AVIATION INVESTIGATION REPORT
A01Q0139

COLLISION WITH TERRAIN

HELIMAX LTD.
HUGHES 369D (500D) HELICOPTER C-GYTY
BAFFIN ISLAND, NUNAVUT, 69° 10' N 074° 21' W
09 AUGUST 2001

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Summary

A Hughes 369D (500D) helicopter, C-GYTY, serial number 270078D, was being used to transport geological survey personnel and geological samples. The helicopter had picked up two passengers and one sample cache and was in a circling descent for landing at another cache. During the final approach, the helicopter struck the ground heavily, bounced, and tumbled. The pilot was fatally injured on impact. The passengers survived the impact, but later succumbed to their injuries. The helicopter was destroyed by impact forces and a post-impact fire. The sky was clear and winds were light and variable. The accident occurred at about 1700 eastern daylight time.

Ce rapport est également disponible en français.

Other Factual Information

The float-equipped Hughes 369D (500D) helicopter was proceeding along a traverse line to retrieve geological samples that had been placed at intervals along the line. While en route to the second cache location, the pilot made a radio transmission to personnel further along the traverse line. The helicopter was observed overflying the second cache site and, from an estimated altitude of 200 feet above ground, started a tight clockwise descending turn to land at the cache location. The helicopter flew a steep, descending, right turn through 270 degrees and continued the descent toward the cache. Ground personnel heard a brief, unintelligible radio transmission, believed to be from the pilot. Shortly thereafter, a large plume of smoke was seen to rise from the accident site.

The terrain was hilly and rock covered. The helicopter, in forward flight, at a high rate of descent, and in a 25-degree nose-down attitude, struck the ground just below the crest of a hill. On impact, the right float and skid tube dug into the surface, and the left float broke free from the helicopter. The belly of the helicopter was crushed, rupturing the internal fuel bladders. The helicopter bounced, tumbled, and came to rest facing the opposite direction to the line of flight, approximately 60 feet from the initial point of impact. There were high concentrations of fuel at both the initial impact point and the final resting point of the fuselage, with traces of fuel spills along the wreckage path. An intense, fuel-fed fire consumed most of the helicopter.

Rotor strike marks were found on the gravel and rock surface approximately 10 feet beyond the initial impact point. All five main rotor blades were within the vicinity of the wreckage area. Each main rotor blade ejected outwards from the body of the helicopter and broke in two or three pieces, suggesting that the rotor system was powered at the time of the accident. Most of the cabin area and main fuselage had burned away. There were no main rotor strikes evident on the tail boom or the fuselage. Damage to the tail boom and tail rotor components was due to impact forces. Other components were examined to the degree possible, and no indication of a pre-existing mechanical malfunction was found.

Various fuel samples were gathered from the fuel supply tank where the helicopter was based. All of the samples were clear and bright, with no trace of contamination. The engine (Rolls-Royce Allison 250-C20B) was examined at the TSB Engineering Branch; no pre-existing mechanical failures were found. An examination determined that the engine was delivering power at impact; however, the level of power could not be established.

The aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. The aircraft had flown a total of 7623 hours and had undergone its last 300-hour inspection at 7543 hours. There were no known mechanical deficiencies before the flight. Although precise data was not available, it was estimated that the aircraft was being operated within the prescribed limits for weight and centre of gravity. The pilot was sitting on the left side.

A helicopter can exhibit the descent profile and impact characteristics of this accident for a couple of reasons: vortex ring state or power turbine rpm (N2) droop. Vortex ring state, also commonly referred to as "settling with power", is a condition of flight where the airflow through the main rotor is re-circulated. The result of this condition is that, as power and pitch are increased, the rate of descent also increases. It is generally accepted

that three conditions are required for the onset of vortex ring state: zero or near-zero airspeed, powered flight (induced airflow passing downward through the disk, with higher power settings being more critical), and a rate of descent between 300-600 feet per minute. Under these conditions, a helicopter may start to descend rapidly. If a pilot then applies more collective pitch to slow the descent, more rotor downwash is created, which intensifies the re-circulation and increases the rate of descent. To recover from vortex ring state, a helicopter must exit the disturbed column of air that is being produced, either by entering autorotation or by gaining clear undisturbed air by displacing the cyclic forward to regain airspeed. A significant amount of altitude may be lost during a recovery attempt, and recovery at low altitude may not be possible.

Power turbine rpm (N2) droop occurs when engine power is unable to increase as the rotor pitch is increased. When the helicopter is decelerated abruptly, or during a normal deceleration with a sudden updraft, it is possible for the main rotor rpm (NR) to exceed the normal governed speed. When this occurs, the N2 momentarily rises above the normal governed N2 speed. The magnitude of the effect is dependent on the rate of deceleration or the suddenness and intensity of the updraft. If the NR and N2 rise above the selected governed speed, fuel flow to the fuel control unit will automatically be reduced to bring the N2 back down to the selected governed speed.

If the collective is subsequently raised rapidly in an attempt to reduce high rotor speed or arrest a developing sink rate, the NR will decelerate quickly, and the N2 will also droop because the fuel control unit is still on a reduced fuel control schedule. Once below the normal N2 rpm, the governor will signal the fuel control to increase fuel flow; however, there will be a lag before increased fuel flow causes an increase in N2 and NR. During this period, low NR and N2 speed states can result. If the aircraft is close to the ground, it may not be possible to regain sufficient NR to arrest the descent rate. In the most extreme case, droop can be so great as to induce main rotor blade stall.

The pilot had approximately 7000 hours of flying experience on various helicopter types. An autopsy of the pilot did not reveal any physiological condition that may have affected his performance. Toxicology examination was negative for the presence of alcohol, medication, or illegal drugs.

Analysis

The brief radio transmission during the accident sequence suggests that the pilot was not incapacitated prior to impact. The tight descending turn to the right on approach suggests that he had not visually acquired the cache and was responding to verbal cues from the passengers. Had the pilot visually acquired the cache, he would likely have flown a left turn to allow him to keep the cache in sight during much of the manoeuvring and the approach to landing. During a right turn, the pilot's view of the approaching terrain and the cache would have been blocked by the passengers on his right and by the right side of the aircraft. This would have made it difficult to judge the requirement for speed and power adjustments.

The helicopter was developing a substantial amount of power at impact, and main rotor damage was consistent with powered flight. As the helicopter struck the ground without any apparent yaw, it is likely that the tail rotor components were functioning, and that the pilot had directional control. The imprint of the skid tubes at the initial impact point, the immediate rupture of the belly fuel tank and the presence of a large fuel spill all indicate a high rate of descent at impact. The nature of other fuel spills on the ground also suggests that the helicopter struck the ground at a low forward speed.

Light local wind conditions, the slow flight profile, and the rate of descent described in this report were all conducive to the development of a vortex ring state. During its final descent, the helicopter may have encountered a slight downwind as it parallelled a ridge line to the west of the landing area. A slight downwind would be hardly noticeable but would cause a decreased airspeed on final. Decreased airspeed would, in turn, increase the likelihood of vortex ring state developing during the final descent. If vortex ring state developed during the latter stages of the approach, chances of a successful recovery would have been significantly decreased, and the pilot may not have been able to arrest the helicopter's rate of descent.

The aircraft flight profile described immediately prior to the accident was that of a tight, descending and decelerating turn to landing. Large and rapid power changes were likely made during this manoeuvre, and droop on short final may have prevented the pilot from arresting the rate of descent.

The following TSB Engineering Branch reports were completed:

LP 062/2001 - Rolls-Royce Allison 250-C20B Engine Teardown
LP 063/2001 - Examination of Main Rotor Blade
LP 064/2001 - Main Rotor Pitch Housing

Findings as to Causes and Contributing Factors

1. The helicopter developed a high rate of descent on short final approach, and the pilot was not able to arrest the rate of descent prior to impact.

Findings as to Risk

1. The approach pattern flown (to the right) would have made it difficult to judge the requirement for speed and power adjustments.

2. Conditions necessary for the development of vortex ring state or N2 droop existed during the approach.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 07 January 2003.