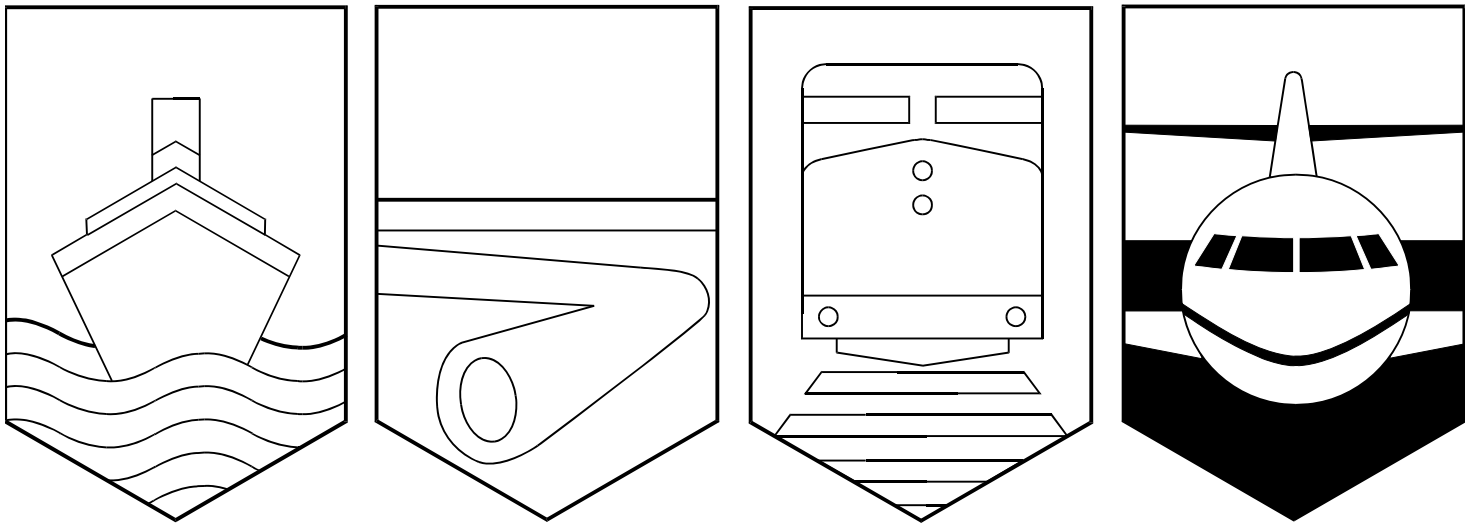
Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada



AVIATION OCCURRENCE REPORT

POWER LOSS

ATHABASKA AIRWAYS LTD
BELL 206B III JETRANGER C-GELT
PORCUPINE PLAIN, SASKATCHEWAN 19 nm S
26 JULY 1994

REPORT NUMBER A94C0141

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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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 Occurrence Report

Power Loss

Athabaska Airways Ltd.
Bell 206B III JetRanger C-GELT
Porcupine Plain, Saskatchewan 19 nm S
26 July 1994

Report Number A94C0141

Synopsis

The pilot of the Bell 206B JetRanger was conducting a series of charter flights in the area of Hudson Bay, Saskatchewan. The purpose of the flights was to locate and tag Trumpeter swans. The pilot and three passengers were flying at an altitude of about 3,000 feet above sea level when they heard a high pitched buzz from the engine compartment. The pilot observed that the engine power was decaying and autorotated into a swamp. The helicopter landed heavily and sustained substantial damage; however, the pilot and passengers were uninjured.

The Board determined that the engine lost power when internal damage to the turbine section was caused by a broken turbine blade. The blade failed in fatigue, likely as a result of engine-induced stresses/excitation. The source of the engine-induced stresses/excitation has not been determined.

Ce rapport est également disponible en français.

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1.0 Factual Information

1.1 History of the Flight

The pilot of the Bell 206B JetRanger was conducting a series of charter flights for the Saskatchewan Environment and Resource Management, Wildlife Branch in the area of Hudson Bay, Saskatchewan. The purpose of the flights was to locate and tag Trumpeter swans. The pilot and three passengers were flying at an altitude of about 3,000 feet above sea level (asl)[1] when they heard a high pitched buzz from the engine. The pilot observed that the power turbine rpm was decaying and advised the passengers to prepare for an emergency landing.

The pilot elected to autorotate the helicopter into a swampy area directly ahead. A significant amount of rotor energy was needed to avoid high trees on the edge of the area, and the pilot was unable to prevent the helicopter from landing heavily in the clearing. The helicopter sustained substantial damage; however, the pilot and passengers were uninjured. The pilot was able to communicate by radio with the operating base and a second helicopter was on site within an hour.

1 See Glossary for all abbreviations and acronyms.

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

The accident occurred at 1740 central standard time (CST)[2], in daylight, about 19 miles south of Porcupine Plain, Saskatchewan, at latitude 52°21'N, longitude 103°02'W, at an elevation of 2,000 feet asl.

1.2 Injuries to Persons

	Crew	Passengers	Others	Total
Fatal	-	-	-	-
Serious	-	-	-	-
Minor/None	1	3	-	4
Total	1	3	-	4

1.3 Damage to Aircraft

The aircraft was substantially damaged during the hard landing. The high skid gear was bent outwards and rearwards and the chin bubble glass was broken. The transmission tilted forward and damaged the upper deck, the control linkages, and the main beams. However, the main rotor did not contact the tail boom or the cabin and the helicopter remained intact.

1.4 Other Damage

There was no other damage.

1.5 Personnel Information

	Pilot-in-Command
Age	37
Pilot Licence	CPL
Medical Expiry Date	01 May 95
Total Flying Hours	2,600
Hours on Type	2,000
Hours Last 90 Days	190
Hours on Type Last 90 Days	190
Hours on Duty Prior to Occurrence	8
Hours off Duty Prior to Work Period	15

The pilot was certified and qualified for the flight in accordance with the existing regulations.

1.6 Aircraft Information

Manufacturer	Bell Helicopter Textron
Type and Model	206B
Year of Manufacture	1980
Serial Number	2994
Certificate of Airworthiness (Flight Permit)	Valid
Total Airframe Time	7,709.6 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 B
Fuel Type Used	Jet B

A review of available records indicated that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

The aircraft was equipped with an Athabaska Airways cargo rack mounted externally on the right-hand cross tubes. The rack was approved by Transport Canada (Approval No. C-78-080) and authorized for use on the occurrence aircraft. The Transport Canada approval included an approved flight manual supplement. The supplement required that cargo carried on the racks not interfere with the opening of the helicopter doors.

1.7 Meteorological Information

The weather was reported as clear, with light southwesterly winds and a temperature of 27 degrees Celsius.

1.8 Warning Circuit Breaker Procedures

The pilot reported that the company procedure is to pull the warning light circuit breaker before the engine is started to mute the warning horns during start. The circuit breaker is then reset immediately after the engine is started.

1.9 Engine Malfunction Indications

The pilot heard a high pitched whine emanating from the engine compartment and observed a decrease in the power turbine rpm indication. He did not see any warning lights or hear any warning horns during the occurrence. He noted that the turbine outlet temperature (TOT) was approximately 650 degrees Celsius and reported that the temperature was maintained until the aircraft was on the ground. He did not close the throttle during the autorotation, but reported that he closed the throttle after landing. After the pilot closed the throttle, the TOT decreased. He then used the radio to call for assistance and turned off the battery switch.

The pilot did not observe any warning lights or hear any warning horns on the ground while he was shutting down the aircraft. However, the pilot believed that he had reset the warning light circuit breaker prior to take-off.

1.10 Flight Recorders

The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was either required by regulation.

1.11 Wreckage and Impact Information

1.11.1 Preliminary Examination

The helicopter landed heavily in a swampy clearing and remained upright. The skids dug through the surface of the swamp and the helicopter sank to the bottom of its fuselage. The helicopter was moved from the occurrence site prior to examination and, therefore, the position of circuit breakers and switches at the time of the occurrence was not determined.

Post-occurrence examination of the flight controls, and the fuel and electrical systems did not reveal any pre-impact unserviceabilities. All warning lights and warning horns were tested and appeared to function normally. The seat structures did not show any deformation.

An external examination of the engine indicated that the trailing edges of the blades of the fourth stage turbine and the guide vanes of the

fourth stage nozzle displayed damage. The exhaust collector assembly displayed multiple dents and a spatter of silver-grey material.

1.11.2 Engine Teardown

The compressor would not turn when rotated in its normal direction of rotation. Disassembly of the engine (Allison model 250-C20B, serial number 830813) revealed that one blade of the second stage gas producer turbine wheel had failed near the base of the blade. The exposed surface where the blade had separated evidenced a flat and darkened section that extended through approximately 65 per cent of the blade cross section. The remaining 35 per cent of the fracture surface was bright.

The blade adjacent to the failed turbine blade in the direction of rotation was bent back and slightly inwards. The bend in that blade was sufficient to make contact with the second stage nozzle assembly and restrict rotation of the gas producer turbine.

The turbine outlet temperature probe at the nine o'clock position had been sheared off. The third stage nozzle shield displayed impact damage and deformation adjacent to the mounting port of the sheared thermocouple probe.

The failed turbine blade and the severed thermocouple had moved downstream in the engine gas path, and had interacted with the nozzle guide vanes and turbine blades of the power turbine assembly. The third and fourth stage turbine nozzles and turbine blades had suffered extensive foreign object damage.

Inspection of the second stage nozzle revealed cracking in the trailing edges of many nozzle guide vanes and one nozzle guide vane displayed a loss of a rectangular section from its trailing edge. The trailing edge damage noted in the second stage nozzle guide vanes was deemed to be normal wear for the time in service for this engine. Additionally, the outer band of the number two nozzle assembly contained a circumferential crack that extended approximately 120 degrees, adjacent to areas of a previous braze repair.

1.11.3 TSB Engineering Branch Laboratory Report

The first stage gas producer nozzle, the second stage gas producer nozzle, the third stage turbine nozzle, the third stage nozzle shield, the second stage gas producer turbine wheel, and the turbine outlet temperature sensing harness were all sent to the TSB Engineering Branch Laboratory for examination.

The fracture surface of the second stage gas producer turbine wheel was removed for detailed scanning electron microscope examination. The examination confirmed the mode of failure of the second stage turbine blade as fatigue originating from the convex side of the blade at the crown. The fatigue crack growth that was observed is typical of a high cycle fatigue cracking process, driven probably by engine vibratory type stresses. The source of the engine-induced stresses/excitation has not been determined.

Metallographic examination of the blade material showed none of the coarsening or solutioning that would be expected had the blades been exposed to operational overtemperatures.

The wheel material was within the composition range of the material required by the engineering specifications.

1.12 Medical Information

There was no evidence that incapacitation or physiological factors affected the pilot's performance.

1.13 Fire

There was no fire either before or after the occurrence.

1.14 Survival Aspects

The cargo rack mounted on the right side of the helicopter was loaded with an 18-foot

canoe. The canoe did not permit egress through either the right front or right rear doors of the helicopter.

2.0 Analysis

2.1 General

The preliminary examination of the engine and the information provided by the pilot permitted the investigation to focus on the engine. However, the external equipment rack and its load were also examined. The analysis is limited to a discussion of the engine malfunction and the external equipment rack.

2.2 Blade Fracture

The flat and darkened section of the fracture face of the failed second stage turbine blade is typical of a fatigue crack development. The remaining 35 per cent of the material of the blade suffered an instantaneous overload failure, as is indicated by its bright appearance. Analysis of the failed turbine blade did not indicate manufacturing or metallurgical problems within the blade material. It is suspected that the failure of this lone blade resulted from vibratory forces experienced within the gas path of the engine. The cracking and deformation of the nozzle circumference may have contributed to an abnormal gas flow and subsequent harmonic interference.

2.3 Power Loss

When the turbine blade failed, it jammed between the following turbine blade and the TOT thermocouple. Simultaneously, the second turbine blade was bent at the tip, the thermocouple sheared off, and the mating surfaces of the gas producer rotor assembly and the third stage nozzle shield were deformed. The separated turbine blade section and thermocouple travelled back through the engine, damaging other blades and components. The resulting damage compromised the function of gas path components downstream of the second stage wheel, and resulted in an engine power loss. The power loss may not have been complete since the pilot observed a turbine outlet temperature reading of about 650 degrees Celsius after landing.

2.4 Warning Indications

Throughout the occurrence, the aircraft had electrical power because the pilot was able to transmit on the radios. However, there was a complete absence of warning lights and horns throughout the occurrence, either in the air or on the ground, although they functioned normally after the occurrence. The position of the warning light circuit breaker was not determined immediately after the occurrence; however, it is likely that this circuit breaker was out and caused the warning circuit to be disabled.

2.5 Rack

The mounting of the canoe on the rack prevented the opening of the doors on the right hand side of the helicopter. Loading in this manner was contrary to the approved flight manual supplement.

3.0 Conclusions

3.1 Findings

1. The pilot was certified, trained, and qualified for the flight in accordance with existing regulations.

2. The weight and centre of gravity were within the prescribed limits.

3. Aircraft documentation indicated that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

4. The loading of the external rack prevented the opening of the right side doors and did not conform to the approved flight manual supplement.

5. It is likely that the warning light circuit breaker was out and caused the warning circuit to be disabled.

6. Circumferential cracking occurred adjacent to braze repairs on the second stage gas producer nozzle.

7. The engine lost power when one blade of the second stage gas producer turbine wheel failed as a result of fatigue and caused internal damage to the turbine section of the engine.

8. The fatigue of the blade was of a high-cycle nature, probably the result of engine-induced stresses/excitation. The source of the engine-induced stresses/excitation has not been determined.

3.2 Causes

The engine lost power when internal damage to the turbine section was caused by a broken turbine blade. The blade failed in fatigue, likely as a result of engine-induced stresses/excitation. The source of the engine-induced stresses/excitation has not been determined.

4.0 Safety Action

The Board has no aviation safety recommendations to issue at this time.

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 05 July 1995.

Appendix A - List of Supporting Reports

The following TSB Engineering Branch Laboratory Report was completed:

LP 128/94 - Turbine Wheel Examination.

This report is available upon request from the Transportation Safety Board of Canada.

Appendix B - Glossary

asl	above sea level
CPL	commercial pilot licence
CST	central standard time
CVR	cockpit voice recorder
FDR	flight data recorder
hr	hour(s)
lb	pound(s)
nm	nautical mile(s)
rpm	revolutions per minute
TOT	turbine outlet temperature
TSB	Transportation Safety Board of Canada
UTC	Coordinated Universal Time
°	degrees
'	minutes

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