

AAIB Bulletin No: 2/94

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Aircraft Type and Registration: Dart Herald 401, G-BEYK

No & Type of Engines: 2 Rolls-Royce Dart 532-9 turboprop engines

Year of Manufacture: 1964

Date & Time (UTC): 5 October 1993 at 2247 hrs

Location: Cardiff Airport

Type of Flight: Public Transport

Persons on Board: Crew - 2 Passengers - None

Injuries: Crew - None Passengers - N/A

Nature of Damage: Nose landing gear doors partially abraded away,
scraping of nose fuselage skin

Commander's Licence: Airline Transport Pilot's Licence

Commander's Age: 54 years

Commander's Flying Experience: 14,000 hours (of which 1,200 hours were on type)
Last 90 days - 160 hours
Last 28 days - 38 hours

Information Source: AAIB Field Investigation

Following normal engine starts and pre-flight checks the aircraft took off from Cardiff Airport at 2148 hrs for a night freight flight to Bristol. The commander reported that shortly after take off the nose landing gear 'UNSAFE' light illuminated and the green locked down light went out before the landing gear was selected up. After the 'UP' selection was made all legs retracted and locked up.

The crew contacted Bristol Approach at 2150 hrs and were cleared to establish for an ILS approach to Runway 09, and they were informed of the weather. This was a surface wind of 140°/08 kt, visibility 7,000 metres in rain, with cloud conditions broken at 300 feet, broken at 1,500 feet and runway conditions wet. The crew acknowledged the information and the approach proceeded normally until the aircraft was established on the ILS localiser. When the landing gear was selected down, only the left main gear indicated locked down with the right main and nose gear indicating unsafe. A further selection was made resulting in both main gears indicating locked down and the nose gear again indicating unsafe. A go-around was carried out and the commander informed the Bristol Approach controller of the situation and requested radar vectors to a clear area over the Channel where the crew could try to resolve the problem.

Further attempts to get the all three landing gears down and locked were made with more 'UP' and 'DOWN' selections including mild 'shaking' and yawing of the aircraft. The main landing gear continued to lock down normally, but the nose landing gear indication continued to show unsafe and the commander therefore elected to try the 'emergency lowering procedure'. This drill was carried out in accordance with the check list and again the main landing gear legs indicated locked down but the nose gear still indicated unsafe. The commander informed the Bristol Approach controller of the problem and requested clearance for a low fly past so that the landing gear might be visually inspected from the ground. Following the low fly past at Bristol the crew were informed that the main landing gears appeared to be down, and the nose landing gear doors appeared to be open but the nose leg could not be seen. The commander decided that he would have to land the aircraft in this configuration but, in view of the wet runway and cross wind at Bristol, preferred to land back at Cardiff.

At 2232 hrs Cardiff ATC was alerted and advised that the aircraft was returning to land at Cardiff with a nose gear unsafe indication. A full emergency was initiated by Cardiff ATC and the aircraft was cleared to land on Runway 12. During the transit back to Cardiff the commander and first officer briefed themselves on the procedures they would follow and at 2247 hrs the commander landed the aircraft, lowered the nose gently and brought it to a halt on the runway. The engines were shut down, the fire bottles operated and the crew vacated the aircraft without injury. Emergency vehicles had followed the aircraft at the end of its landing roll, and were ready around the aircraft as it came to a stop.

Aircraft Examination

The aircraft was initially examined at Cardiff Airport after the nose landing gear had been lowered to facilitate removal from the runway. The crew tasked with the recovery reported that they had first noticed that the wheels were just protruding from the bay and appeared to be skewed to one side, jamming them against the nosewheel doors, as though the steering had inadvertently been actuated whilst the gear was still in the bay. Using crowbars they had straightened the wheels, allowing the nose gear to be lowered under gravity whence it could be 'kicked' into the downlock and made safe. Plans were then prepared for an inspection followed by removal of the bay doors and a landing gear down ferry flight to Norwich Airport where detailed diagnostic and repair work was to be carried out

During the preparation for the ferry flight it was found that the nosewheel steering turned hard over to the right when hydraulic pressure was applied, but that this could be countered by applying a left command on the steering tiller. Replacement of the steering selector valve Part No 8568 cleared this defect. The ferry flight was uneventful.

Upon arrival at Norwich the defective steering selector valve was refitted and the aircraft put on jacks with electrical and hydraulic power applied. The malfunction observed at Cardiff was repeated and the valve was removed for test and strip examination at an overhaul agency. This testing confirmed the presence of an apparently jammed-open electro-hydraulic solenoid valve, one of four forming part of the steering selector valve. Failure in the open (energised) position was consistent with the observed behaviour of the steering system. Unfortunately, the subsequent strip inspection failed to reveal a reason for the jamming since the valve worked correctly when re-assembled. It was considered probable that a piece of debris had lodged in the valve which had not been noticed during the strip-down.

An in-depth study of the steering system revealed that a probable sequence of events commenced with failure of the solenoid valve in the open position sometime after rotation during the take off from Cardiff (otherwise it is felt that the aberrant behaviour of the steering would have been obvious to the crew). During climb out but before gear 'UP' selection, the nosewheel centring system would have been able to keep the wheels sufficiently central for retraction to be possible. With 'UP' selected, 'UP' line pressure hydraulically locked the steering even though the centralising circuit was now disabled. Retraction would then commence normally as reported by the crew.

However, upon 'DOWN' selection the centralising circuit was still disabled but the 'DOWN' line pressure now applied to the system with the stuck valve would immediately cause the steering to turn to the right as the nose leg extended. This sequence had been demonstrated during the ground tests at Norwich but had not actually resulted in jamming of the tyres in the bay because the leg had not twisted sufficiently before it had dropped clear of the wheelwell. The tests were not, of course, able to truly replicate the combination of air loads and hydraulic pressures and no doors were fitted at the time.

Thus the failure of the nose leg to extend has been attributed to a malfunction of the steering selector valve. The valve was fitted on 11 December 1991 as an overhauled component and had accrued some 767 flying hours to the time of its failure. The overhaul life was 9,000 flying hours. G-BEYK was not owned by the operator and it is understood that it had spent much of the time since fitment of the valve in storage between ad hoc leases.

It is clear that the precise sequence of landing gear indication lights as reported by the crew has not been fully explained, although during the ground tests some intermittent anomalies not associated with the selector valve malfunction were evident. It was also observed during the ground tests that the downlock jack appeared reluctant to retract as the 'UP' hydraulic line depressurised. This jack extends when 'up' line pressure is applied to it via the solenoid valve which is signalled open when the steering is centralised. Extension of the jack breaks the downlock mechanism and, when 'UP' line pressure is

released, spring pressure should retract it, but in this case the downlock mechanism itself seemed to push the jack in as the nose leg extended. Again, the jack was tested and found to work normally, leading to the conclusion that the aircraft's 'UP' line pressure was greater than it should have been during nose leg extension but by then the aircraft was no longer in a state where the system could be conveniently tested to see if this was the case.

Previous similar incidents

The CAA database for incidents and accidents contained details of only one reported occasion since 1976 when a Herald nose leg failed to extend. This bore many similarities to the subject G-BEYK accident inasmuch as the reason was stated to be movement of the nosewheel steering in the retracted position causing jamming of the wheels against the structure. The reason for the uncommanded steering was, however, given as a fluid leak from the steering system. As a result, the operator concerned (who was not the same as G-BEYK's) devised two modifications: one removed a 'lip' around the inside of the bay against which the tyres were thought to have jammed whilst the second introduced a non-return valve into the hydraulic system. The precise way in which the second modification was thought to be effective is not immediately apparent since it is not fully understood why the fluid leak resulted in a steering movement, but G-BEYK had neither of these modifications embodied.