Aviation Investigation Final Report

Location:	Anaconda, Montana	**Accident Number:**	WPR24FA132
Date & Time:	April 26, 2024, 06:59 Local	**Registration:**	N988B
Aircraft:	Bell 206-L4	**Aircraft Damage:**	Destroyed
Defining Event:	Loss of engine power (total)	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 133: Rotorcraft ext. load		

Analysis

The pilot of the helicopter was performing aerial application operations. Security video showed the helicopter approach the loading truck for a third load of fertilizer and complete an onload of fertilizer before departing. The helicopter reached about 150 ft above ground level (agl) and 40 kts groundspeed when it rotated about 180° to the left and descended, consistent with an emergency autorotation. The helicopter impacted an area of flat terrain in a mostly level attitude. Examination of the wreckage revealed no anomalies with the airframe or flight controls that would have precluded normal operation.

Examination of the engine revealed that the gas producer turbine rotor did not turn when the N1 rotor was rotated. The N2 rotor was continuous from the 4th-stage power turbine rotor to the output driveshaft, but an audible rubbing or scraping sound was heard when it was rotated. The engine was disassembled and the turbine-to-compressor coupling shaft was found fractured into three pieces. Coking was observed in the forward and aft spline locations of the turbine-to-compressor coupling shaft and between the turbine-to-compressor coupling shaft and the power turbine outer shaft. Extensive coking was noted upon removal of the power-turbine-to-pinion-gear coupling shaft. The two O-rings of the spur adapter gearshaft, which manage oil distribution in the turbine-to-compressor coupling shaft, were not present in their designated grooves.

Coked material was found that restricted oil flow in one orifice of the piccolo tube and blocked a second orifice of the oil jet to the No. 3 bearing. Analysis of the coked material revealed fluorocarbon rubber signatures consistent with O-ring material. The engine manufacturer stated they were not aware of any previous instances of O-rings disintegrating. The initiating event for the disintegration of the O-rings could not be determined.

Maintenance records indicated that the spur adapter gearshaft, where the O-rings would normally be located, was last accessible when the engine was overhauled about 5 years (1,414.1 flight hours) before the accident. According to the engine manufacturer, a damaged or wrong part number O-ring (or a missing O-ring) may allow cooling oil flow to leak back into the gearbox rather than flow between the concentric shafts. The reduced oil flow between the shafts is not sufficient to cool the shafting below oil carboning temperatures, as evidenced by the finding of coked carbon material in the area of the fractured compressor coupling shaft. Carbon deposits on the outside diameter of the turbine-to-compressor coupling and the inside diameter of the power turbine inner shaft and turbine-to-compressor coupling can build up until rub occurs, causing interference between the shafts, resulting in frictional heating and ultimate failure, which subsequently resulted in a total loss of engine power.

It is likely that the carbon buildup in the piccolo tube screen and nozzles reduced cooling oil flow to the turbine-to-compressor coupling and the turbine inner shaft that caused the shafts to operate at a higher temperature than the carboning limits of the oil, allowing coke to build up between the shafts. The reason for the carbon accumulation in the piccolo tube screen and nozzles was not determined.

The helicopter's Height-Velocity performance chart indicated that, in general, pilots should avoid operations below 600 ft agl and below 65 kts, when above 4,150 lbs gross weight, and 500 ft agl and below 45 kts when below 4,150 lbs gross weight. Operations within these parameters reduce the likelihood of completing a successful autorotation. Practice 180° autorotations are not recommended below 700 ft agl. Given the helicopter's altitude and speed at the time of the engine power loss, the pilot likely had insufficient altitude from which to establish an autorotation and perform a successful landing following the loss of power.

The pilot's toxicology results indicate he had used the sedating antihistamine medication diphenhydramine. Although caution must be used interpreting the diphenhydramine level measured in postmortem subclavian blood, the level indicates a reasonable probability that the pilot was experiencing some associated sedation or psychomotor impairment at the time of the accident. However, given the lack of clear evidence for any deficiency of the pilot's preflight or inflight performance, and the altitude at which the sudden total loss of engine power occurred, it is unlikely that the pilot's use of sedating antihistamine medication contributed to the accident.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

A total loss of engine power due to a loss of cooling oil to the turbine-to-compressor coupling shaft and subsequent fracture of the shaft at an altitude too low for the pilot to complete a

successful autorotation. Contributing to the accident was carbon buildup in the piccolo tube screen and nozzles and the disintegration of the spur adapter gearshaft O-rings for reasons that could not be determined.

Findings

Aircraft	(general) - Unknown/Not determined
Aircraft	Oil system - Unknown/Not determined
Aircraft	Turbine section - Failure
Aircraft	Altitude - Attain/maintain not possible

Factual Information

History of Flight

Prior to flight	Unknown or undetermined
Initial climb	Loss of engine power (total) (Defining event)
Autorotation	Off-field or emergency landing
Autorotation	Hard landing

On April 26, 2024, at 0659 mountain daylight time, a Bell 206-L4 helicopter, N988B, was destroyed when it was involved in an accident near Anaconda, Montana. The pilot was fatally injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 137 aerial application flight.

The pilot had been conducting flights to distribute fertilizer from the same staging location for several days. The staging area was surrounded by hilly terrain. An employee of the operator, who was performing ground support duties, met the pilot at their base at Deer Lodge-City-Municipal Airport (38S), Deer Lodge, Montana, about 0545 on the day of the accident. The employee then drove a support vehicle to the staging area about 1 mile southeast of Anaconda, Montana.

Onboard GPS data showed that the helicopter departed 38S about 0613 and proceeded to overfly the intended application area before proceeding to the staging area. Security camera video, taken from cameras located about 0.5 miles north of the staging area, captured the helicopter arriving and landing at the staging area at 0633. The pilot and ground crewmember then conducted a safety briefing with a customer representative. According to the representative, the wind was calm during the briefing and remained calm for several hours that morning.

After the briefing, the helicopter lifted off at 0643 and maneuvered over the load truck. The helicopter departed the staging area with the first load of fertilizer about 0644, flew to the west and exited the view of the security camera. The helicopter re-entered the camera's field of view from the west, flew past the south side of the staging area, and turned to a northwest heading as it approached the load truck before completing a second onload of fertilizer. The helicopter departed the staging area the second time about 0650, flew out of the field of view to the west, and returned into view from the west at 0656.

The helicopter approached the load truck a third time heading to the northwest, flying an approach similar to the previous approach. The helicopter appeared to hover over or near the load truck for 2 to 3 seconds, then turned and flew away in an easterly direction. The helicopter

reapproached the load truck and completed a third onload of fertilizer. The helicopter then departed and climbed to the west. The helicopter reached about 150 ft above the ground and 40 kts groundspeed when the helicopter rotated about 180° to the left and descended rapidly until it went out of view of the security camera behind terrain. There were no known witnesses to the accident sequence.

The ground crewmember, who was in regular communication with the pilot, attempted to contact the pilot via radio when he did not return when expected; however, he received no response. The customer representative was conducting other work duties from his truck, which was positioned southwest of the load truck. He also thought it strange that he hadn't heard the helicopter for a while and drove to a different location to observe the area. During the drive, he saw the helicopter in a nearby gully. He drove back to pick up the ground crew member, responded to the accident site, and initiated an emergency call to 911.

Pilot Information

Certificate:	Commercial	**Age:**	28,Male
Airplane Rating(s):	None	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	Unknown
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 None	**Last FAA Medical Exam:**	March 20, 2024
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	January 10, 2023
Flight Time:	4185 hours (Total, all aircraft), 1658 hours (Total, this make and model), 4185 hours (Pilot In Command, all aircraft), 7 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	**Registration:**	N988B
Model/Series:	206-L4	**Aircraft Category:**	Helicopter
Year of Manufacture:	2005	**Amateur Built:**	
Airworthiness Certificate:	Normal; Restricted (Special)	**Serial Number:**	52304
Landing Gear Type:	High skid	**Seats:**	7
Date/Type of Last Inspection:	February 10, 2024 100 hour	**Certified Max Gross Wt.:**	4550 lbs
Time Since Last Inspection:	49.2 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	5888.1 Hrs at time of accident	**Engine Manufacturer:**	ROLLS-ROYCE
ELT:	Installed	**Engine Model/Series:**	250-C30P
Registered Owner:	HELI WORKS FLIGHT SERVICES LLC	**Rated Power:**	420 Horsepower
Operator:	HELI WORKS FLIGHT SERVICES LLC	**Operating Certificate(s) Held:**	Rotorcraft external load (133), Agricultural aircraft (137)

The helicopter was equipped with a bubble window, which was installed on the left door. The pilot was operating the helicopter from the left seat position. A spreader was suspended beneath the helicopter using a 25-ft long line attached to a load hook installed on the belly of the helicopter. The pilot could open the load hook and release the load in flight in the event of an emergency.

A review of the engine logbooks revealed that the spur adapter gearshaft was last accessible when the engine was overhauled in March, 2019, at an engine total time of 6,328.1 hours, which was 1,414.1 hours before the accident.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KBTM,5505 ft msl	**Distance from Accident Site:**	20 Nautical Miles
Observation Time:	07:53 Local	**Direction from Accident Site:**	118°
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:	Broken / 6000 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.76 inches Hg	**Temperature/Dew Point:**	5°C / 1°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Anaconda, MT	**Type of Flight Plan Filed:**	None
Destination:	Anaconda, MT	**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	46.116655,-112.9266(est)

Examination of the accident site revealed that the helicopter came to rest in a mostly upright position immediately adjacent to a flat and dry pond area in a gully about 855 ft southwest of the load truck (see figure 1).The fuselage came to rest oriented on a heading of about 060°. The bottom of the fuselage exhibited crushing deformation and the left skid was splayed outward. One main rotor blade was fracture-separated about 3 ft from the rotor attachment point just outboard of the blade doubler and the fracture surfaces exhibited downward deformation. The remainder of the blade was located about 15 ft forward of the helicopter. The second rotor blade remained attached to the rotor mast and exhibited some bending opposite of rotation. The spreader and 25-ft long line were located about 30 ft aft of the helicopter and were not attached to the helicopter, consistent with separation prior to impact. The long-line attachment shackle was unmarred and showed no visible damage. Fuel was observed leaking from the wreckage following the accident.

Figure 1. Helicopter Wreckage

The wreckage was recovered to a secure location and examined. All cockpit flight controls were present. The left collective was completely fractured at the elbow. The cyclic yoke was fractured in two places. Both cyclics displayed control continuity to the yoke. The collective levers displayed continuity to the elbow break on the left collective. All control tubes in the control closet displayed fractures consistent with overload. Cyclic and collective control continuity was established (with breaks) to the hydraulic actuators. Tail rotor continuity was established throughout, with breaks consistent with overload. No anomalies were noted with the airframe or flight controls that would have precluded normal operation.

The engine was displaced vertically within the engine compartment, with all engine mount struts exhibiting varying degrees of damage. All but two of the mount struts were found fractured. Cockpit control continuity was not continuous from the collective lever and throttle twist grip through the respective linkages to the power turbine governor and fuel control unit due to impact damage. The pilot throttle was observed in the ground idle position and was immovable. The throttle control linkage, push-pull tubes, and bellcranks in the engine bay were continuous to the fuel control unit (FCU) input control lever. The FCU pointer indicator was positioned at 0° (OFF).

Clean, clear liquid consistent with Jet A fuel was observed from the airframe fuel filter to the engine fuel pump, FCU, and fuel spray nozzle.

The N1 rotor was continuous from the compressor impeller, engine gearbox, starter generator, fuel pump, and FCU. The gas producer turbine rotor did not turn when the N1 rotor was rotated. The N2 rotor was continuous from the 4th-stage power turbine rotor to the output driveshaft, but an audible rubbing or scraping sound was heard when it was rotated.

The engine was removed from the wreckage and transported to a manufacturer facility for further examination. The engine was disassembled and the spur adapter gearshaft (SAG) O-rings were not present in either the forward or aft O-ring grooves during engine disassembly (see figure 2).

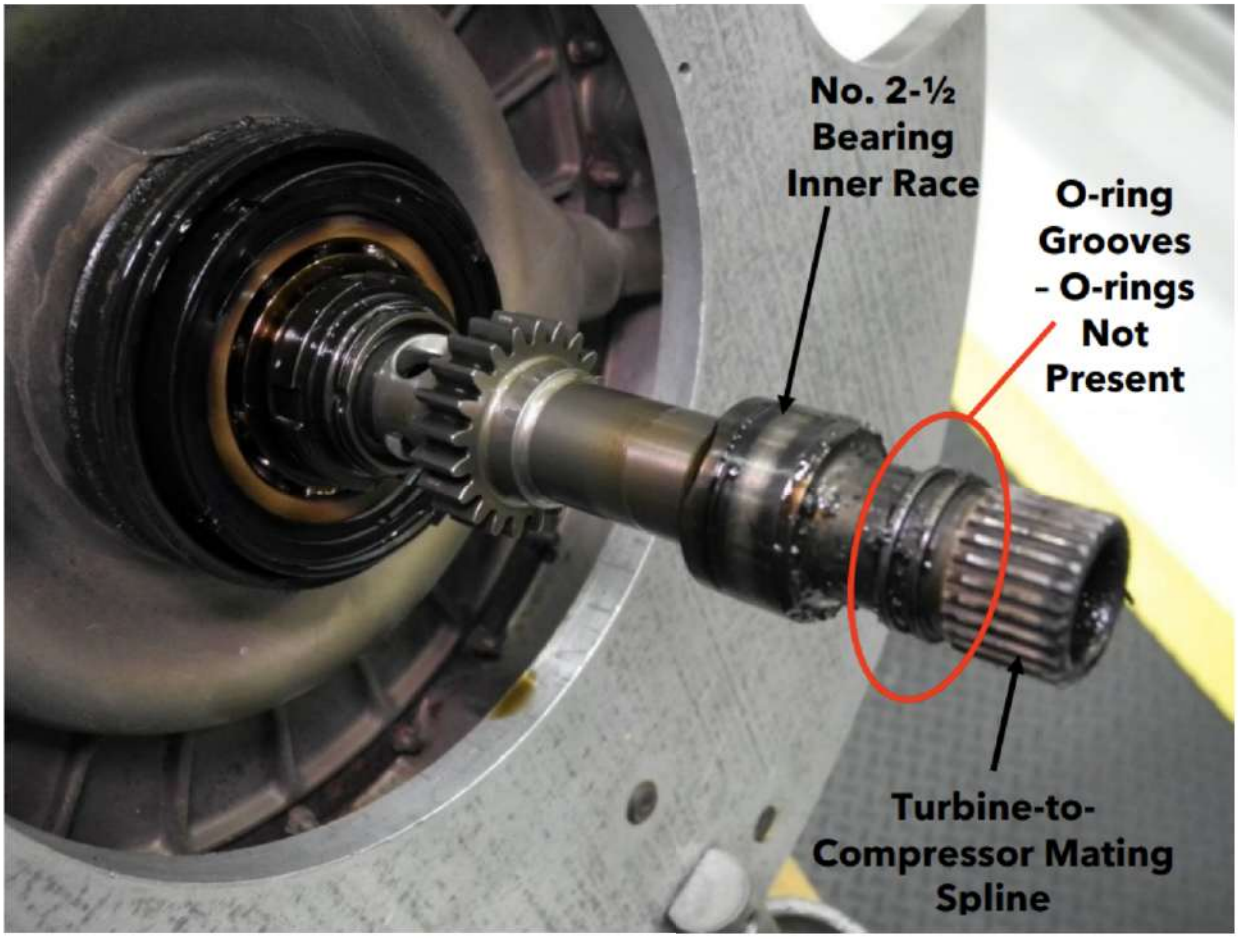

Figure 2. Spur Adapter Gearshaft

The turbine-to-compressor coupling shaft was found fractured into three pieces as shown in figure 3.

Figure 3. Turbine-to-compressor coupling shaft fractured. Photo courtesy Rolls-Royce.

Heavy coking was observed in the forward and aft spline locations of the turbine-to-compressor coupling shaft. Coking was noted between the coupling shaft and the power turbine outer shaft. Extensive coking was noted upon removal of the power-turbine-to-pinion-gear coupling shaft. No evidence of coked oil was observed in the aft O-ring groove. Analysis of the coked material revealed fluorocarbon rubber signatures consistent with O-ring material. A computer tomography (CT) scan of the piccolo tube revealed coked material sufficient to restrict oil flow in one orifice and block the other orifice of the oil jet to the No. 3 bearing (see figure 4).

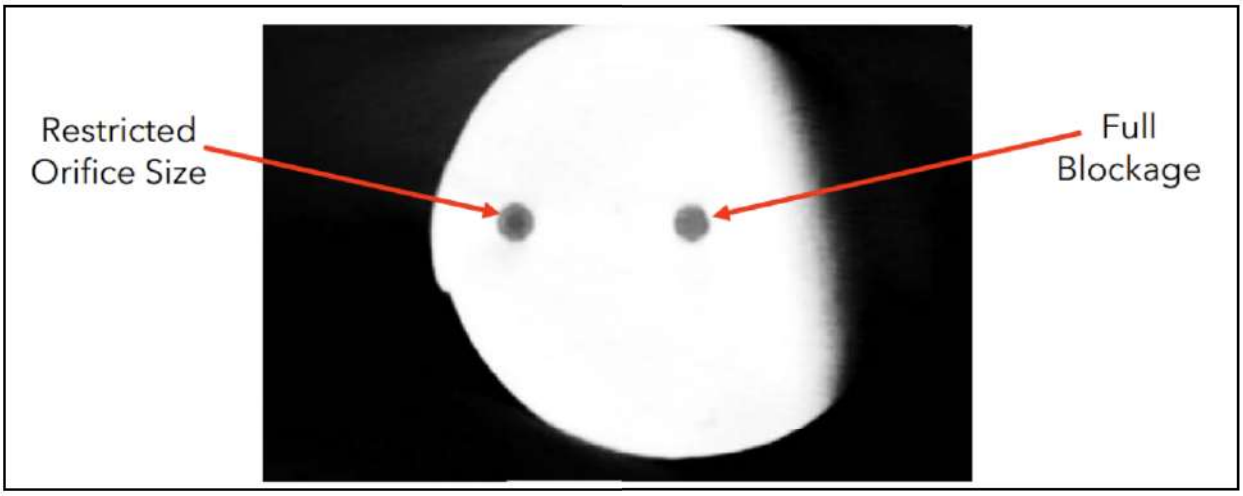

Figure 4. Restricted oil jet orifices in piccolo tube. Photo courtesy Rolls-Royce.

Medical and Pathological Information

The State of Montana, Department of Justice, Forensic Science Division performed the pilot's autopsy. According to the pilot's autopsy report, his cause of death was multiple blunt force injuries.

The FAA Forensic Sciences Laboratory performed toxicological testing of postmortem specimens from the pilot. Diphenhydramine was detected at 118 ng/mL in subclavian blood and at 675 ng/mL in urine. Acetaminophen was detected in heart blood and urine.

Diphenhydramine is a sedating antihistamine medication widely available over the counter in multiple sleep aids and cold and allergy products. Diphenhydramine can cause cognitive and psychomotor slowing and drowsiness, and often carries a warning about driving and operating machinery. In one driving simulator study, a single dose of diphenhydramine impaired driving ability more than a blood alcohol level of 0.1 g/dL. The FAA states that pilots should not fly within 60 hours of using diphenhydramine, to allow time for it to be cleared from circulation.

Additional Information

Allison Engines Commercial Engine Bulletin (CEB) A-72-3108, Rev. 3, September 15, 1985, states:

Leakage through the spur adapter gearshaft & turbine-to-compressor coupling joint reduces oil flow available for turbine shafting lubrication and cooling. When the O-ring between these two shafts seal properly, sufficient oil flows through the concentric gap between the gas producer and power turbine shafts to keep the shafting temperature below the carboning temperature of the oil. However, a damaged or wrong part number O-ring may allow a significant portion of the cooling oil flow to leak back into the gearbox rather than flow between the concentric shafts. The reduced oil flow between the shafts is NOT SUFFICIENT to cool the shafting below oil carboning temperatures. Carbon deposits on the outside diameter of the turbine-to-compressor coupling and the inside diameter of the power turbine inner shaft and turbine-to-compressor coupling can build up until rub occurs. Continued rub could cause coupling or shaft failure.

The engine maintenance manual current when the engine was last overhauled in March, 2019, contained the following within the procedures to install the turbine assembly:

CAUTION – Failure to replace the missing or damaged forward and aft spur adapter gearshaft seal ring and packing can cause too much carbon build-up and can cause sudden engine stoppage.

According to the FAA Rotorcraft Flying Handbook, when performing a turning autorotation the pilot should, "Establish the aircraft on downwind at recommended airspeed at 700 feet AGL [above ground level], parallel to the touchdown area."

FAA pamphlet P-8740-71, Planning Autorotations, states, "Use a minimum altitude of 700 feet AGL with an entry point on the downwind leg abeam the touchdown point for a 180° autorotation."

The helicopter's Height-Velocity performance chart indicated that, in general, pilots should avoid operations below 600 ft agl and below 65 knots, when above 4,150 lbs gross weight, and 500 ft agl and below 45 knots when below 4,150 lbs.

Administrative Information

Investigator In Charge (IIC):	Baker, Daniel
Additional Participating Persons:	Nick Shepler; Rolls-Royce; Indianapolis, IN Tracy Brendal; FAA; Helena, MT
Original Publish Date:	April 3, 2026
Last Revision Date:	
Investigation Class:	Class 3
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=194154