Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A07P0123

REDUCTION GEARBOX FAILURE/ENGINE POWER LOSS

PACIFIC WESTERN HELICOPTERS
BELL 212 (HELICOPTER) C-GPWX
PRINCE GEORGE, BRITISH COLUMBIA
26 APRIL 2007

Canada

Aviation Investigation Report

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Pacific Western Helicopters
Bell 212 (Helicopter) C-GPWX
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Summary

The Bell 212 helicopter (registration C-GPWX, serial number 30535) was being ferried from Grande Cache, Alberta, to a company maintenance base in Prince George, British Columbia, following several chip light illuminations. Shortly before the helicopter reached Prince George, the number one engine decelerated and ejected engine parts from its exhaust. The helicopter was able to continue flight on the remaining engine and landed safely at Prince George.

Ce rapport est également disponible en français.

Other Factual Information

Flight History

The helicopter was being used for visual flight rules flight training in the Grande Cache area. During the 6.7 hours of operation prior to the occurrence flight, four separate chip light illuminations [1] from the number one engine were reported by the flight crew. After each chip light illumination, black paste and a small number of metallic particles were found on the number one chip plug in the reduction gearbox (RGB). After the third chip light illumination, fine metal particles were also found in the oil filter. Following the fourth chip light illumination, the company temporarily grounded the helicopter and then issued a ferry permit in accordance with its *Maintenance Control Manual* to ferry the helicopter to a maintenance base in Prince George, B.C., approximately 135 nautical miles away.

About 48 minutes into the 70-minute flight, the chip light began to flicker on and off. About nine minutes later, the chip light became steadily illuminated and, about five minutes after that, the helicopter yawed and the number one engine decelerated. The flight continued single-engine for a further six minutes to the maintenance base in Prince George, where an uneventful landing was conducted. There were no injuries and there was no fire. The five chip light illuminations, including the chip light illumination during the occurrence flight, occurred over 7.5 flight hours.

An inspection of the helicopter conducted by company maintenance personnel following the occurrence flight determined that debris ejected from the number one engine exhaust had struck the main and tail rotor blades, the latter being damaged beyond repair. The number one chip plug in the RGB was examined and was found to have the previously-noted black paste as well as small metal particles on it.

Maintenance Instructions

The Pratt & Whitney Canada *Maintenance Manual* indicates, in part, that if the material found on the RGB chip plug or in the oil filter is flakes or particles not in the category of fuzz or fine slivers, then excessive wear is indicated and the RGB should be replaced.

Drivetrain Inspection

The helicopter was powered by a "Twin-Pac" ® that consisted of two Pratt & Whitney Canada PT6T-3B engines (referred to by the manufacturer as "power sections") coupled to a single Pratt & Whitney Canada reduction gearbox (also referred to as the "combining gearbox"). Coupling shafts between the power sections and RGB connect the power turbines (PTs) to the number one and number two main input driveshafts. Each main input driveshaft is supported

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[1] A warning light will illuminate in the cockpit if metal chips are captured on a magnetic chip plug in the lubricating oil system. This is a sign of components degrading.

on its forward end by a number five duplex ball bearing and on its aft end by a number six roller bearing. The PTs, coupling shafts, main input driveshafts, and their associated bearings operate at about 33 000 revolutions per minute.

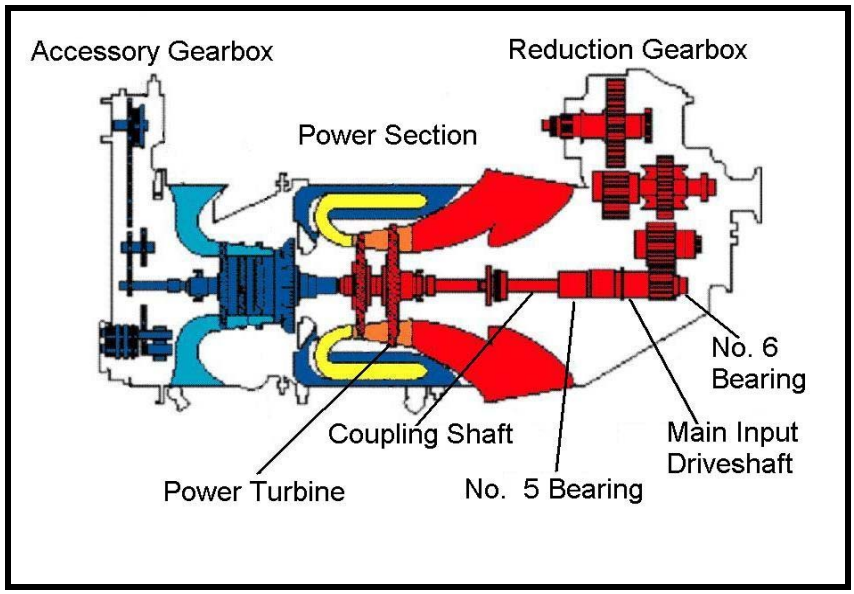

Figure 1. PT6T-3B engine, side view

Post-occurrence examination of the RGB revealed that the rolling elements (balls) and raceways of the number five bearing (part number 3021467, serial numbers F619A and F619B) installed on the number one main input driveshaft had deteriorated, allowing the main input driveshaft to move aft until the coupling shaft decoupled from the PT. The PT subsequently oversped, the PT bearing support failed, and the PT blades contacted the shroud. All of the PT blades suffered severe tip damage and several blades broke off near their platform.

The post-occurrence examination also found two areas of localized spalling (also referred to as surface contact fatigue) on the aft (furthest from the power section) inner race of the failed bearing. The 38 balls were found in varying states of distress, with the most heavily damaged being from the aft bearing half. The balls were heavily worn, some to half the size of others. Examination determined that bearing preload [2], lubrication, and materials were unlikely to have been factors in the bearing's failure. The cause of the spalling was not determined.

Reduction Gear Box

The RGB (model PT6-3-6, assembly number 3024780, serial number CPGB 1288) was overhauled on 26 June 1995 by Consolidated Heliflight, Inc. (now known as Northstar Aerospace) and had accumulated about 2331 flight hours at the time of the occurrence. The number five bearings installed on the main input driveshafts during that overhaul had been reconditioned in September 1994 by Bearing Inspection, Inc (BII). In part, the reconditioning performed at BII involved disassembling the bearing, honing the inner and outer raceways, and reassembling the bearing using balls with diameters larger than those originally installed. Although still approved by the United States Federal Aviation Administration (FAA)

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[2] Preload is the removal of internal clearance in a bearing by applying a permanent thrust load to it. Correct preload ensures that the rolling elements do not skid on the bearing races, particularly during rapid acceleration of the bearing such as occurs during start-up of the second engine.

to perform that work, BII has stopped reconditioning number five bearings based on a history of failures that have occurred to both new and reconditioned bearings. Issues believed to have contributed to previous reconditioned number five bearing failures include lack of bearing preload and incorrect ball cages.

The Transport Canada and FAA service difficulty report databases contain several reports of number five bearing failures in Bell 212 helicopters. At least one major RGB overhaul facility has found several additional cases of premature bearing wear and failure involving both new and reconditioned number five bearings. That overhaul facility recalled all RGBs in which it had installed reconditioned number five bearings. It removed those bearings and replaced them with new bearings.

The Pratt & Whitney Canada *Overhaul Manual* states: "No bearing repairs are permitted other than the repairs contained in Pratt & Whitney Canada approved manuals or the Anti-Friction Bearing Overhaul Visual Inspection Standard P/N 3039731." None of the referenced manuals approves the BII reconditioning procedure. The Pratt & Whitney *Aircraft Overhaul Standard Practices Manual*, Antifriction Bearing Inspection section states: "No work is permitted on internal load carrying surfaces of bearing."

Analysis

The number five bearing on the number one main input driveshaft failed, likely as a result of the balls jamming in the cage due to spalling-generated debris. Once the balls jammed, they ceased rolling and began skidding on the bearing races, rapidly wearing the balls. Reduction of the ball size allowed the main input driveshaft to move aft until the coupling shaft decoupled. Once the power section was no longer driving the reduction gearbox (RGB), the power turbine (PT) oversped, the PT bearing support failed, the PT blades contacted the shroud, and the engine decelerated. The progressive failure of the bearing occurred over many hours as evidenced by the five chip light illuminations during a 7.5-hour period.

Pratt & Whitney Canada states that bearing repairs, such as those performed during the bearing reconditioning procedure, are not permitted. It is not known if the reconditioning procedure contributed to the failure of this bearing.

The Transport Canada and Federal Aviation Administration service difficulty report databases contain several reports of number five bearing failures. Other sources, including an RGB overhaul facility, also report numerous instances of premature wear and failure of number five bearings, particularly number five bearings that have been reconditioned.

When multiple, consecutive chip light illuminations occur and metal particles are found, it is common practice to ground the aircraft until a determination is made as to the source of the metal particles.

Findings as to Causes and Contributing Factors

1. The number five bearing on the number one main input driveshaft failed due to spalling. The cause of the spalling was not determined.

2. The helicopter continued to be operated following several consecutive chip light illuminations, resulting in failure of the engine.

Finding as to Risk

1. It is not known if the reconditioning procedure contributed to the failure of this bearing; however, there are numerous instances of premature wear and failure of number five bearings.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 08 July 2008.