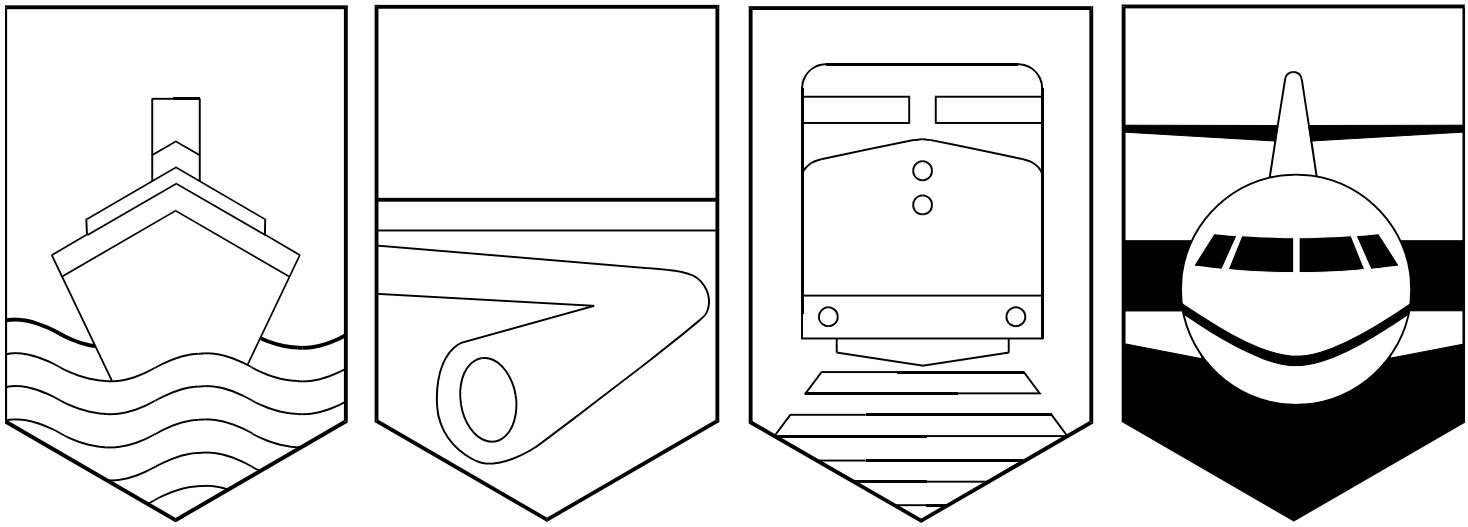
Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada



AVIATION OCCURRENCE REPORT

FUEL CONTAMINATION

FRONTIER HELICOPTERS
A DIVISION OF CONAIR AVIATION LTD.
BELL 206B JETRANGER III (HELICOPTER) C-GLGF
WATSON LAKE AIRPORT, YUKON 1.8 nm S
26 JULY 1994

REPORT NUMBER A94W0124

Canada

MANDATE OF THE TSB

The Canadian Transportation Accident Investigation and Safety Board Act provides the legal framework governing the TSB's activities. Basically, the TSB has a mandate to advance safety in the marine, pipeline, rail, and aviation modes of transportation by:

- conducting independent investigations and, if necessary, public inquiries into transportation occurrences in order to make findings as to their causes and contributing factors;
- reporting publicly on its investigations and public inquiries and on the related findings;
- identifying safety deficiencies as evidenced by transportation occurrences;
- making recommendations designed to eliminate or reduce any such safety deficiencies; and
- conducting special studies and special investigations on transportation safety matters.

It is not the function of the Board to assign fault or determine civil or criminal liability. However, the Board must not refrain from fully reporting on the causes and contributing factors merely because fault or liability might be inferred from the Board's findings.

INDEPENDENCE

To enable the public to have confidence in the transportation accident investigation process, it is essential that the investigating agency be, and be seen to be, independent and free from any conflicts of interest when it investigates accidents, identifies safety deficiencies, and makes safety recommendations. Independence is a key feature of the TSB. The Board reports to Parliament through the President of the Queen's Privy Council for Canada and is separate from other government agencies and departments. Its independence enables it to be fully objective in arriving at its conclusions and recommendations.

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Aviation Occurrence Report

Fuel Contamination

Frontier Helicopters
A Division of Conair Aviation Ltd.
Bell 206B JetRanger III (Helicopter) C-GLGF
Watson Lake Airport, Yukon 1.8 nm S
26 July 1994

Report Number A94W0124

Synopsis

The Bell 206B helicopter was being utilized to transport a two-person initial attack fire crew to a recently spotted forest fire. Shortly after take-off, at an altitude of approximately 300 feet above ground, the engine lost all power. The pilot attempted to autorotate to the only available road; however, the helicopter overshot the intended landing area, struck trees, and crashed beside the road. The pilot sustained fatal injuries and the two passengers received serious injuries. The helicopter was destroyed.

The Board determined that the engine lost power due to water-contaminated fuel. It is probable that the pilot mistakenly introduced water into the fuel system through the fuel cell vent tube when he attempted to back-flush the adjacent engine pan drain tube with a water hose. The low altitude at which the loss of power occurred precluded successful autorotation to a suitable landing site.

Ce rapport est également disponible en français.

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1.0 Factual Information

1.1 History of the Flight

The pilot and Bell 206B helicopter had been placed on standby for initial attack (IA)[1] at the Department of Indian and Northern Affairs Forest Resources Fire Centre, at the Watson Lake Airport, Yukon. The pilot arrived at the Fire Centre in the early afternoon, accomplished a five-minute IA performance flight, and returned to the landing pad. Later in the afternoon, he washed and groomed the helicopter. At 1840 Pacific daylight time (PDT)[2] the pilot was dispatched to a nearby British Columbia Forest Service (BCFS) IA base to pick up and transport an IA crew to a new forest fire located 20 miles away in Northern British Columbia. Immediately after boarding the two-person IA crew, the pilot departed to the southwest. Approximately two minutes after take-off, at an altitude of about 300 feet above ground, the engine (Allison 250 C20B) lost all power. The pilot transmitted a MAYDAY, and advised his passengers that he was experiencing a problem and would have to set the helicopter down. The helicopter was observed to turn right 180 degrees, descend, turn right an additional 90 degrees, and crash into trees immediately adjacent to a secondary road. The pilot sustained fatal injuries, and the two IA crew members sustained serious injuries. The helicopter was destroyed.

The accident occurred at latitude 60°05'N and longitude 128°49'W at approximately 1900 PDT, during daylight hours, at an elevation of 2,240 feet above sea level (asl)[3].

1 See Glossary for all abbreviations and acronyms.

2 All times are PDT (Coordinated Universal Time [UTC] minus seven hours) unless otherwise stated.

3 Units are consistent with official manuals, documents, reports, and instructions used by or issued to the crew.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	1	-	-	1
Serious	-	2	-	2
Minor/None	-	-	-	-
Total	1	2	-	3

1.3 Damage to Aircraft

The helicopter was destroyed by the impact.

1.4 Other Damage

The helicopter crashed into standing spruce and pine trees. No other significant property damage occurred.

1.5 Personnel Information

	Pilot-in-Command
Age	28
Pilot Licence	CPL
Medical Expiry Date	01 Jan 95
Total Flying Hours	2,947
Hours on Type	2,147
Hours Last 90 Days	69
Hours on Type Last 90 Days	69
Hours on Duty Prior to Occurrence	13
Hours off Duty Prior to Work Period	9

The pilot was certified and qualified for the flight in accordance with existing regulations. He was characterized as being safety conscious. He had flown for Frontier

Helicopters for approximately five years, and currently held the position of Watson Lake Base Manager. The pilot was involved in an accident two years earlier when he autorotated a Bell 206B into trees following an engine flame-out. The helicopter was destroyed and the pilot sustained minor injuries.

The pilot prided himself in keeping the helicopters he flew clean. He was observed washing and grooming C-GLGF with a bucket of soapy water and a water hose at the Watson Lake Fire Centre pad for approximately three hours before the flight. At one point he advised bystanders that the engine pan drain tube was clogged, and he was observed probing the tube from the engine compartment and from the lower right side of the fuselage with a wire. Later he advised two Fire Centre employees that he had succeeded in unclogging the drain tube.

The pilot was observed draining a small quantity of fuel from the fuel cell sump after he landed at the Fire Centre pad, before he washed the helicopter.

1.6 Aircraft Information

Manufacturer	Bell Helicopter Textron
Type and Model	206B JetRanger III
Year of Manufacture	1978
Serial Number	2421
Certificate of Airworthiness (Flight Permit)	Valid
Total Airframe Time	6,646 hr
Engine Type (number of)	Allison 250-C20B (1)
Propeller/Rotor Type (number of)	Semi-rigid (1)
Maximum Allowable Take-off Weight	3,200 lb
Recommended Fuel Type(s)	Jet A, Jet A1, Jet B
Fuel Type Used	Jet B

Log-book entries stated the helicopter had been maintained in accordance with the applicable standards of airworthiness. The weight and centre of gravity were within the prescribed limits.

1.6.1 The Engine Pan Drain Tube

The Bell 206B is fitted with an engine compartment stainless steel drain tube which discharges fluids overboard from the engine pan. The drain tube routes from the bottom lower centre of the engine pan, horizontally to the right above the baggage compartment, and vertically down the right side of the fuselage to exit approximately three inches aft of the fuel cell vent tube. The drain tube has an outside diameter of approximately ½ inch and protrudes approximately 3 inches from the fuselage. Field reports indicate

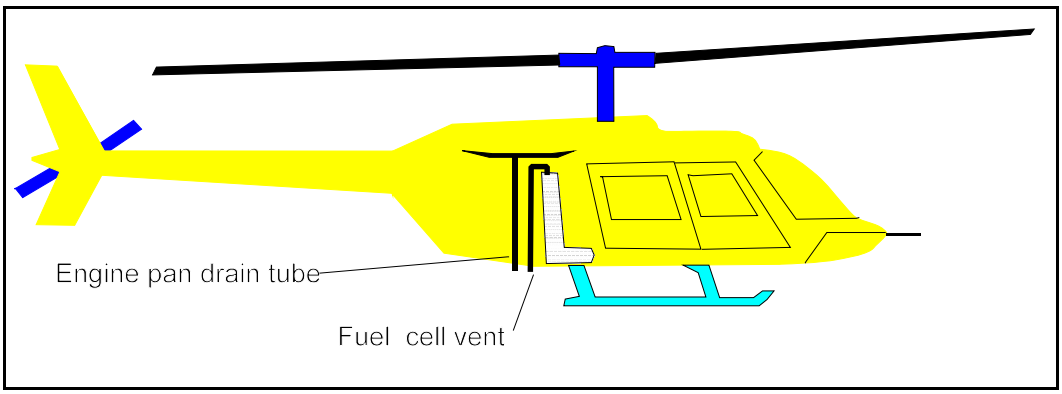

Figure 1 - B206 Engine Pan Drain and Fuel Cell Vent Tubes

that the engine pan drain tube frequently clogs. Foreign material such as bugs, dirt, and small leaves may collect in the engine pan during normal operation and wash into the tube whenever fuel is drained onto the pan from the airframe or engine fuel filters.

The *Bell 206B Maintenance and Overhaul Manual* does not identify a procedure to clean the engine pan drain tube. Operators report that the tube is normally cleaned by probing with a wire and/or purging with shop air or solvents. The pilot reportedly carried a twisted piece of wire in the helicopter for use as a probe when the drain tube clogged.

1.6.2 The Fuel Cell Vent

The fuel cell vent is an aluminum tube which exits the Bell 206B on the right lower side of the fuselage, aft of the right cabin door and forward of the engine pan drain tube. The outside diameter of the tube is approximately ½ inch, and it protrudes approximately 3 inches from the fuselage skin. There is no check valve in the vent tube to prevent fluids from entering the fuel cell if the tube is back-flushed.

The fuel cell vent tube was not identified externally by label or decal, and there was no requirement for markings to exist. Chapter 11 (Placards and Markings) of the *Bell 206B III Maintenance Manual* identifies that a "FUEL CELL VENT" decal is applicable to the Bell 206B III S/N 3890 and subsequent.

The engine pan drain tube and the fuel cell vent tube were submitted to the TSB Engineering Branch Laboratory for examination (see Appendix A). The tubes were sectioned and visually inspected. Scratches on the inner wall of the fuel cell vent tube indicated that the tube had recently been probed with a wire or a similar instrument. The harder stainless steel engine pan drain tube did not display clear evidence of recent probing. Faint rub lines existed on the inner wall of the tube; however, it was not certain that these indistinct marks had been made as recently as the scratches in the vent tube.

1.6.3 Recent Inspection

A 1200-hour inspection had been completed on the helicopter on 29 June 1994, 62.7 hours prior to the occurrence. The helicopter was a Bell 206B3 model; however, Bell 206A/B inspection sheets had been utilized for the inspection. Although the inspection sheets for each model are similar, the Bell 206B3 100-hour inspection sheets include a specific requirement to "Inspect and ensure the engine pan drains are free from obstruction." This requirement is not identified on the Bell

206A/B 100-hour inspection sheets. The 1200-hour inspection includes 100-hour items.

The pilot had not recently reported to the maintenance staff that the engine pan drain tube was clogged.

1.7 Meteorological Information

Good visual meteorological conditions existed at the time of the occurrence, and weather was not considered to be a factor. An AUTO5 automated weather observation system (AWOS) located at Watson Lake Airport recorded the weather conditions at 1900 PDT as no clouds below 10,000 feet asl, temperature 25 degrees Celsius, visibility greater than nine statute miles, and winds calm. Witnesses reported similar weather conditions. One of the IA crew members reported that smoke from the fire they were transitting to was visible immediately after they lifted off from the BCFS helicopter pad.

1.8 Communications

Several aircraft were operating in the vicinity of Watson Lake at the time of the occurrence. Two Forestry FM frequencies, the very high frequency (VHF) aerodrome traffic frequency (123.2 MHz) and the VHF water bomber air attack frequency (122.7 MHz), were in use. A "bird dog" aircraft and three water bombers were departing the Watson Lake Airport to fight the forest fire. The pilot of the helicopter transmitted a MAYDAY distress call on the Forest Resources Fire Centre FM frequency shortly before impact. The crew of the bird dog aircraft heard the distress call and observed the helicopter strike the trees. They proceeded without delay to circle the crash site and advised the Forest Resources Fire Centre duty officer of the accident. The duty officer immediately initiated an emergency response by calling the local police and ambulance services. The bird dog crew continued to circle, and subsequently guided responding ground personnel to the accident site.

1.9 Fuel System Examination

Fuel samples collected from the airframe fuel filter, the engine-driven high-pressure fuel pump filter cavity, the fuel control unit, and the fuel nozzle supply line contained large quantities of water. Fuel from the three most recent refuelling sources was examined with water detecting paste, and found to be clear and free of water. The hose and filter housings of the portable barrel pump which was on board the helicopter contained no detectable water. No discrepancies which would permit water leakage into the cell were noted during an examination of the fuel tank range extender and cap. The pilot was known to frequently drain the airframe fuel filter and fuel cell sump to check for water.

1.10 Wreckage and Impact Information

The helicopter crashed approximately 60 feet north of a secondary road which accessed a local campground. It had crossed the road and collided with several 30- to 40-foot-tall trees prior to ground impact. The wreckage trail was approximately 60 feet long. Damage and ground scars indicated that the helicopter had struck the ground in a right-side-low attitude, at a high impact angle and a high rate of descent.

The helicopter broke into several sections at impact. The cross-tubes and fuselage floor detached, the fuel cell ruptured, the tail boom detached, and the cockpit collapsed. The forward right side of the cockpit adjacent to the pilot's position sustained severe impact damage.

1.11 Medical Information

There was no evidence of incapacitation or physiological or psychological factors which would have adversely affected the pilot's performance.

1.12 Fire

There was no evidence of fire either before or after the occurrence.

1.13 Survival Aspects

Both surviving passengers sustained serious back injuries due to the high vertical deceleration forces. The fuel cell ruptured at impact. Both survivors were doused with jet fuel, and sustained chemical burns as a result.

1.14 Tests and Research

Laboratory testing determined that the water in the fuel samples and the water in the hose used to rinse the helicopter were similar in hydrogen ion concentration (pH) and mineral content.

1.15 Additional Information

Reports from industry indicate that Bell 206 fuel systems have previously been contaminated when the fuel cell vent tube was mistaken for the engine pan drain tube and inadvertently back-flushed with water or solvent. In all reported incidents, the condition was identified and rectified before flight.

2.0 Analysis

2.1 Introduction

The investigation determined that the Allison 250 C20B engine lost power due to water-contaminated fuel. The analysis will focus on the introduction of water into the helicopter fuel system, and on the subsequent autorotational forced landing. Although improper inspection sheets had been used during a recent 1200-hour inspection, there was no evidence to indicate that this was a factor in the accident. The pilot had not reported a problem with the engine pan drain tube during the 60 hours of flight since the last scheduled inspection, which suggests that the tube had only recently clogged.

2.2 The Introduction of Water into the Fuel System

The engine pan overboard drain tube and fuel cell vent tube are easily misidentified where they protrude from the Bell 206B3 fuselage. The tubes are visually similar and are located very close to each other. They are not required to be labelled on the first 3,889 Bell 206 production helicopters. The engine pan drain tube is susceptible to blockage due to the flat routing of the horizontal portion of the tube, the minimal size of the line, and the migration of engine compartment debris.

The pilot had the time and facility available to him on fire standby to wash the helicopter and clean the clogged engine pan drain tube. He was familiar with the problem of a blocked drain tube, as evidenced by his habit of carrying a twisted wire to probe the tube. Scratches on the inside wall of the fuel cell vent tube indicate that he may have probed the vent tube when he was clearing the clogged drain tube. It is probable that he also mistakenly back-flushed the fuel cell vent tube, instead of the drain tube, with the available water hose and thereby introduced water into the fuel system.

2.3 The Autorotational Forced Landing

The loss of power occurred at low altitude over heavily treed terrain. The proximity of the accident location to an available secondary road and the manoeuvring that was observed by the airborne bird dog crew suggest that the pilot attempted to force land on the road. The low altitude at which the loss of power occurred may have precluded successful autorotation to the site. The pilot's previous experience of a forced landing in a heavily wooded area may have motivated him to attempt to reach the road rather than again autorotate into trees. This most likely resulted in a loss of main rotor autorotational rpm and control, a high rate of descent, and the subsequent overshoot of the intended landing site.

3.0 Conclusions

3.1 Findings

1. The engine lost all power due to water in the fuel.

2. The low altitude at which the loss of power occurred precluded autorotation to a suitable forced landing site.

3. The pilot was observed washing the helicopter and probing in the vicinity of the lower end of the engine pan drain tube with a wire prior to the flight.

4. Laboratory examination identified that the fuel cell vent tube had recently been probed with a wire or a similar instrument.

5. The fuel cell vent tube was not externally identified by label or decal, nor was it required to be by existing regulations.

6. Field reports indicate that the engine pan drain line frequently clogs due to accumulation of bugs, vegetation, and dirt.

7. The helicopter was a Bell 206B3 model; however, Bell 206A/B inspection sheets were utilized for the recent 1200-hour inspection.

3.2 Causes

The engine lost power due to water-contaminated fuel. It is probable that the pilot mistakenly introduced water into the fuel system through the fuel cell vent tube when he attempted to back-flush the adjacent engine pan drain tube with a water hose. The low altitude at which the loss of power occurred precluded successful autorotation to a suitable landing site.

4.0 Safety Action

4.1 Action Taken

4.1.1 Operator Action

The operator has issued a technical memorandum requiring that all drain lines and vent lines on company Bell 206 helicopters be identified. In addition, the memorandum states that a drain line that is blocked must be removed for cleaning or flushed from the top down to the exit. The memorandum also contains the following warning: "UNDER NO CIRCUMSTANCES IS IT PERMISSIBLE TO BACK FLUSH ANY LINE, AS THIS COULD CAUSE CONTAMINATION OF A SYSTEM."

4.1.2 Vent Lines Identification

On 09 September 1994, the TSB forwarded an Aviation Safety Advisory to Transport Canada (TC) suggesting that TC require that the fuel vent and engine drain tubes on all Bell 206 helicopters be clearly identified. TC has indicated that a Service Difficulty Advisory will be released to inform operators of the hazards of backflushing vent lines, and recommending that a warning decal be installed near the fuel vent tube outlet. An article on this issue was published in the 4/94 edition of the TC safety publication *Maintainer*.

4.1.3 Manufacturer Action

Bell Helicopter Textron has indicated that a new Technical Bulletin will be released to permit operators of JetRangers with serial numbers prior to 3890 to use the "Fuel Cell Vent" decal if they so desire. Also, on 19 January 1995, the manufacturer released Operations Safety Notice OSN-GEN-95-26 to all operators of Bell helicopters. This OSN addresses improper washing techniques, and refers operators to appropriate cautions and procedures published in the Bell Helicopter Corrosion Control Guide.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson John W. Stants, and members Zita Brunet and Hugh MacNeil, authorized the release of this report on 10 May 1995.

Appendix A - List of Supporting Reports

The following TSB Engineering Branch Laboratory report was completed:

LP 118/94 - Tube Assembly Examination.

The following supporting report was completed by the Alberta Research Council:

Lab number G0-94-1344 to G0-94-1347.

TSB Engineering reports are available upon request.

Appendix B - Glossary

asl	above sea level
AWOS	automated weather observation system
BCFS	British Columbia Forest Service
CPL	Commercial Pilot Licence
hr	hour(s)
IA	initial attack
lb	pound(s)
Ltd.	limited
MHz	megahertz
nm	nautical miles
OSN	Operations Safety Notice
PDT	Pacific daylight time
pH	hydrogen ion concentration
rpm	revolutions per minute
TC	Transport Canada
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time
VHF	very high frequency
°	degrees
'	minute(s)
"	second(s)

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