AVIATION INVESTIGATION REPORT
A03W0148

LOSS OF POWER – MECHANICAL MALFUNCTION

DELTA HELICOPTERS LTD.
BELL 204B C-GTNP
MANNING, ALBERTA 75 NM NE
13 JULY 2003

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Investigation Report

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Summary

The Delta Helicopters Ltd. Bell 204B helicopter (registration C-GTNP, serial number 2028) was conducting slinging operations in the Wadlin Lake, Alberta, area. At approximately 1420 mountain daylight time, as the helicopter was descending to position a load of seedlings, the pilot heard a scraping sound from the engine. The engine then lost power and the helicopter descended rapidly, resulting in a hard landing and substantial damage. The helicopter remained upright with the load attached to the longline. Another company pilot located the wreckage at approximately 1915 and found the pilot with serious, but non-life-threatening, injuries. The pilot was extracted from the site at 2145.

Ce rapport est également disponible en français.

Other Factual Information

The helicopter had departed Wadlin Lake for Block 106 with a load of tree seedlings in three cargo nets hooked onto a carousel at the end of a 150-foot longline. In the final stage of the approach at destination, when the helicopter was approximately 250 feet above ground while descending and reducing forward speed, the pilot heard a scraping sound and noticed a vibration, and the engine lost power. During the ensuing rapid descent, the load contacted the ground at the intended landing site, and the helicopter continued to descend in the direction of flight until ground impact approximately 80 feet beyond the load. The time of the occurrence was approximately 1420 mountain daylight time.[1]

Disassembly and examination of the engine (Lycoming T53-11B, serial number LE08253) revealed that two blades had separated from the power turbine disc and caused extensive damage to the other blades, the shrouds and the power turbine nozzle. Blade No. 1 had fractured at the disc platform from a pre-existing fatigue crack that extended for approximately 50 per cent of the blade chord back from the leading edge. Blade No. 52 had fractured approximately ¼ inch above the platform from a pre-existing fatigue crack; the fracture extended for approximately 35 per cent of the blade chord forward from the trailing edge. It could not be determined which blade had failed initially, but the second weakened blade failed from debris impact. Scanning electron microscope examination of the crack-initiation points did not reveal the cause of the cracks, as none of the usual indications such as mechanical damage, discontinuities, inclusions or corrosion was evident.

All remaining blades on the turbine disc were examined, and no further cracks were found. Two of the remaining blades were sectioned to try to determine if an overheat situation may have been responsible for a metallurgical weakness due to changes in the alloy microstructure. However, the results were inconclusive due to a lack of comparison data from the manufacturer. Other hot-section components between the combustion chamber and the power turbine nozzle were undamaged and did not exhibit heat distress.

The turbine disc (part number 140-250-6, serial number 4454) was new with an overhaul life of 2000 hours when installed during the previous engine overhaul on 14 June 2000. Total engine time in service since the overhaul was 1284 hours. The turbine blades were "on condition," with no timed overhaul or replacement life, and no time-in-service history. The last major inspection was the engine mid-life hot-section inspection, which had been completed about 191 hours prior to the occurrence on 13 July 2002, at 1092.7 hours since overhaul.

The current engine type certificate holder researched the original manufacturer's database and found one previous similar occurrence for the T53-11B engine. In that occurrence, the stress rupture was induced by "temperatures in excess of the design operational limits." Transport Canada's Service Difficulty Report database contained one reported occurrence since 1995, and the airframe manufacturer's database listed two possible events since 1965. T53-11 model engines were manufactured from 1963 to 1967.

The load consisted of 130 boxes of seedlings; the average weight of each box, from a 10-box sample, was approximately 28.5 pounds (lb). With a weight reduction of one pound per box to allow for the weight of water from a light rain shower between the time of the occurrence and the weighing of the boxes, the weight of the load of seedlings was calculated to be approximately 3575 lb. These weights were consistent with the tree

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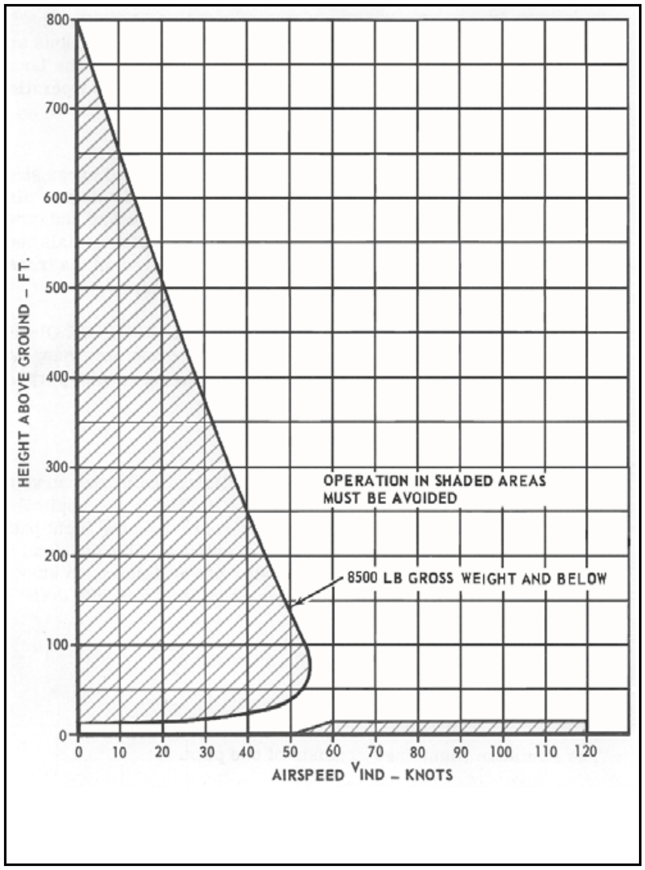
[1] All times are mountain daylight time (Coordinated Universal Time minus six hours).

nursery projected weight of 27 to 33 lb per box, depending on moisture content. The carousel weighed 80 lb, and the weight of the nets and longline were estimated to be 120 lb, for a total load weight of approximately 3775 lb. The gross weight of the helicopter was calculated to be approximately 9680 lb at take-off and 9480 lb at the crash site. C-GTNP had been modified as per Bell Service Instruction 204-3 to increase the maximum allowable gross weight with external load from 8500 lb to 9500 lb. Calculated out-of-ground-effect hover weight for the conditions was 8600 lb.

Section 1 of the approved flight manual for the Bell 204B (BH204) contains a height-velocity (H-V) chart, which has a shaded area that was originally a flight limitation "... critical in the event of an engine failure during take-off, landing or other operation near the surface" (see Figure 1). Operation in this critical area reduces the possibility of a successful autorotative landing in the event of an engine failure. This H-V chart has been appended as an operating limitation for Canadian-operated helicopters conducting external load operations, as an addendum (BHT-204-FM-CAN-O) to the flight manual. However, the information is relevant for all low-level operations.



Records indicate that the pilot was certified and qualified for the flight, in accordance with existing regulations. His total flying time was approximately 13 250 hours, of which approximately 4500 hours were on the BH204 series. His medical was valid to 05 November 2003, and his pilot proficiency check was valid to 01 November 2003.

During the investigation, weather information was obtained from Alberta Forestry Services observation towers in the vicinity. The report for the Wadlin Lookout Tower (17 nautical miles [nm] northeast of the occurrence area) at 1200 was as follows: sky condition 6/10 covered, mid-level cloud, visibility 20 nm, winds east at 4 knots, temperature 14°C, dew point 10°C. The report for the Talbot Lookout Tower (17 nm southeast of the occurrence area) at 1200 was as follows: sky condition 1/10 cumulonimbus, 2/10 low cloud, visibility 20 nm, winds southeast at 6 knots, temperature 15°C, dew point 13°C. Weather was not considered a factor in this occurrence.

Analysis

The engine failure was the result of damage to the power turbine and nozzle, following the fracture of two turbine blades. The turbine blades failed due to the overstress extension of pre-existing fatigue cracks. It was not determined what initiated the cracks, but the most common initiators are mechanical damage (nicks), manufacturing faults (inclusions or discontinuities), corrosion and metallurgical deterioration due to heat. No damage, faults or corrosion were found, and the metallurgical examination was inconclusive.

The history of the failed turbine blades could not be ascertained because they were maintained “on condition.” Therefore, the blades had been in service in this engine or other engines for an undetermined time. Database information confirms that power turbine blade failures have not been a problem area with this model of engine.

The helicopter was being operated at a weight exceeding the maximum out-of-ground-effect hover weight, but within the increased gross weight limit with an external load at the time of the accident. The increased weight would have required a significant amount of collective pitch for all phases of flight, especially at lower speeds or in a hover. When the engine failed, the undriven main rotor blades generated a considerable amount of drag, resulting in the rapid decay of the main rotor speed. This loss of rotor speed reduced the rotor system kinetic energy available to the pilot for control of the helicopter’s descent, and, combined with the low altitude, the attached load and airspeed delineated within the critical area of the H-V chart, thereby increasing the severity of the impact and injuries.

The following TSB Engineering Laboratory report was completed:

LP 64/03 – *Examination and Analysis of Turbines*

Findings as to Causes and Contributing Factors

1. Two turbine blades failed due to the overstress extension of pre-existing fatigue cracks, resulting in the substantial damage of the power turbine section and loss of engine power. The cause of the fatigue cracks could not be determined.

2. The loss of engine power occurred at a low altitude and airspeed, and a hard landing ensued.

Findings as to Risk

1. The helicopter was being operated at a weight that exceeded the maximum out-of-ground-effect hover weight, and within the speed and height parameters that the aircraft flight manual H-V diagram states should be avoided.

Safety Action

The company has initiated several changes to improve flight crew awareness of situations they encounter during daily operations. These changes include the following:

Training (during annual recurrence training ground school):

- stressing the importance of understanding and applying aircraft performance charts, specifically, hover in and out-of-ground-effect charts and the H-V charts;
- including more detailed questions regarding performance charts on the written aircraft type examinations; and
- establishing an in-house pilot decision making course, using in-house examples for review.

Management Supervision:

- greater emphasis placed on field supervision; and
- reviews of work zone plans, aircraft load control, communications and field maintenance on the job site with crews and customers.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 15 December 2004.

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