# National Transportation Safety Board
# Aviation Incident Final Report

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| **Location:** | New York, NY | **Incident Number:** | ERA13IA313 |
| **Date & Time:** | 06/30/2013, 1155 EDT | **Registration:** | N405MR |
| **Aircraft:** | BELL HELICOPTER TEXTRON CANADA 206 | **Aircraft Damage:** | Minor |
| **Defining Event:** | Loss of engine power (total) | **Injuries:** | 5 None |
| **Flight Conducted Under:** | Part 91: General Aviation - Other Work Use - Sightseeing | | |

## Analysis

The commercial pilot reported that, during an overwater sightseeing flight in the single-engine helicopter and while at 1,500 ft, he heard a "bang," followed by the "engine out" warning. He then saw that the N2 (power turbine) indication was dropping. The pilot decided to perform an autorotation, and just before lowering the collective and rolling the throttle to flight idle, he saw the "engine chip" light illuminate. During the landing flare, the pilot deployed the skid-mounted floats, bled off all forward airspeed, and completed a successful autorotation.

The turbine section of the turboshaft engine had recently been overhauled, and the engine had operated for about 2 hours before the incident. The No. 2 bearing in the compressor section and its corresponding races were found damaged and appeared dry with evidence of high-temperature exposure. The forward side of the bearing cage exhibited significantly more damage than the aft side; the forward side was deformed, and the bearing balls on that side appeared rough and had large areas of material loss. Metallurgical examination revealed thermal distress to the raceway surfaces consistent with the bearing operating with reduced oil flow.

To confirm oil flow, the engine gearbox was attached to an oil supply, and the engine oil pump was rotated by a hand drill. Three of the four jets from the oil supply tube produced streams of oil; however, the fourth jet, which normally supplied oil to the aft face of the No. 2 bearing, did not. Visual examination of the oil supply tube revealed that a dark, thick substance was adhered to the face and chamfer. Analysis of the substance determined that, although it was the correct-specification turbine oil, it was thermally degraded. Initial flow tests revealed that the oil supply tube that lubricated the No. 2 bearing was operating below the total flow requirement. The tube was cleaned ultrasonically multiple times, and, with each subsequent cleaning, the amount of debris collected decreased. After the cleanings, the No. 2 bearing orifice met the flow requirement.

Nearly the entire surface of the pressure oil screen, except for the area covered by an O-ring, was also covered in a thick, dark substance. A sample of the substance was also determined to

be consistent with correct-specification but thermally degraded turbine oil. Additional components were also covered with coked and degraded turbine oil.

In addition, the engine oil pressure regulator valve was found backed out, and the poppet guide was atypically close to the outer lip of the housing. The atypical position indicated that adjustments, which were not documented, were likely made in response to high oil pressure indications. However, any adjustment to the oil pressure regulator valve would have been contrary to the engine manufacturer's maintenance manual, which cautioned not to do so for high oil pressure, which would have been "cause to suspect other oil system problems have developed."

The origin of the coking and buildup of degraded turbine oil within the supply system could not be determined; however, the extent to which the oil pressure regulator valve was found adjusted indicated that it had likely occurred over time, which in turn then masked a growing oil blockage problem within the oil lubrication supply paths.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be: The improper maintenance decision to adjust the engine oil pressure regulator valve in response to high oil pressure indications rather than to properly troubleshoot the anomaly, which then allowed an existing oil supply path blockage to increase and led to the eventual insufficient lubrication of the compressor section No. 2 bearing and the subsequent loss of engine power. Contributing to the incident was an engine oil lubrication system anomaly of unknown origin.

### Findings

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| **Aircraft** | Compressor section - Incorrect service/maintenance (Cause) |
| | Oil system - Damaged/degraded (Factor) |
| | Compressor section - Damaged/degraded |
| **Personnel issues** | Incorrect action performance - Maintenance personnel (Cause) |

## Factual Information

HISTORY OF FLIGHT

On June 30, 2013, about 1155 eastern daylight time, a Bell Helicopter Textron Canada 206L-4, N405MR, operated by New York City Helicopter Charter, Inc., incurred minor damage after an engine failure and subsequent forced landing to the Hudson River in New York, New York. The commercial pilot and four passengers were not injured. Visual meteorological conditions prevailed for the flight, which departed Downtown Manhattan/Wall Street Heliport (JRB), New York, New York, about 10 minutes earlier. The local sightseeing flight was being operated under the provisions of 14 Code of Federal Regulations Part 91.

According to the pilot, he had flown seven previous segments that day in the incident helicopter, with most of those under 20 minutes and the last segment being a trip to JRB after obtaining fuel in New Jersey. After landing at JRB, the pilot met the four passengers and provided them a safety briefing.

The helicopter subsequently took off and headed northbound along a standard company tour route. Approaching the 79th Street Boat Basin, at 1,500 feet, the pilot heard a "bang" and a passenger asked if the helicopter had hit a bird. The pilot answered no, then heard the "Engine Out" warning and saw that the N2 [power turbine] indication was dropping. The pilot decided to perform an autorotation, and just prior to lowering the collective and rolling the throttle to flight idle, he saw the "Engine Chip" light illuminate.

The pilot advised the passengers that they were "going down" and transmitted a Mayday call to LaGuardia Tower. During the flare, the pilot deployed the skid-mounted floats and bled off all forward airspeed. Following impact, the chin bubbles broke and water rushed into the cabin.

Once the helicopter came to rest, the pilot verified that all of the passengers were safe, confirmed same with LaGuardia Tower, secured all switches and circuit breakers, and helped the passengers to board a boat before boarding another one himself for the trip to

shore.

ENGINE EXAMINATION

According to the responding Federal Aviation Administration (FAA) inspector, the turbine section of the Rolls Royce 250-C30P engine had been recently overhauled, and the engine was returned to service with about 2 hours of operation prior to the incident.The inspector also stated that following the incident, the helicopter was transported to JRB, where an initial examination was performed. He further noted that with power applied from the battery, the engine chip light illuminated, and the chip detector was subsequently found to be caked with carbon and small metal specks. In addition, the starter would not rotate the engine, and the compressor section was difficult to turn by hand, but the turbine section rotated freely. Fuel samples taken at the helicopter's last refueling stop were also found to be clear, free of water and "within specifications."

The engine was subsequently removed from the helicopter and transported to the overhaul facility where it was further examined under NTSB oversight. During the examination, the No. 2 bearing in the compressor section and its corresponding races were found to be damaged, and appeared dry with evidence of high temperatures. The forward side of the bearing cage exhibited significantly more damage than the aft side, with the forward side bearing cage

deformed and the bearing balls on that side appearing rough, with large areas of material loss.

To confirm oil flow, the engine gearbox was attached to an oil supply and the engine oil pump was rotated by a hand drill. Three of the four jets from the oil supply tube (piccolo tube) produced streams of oil; however, the fourth, which normally supplied oil to the aft face of the No. 2 bearing, did not.

Also noted, was that the oil pressure regulator adjustment was found backed out, with the poppet guide observed atypically close to the outer lip of the housing. After removal of the lock wire, unscrewing the poppet guide approximately one turn revealed the presence of the O-ring.

The Rolls Royce report to this accident stated that an initial approximate oil pressure adjustment would have been set by bottoming the poppet guide, then backing it out about 5 ½ turns. Backing out the poppet would decrease system oil pressure, with each turn about 13 psi.

In comparison with an exemplar factory-adjusted poppet guide, the incident poppet guide was observed to be backed out a significant number of additional turns, but the exact number could not be determined since the position of the original setting could also not be determined.

There were no recorded maintenance actions that indicated any adjustment of the poppet guide had occurred. (However, there was a notation, dated November 17, 2013, that the engine turbine section was "removed due to smoke.")

Per the Rolls Royce M250-C30 Series Operation and Maintenance Manual, "CAUTION: EXCEPT FOR INITIAL ADJUSTMENTS ON NEWLY INSTALLED ENGINES, DO NOT ADJUST THE PRESSURE REGULATING VALVE TO CORRECT FOR HIGH OIL PRESSURE. DO NOT MAKE A PRESSURE REGULATING VALVE ADJUSTMENT TO CORRECT FOR A SUDDEN INCREASE OR RAPID CHANGE IN OIL PRESSURE. THESE CONDITIONS ARE CAUSE TO SUSPECT OTHER OIL SYSTEM PROBLEMS HAVE DEVELOPED."

The piccolo tube, No. 2 bearing and several associated parts were retained by the NTSB for further examination.

ADDITIONAL ENGINE EXAMINATION

The engine was subsequently shipped to the manufacturer, and along with the items retained by NTSB, further examined under NTSB and FAA oversight. Due to the complexity of the investigation, examination of individual components and fluids could not be conducted at one time; FAA inspectors provided oversight where applicable, and the final results were published by Rolls Royce and provided to all parties for review.

As confirmed in the Rolls Royce engine investigation report, the No. 2 bearing exhibited signs of thermal distress. The forward side was more distressed than the aft side. All 10 balls had remained in place, and were generally round; however some areas were rough and exhibited loss of material. The material was transferred onto both the inner and outer races.

Metallographic examination revealed thermal distress to the raceway surfaces consistent with the bearing operating with reduced oil flow. Thermal distress extended completely through the ball cross-section and localized spalling damage was evident along the ball surface. The separator showed thermal distress across approximately 75% of the cross-section extending from the forward face aft. A hardness test was not conducted due to the thermal distress of the bearing.

The microstructure and chemistry of the bearing and associated hardware conformed to the

engineering drawing requirements.

Oil Delivery Tube

Visual examination of the oil delivery (piccolo) tube revealed that a dark, thick substance adhered to the face and chamfer. Analysis of the substance determined it was consistent with thermally-degraded MIL-PRF-23699 type turbine oil. The oil jet that lubricated the No. 2 bearing did not show obvious obstruction in the orifice. The oil delivery tube was x-ray inspected for internal blockage with no restrictions detected in any of the oil passageways.

Two flow tests of the oil delivery tube were conducted. As-received, the orifice that lubricated the No. 2 bearing was below the engineering drawing total flow requirement. The tube was cleaned ultrasonically while being submerged in various cleaning solutions (methanol, acetone, isopropanol, and methanol) a total of four times. The amount of debris collected decreased after subsequent cleanings. After cleaning the internal passageway, the total flow of the No. 2 bearing orifice met the engineering drawing requirement during retesting.

Pressure Oil Screen

Nearly the entire surface of the screen was covered in a thick, dark substance. The area that was not blocked was covered by the O-ring. A sample of the substance from the screen assembly was determined to be consistent with thermally degraded MIL-PRF-23699 type turbine oil.

Pinion Bearing Oil Nozzle

The pinion bearing oil nozzle supplied lubrication to the No. 4 and No. 5 bearings. Binocular examination of the three orifices showed no obvious blockages. The oil nozzle was flow-tested two times. Both tests conformed to the engineering drawing requirements.

No. 2 ½ Bearing and Bearing Support Cage

Hard-coked oil deposits were adhered to the surfaces of both components. The bore of the support cage had sheets of a thick-dark substance that were peeled off the surface. A sample of the substance from the bore of the support cage was consistent with thermally degraded MIL-PRF-23699 type turbine oil.

Spur Adapter Gearshaft

The Teflon seal just aft of the forward splines was distorted and appeared partially melted. There were coked oil deposits along the shaft in the area of the No. 2 1/2 bearing inner ring. The inside surface of the gearshaft (forward end) was covered with coked oil.

Pinion Gear, No. 3 Bearing, And No. 4 Bearing

The forward and aft sides of the assembly were dark black in color. The deposits could be partially wiped off with a rag indicating the oil had not completely coked. However, the internal splines did show coked oil deposits.

No. 5 Bearing

The bearing was a brownish color but it appeared free of coked oil deposits. No destructive evaluations of the No. 5 bearing were conducted.

No. 6 and 7 Bearing Pressure Oil Screen

The pressure oil screen assembly that was located in the tee-fitting provided lubrication to the

No. 6 and No. 7 bearings. The screen was clean and unremarkable.

Power Turbine Support Pressure Oil Nozzle

The oil nozzle had a thick-dark substance adhered to the inboard surface similar to the material adhered to the surface of the pressure oil screen.

External Scavenge Oil Sump Assembly

A thick-dark substance similar to the material adhered to the surface of the pressure oil screen assembly was found adhered to the inboard surface of the sump. The substance was determined to be consistent with thermally degraded MIL-PRF-23699 type turbine oil. An oil sample from the sump assembly was also collected. Analysis of the oil sample determined it to be consistent to MIL-PRF-23699 type turbine oil as well.

Gas Producer Support Pressure Oil Fitting Assembly

The gas producer support pressure oil fitting assembly displayed thick-dark substance adhered to the inboard surface. Analysis of the substance determined it to be consistent to thermally degraded MIL-PRF-23699 type turbine oil

Gas Producer Scavenge Oil Drain Fitting

A thick-dark substance similar was adhered to the inboard surface of oil drain fitting. Analysis of the substance determined it to be consistent to thermally degraded MIL-PRF-23699 type turbine oil.

Oil Pressure Regulator Filter Housing

The oil filter was not provided for examination, however the O-ring that seated against the filter remained in the filter bowl. The O-ring showed damage to the outer surface. Visual inspection of the internal cavities of the housing showed no evidence of the thick-dark substance as observed on other engine components described earlier.

The Rolls-Royce Engine Investigation Report with photographs is located in the public docket associated with this investigation.

ADDITIONAL INFORMATION

Oil Flow

According to a Rolls Royce investigator: "At normal engine operating pressures, the volumetric flow rate through the Oil Delivery Tube (piccolo tube) represents roughly 50% of the total engine oil flow. Therefore, any significant blockage of this oil passage would have a correspondingly significant effect on system oil pressure.

Rolls-Royce conducted testing to measure the effect on engine oil system pressure with varying degrees of blockage of the Oil Delivery Tube, simulating a clogged oil filter screen. The testing demonstrated that engine oil pressure was largely unaffected by filter screen blockage up to 55%. However, when testing was conducted with more significant blockage of the oil filter screen, engine oil system pressure increased dramatically.

Testing revealed:

With 90% blockage, engine oil pressure increased approximately 21%.

With 93% blockage, engine oil pressure increased approximately 40%.

Rolls-Royce conducted testing to measure the effect on oil flow rates through an oil filter screen with varying degrees of blockage.

Testing revealed:

With 80% blockage, flow was reduced by 5.87%.

With 90% blockage, flow was reduced by19.39%.

With 93% blockage, flow is reduced by 32.67%.

It should be noted that, in addition to the filter screen blockage, the Oil Delivery Tube itself was also partially blocked, with a measured flow rate approximately 8% below the minimum required flow rate. The cumulative effect of filter screen blockage and Oil Delivery Tube blockage was not tested."

No. 2 Bearing Failures

Per the Rolls Royce investigator: "The C30R/3 (Kiowa Warrior), C40 (Bell 430), C47B (Bell 407) and C47M (MD-600) engines were experiencing unacceptably high failure rates of the #2 bearing. The failure mode was determined to be a thermal runaway, which was addressed by a redesign of the oil supply jet to the bearing. The C30 engine line has not had such failures."

Smoke on Shutdown

The operator reported smoke during previous engine shutdowns. Per the Rolls Royce investigator, "Typically, smoke on shutdown suggests a worn carbon seal on the #5 bearing, but there can be other causes. (especially since this turbine just came from the shop and the #5 [bearing] was removed/inspected and re-installed.) An improperly serviced external oil check valve can allow oil to seep back into the turbine section. Any air/oil seal within the turbine could pass oil if the oil pressure is high enough to overcome the air pressure across the labyrinth seal."

Oil Degradation

From a Rolls Royce oil specialist, "Oil degradation is often a result of thermal (high temperature) and oxidative (oil churning, oxygen) stresses applied to the oil. A degraded oil can affect the bulk chemical/physical properties of the oil, increase the risk of deposit (coke) within the engine, raise the level of insoluble material suspended within the oil and affect the tribological properties of the fluid. Once the thermal/oxidative stability of oil degrades, it is not reversible. Typical properties that suffer during degradation include increased viscosity, high levels of insoluble particles, increased deposition characteristics, higher TAN (acidity) levels, etc." The specialist also noted that visually, it appeared that material could have built up on the screen wires over time, eventually causing blockage, based on the screen pattern in the deposit. Or, perhaps larger slugs of solid debris collected on the screen and were mashed against it due to high oil pressures.

## History of Flight

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| **Enroute-cruise** | Loss of engine power (total) (Defining event) |
| **Emergency descent** | Off-field or emergency landing |

## Pilot Information

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| **Certificate:** | Commercial | **Age:** | 22, Male |
| **Airplane Rating(s):** | None | **Seat Occupied:** | Right |
| **Other Aircraft Rating(s):** | Helicopter | **Restraint Used:** | Seatbelt, Shoulder harness |
| **Instrument Rating(s):** | Helicopter | **Second Pilot Present:** | No |
| **Instructor Rating(s):** | Helicopter | **Toxicology Performed:** | No |
| **Medical Certification:** | Class 2 Without Waivers/Limitations | **Last FAA Medical Exam:** | 07/20/2012 |
| **Occupational Pilot:** | Yes | **Last Flight Review or Equivalent:** | 09/13/2012 |
| **Flight Time:** | 1884 hours (Total, all aircraft), 763 hours (Total, this make and model), 1833 hours (Pilot In Command, all aircraft), 190 hours (Last 90 days, all aircraft), 73 hours (Last 30 days, all aircraft) | | |

## Aircraft and Owner/Operator Information

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| **Aircraft Make:** | BELL HELICOPTER TEXTRON CANADA | **Registration:** | N405MR |
| **Model/Series:** | 206 L-4 | **Aircraft Category:** | Helicopter |
| **Year of Manufacture:** | | **Amateur Built:** | No |
| **Airworthiness Certificate:** | Normal | **Serial Number:** | 52391 |
| **Landing Gear Type:** | Emergency Float; Skid | **Seats:** | 5 |
| **Date/Type of Last Inspection:** | 06/28/2013, 100 Hour | **Certified Max Gross Wt.:** | 4550 lbs |
| **Time Since Last Inspection:** | 2 Hours | **Engines:** | 1 Turbo Shaft |
| **Airframe Total Time:** | 2536 Hours at time of accident | **Engine Manufacturer:** | ROLLS-ROYC |
| **ELT:** | Not installed | **Engine Model/Series:** | 250-C30P |
| **Registered Owner:** | NEW YORK HELICOPTER CHARTER INC | **Rated Power:** | 650 hp |
| **Operator:** | NEW YORK HELICOPTER CHARTER INC | **Operating Certificate(s) Held:** | On-demand Air Taxi (135) |
| **Operator Does Business As:** | | **Operator Designator Code:** | NY9A |

## Meteorological Information and Flight Plan

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| **Conditions at Accident Site:** | Visual Conditions | **Condition of Light:** | Day |
| **Observation Facility, Elevation:** | LGA, 21 ft msl | **Distance from Accident Site:** | 5 Nautical Miles |
| **Observation Time:** | 1151 EDT | **Direction from Accident Site:** | 90° |
| **Lowest Cloud Condition:** | Few / 2300 ft agl | **Visibility** | 10 Miles |
| **Lowest Ceiling:** | Broken / 3400 ft agl | **Visibility (RVR):** | |
| **Wind Speed/Gusts:** | 6 knots / | **Turbulence Type Forecast/Actual:** | / None |
| **Wind Direction:** | Variable | **Turbulence Severity Forecast/Actual:** | / N/A |
| **Altimeter Setting:** | 29.81 inches Hg | **Temperature/Dew Point:** | 29°C / 21°C |
| **Precipitation and Obscuration:** | No Obscuration; No Precipitation | | |
| **Departure Point:** | New York, NY (JRB) | **Type of Flight Plan Filed:** | VFR |
| **Destination:** | New York, NY (JRB) | **Type of Clearance:** | VFR |
| **Departure Time:** | 1140 EDT | **Type of Airspace:** | Class B |

## Wreckage and Impact Information

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| **Crew Injuries:** | 1 None | **Aircraft Damage:** | Minor |
| **Passenger Injuries:** | 4 None | **Aircraft Fire:** | None |
| **Ground Injuries:** | N/A | **Aircraft Explosion:** | None |
| **Total Injuries:** | 5 None | **Latitude, Longitude:** | 40.785000, -73.988056 (est) |

## Administrative Information

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| **Investigator In Charge (IIC):** | Paul R Cox | **Report Date:** | 04/20/2016 |
| **Additional Participating Persons:** | Marc Cabibbo; FAA/FSDO; Farmingdale, NY<br>Casey Lehman; Rolls Royce Corp; Indianapolis, IN<br>Timothy Walsh; Keystone Turbine Services; Coatesville, PA<br>Michael Roth; New York Helicopter Charter; New York City, NY | | |
| **Publish Date:** | 04/20/2016 | | |
| **Note:** | The NTSB did not travel to the scene of this incident. | | |
| **Investigation Docket:** | http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=87366 | | |