DHC-8-311, G-BRYP

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Aircraft Type and Registration:	DHC-8-311, G-BRYP
No & Type of Engines:	2 Pratt & Whitney Canada PW-123 turboprop engines
Year of Manufacture:	1992
Date & Time (UTC):	12 August 1999 at 0610 hrs
Location:	Manchester International Airport
Type of Flight:	Public Transport
Persons on Board:	Crew - 4 - Passengers - 50
Injuries:	Crew - None - Passengers - None
Nature of Damage:	Damage to nose landing gear and front fuselage
Commander's Licence:	Airline Transport Pilot's Licence
Commander's Age:	34 years
Commander's Flying Experience:	2,390 hours (of which 820 were on type)
	Last 90 days - Not known
	Last 28 days - Not known
Information Source:	AAIB Field Investigation

The aircraft had been parked at Manchester overnight, during which time a routine pre-flight engineering inspection had been carried out. This inspection revealed that the hydraulic fluid contents of both systems were found to be above the required minimum dispatch quantities. It was subsequently ascertained that this inspection had been carried out shortly after the arrival of the aircraft during the previous evening.

The flight crew reported at 0505 hrs in order to operate a scheduled passenger service to Glasgow, which was planned to depart at 0605 hrs. During the course of the flight crew external pre-flight inspection, the first officer noted that the remote quantity indicator for the No 1 Hydraulic System was indicating below the minimum level acceptable for dispatch of the aircraft (1.5 US Quarts, 1.41 litres). On reboarding the aircraft, the first officer informed the commander of this condition. The commander checked the flight deck gauge, which displayed a hydraulic fluid content slightly higher than the remote quantity indicator. The commander indicated that he would transfer some fluid (from the No 2 system) during the flight. There was also some discussion with Line Maintenance Control regarding the status of a nose landing gear alternate gear extension indicator

light, which was illuminated but dim. It was decided that it was acceptable to dispatch the aircraft in that condition.

The passenger boarding was completed and the aircraft received ATC clearance to push back from the stand. Both engines had been started on stand prior to the pushback in accordance with the Standard Operating Procedures (SOP's).

The commander was in communication with the ground crew engineer via a headset. The commander indicated that the brakes were released and the pushback commenced. The commander noted that the hydraulic quantity in the No 1 system appeared to have dropped and he decided to carry out a fluid transfer. About 15 seconds after brake release, the commander indicated to the engineer that he was going to perform a hydraulic fluid transfer at the end of the pushback. The engineer queried whether this was to be done with the tug attached or uncoupled. The commander responded that the tug should remain attached. The engineer indicated that he would inform the tug driver of this plan.

At this time, the engineer went across to the tug to inform the tug driver. The tug driver halted the tug while he received this message from the engineer. No signals were passed to the commander that would indicate that the pushback was complete and the aircraft had moved back only a few feet from the parking position. The ground engineer returned to the side of the aircraft and informed the commander that it was 'all right, no problem'.

Immediately upon receipt of this, the commander indicated to the first officer that he should pay attention during the transfer to ensure that the fluid was being moved the correct way. As the commander looked across the flight deck, he did not notice that the pushback had recommenced very gently. The first officer had just completed an entry in the flight paperwork when he looked up and realised that the aircraft had recommenced the pushback. He attempted to warn the commander just as the commander applied the Emergency/Parking Brake as the first stage of the fluid transfer process. The tug continued to attempt to push the aircraft back and the nose landing gear collapsed. A quantity of hydraulic fluid was released as a spray from the area of the nose landing gear. The ground engineer subsequently required treatment for the effects of hydraulic fluid contamination of his skin and eyes.

After the nose landing gear collapse, several seconds elapsed before the first officer prompted the commander regarding the shutdown of the engines, and the need to carry out a passenger address. The first officer informed ATC and the emergency services were alerted to attend. The commander shutdown the engines. He elected to carry out a precautionary disembarkation by means of the normal passenger door and initiated this in consultation with the senior cabin crew member. None of the aircraft occupants was injured.

Engineering investigation

As a result of the nose landing gear collapse, the nose of the aircraft had settled onto the wheels supported by direct contact with the tyres. The 'A' frame style upper drag link had pulled out of its

trunnions allowing the nose landing gear to rotate rearwards, further damaging the nosewheel bay and adjacent fuselage structure. The propellers did not make contact with the ground, and no damage occurred to them or to the engines.

The nose of the aircraft was lifted on to a steerable trolley with airbags between the trolley and the aircraft nose, with strops tying the nose down to the trolley. This was satisfactory for straight towing and gentle turns, and in this condition the aircraft was slowly towed off the apron and into a hangar. Tighter turns were needed to get the aircraft away from the stands and to turn into the hangar, and as a result some very minor additional damage to the aircraft was caused by the strops.

In the hangar the nose landing gear was removed and inspected. It was apparent that the nose landing gear had collapsed rearwards as a result of the 'A' frame upper drag strut trunnions pulling out of their housings in the sidewall structure of the nose gear bay. Deformation of the upper drag strut trunnions themselves showed that the loads involved had been very high, consistent with high loads being applied during pushback. While the damage to the trunnions was broadly symmetrical, as might be expected from a straight pushback, the nose gear bay structure had distorted more on the left side, indicating that the right hand trunnion had released first. Considerable structural distortion and damage, which extended outside the nosewheel bay, had been incurred during the release of the upper drag link. Further damage was then incurred as the nose gear over-rotated rearwards.

The tug and towbar used for the pushback operation were impounded and a full inspection of the tug took place. It was a large tug, specified for aircraft of DC10 size and it weighed 32,600 kg. It failed the subsequent vehicle safety inspection on six counts including some deficiencies in the brakes, stop lamps, washers and instrument illumination, however none of these had any clear bearing on the circumstances of this accident. The towbar was a suitable standard type of equipment, fitted with three shear bolts designed to act as mechanical 'fuses'. These had all sheared, however when the towbar is being used for pushback the load applied is compressive. In that case shearing of the bolts causes the sections of the towbar to telescope down as far as they are able, which in this case is a matter of a few inches. Once all the telescopic movement is taken up, the compressive load is suddenly re-applied to the nose gear, with no limitation other than the capability of the tug vehicle.

Aircraft systems description

The DHC Dash 8 is fitted with two hydraulic systems. The No 1 hydraulic system supplies hydraulic power for the Normal Brake system. When the pilot's brake pedals are operated, No 1 system pressure is modulated by the brake control valves and directed, via the anti skid control valves and shuttle valves, to the wheel brake units. The No 2 hydraulic system supplies hydraulic power for the Emergency/Parking Brake system. When the parking brake is applied, hydraulic pressure is supplied to the other side of the shuttle valves and thence to the wheel brake units. Although the hydraulic systems are separate, downstream of the shuttle valves the two brake systems are common and the same brake pistons are operated by both systems. As a result it is possible, by repeated sequencing of brake application and release, to transfer hydraulic fluid from

one system to the other. The sequence which transfers fluid from No 1 system to No 2 system is as follows: (i) brake pedals depressed, No 1 system fluid pressurises the brake units shuttle valves, and a very small quantity of fluid from No 1 system moves downstream of the shuttle valves; (ii) parking brake applied - the brakes are already pressurised so there is no fluid movement; (iii) brake pedals released - brakes are still applied therefore there is no fluid movement, however the shuttle valves are now moved by No 2 system pressure; (iv) parking brake released - the brakes release and a small quantity of fluid passes back through the shuttle valves, and into the No 2 system return line. Fluid can be transferred from No 2 system to No 1 system by reversing this process.

Fluid can also be correctly balanced by this means, if the hydraulic pressure is available from either the engine driven pumps or the electrically driven standby power unit pumps. Dispatch is not permitted if the hydraulic fluid quantities are below published limits. Quantity indication for each system is by means of a mechanically driven quantity indicator fitted to each nacelle adjacent to the hydraulic reservoir. For flight deck indications, a synchro transmitter provides an electrical signal to the dual flight deck quantity gauge fitted on the right hand side of the cockpit. It is sometimes possible for the flight deck indication to vary from the nacelle indication. Flight deck indications are only available when electrical power is available.

In August 1992 as a result of operator concerns DHC published a Service Letter, DH8-SL-29-002, addressing the matter of inadvertent hydraulic fluid transfer. Information had previously been given in the DHC 'Straight Eight' publication in March 1988. The Service Letter confirmed that hydraulic fluid could be transferred between serviceable systems in normal use, and described the sequences of brake application and release which would give rise to such fluid transfer. It advised operators of the causes and suggested that operators should advise flight crews of the methods that can be used to control, or correct, fluid transfer. It was not prescriptive as to the procedures to be adopted, leaving this to each operator according to his operational requirements.

Operator action

Based on this Service Letter, the operator had published Flight Crew Notice 39/97. This Notice detailed an appropriate procedure to enable flight crew to rebalance the fluid quantities at the end of a flight. The Notice specified that fluid transfer, which involved appropriate sequential application or release of either Toe Brakes or Emergency/Parking Brake, was intended to be carried out only after arrival on a level stand, with engines running, Condition Levers at Feather with suitable wheel chocks inserted.

After this accident, a qualitative assessment was carried out as to actual flight crew line flying experience of this procedure. It became apparent that hydraulic fluid transfer was being carried out not only under the conditions specified in the Notice, but also during taxying or at the end of pushbacks. Certainly the flight crew involved in this event indicated that this was not uncommon practice during routine line operations. It was apparent that, on occasions such as the first flight of the day, the aircraft sometimes required to have the hydraulic fluid contents balanced before flight and there was no flight crew SOP to apply to this event.

As a result of this accident, the operator issued Flying Staff Instruction 39/99, which indicated that flight crews should not accept an aircraft for flight with either of the hydraulic contents indicating less than the minimum quantity for dispatch. Also, the only conditions under which fluid transfer should be attempted by flight crews, ie with the aircraft on a level stand, parked and chocked, has been reiterated.

The operator's engineering contractors have also been made aware of this requirement and have been requested to pay particular attention to this aspect during pre-flight engineering inspections.

Communications

This accident occurred primarily as a result of a breakdown in communication between the flight crew and the pushback ground crew. Although communication was clear initially, it began to break down at the time the subject of hydraulic fluid transfer was raised, when the ground engineer went to liaise with the tug driver and the pushback tug stopped moving. This led to an incorrect assumption that the pushback was complete.

On this type of aircraft, pushback operations are handled from the left hand seat, necessitated by flight deck layout. Therefore, first officers do not have any experience of carrying out pushback handling until their promotion to command status. The commander in this event had been newly promoted from first officer, having completed his Final Line Check in this new role on 30 July 1999. The commander indicated that, during his command Line Training phase, most of the supervised training sectors were carried out from airports where pushbacks were not required. His overall experience of handling pushback operations was therefore very limited.

At the commencement of the pushback, once the aircraft brakes are released, control of the aircraft is effectively passed to the ground engineer in charge of the pushback team. At the end of the pushback, control is passed back to the flight deck for the aircraft brakes to be reapplied before the uncoupling of the towbar is carried out. It is therefore very important to ensure that this handing over of control is carried out in a clear unequivocal manner, using standard phraseology wherever appropriate. The operator's Operations Manual details suitable phaseology to be used during pushback operations.

This accident highlights the need for SOP's to be appropriate to the actual operating environment and that they should be strictly adhered to by flight crews. In this case, there was no appropriate SOP which applied to a first flight of the day situation. A non-standard practice of carrying out hydraulic fluid transfer at the end of pushbacks had thus developed amongst some pilots within the company to cover this type of situation.

Suitable engineering action during the pre-flight phase would have been more appropriate, and this has now been highlighted by the operator in order to avoid any recurrence.