Aviation Investigation Final Report

Location:	Reedsville, Wisconsin	**Accident Number:**	CEN16FA171
Date & Time:	May 4, 2016, 10:02 Local	**Registration:**	N629JK
Aircraft:	McDonnell Douglas Helicopter 369E	**Aircraft Damage:**	Substantial
Defining Event:	Loss of engine power (total)	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 133: Rotorcraft ext. load		

Analysis

The helicopter was being used to transport personnel and equipment in support of a power line construction project. The helicopter departed the landing zone (LZ) and transported two linemen from one power line tower to another using a 50 ft long line. When the linemen detached from the long line, the helicopter proceeded to the east where it hovered for 2 to 3 minutes. The linemen requested that the helicopter return to the tower to pick up equipment and then return to the LZ. The helicopter approached the tower, and, when the long line was nearing their reach, the linemen noticed the helicopter's sound change, and it descended suddenly. The helicopter veered to the right away from the tower, and the main rotor blades slowed noticeably as the helicopter descended into the trees and impacted terrain. The linemen climbed down from the tower and heard the helicopter's engine still producing noise, so one of them pulled the emergency fuel shutoff valve and turned the battery off.

A postaccident examination of the helicopter revealed damage to the main rotor blades and main rotor hub consistent with sudden stoppage at low rotor rpm. The tail rotor exhibited damage consistent with no rotation during impact. The engine was removed from the airframe and connected to an engine test stand for a functional test, but it would not start after several attempts. The power turbine governor (PTG) was removed, and its main drive shaft was found fractured. The original PTG was replaced with a new PTG. With the new PTG installed, the engine started normally, produced rated horsepower, and met production test specifications with no anomalies noted.

Examination of the PTG revealed that a portion of the drive shaft remained embedded in the spindle of the spool bearing assembly. The fracture surface features of the shaft were consistent with overstress. The internal elements of the spool bearing assembly were seized and would not rotate. The ball bearings and spacers were found coated with voluminous, powdery, black particulate consistent with oxidized metallic wear debris, and no grease was observed. The ball retainers were fragmented, the inner surfaces were found coated with a powdery, black particulate consistent with oxidized metallic wear debris, and no grease was observed. The inner bearing surfaces were rough and frosted, consistent with three-body

abrasive wear. The examination indicated that the fractured PTG drive shaft was the result of a spool bearing that seized due to a lack of lubrication.

In 2008, a service bulletin (SB) and commercial engine bulletin (CEB) were issued by PTG and engine manufacturers, respectively, that called for replacement of the dual-spool bearing, the type installed in the accident PTG, with a single-spool bearing. The dual-spool bearing had experienced 23 previous failures that had led to either engine oscillations, uncommanded engine acceleration, or a loss of engine power. Although the SB and CEB called for replacement of the accident PTG's dual-spool bearing not later than 750 hours after the PTG was installed new, the accident PTG had accumulated 1,048.7 hours since new when the accident occurred, and the SB and CEB had not been completed. As stated in the operator's Federal Aviation Administration (FAA) approved operations specifications, the operator was required to comply with FAA Airworthiness Directives but was not required to comply with manufacturer's service bulletins. It is likely that had the SB and CEB been completed, the PTG would not have failed and the engine would not have lost power.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The failure of the power turbine governor's dual-spool bearing due to a lack of lubrication, which resulted in a complete loss of engine power and subsequent impact with terrain.

Findings

Aircraft	Turbine governor - Failure
Aircraft	Turbine governor - Not serviced/maintained

Factual Information

History of Flight

Maneuvering-hover	Loss of engine power (total) (Defining event)
Maneuvering-hover	Powerplant sys/comp malf/fail

On May 4, 2016, at 1002 central daylight time, an MD Helicopters 369E helicopter, N629JK, impacted trees and terrain near Reedsville, Wisconsin. The commercial-rated pilot, who was the sole occupant, was fatally injured, and the helicopter sustained substantial damage. The helicopter was registered to Padgett Ag Air, LLC, Pawleys Island, South Carolina, and operated by Rotor Blade, LLC Georgetown, South Carolina, under the provisions of 14 Code of Federal Regulations (CFR) Part 133 as an external load operation. Visual meteorological conditions prevailed at the time of the accident, and no flight plan was filed. The flight departed from the Manitowoc County Airport (MTW), Manitowoc, Wisconsin, about 0730.

The helicopter was being used to transport personnel and equipment in support of a power line construction project to replace a shield wire with a fiber optic cable. The project began on March 10, 2016, with a basic helicopter and landing zone (LZ) safety course provided by Rotor Blade for the construction employees. The project had continued without interruption except for weather delays. On the morning of the accident, the helicopter arrived at the LZ about 0800. Two job briefings were conducted, and the helicopter was to transport linemen, equipment, and materials to various power line tower structures that were about 125 ft tall using a 50 ft long line attached to the cargo hook. The helicopter flew from 0842 to 0906 and then returned to the LZ.

At 0949, the helicopter departed the LZ and transported two linemen from tower 9903 to the neighboring tower, 9904 (figure 1). When the linemen detached from the long line, the helicopter proceeded to the east and hovered for 2 to 3 minutes. The linemen requested that the helicopter come back to tower 9904 to pick up equipment and return to the LZ. The helicopter approached the tower from the southwest and faced northeast into the wind as the linemen presented hand signals to the pilot. The linemen stated that the end of the long line was about 20 ft laterally and 15 ft vertically from their reach when they noticed the helicopter's sound change and it descended suddenly. The helicopter veered to the right away from the tower, and the main rotor blades slowed noticeably. The helicopter continued into the trees and terrain south of the tower. The linemen climbed down from the tower and heard the helicopter's engine still producing noise. One lineman pulled the emergency fuel shutoff valve and turned off the battery.

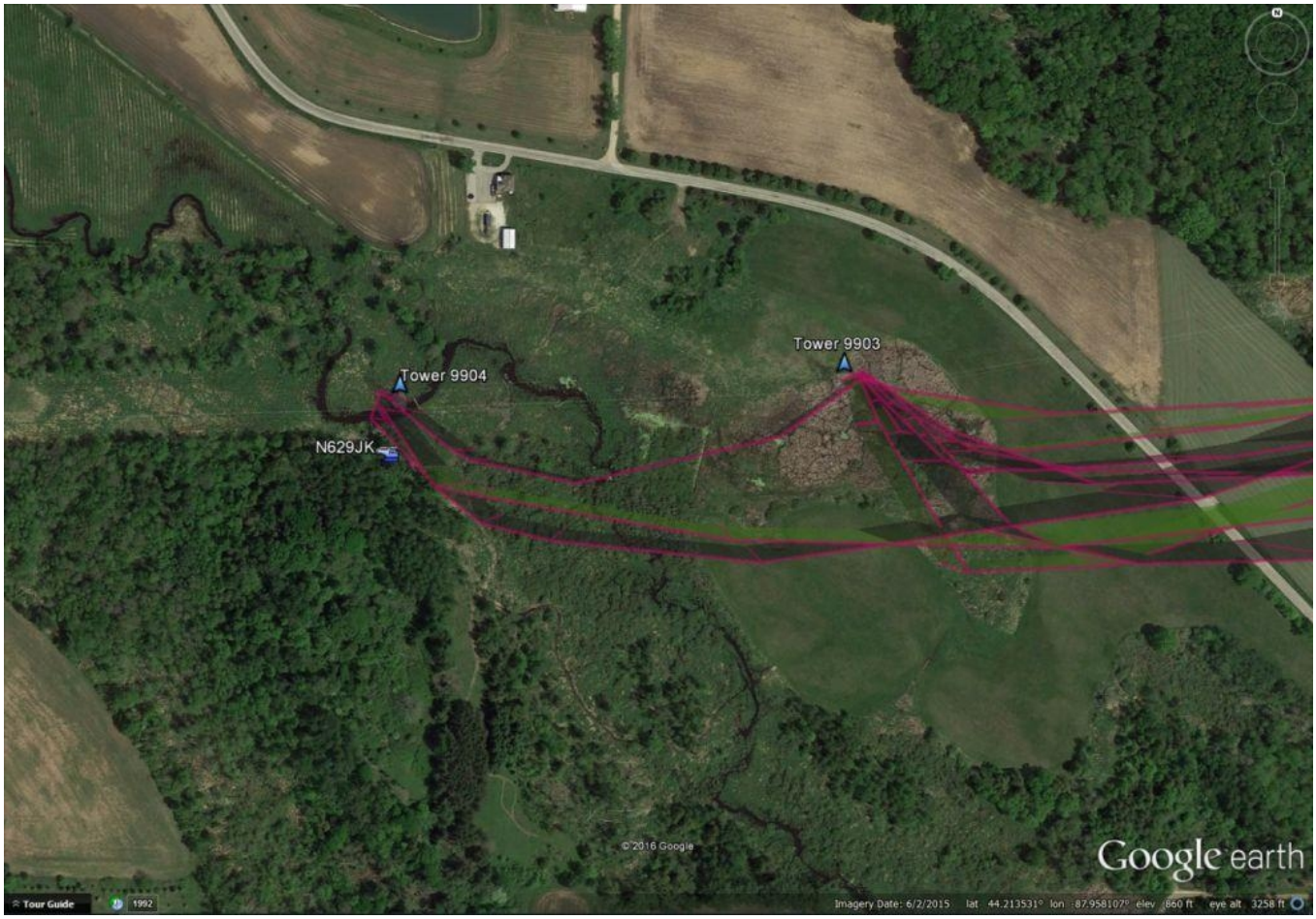

Figure 1 – Google Earth overview of the accident area with GPS track downloaded from Garmin 496 onboard helicopter

Two other project employees were about 150 yards north of tower 9904 (figure 2); they stated that, as the helicopter approached tower 9904 for the final time, the main rotor blades slowed down, the engine sound decreased, and the helicopter veered right toward the ground.

Figure 2 – View from project employee witness location, facing south toward tower 9904

Pilot Information

Certificate:	Commercial	**Age:**	61,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	April 14, 2016
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 20678 hours (Total, all aircraft), 70 hours (Last 90 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

The pilot's logbooks were not found during the course of the investigation. Company flight log

reports revealed that the pilot flew the accident helicopter from March 8 to May 3, 2016, for a total of 67 hours. The pilot also flew the accident helicopter for an estimated 2.5 hours on the morning of the accident.

Aircraft and Owner/Operator Information

Aircraft Make:	McDonnell Douglas Helicopter	**Registration:**	N629JK
Model/Series:	369E	**Aircraft Category:**	Helicopter
Year of Manufacture:	1999	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	0542E
Landing Gear Type:	Skid	**Seats:**	
Date/Type of Last Inspection:	April 6, 2016 Continuous airworthiness	**Certified Max Gross Wt.:**	3000 lbs
Time Since Last Inspection:	51 Hrs	**Engines:**	Turbo shaft
Airframe Total Time:	7688.4 Hrs at time of accident	**Engine Manufacturer:**	Rolls Royce
ELT:	Installed, activated, did not aid in locating accident	**Engine Model/Series:**	M250-C20B
Registered Owner:	PADGETT AG AIR LLC	**Rated Power:**	420 Horsepower
Operator:	Rotor Blade LLC	**Operating Certificate(s) Held:**	Rotorcraft external load (133)

The MD 369E features a fully articulated five-bladed main rotor system with anti-torque provided by a four-bladed semi-rigid tail rotor. The helicopter was configured to be flown from the left pilot seat (figure 3).

Figure 3 – Preaccident photograph of the helicopter

The helicopter had accumulated 7,688.4 hours total time (TT) at the time of the accident. A review of the maintenance records revealed an annual inspection was completed on December 4, 2015, at 7,522.6 hours TT. At the time of the accident, the engine, a Roll-Royce 250-C20B, had accumulated 1,048.7 hours TT since new. On April 3, 2016, at 987.4 hours engine TT, a 150-hour engine inspection was completed, and a fuel control tube was replaced. Also replaced during the maintenance work were the engine combustion case, combustion liner, and engine bleed valve due to a power transient over-temperature of 850°C for 2 seconds.

On April 16, 2016, an inoperative power turbine speed (N2) dual tachometer was replaced. On April 26, 2016, a video was taken of the dual tachometer as the helicopter was in flight, and it showed that the dual tachometer indicated about 475 rotor rpm and about 60% N2 rpm. The Rotor Blade ground crewman who took the video stated that the pilot wanted him to send the video to a Rotor Blade mechanic to show him that there was still an issue with the dual tachometer. The Rotor Blade mechanic stated that he watched the video, but it was not sent directly to him. He stated that he told the pilot not to

fly the helicopter if there was a problem. The mechanic and the pilot discussed that it was likely only an indicating issue.

The engine was installed new on the helicopter on November 21, 2007. The engine's accessories, including power turbine governor (PTG) model AL-AA2, part number 2549170-1, serial number HR48214, were installed new with 0.0 hours TT. No records indicated any maintenance completed on the PTG after initial installation. The records revealed that all applicable Federal Aviation Administration (FAA) Airworthiness Directives had been completed.

Weight and balance calculations for the helicopter revealed that the center of gravity was within limits, the gross weight at the time of the accident was 2,097 lbs, and the maximum gross weight was 3,550 lbs.

The operator was authorized by the FAA to conduct class A, B, and C external load operations. The helicopter was equipped with an Onboard Systems hydraulic hook kit and Rotor Blade, LLC, H500 side hook assembly.

On May 3, 2016, the company fuel truck was fueled with 211.3 gallons of Jet-A at MTW. The fuel logs revealed that, before the 0800 departure from the LZ, the helicopter was refueled at the fuel truck and departed with 260 lbs of fuel. Before the final departure at 0949, the helicopter was refueled and departed with 240 lbs (35.29 gallons) of fuel, which was estimated to provide 1 hour 10 minutes of flight time.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KMTW,651 ft msl	**Distance from Accident Site:**	13 Nautical Miles
Observation Time:	09:56 Local	**Direction from Accident Site:**	110°
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:	Overcast / 2600 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	22 knots / 32 knots	**Turbulence Type Forecast/Actual:**	/ Unknown
Wind Direction:	340°	**Turbulence Severity Forecast/Actual:**	/ Unknown
Altimeter Setting:	29.77 inches Hg	**Temperature/Dew Point:**	8°C / 2°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Reedsville, WI	**Type of Flight Plan Filed:**	None
Destination:	Reedsville, WI	**Type of Clearance:**	None
Departure Time:	09:49 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	44.213333,-87.960281

The helicopter came to rest in a wooded area about 125 ft south of tower 9904 (figure 4/5). The surrounding trees were 50 to 75 ft tall, and several of them were broken or showed signs of recent scaring and damage, consistent with the helicopter's impact sequence. All of the major components of the helicopter were found at the accident site. The long line remained attached to the cargo hook and trailed north toward the tower. There was an odor of Jet-A fuel around the main wreckage, and fuel was observed leaking from the helicopter. On-scene documentation was completed, and the wreckage was recovered to a secure examination facility.

Figure 4 – The accident helicopter surrounded by trees

Figure 5 – Front view of accident helicopter damage

On May 5, 2016, a postaccident examination of the wreckage was completed by the investigation team. The main transmission and its mounting revealed no exterior impact damage. The transmission fluid level was verified full using the sight glass. The upper and lower transmission chip detectors were removed and were clear of debris. The gearbox was rotated by hand and exhibited movement to indicate that the transmission internal gearing and the main rotor drive shaft were continuous. The engine drive shaft remained connected at both ends and appeared undamaged. Drive continuity from the engine to the main rotor and tail rotor output pinion was verified. The overrunning clutch was found to be functional.

All five main rotor blades remained attached to the hub and were cut or removed during the examination. The blades exhibited impact damage with minimal signatures of preimpact rotation.

The aft section of the tail boom was fractured and remained attached by the electrical conduit and wiring. The forward section of the tail boom remained attached to the fuselage. There was no evidence of a main rotor blade strike to the tail boom. The tail rotor gearbox and tail rotor swashplate operated smoothly when rotated by hand. The tail rotor gearbox chip detector was clear of debris. The tail rotor blades were manipulated by hand, and the control linkages and mechanisms responded appropriately. The right horizontal stabilizer was crushed inward.

Lateral cyclic control continuity was established through the main rotor head. Longitudinal cyclic control continuity was established to the fractures in the interconnecting torque tube and one-way lock attachment. Beyond the fractures, control continuity was established to the rotor head. The trim actuators were near center position. The actuators could not be electrically tested due to circuit breaker damage. The trim actuators were removed, and the actuators measured between mounting centers. Collective control continuity was established through the main rotor head. Anti-torque control continuity was established from the upper control column bellcrank to the control mechanism fractures under the cockpit floor and back to the fracture in the tail rotor control tube. All breaks in control continuity were consistent with impact damage.

The instrument console and slant panel were still in place but sustained damage primarily on the right side of the slant panel that housed the circuit breaker panel. Although several circuit breaker housings were cracked and some circuit breakers did not appear to reset properly, battery power was applied to evaluate the caution/warning panel lights. The caution/warning lights were functionally tested and illuminated when the push-to-test button was depressed. The engine out warning functioned normally. The trim motors and N2 beep did not function due to impact damage.

An engine fuel vacuum check was performed and revealed a slow leak on the engine side; the system held vacuum on the airframe side. No vacuum check isolation procedure was performed on the engine side since the engine was removed for additional examination. The fuel start pump inlets and the fuel tank sump area were found clean and unobstructed. Fuel was noted within the fuel pump inlet port and at the fuel nozzle. The fuel sender electrical wire was verified to be wrapped around the fuel line preventing interference with the fuel gauge sending unit. About 6 gallons of fuel were drained from the fuel tank sump. The fuel appeared clean with no contaminants observed. The low fuel warning light was functional.

The engine and accessories exhibited minimal external damage, and the engine mounts appeared undamaged. All pneumatic, oil, and fuel lines displayed no damage or evidence of leakage, and all "B" nut connectors were at least finger tight. The compressor inlet and visible stages of blades and vanes revealed no evidence of foreign object debris damage. Upon removal of the engine from the airframe, manual rotation of the gas generator drive train revealed that it was rotationally free and continuous from the starter generator pad to the compressor. Manual rotation of the power turbine drive train revealed that it to be free and continuous from the power take off gear to the stage four turbine wheel. The upper and lower engine chip detectors were clear of debris.

Medical and Pathological Information

Manitowoc County Coroner's Office, Fond du Lac, Wisconsin, completed an autopsy on the pilot, and the cause of death was blunt force trauma to the head and chest. The pilot was wearing an MSA LH250 flight helmet during the accident. The Bioaeronautical Research Laboratory at the FAA's Civil Aerospace Medical Institute conducted toxicology testing, which revealed the presence of amlodipine and atorvastatin and was negative for other substances.

Amlodipine (brand name Norvasc) is a prescription medication used to treat high blood pressure. Atorvastatin (brand name Lipitor) is a prescription medication used for lowering high blood cholesterol. The pilot had previously reported these medications to the FAA.

Tests and Research

The engine was shipped to a Rolls-Royce facility and connected to an engine test stand for a functional test. Several attempts to start the engine were made, but the engine did not start. The fuel system was checked, and fuel was noted throughout the system, up to and including the fuel nozzle where normal spray patterns and pressures were observed. The fuel control unit was removed and replaced with a new fuel control unit; subsequent engine start attempts were unsuccessful. The governor servo pressure (Py) line between the PTG and fuel control unit was removed, and its fittings were capped off to test operation of the PTG. A successful engine start was made in this condition. The PTG was removed, and its main drive shaft was found fractured. The original PTG was replaced with a new PTG, and the original fuel control was reinstalled on the engine. With the new PTG installed, the engine started normally, produced rated horsepower, and met production test specifications with no anomalies noted.

On August 9, 2016, the PTG, which was designed and manufactured by Honeywell, was disassembled and examined at a Honeywell facility under the auspices of the NTSB. A functional performance test could not be performed due to the internal damage. The examination revealed that the governor pressure (Pg) lever clevis fork was bent, and the spool bearing assembly was loose within the drive body cavity (figure 6). The drive shaft guide post was fractured and trapped within the spool bearing bushing. Metallic debris was found within the interior of both the drive body and the drive body cover. The internal bearing elements of the spool bearing assembly were seized and would not rotate. One flyweight was bent and did not pivot freely. The drive shaft was found fractured at the guide post and at the drive spline. The PTG was sent to the NTSB Materials Laboratory, Washington, DC, for further examination.

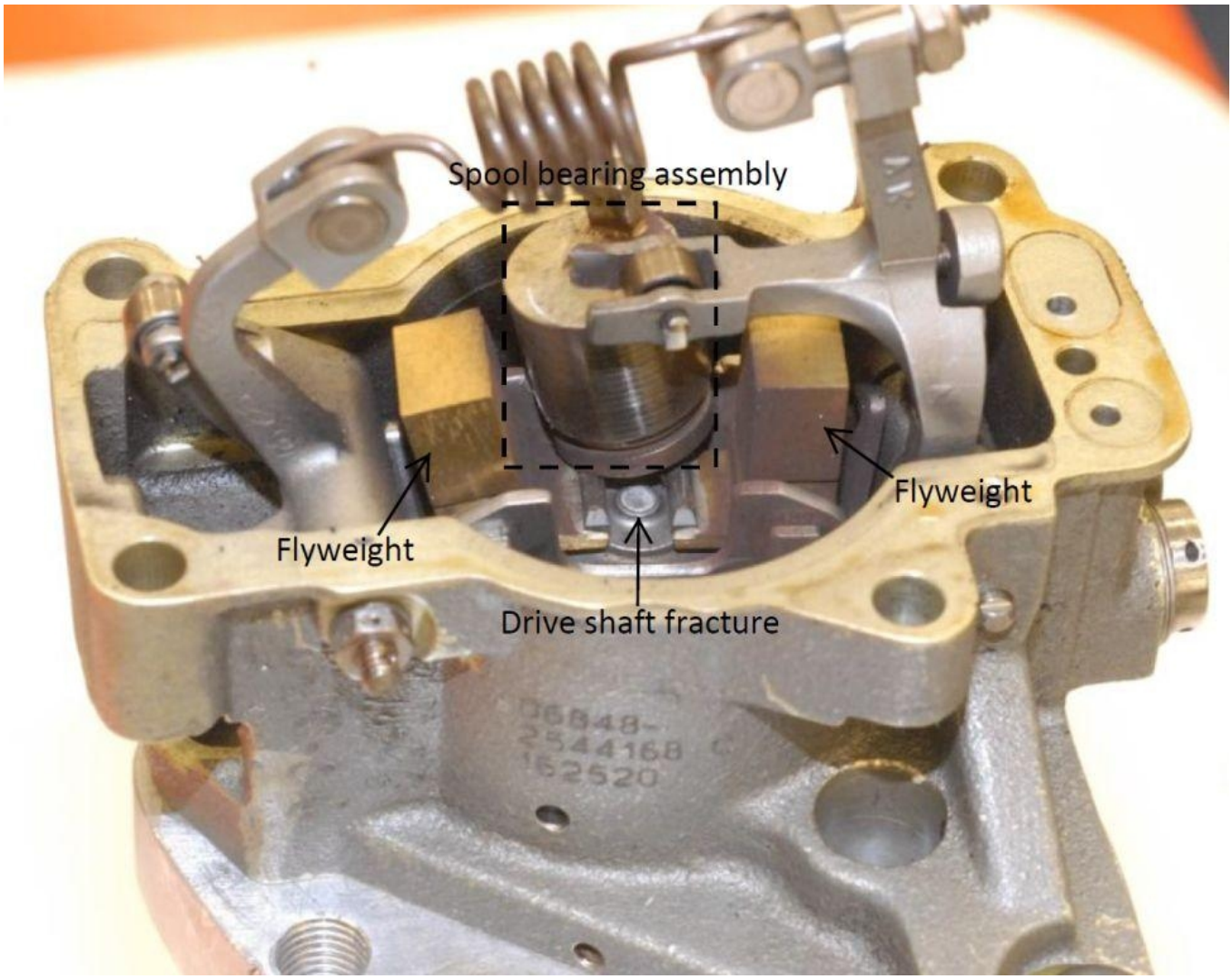

Figure 6 – Internal view of the PTG

On September 16, 2016, the NTSB examination of the PTG revealed that a portion of the fractured drive shaft remained embedded in the spindle of the spool bearing assembly. The fracture surface features of the shaft were consistent with overstress. The outer cap of the spool bearing assembly was removed, and the ball bearings and spacers were found coated with voluminous, powdery, black particulate. Much of the powder fell from the assembly upon removal of the cap. No grease was observed. Disassembly of the bearings revealed that the ball retainers were fragmented, the inner surfaces were found coated with a powdery, black particulate, and no grease was observed. The inner bearing surfaces were rough and frosted. Figure 7 shows the disassembled pieces of the spool bearing.

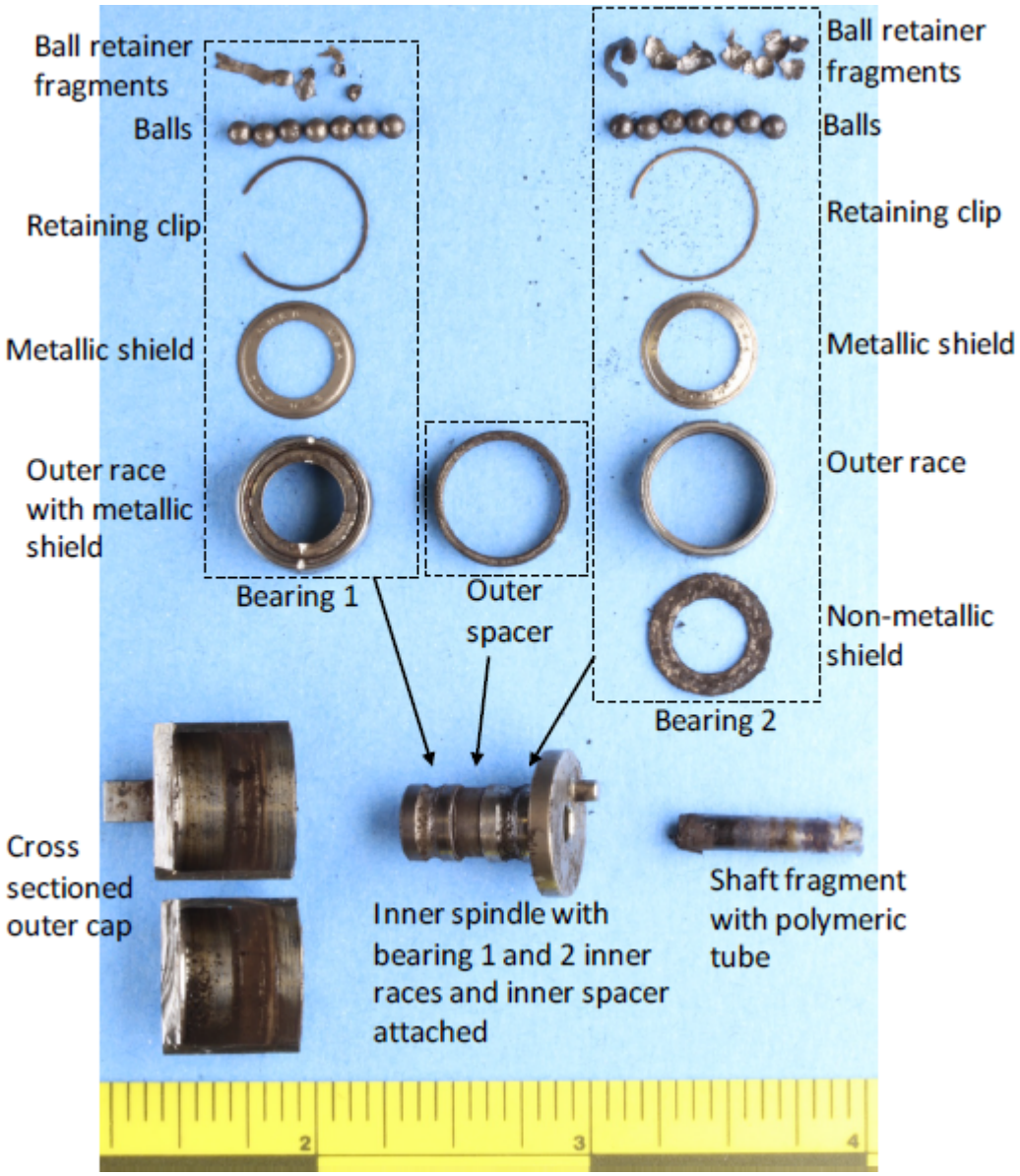

Figure 7 – Disassembled spool bearing with labels

Additional Information

14 CFR Part 133 Operations Specifications
The Operations Specifications for Rotor Blade, LLC, as approved by the FAA, states:
The owner or operator of the aircraft identified in the certificate holder or operator' s aircraft listing is primarily responsible for maintaining that aircraft in an airworthy condition as required by 14 CFR

91.403(a) and Part 39.

PTG Information

According to the component maintenance manual, the model AL-AA2 PTG is an element of the engine fuel controlling system. The function of the governor is to maintain the speed of the power turbine (N2) by resetting the main fuel control; the PTG supplements the main fuel control. This resetting establishes the gas producer speed (N1) required to supply N2. The PTG is mounted on the accessory case and senses N2 speed through reduction gearing. When an N2 off-speed condition is sensed by the PTG, it supplies a signal to the fuel control to change N1 speed to eliminate the off-speed condition. A complete description of the PTG is available in the public docket for this accident.

In 2003, Honeywell introduced a dual-spool bearing for the PTG to lower cost of ownership and commonize the design. The bearing installed in the accident PTG was the dual-spool bearing. The dual-spool bearing replaced the legacy design single-spool bearing; the legacy design had no previous service issues. Honeywell reported that the dual-spool bearing had experienced a total of 23 field failures before this accident. The spool bearing failures led to either engine oscillations, uncommanded engine acceleration, or a loss of engine power.

Honeywell Service Bulletin (SB) GT-73-344

Honeywell issued SB GT-73-344, Revision 2, on October 30, 2008, to replace the bearing assembly on PTGs used on Rolls-Royce 250 series engines in order to increase PTG reliability. The SB applied to several PTG models including the AL-AA2 model on the accident engine. Revision 1 was issued March 7, 2008.

Rolls-Royce Commercial Engine Bulletin (CEB) 1402

Rolls-Royce issued CEB 1402 on April 21, 2008, to increase PTG reliability by incorporating a new bearing assembly. The CEB referenced Honeywell SB GT-73-344 and specified compliance times. The SB and CEB were issued after the accident PTG was installed new, and the SB and CEB were applicable to it. According to the CEB compliance times, the accident PTG's dual-spool bearing should have been replaced with a single-spool bearing no later than 750 hours TT since new.

As a result of this investigation, Rolls-Royce issued a Commercial Service Letter (CSL), revision 1, on November 11, 2016, to remind customers that there are engines operating in the field that have not complied with CEB 1402 and other CEBs. The CSL recommends that customers should review the referenced CEBs to determine if they are applicable to their engine. The CSL also states: "Rolls--Royce has been involved in investigations where failure of the user to comply with the identified bulletins resulted in an uncommanded engine power reduction. It is the owner/operator's sole responsibility to comply with the identified bulletins within the specified timeframe or risk a potential for loss of aircraft or loss of life. Rolls-Royce is not responsible for an owner/operator's failure to comply."

Administrative Information

Investigator In Charge (IIC):	Lindberg, Joshua
Additional Participating Persons:	Joe Saunders; FAA; Milwaukee, WI Dave Riser; Rolls-Royce; Indianapolis, IN Joan Gregoire; MD Helicopters; Mesa, AZ John Hobby; Boeing; Mesa, AZ Jim Holmes; Rotor Blade LLC; Georgetown, SC
Original Publish Date:	April 20, 2017
Last Revision Date:	July 3, 2024
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=93097