significant impressions in the soft top layer where the aircraft had first run off the end of the runway. The left main wheels had then gradually made progressively deeper tracks in the surface until, after about 30 metres, the left mainwheels had penetrated the surface by about 12 to 18 inches, and the right mainwheels had also touched down again and penetrated the surface to a similar depth. The aircraft then appeared to have rebounded on its landing gear, but had not broken clear of the surface, before settling again and coming to a halt about 146 metres beyond the end of the runway. There was no evidence that the nosewheel had contacted the ground in the overrun area until about 50 feet before the position where aircraft had come to a halt.

An initial on-site examination of the aircraft showed there to be very little significant damage. The main and nose landing gears were heavily packed with wet mud but no damage had occurred to any of the hydraulic pipework, nor to the wheel well doors. The airbrakes, fuselage underside and right side engine nacelles had been heavily spattered with mud. The intakes of nos. 3 & 4 engines also showed mud spattering indicative of some mud ingestion into those engines. The flight data and cockpit voice recorders were removed from the aircraft and taken to the AAIB for replay. The aircraft was pulled from the overrun area and, after basic cleaning of the landing gear, was taken to a hangar on the airport for preliminary investigations.

Preliminary examination of aircraft

Examination of the tyres showed there to be no overt signs of 'aquaplaning' or under-inflation on any of the mainwheel tyres. Neither the nosewheel nor the mainwheel tyres showed evidence of sideways 'scrubbing' and all were within the wear limits laid down by the manufacturer. The mainwheel tyres all showed evidence of peripheral tread cuts consistent with running over an unprepared surface, but none of these cuts had damaged the carcass of the tyre.

A built-in test equipment ('BITE') check performed on the brake anti-skid system did not reveal any faults within the electronics of the system. A check of correct brake system functioning and antiskid

interconnection was performed by operating the wheel speed sensors on each wheel individually whilst brake pressure was applied. This showed that hydraulic pressure was applied to all wheel brakes, using either hydraulic system, and that the correct wheel brake on the opposite side of the aircraft was released by the antiskid system when each wheel speed sensor was turned.

Before testing the effectiveness of the brakes, the brake packs were disassembled and all the rotor and stator elements were cleaned of mud (using water only) and examined. After examination, which revealed no significant defects, the brake packs were reassembled in their original order and a test of braking from 80 kt was performed satisfactorily before the aircraft was next flown.

A function test of the spoiler systems, together with the associated landing gear 'weight-on-wheels' proximity switches and throttle microswitches, was performed. The spoilers were found to operate satisfactorily and the operating status captions to indicate correctly.

An inspection of the engines revealed that both right side engines had ingested appreciable quantities of wet mud. After washing and reinspection, ground test runs indicated that although the engines were still within turbine temperature limits, they had deteriorated significantly from their pre-ingestion condition. The aircraft was then ferried to the operators maintenance base for further examinations.

Further examination

The aircraft was supported on jacks and the operation of each individual squat proximity switch, on the main landing gears, checked. It was found that all had switched after the associated wheels had been deflected about 2 inches upwards, relative to the fuselage, and that, at empty weight, the wheels rose a further 18 inches before the full aircraft weight was taken by the landing gear. A full test of the braking system, as described in the Aircraft Maintenance Manual, was carried out and no faults in the system were revealed. The airspeed indicators were calibrated, and the pitch and roll datums for the FDR signals were obtained.

A complete check of the spoiler indications and warnings, as described in the Aircraft Maintenance Manual, showed that the LIFT SPOILER warning captions on the glareshield edge were inoperative as a result of a failure of the output driver transistor on the caption control PCB unit. This warning was offered as a modification (HCM 00913{*A & B as retrofit, or C as installed at manufacture*}) to the original design "to reduce the possibility of the flight crew failing to deploy the lift spoilers on landing". This warning system was designed to indicate, 'weight on wheels' and either no selection of spoilers within 6 seconds; or spoilers selected, but not deployed within 3 seconds of selection.

This warning system was scheduled to be functionally tested, during routine maintenance, at 6000 flight intervals. A review of the pre-flight and maintenance checks revealed that, during normal

(correct) operation of the aircraft, this warning would never be seen by aircrew. A 'Dim and Test' addition to this modification (HCM 00913 D - not fitted to this aircraft) is available, but this modification is designed to test only the integrity of the warning light bulb filaments; the logic and driving circuits are untested by this means.

The aircraft involved in this incident at Aberdeen was on a progressive maintenance check cycle and the LIFT SPOILER warning system had last been checked in July 1990. At the current rate of utilisation it would next have been checked in December 1992.

The Chief Inspector of Air Accidents has ordered a Formal Investigation into the circumstances of this incident.

Safety Recommendations

Even without modification HCM 00913 D fitted, a simple procedure which checks the lift spoiler caption bulbs and the associated driving circuitry (though not the logic nor all the time delays) can be carried out on the ground when electrical power is on-line, but hydraulic power is not available to the spoiler actuators.

As a result of these findings, two Safety Recommendations are being pursued with the CAA and will be published in the next issue of the AAIB Bulletins.