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Inconsistent Placement of External-cargo Release Switches Can Hinder Emergency Landings

In its final report on the fatal accident of a Bell 204B during a fire fighting flight, the Transportation Safety Board of Canada said that the absence of a standard location for the external-cargo release switch 'increases the risk of pilot confusion during an emergency.'

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FSF Editorial Staff

The pilot of a Bell 204B fire fighting helicopter was unable to complete an emergency landing in part because he could not release a long line that had become entangled in trees, the Transportation Safety Board of Canada (TSB) said in its final report on the fatal accident.[1]

The report said that the Aug. 17, 2003, accident at Bonaparte Lake, British Columbia, was caused by an engine failure resulting from an imbalance of the engine compressor rotor assembly. The TSB did not determine the cause of the imbalance. After the engine failure, a "combination of altitude, terrain features and the trailing long line negatively affected the pilot's ability to complete a successful emergency landing in autorotation," the report said.

The helicopter was destroyed in the accident and the subsequent fire, and the pilot — the only person in the helicopter — was killed.

The accident occurred during the first flight of the day, soon after the pilot conducted a departure to the east from a staging site at about 1105 local time; an empty water bucket was at the end of the 100-foot (31-meter) long line. Soon after takeoff, the helicopter emitted a "high-pitched, oscillating sound," the report said.

"The flight path and behavior of the helicopter were normal as it went out of view over some trees. Immediately thereafter, there was the pronounced sound of main-rotor-blade slap, followed by the sounds of impact with the trees."

The helicopter struck the ground in a wooded area near a small clearing next to a fire road about 0.25 nautical mile (0.46 kilometer) southeast of the staging site on a heading "approximately 160 degrees greater than the departure heading," the report said. A post-impact fire destroyed the helicopter cabin. The braided-fabric long line was found wrapped around a tree and extended "in a direct line to the helicopter"; the top 15 feet (five meters) of the long line was burned away, the report said. The water bucket, which had separated from the long line, was found in another tree.

Four days before the accident, after completing his daily flights, the accident pilot had flown the helicopter to Kamloops, British Columbia, where company maintenance personnel replaced the helicopter's engine and transmission. At the time, the airframe had accumulated 11,539 flight hours, and the engine and the transmission were due for overhauls.

Maintenance personnel installed a Honeywell (Lycoming) T53-11B engine assembly, which had a total time of 7,398 flight hours since new and zero hours since overhaul, the report said. Maintenance personnel also installed a new Bell Helicopter Textron transmission assembly (part no. 204-040-009-087), which had a total time of 6,808 flight hours since new and 397 flight hours since overhaul.

The new engine and transmission were tested, adjustments were made and, on Aug. 15, a test flight was conducted. Data obtained during the test flight and entered in maintenance records showed that the engine was operating at an N_1 speed[2] that was 2.3 percent below the allowable limit of 93.3 percent and that the exhaust gas temperature (EGT), which had an allowable limit of 590 degrees Celsius (C; 1,094 degrees Fahrenheit [F]), was below the limit at 530 degrees C (986 degrees F).

The data were recorded in the journey log as a method of estimating engine power output and tracking engine performance. The N_1 check (N_1 topping check) was required to "confirm that the engine achieves the rated performance without exceeding its engine data plate placard limit," the report said.

The pilot signed the journey log — a requirement in approving the helicopter for further flight.

Contrary to instructions in the Honeywell (Lycoming) engine maintenance manual, an engine-vibration check — a method of checking alignment of the engine and transmission and of detecting engine damage — was not conducted before the helicopter was returned to service on Aug. 15 in fire fighting operations at Bonaparte Lake.

"After about 20 minutes of working, the pilot relayed a message to the maintenance crew in Kamloops, requesting that the engine-vibration test equipment be kept," the report said. "Another 30 minutes later, the pilot reported to the British Columbia Forest Service office that the helicopter was unserviceable, and he returned to Kamloops."

The pilot said that a cowling was "buzzing" and that the engine was not producing enough power to lift the load; as a result, main-rotor revolutions per minute (rpm) was "drooping." (Drooping is a reduction of the main-rotor rpm and mechanically linked power turbine [N_2] because the engine is unable to sustain the existing load, the report said.)

An engine-vibration check then was conducted; it showed that the engine was operating within specifications.

"The failure to perform a vibration check at initial installation, therefore, had no bearing on the subject failure, since a vibration check was conducted with no problems being indicated approximately 50 flying minutes after engine installation," the report said.

After the vibration check, maintenance personnel increased the N_1 takeoff-trim setting in an attempt to correct the power problem and the drooping problem; no records were provided for the N_1 topping check.

"It is known that the N_1 speed was established to be 97.6 percent at the overhaul facility, and this was the placard setting at which the engine produced its full-rated horsepower under international standard atmosphere conditions at sea level," the report said. "By providing a physical restriction to fuel flow, the takeoff trim setting is the N_1 overspeed-protection device. It is possible to operate the engine at higher N_1 speeds, approaching the compressor overspeed limit, and it appears to produce all desirable effects — that is, more power while apparently remaining within the allowable engine torque and EGT parameters. Without the confirmation of an N_1 topping check after an adjustment, it is not known whether the N_1 speed is within specifications."

On Aug. 16, the helicopter was returned to the staging site and was flown for 8.8 flight hours. During that time, the pilot made several reports indicating that operations were normal; this indicated that the N_1 adjustment apparently was beneficial.

"However, if the N_1 was above specification, excessive T5 [turbine inlet] temperatures could result in a degradation of the hot section components," the report said.

At the end of the workday on Aug. 16, the helicopter was returned to Kamloops, where it was refueled with 563 liters (149 U.S. gallons) of Jet A fuel. (The helicopter's maximum fuel capacity was 915 liters [242 U.S. gallons]).

Pilot Was Hired as Temporary Worker

The accident pilot held an airline transport pilot certificate, with a helicopter rating. He had about 7,500 flight hours, including 200 flight hours in Bell 204 helicopters in the 90 days before the accident, and had completed a proficiency check in the Bell 204 in June 2003. He had flown the accident helicopter during the last two weeks of June and again beginning Aug. 13.

He was hired by Gemini Helicopters for a temporary assignment to provide relief for the pilot who usually flew the helicopter. The report provided no other information about the pilot.

The helicopter had been flown for nearly 11 flight hours after installation of the transmission and engine.

Regulations did not require the helicopter to be equipped with a flight data recorder or a cockpit voice recorder, and the helicopter had neither.

Density Altitude Estimated at 5,900 Feet

At the time of the accident, a British Columbia Forest Service weather observation at an area 14 nautical miles (26 kilometers) southwest of the accident site included a temperature of 20 degrees C (68 degrees F), with variable winds up to eight knots. The temperature at the staging site, located at 4,500 feet, was estimated at about 19 degrees C (66 degrees F). The report said that the pressure altitude was about 4,620 feet and the density altitude was about 5,900 feet.

Neither weight nor center of gravity was considered a factor in the accident. The helicopter's weight at the time of the accident was estimated at 3,548 kilograms (7,822 pounds). The gross takeoff weight for external-load operations was 4.309 kilograms (9,500 pounds).

‘Vertical Reference Kit’ Had Been Installed

The accident helicopter was equipped with a “vertical reference kit” to allow single-pilot operation from the left seat for long line operations. The vertical reference kit included a third foot pedal for release of the external-cargo hook, located on the helicopter’s belly, to which the long line was attached. Within the long line were two electrical wires that supplied the power required to operate either the remote hook, located at the end of the long line, or the bucket water-release mechanism; in the accident helicopter, the electrical wires were connected to the bucket water-release mechanism. This disarmed the remote hook, which was not required for the operation or for emergency purposes.

A standard electrical extension cord was attached to the long line. The extension cord was intended to supply electrical power from a control box between the pilot seats to a foam-injection pump in the water bucket.

However, the report said, “The bucket was not equipped with such a pump, and, therefore, this cord was not serving any purpose.”

After the accident, an examination of the external-load system found that the water bucket had separated from the remote hook. The remote hook apparently was not damaged, and tests found that the remote hook could be operated both manually and electrically. On the bucket assembly, the control head and its attached shackle also appeared undamaged.

Canadian Aviation Regulations Part 527.865 and Part 529.865 require a primary quick-release system for the external-cargo hook, but the regulations do not specify which of five switches typically found on the cyclic control grip of many helicopters should be configured as the quick-release switch.

“There is no common design among manufacturers and operators to configure the function of these switches to suit their types of external-load operations,” the report said.

The operator of the accident helicopter — in response to another pilot’s preference — had reconfigured three switches on the grip so that the middle switch (activated by the thumb) controlled the external-cargo release switch. Two other switches (the top switch, which also was activated by the thumb, and the bottom switch, which was activated by the little finger) controlled the bucket-water release mechanism.

‘Not What He Was Accustomed To’

“Most of the pilot’s experience consisted of long line operations, and records of the pilot’s flight time indicate that at least 2,700 [flight] hours of his most recent experience involved the use of cyclic grip configurations in which the bottom switch, operated by the little finger of the pilot’s right hand, was used to release the external-cargo hook,” the report said. “This helicopter was configured differently. Although the pilot knew that the external-cargo-hook-release switch position had been changed, and he had used this system for two weeks in June and again for two days in August prior to the accident, it was not what he was accustomed to.

“Studies in human behavior suggest that, among other variables, relative and finite amounts of practice influence which automatic behavior occurs in an emergency situation; the more practiced behavior will be the default behavior.”

The studies found that a new behavior (such as activating a release switch with the thumb instead of with the little finger) would not become automatic until the pilot had practiced with the new switch configuration “for 30 days, or 85 hours, or 1,000 repetitions or more,” the report said. “With less practice, it would be difficult for the pilot to automatically and correctly select the appropriate switch to jettison the external load from the helicopter.”

In most emergencies, the long line is released from the external-cargo hook. Sometimes, however, the release cannot be accomplished because of complicating factors, such as insufficient time, low altitude, terrain, type of emergency and pilot familiarity with the release system. Examination of the wreckage showed that the long line had not been released and that it had become entangled in a tree during the attempted emergency landing. Investigators did not determine whether the pilot had attempted to release the long line or whether the quick-release system was serviceable.

“It was learned that the pilot’s normal practice was to operate the helicopter with the external-cargo-hook switch in the armed position; however, damage prevented investigators from determining the position of this switch,” the report said.

No Explanation for Imbalance in Rotor Assembly

Examination of the engine revealed that the engine had failed because of an imbalance of the compressor rotor assembly, which led to contact between the rotor assembly and stator assemblies; this contact caused the destruction of the rotor assembly. The report said that the investigation reached no conclusion about the cause of the rotor assembly imbalance.

The report said that the investigation’s findings as to risk included the following:

- “Some procedures used in the engine overhaul process were not in accordance with the manufacturer’s overhaul manual; failure to comply with the manufacturer’s instructions could compromise the integrity of the assembly and result in failure; [and,]

- "Field adjustments to the engine fuel control takeoff trim without the confirmation of an N_1 topping check for accuracy introduces a risk of frequent or continuous operations at gas-generator speeds and internal temperatures beyond established limits."

The position of the wreckage indicated that the pilot probably detected a problem and was attempting to return the helicopter to the staging site when the accident occurred, the report said.

"It is highly likely that the pilot had yet to change his automatic behavior and activate the external-cargo release switch in the 'new' location in an emergency," the report said. "Therefore, it is probable that the pilot's action during the emergency did not activate the external-cargo-hook release mechanism and, rather, that the trailing long line snagged a tree while the helicopter was still airborne. This factor was an additional complication to the survivability aspects of this accident."

In its findings as to risk, the report said that the "inconsistent placement" of the external-cargo release switch "increases the risk of pilot confusion during an emergency when trying to activate the external-cargo-hook release mechanism, possibly complicating an emergency landing."

The foot-pedal release in the accident helicopter was an approved backup quick-release system; nevertheless, the effectiveness of a foot-pedal release is limited because it requires a pilot to remove one foot from a primary flight control during an emergency, the report said in its findings as to risk.

After the accident, the operator standardized the location of the switches on the cyclic grips in its helicopters (except in its Robinson R44s, which are "incompatible for such a modification," the report said).

In addition, the operator installed emergency release switches on the collective in its Eurocopter AS 350s and "is searching for supplemental type certificates applicable to the rest of its fleet," the report said. "The rationale is that the emergency release systems (isolated pull handles or foot pedals) in the other aircraft also require the use of either hands or feet to operate; therefore, requiring the pilot to let go of a flight control to release an external load via the manual release. With the manual release on the collective, activation is possible without requiring pilots to remove their hands or feet from primary flight controls."♦

Notes

1. Transportation Safety Board of Canada. Aviation Investigation Report A03P0247, *Loss of Engine Power — Collision With Terrain, Gemini Helicopters Inc., Bell 204B (Helicopter) C-GEAP, Bonaparte Lake, British Columbia, 17 August 2003*.

2. The report defined N_1 as gas-producer rotational speed, which is indicated as a percentage of designed rotational speed.

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