

Transportation Safety Board  
of Canada



Bureau de la sécurité des transports  
du Canada

## AVIATION INVESTIGATION REPORT

A01Q0105



### FUEL EXHAUSTION

**CANADIAN HELICOPTERS LIMITED**

**BELL-212, C-FXDS**

**ROBERVAL, QUEBEC, 80 NM NORTH**

**27 JUNE 2001**

**Canada**

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

### Fuel Exhaustion

Bell 212 C-FXDS

Operated by Canadian Helicopters Limited

Roberval, Quebec 80 nm N

27 June 2001

Report Number A01Q0105

### *Summary*

A Canadian Helicopters Limited Bell 212 twin-engine helicopter, registration C-FXDS, serial number 30806, with one pilot and one passenger on board was on its first flight of the day. It was operating under contract with the *Société de la protection des forêts contre le feu* (SOPFEU). At approximately 0708 hours eastern daylight time, after 1 hour 47 minutes of flight, the right engine FUEL LOW warning light illuminated. The pilot departed the site of fire 496 for Liberal Camp to refuel. Relying on the global positioning system, the pilot estimated the time of arrival to be 14 minutes. Twelve minutes later, the right engine stopped; the pilot elected to abort the flight immediately and land in a sand pit near a logging road. Forty-four seconds later, approximately 300 feet above ground level, the second engine stopped. The pilot commenced an autorotation that resulted in a hard landing. The two occupants sustained serious injuries.

*Ce rapport est également disponible en français.*

## *Other Factual Information*

At approximately 0520 hours eastern daylight time,<sup>1</sup> the pilot took off with approximately 1400 pounds of fuel toward the spray site. At approximately 0706, after 1 hour 45 minutes of flight, the pilot checked the fuel gauge and elected to refuel the aircraft at the alternate base at Liberal Camp, 26 nautical miles (nm) to the northeast. The pilot completed his water-bucket cycle and, being unable to find a suitable location to drop the Bambi bucket, the pilot elected to carry it, despite the fact that this sling load reduced the aircraft's range. To stabilize the bucket in flight, he returned to the refill point to fill the Bambi bucket halfway (approximately 1900 pounds). He estimated that he could land at Liberal Camp 14 minutes later with 100 pounds of fuel in reserve.

At 0708, when departing the site, the right engine fuel low warning light illuminated, followed a few seconds later by the left engine fuel low warning light. The warning light indicates that approximately 140 pounds of fuel remains in the tank. At 0711, the pilot informed the SOPFEU communications operator at Roberval base that he was en route to Liberal Camp to refuel. The pilot decided to reassess the amount of fuel halfway between the fire site and Liberal Camp. At approximately 0715, at the halfway point, the pilot noted that he did not have sufficient fuel to reach his destination and elected to land as soon as possible. He continued onward to his destination, seeking a suitable landing area.

At 0720:51, 12 minutes after the fuel low warning light illuminated, the right engine stopped. The pilot elected to abort the flight immediately and land in a sand pit beside a logging road. He informed the passenger of his intention and asked the passenger to notify SOPFEU and request fuel from them. Forty-four seconds after the first engine stopped, the second engine stopped when the helicopter was approximately 300 feet above ground level. The pilot commenced an autorotation and dropped the Bambi bucket during the descent. One second later, the low rotor horn (Nr) activated and remained on until ground impact 13 seconds later. The passenger's attempt at communicating with the firefighting chief was interrupted by the loss of both engines. After striking a flat area, sparsely covered with alder trees, the helicopter bounced 10 metres on a heading of 27 degrees magnetic and came to rest on its right side on the shore of the Mistassini River. The emergency locator transmitter (ELT) activated on impact. The pilot, who was flying the helicopter from the right seat, was ejected from the aircraft. Though wearing a helmet, the pilot sustained serious lacerations to his head and face. The passenger, who was seated in the left front seat, was trapped in the cockpit.

After attempting for one hour to contact C-FXDS by radio, SOPFEU began an aerial search at approximately 0820. The aircraft was found at 0855.

At 0700, Roberval weather station, located 77 nm to the south of the occurrence site, reported no cloud ceiling, visibility 15 miles, temperature 23°C and winds from the west at 8 knots.

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<sup>1</sup> All times are eastern daylight time (Coordinated Universal Time minus four hours) unless otherwise stated.

The pilot was certified and qualified for the flight in accordance with existing regulations. His employer considered him a capable pilot who always exhibited a professional attitude. He received his commercial pilot licence in April 1991. In November 1999, the company provided him with theory and practical training on the Bell 212, a medium-weight, twin-engine helicopter. The pilot's licence was endorsed for the Bell 212 in December 1999. In January 2001, he renewed his Pilot Proficiency Check on the Bell 212. For this type of endorsement, the company does not provide a practical, on-site training program with an experienced pilot. On-site training is not required by regulation, and the company does not normally provide it to the pilots. Prior to his training on the Bell 212, the pilot had some 3000 flying hours logged exclusively on lightweight, single-engine helicopters. The contract with SOPFEU came into effect on 10 June 2001; it was the pilot's first commercial contract with the Bell 212. Until then, the pilot had just over 25 flying hours on type. The pilot also held an aircraft maintenance engineer licence, which authorized him to sign a maintenance release for the Bell 212.

In January 2001, on a theory examination on the Bell 212, the pilot's correct answers to questions on the fuel system indicated that he knew that when the FUEL LOW warning light illuminated, 140 pounds of fuel remained and, according to the same examination, that the company considered 210 pounds as the low fuel level for the Bell 212. The flight manual states that approximately 10 minutes of flying time at cruise power remains once the light is activated, and describes the procedure for opening the cross-feed valves. It does not state that the aircraft should be landed on a low-fuel indication. The aircraft was in flight for approximately two hours when the first engine stopped; this is consistent with fuel consumption of 700 pounds per hour, which is normal for this type of operation.

Under the regulations, a helicopter in VFR flight must have sufficient fuel to fly to the destination aerodrome and then to fly for 20 minutes at normal cruising speed. The requirements of Canadian Helicopters Limited regarding fuel, published in their operations manual, reiterate the regulations in effect. The company has no specific procedures (none is required) for low-fuel situations or when FUEL LOW warning lights illuminate on an aircraft equipped with them.

The pilot took the Transport Canada Pilot Decision-Making course in November 1998. Pilot decision-making training introduces pilots to the factors that affect human performance, the decision-making process, and how to counteract human error.

The day before the occurrence, the pilot flew for two hours between 0930 and 2000. He went to bed at approximately 2130. He was awake from 2300 to 0100 on work-related duties. The day of the occurrence, he awoke at approximately 0430 to prepare for the day's flights. A breakfast was prepared for him, which he ate in the aircraft.

Aircraft records indicate that the aircraft was certified and maintained in accordance with existing regulations and approved procedures. The helicopter's weight was within limits and its centre of gravity was within the normal range. Because of the extensive damage, calibration of the fuel system could not be verified. However, in February 2001, both fuel tank probes and each main tank's fuel low indicator switch were calibrated in accordance with approved procedures. When there is a low fuel level situation, the FUEL LOW warning light illuminates for the engine No. 1 side or the engine No. 2 side, indicating that a total of approximately 140 pounds of fuel remains.

Though not required for the occurrence flight, the aircraft was equipped with a cockpit voice recorder (CVR) (Fairchild model 93-A100-31) with 32 minutes 15 seconds of digital recording capacity that loops and continues to record over itself. The CVR was installed in accordance with a Limited Supplementary Type Approval (LSTA), number P-LSH 92-315, approved by Transport Canada. One of the criteria outlined in Subchapter F 525.1457 (d) (2) was that each cockpit voice recorder must be installed so that, within 10 minutes after crash impact, there is an automatic means to simultaneously stop the recorder and prevent each erasure feature from functioning. In accordance with the LSTA, a G switch was installed to stop the CVR recording on impacts over 5Gs (acceleration due to gravity). Nonetheless, the CVR continued to operate until the pilot cut the electrical power 9 minutes 44 seconds after the crash. Examination of the G switch indicated that it was pointing in the direction of flight as specified in the LSTA. Tests carried out showed it activated at 4G impacts.

Given that the CVR did not stop recording as stipulated by regulations, its installation was compared with the installation of the ELT, also activated by a G switch, which did set off on impact. It was found that regulatory requirements governing ELT installation on helicopters differ from those governing aeroplanes. When installed in an aeroplane, the ELT must be mounted with its sensitive axis pointing in the direction of flight, while on a helicopter the ELT must be mounted with its sensitive axis pointing approximately 45 degrees downward from the normal forward direction of flight. The ELT installation requirements take into account the most likely flight line at impact of both type of aircraft. However, regulatory requirements governing CVR installation make no distinction between installation in helicopters or in aeroplanes.

SOPFEU was responsible for operational and administrative supervision of helicopters operating under contract. On each take-off from a main, secondary or pre-positioning base, the pilot is required to report, to either the message centre or land operations, the departure time, the estimated arrival time at the destination, the destination itself and the nature of the work to be carried out. These same procedures apply when the pilot arrives and departs from the site. For safety reasons, the pilot must also report his position every 20 minutes during flight. In the event that an aircraft does not report its position during flight, search procedures would be initiated after 30 minutes for a search aircraft and after 60 minutes for transport aircraft. During the flight, position-reporting procedures were not strictly followed. The estimated time of arrival was not reported until arrival at the fire, the Roberval message centre was not informed that the aircraft had taken off to carry out water bucketing, and no estimated time of arrival at Liberal Camp was provided or requested. Though not required, the low fuel level situation was not reported during the final stage.

## *Analysis*

The engines stopped because of fuel exhaustion, which occurred after 2 hours 1 minute of flight. The flight duration is consistent with normal fuel consumption for the type of flight. Neither the pilot nor previous crews indicated any gauge malfunctions. The gauge was calibrated a few months prior to the occurrence. Consequently, an unserviceability of the aircraft or one of its systems was ruled out. Fuel exhaustion can thus be attributed to poor fuel management.

The pilot had to assess his fuel supply during flight by monitoring gauge readings, calculating the quantity of remaining fuel and comparing the cruising range and the remaining flight time in order to decide when to refuel. Engrossed in water bucketing, the pilot lost track of flight time and did not monitor the quantity of fuel on board the aircraft. The pilot elected to head to

Liberal Camp, a decision that entailed more serious consequences that were less likely to occur, rather than to land near the fire site, which entailed less serious consequences that were inevitable.

The pilot was experiencing a more difficult adjustment period than usual owing to his lack of experience with the Bell 212, a more complex aircraft than those he was used to flying. His experience was spread out over three separate periods over 18 months. The relatively long intervals between training sessions and the SOPFEU contract, coupled with the lack of recency of his training, likely contributed to a deterioration of the pilot's theoretical and technical knowledge and, consequently, poor fuel management. Also, the pilot was not given on-the-job training, which would have allowed him to update his knowledge of the aircraft while carrying out his duties. Lastly, a somewhat short sleep period that was interrupted for two hours may have had an effect on the pilot's performance.

The pilot's decision to wait until halfway between his departure point and Liberal Camp to assess his fuel load was questionable. As in this case, the pilot could only conclude that it was impossible to return to his point of departure or to make it to his destination.

The Company's operations manual merely reiterates the regulations governing fuel-related requirements. Canadian Helicopters Limited did not deem it necessary to establish a special procedure to follow in low fuel level situations or when the FUEL LOW indicator light illuminates; such procedures are not mandatory under the regulations or regulatory requirements. Rather than accurately determine the amount of fuel remaining when the flight had to be aborted, the company, referring to the regulation, allows a greater degree of operational flexibility to its pilots. Consequently, the onus is on the pilot, based on experience, knowledge and judgement, to decide when to abort the flight. In this occurrence, the pilot's experience in similar situations and his lack of familiarity with the aircraft were factors that led him to elect to continue the flight. Had a clear, specific company policy on fuel management been followed, fuel exhaustion would not have occurred. If the pilot had elected to abort the flight when the FUEL LOW warning light illuminated, he would have had sufficient fuel remaining to locate a suitable landing area.

During the autorotation, rotor speed decreased continuously until impact. Normally, if the collective is lowered to the stop position, rotor speed will return to the prescribed range. It is possible that the sudden nature of the second engine stoppage, the release of the Bambi bucket and the low altitude could have been factors that delayed the lowering of the collective control to the minimum following the engine stoppage. Accordingly, the decrease in rotor speed was constant and, because of very low rotor rpm on the landing flare, ground contact was not softened sufficiently to prevent substantial damage to the aircraft and serious injuries to its occupants.

Though notifying SOPFEU of the illumination of the FUEL LOW warning lights would have been prudent, the pilot was not required to do so since he believed he would reach his destination. However, once he realized, halfway to his destination, that an unscheduled landing was the only viable option, the pilot should have notified the client of the flight emergency. A search could have begun immediately. In fact, after the first engine stopped, the pilot neither radioed an emergency nor notified the passenger of the impending autorotation. Rather, the pilot asked the passenger to notify SOPFEU that he was making a forced landing and required fuel. Because the second engine stoppage occurred less than forty-four seconds later and before the passenger had time to send the message, the search began one hour following the accident.

The facts that the helicopter was severely damaged and that the ELT activated, indicate that the impact forces exceeded the activation threshold of the CVR G switch. However, since the G switch was mounted in the direction of flight, horizontally, it was less sensitive to the vertical impact sustained by the helicopter following the autorotation. A CVR G switch, mounted at a 45-degree angle as required for ELT installation on board helicopters, would be more likely to stop the CVR recording at impact.

### *Findings as to Causes and Contributing Factors*

1. The engines stopped because of fuel exhaustion as a result of poor fuel management and a questionable decision by the pilot to continue the flight despite a low fuel indication.
2. The relatively long intervals between the pilot's training sessions and his first commercial contract using a Bell 212, coupled with the lack of recency of his training and his limited experience with this aircraft, likely contributed to a deterioration in the pilot's theoretical and technical knowledge.

### *Findings as to Risk*

1. The search was delayed because the pilot did not report the urgency of his situation by radio.
2. The approved G-switch installation did not favour stoppage of the CVR following a vertical impact.
3. Existing regulations for CVR installation do not take into account the potential vertical impact from a helicopter crash.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 21 July 2003.*

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