



# National Transportation Safety Board Aviation Accident Final Report

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<b>Location:</b>	Philip, SD	<b>Accident Number:</b>	CEN12FA001
<b>Date &amp; Time:</b>	10/01/2011, 1255 MDT	<b>Registration:</b>	N266CY
<b>Aircraft:</b>	ROBINSON HELICOPTER CO R66	<b>Aircraft Damage:</b>	Destroyed
<b>Defining Event:</b>	Unknown or undetermined	<b>Injuries:</b>	1 Fatal
<b>Flight Conducted Under:</b>	Part 91: General Aviation - Personal		

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## Analysis

The helicopter was on a cross-country flight when it experienced a separation of the main rotor mast 8 inches below the teeter bolt, and the main rotor blade assembly separated from the flying helicopter. Subsequently, the helicopter impacted terrain and a postimpact fire ensued. Examination of the mast revealed fracture features consistent with overload failure and mechanical damage indicative of mast bumping. An examination of the airframe, engine, and remaining systems revealed no preimpact anomalies. The reason for the mast bumping event could not be determined due to the amount of thermal damage to the wreckage.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The in-flight separation of the main rotor mast following a mast bumping event. The reason for the mast bumping event could not be determined due to postaccident damage.

## Findings

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<b>Aircraft</b>	Main rotor head system - Damaged/degraded (Cause)
	Main rotor head system - Failure (Cause)

## Factual Information

### HISTORY OF FLIGHT

On October 1, 2011, about 1255 mountain daylight time, a Robinson Helicopter, R66, N266CY, was destroyed during an in-flight breakup while in cruise flight near Philip, South Dakota. The private pilot, the sole occupant, was fatally injured. The helicopter was registered to and operated by P.P. and J. LLC., of Gillette, Wyoming. Visual meteorological conditions prevailed and a flight plan was not filed for the 14 Code of Federal Regulations Part 91 personal flight. The cross-country flight originated from the Gillette-Campbell County Airport (GCC), around 1105 and was en route to the Winner Regional Airport (ICR), in Winner, South Dakota.

A friend of the pilot was at GCC when the pilot was preparing for the flight. The friend reported that the pilot appeared to be in good health and was excited about the flight. He further reported that the pilot had "topped off" the helicopter with fuel before departure. Approximately an hour and a half later the pilot called the friend during the flight. The pilot reported that he was between Wall, South Dakota, and Philip, South Dakota, and inquired if the Philip Airport (PHP), had jet fuel available. The friend called the pilot back a few minutes later to report that PHP did not have jet fuel. The friend stated that the pilot did not report any anomalies with the helicopter during either conversation.

An eyewitness located approximately 2 miles northwest of the accident site, observed the helicopter flying from west to east, along a river, approximately 1,000 feet above ground level (AGL). The eyewitness reported that he heard nothing abnormal as the helicopter flew past him. He then observed the helicopter make a turn to the left before it flew out of view behind trees. About 20-30 seconds later, he heard a noise that he described as sounding like an "exploding propane tank."

### PERSONNEL INFORMATION

The pilot, aged 64, held a private pilot certificate with airplane single and multi-engine land, rotorcraft helicopter, and instrument airplane. He was issued a third-class medical on November 3, 2009, with the limitation of "Must have available glasses for near vision."

The pilot's flight logbooks were not recovered during the course of the investigation. On an aircraft insurance application dated February 4, 2011, the pilot estimated having logged 3,600 hours of total flight time with 60 hours in the last 90 days. Of that time, 210 hours had been in helicopters and 22 hours had been in the Robinson R66. The pilot also indicated that his last biannual flight review had taken place on May 5, 2010.

The NTSB investigator-in-charge (IIC), contacted the two flight instructors who instructed the accident pilot. The first instructor reported that he had provided instruction to the accident pilot once or twice for an estimated total of 2 hours in the R66. The second instructor reported that he had instructed the accident pilot for 1 flight in the R66. Both instructors stated that they did not provide a signoff for the accident pilot in the R66; however, a signoff was not required. Although the Federal Aviation Administration (FAA) had issued SFAR 73-2, Special Training and Experience Requirements for the Robinson R-22 and the R-44, the R66 was excluded.

### HELICOPTER INFORMATION

The 2011-model Robinson Helicopter Co R66, serial number 0010, was registered with the

Federal Aviation Administration standard airworthiness certificate for normal operations. The helicopter was powered by a turbo-shaft Rolls-Royce RR300 engine, serial number (SN) RRE200013, which drove the two-blade main rotor.

According to the airframe and engine logbooks, the helicopter's most recent 100-hour inspection was completed on June 6, 2011, with an airframe and engine total time of 82.6 hours.

#### METEOROLOGICAL INFORMATION

At 1255, the automated weather observing system at PHP, located 3 nautical miles northeast from the site of the accident, reported wind from 150 degrees at 6 knots, 10 miles visibility, clear of clouds, temperature 84 degrees Fahrenheit, dew point 39 degrees Fahrenheit, and a barometric pressure setting of 30.00 inches of Mercury.

#### WRECKAGE AND IMPACT INFORMATION

The helicopter wreckage and debris came to rest on rolling ranch land and was spread out over an area approximately 1,520 feet long by 600 feet wide. The main rotor head, with attached blades, came to rest 513 feet from the main wreckage. The main wreckage consisted of the fuselage, engine, and tail rotor assembly.

The airframe was severely damaged by fire and impact forces. A few pieces of airframe and numerous pieces of Plexiglas were located away from the main wreckage and were not fire damaged. Two portions of the right forward door frame exhibited scoring and deformation similar to the shape of the main rotor blade leading edge. The right front seat bottom had a lateral cut/impact mark near the forward edge and was detached from the helicopter. The controls and tunnel structure exhibited what appeared to be a cut/gash in a vertical line, from the right side, approximately 5 inches forward of the collective pivot. A section of the door frame from the left door exhibited large curved dents, one with paint smearing, on the inside surfaces.

The cabin area was nearly consumed by a post-crash fire. All removable controls were found installed. The engine fuel control was found in the full "ON" position. The collective was in a full up position, based on the friction slider. The airframe fuel cutoff valve was extended ¼ inch from its full down position. The remains of what appeared to be a steel shot bag were found beneath the cabin remains.

The forward 1.5 bays of tailcone were consumed by fire. The remainder of the tailcone was intact aftward to the last bay, which was separated at the forward end. The empennage had separated from the tail cone and sustained light fire damage. The small horizontal stabilizer at the base of vertical stabilizer was damaged on left side. The tail rotor visual guard separated from aircraft and fractured in 4 places.

Both skid toes and both forward struts separated from the skids. Both rear struts remained attached to skids. The forward cross tube was straight in the horizontal plane and bent forward at the left end in the longitudinal plane and burned through at left side. The rear cross tube destroyed was by fire. The left rear strut exhibited a deep dent on the upper end inboard side.

The fuel system was mostly destroyed by fire. The fuel vent tubes had been consumed and only one rollover vent fitting could be located. Investigators were able to blow air through this vent in the upright and inverted positions. The fuel bladder was consumed by fire. The finger screen was recovered and was clear of any debris. The D205-21 fuel hose was found intact, connected

to the F670-1 valve.

All rod ends for the main rotor flight controls were accounted for and secure to their mounting device, other than at components that were destroyed by fire. The disconnects in the push/pull tubes were consistent with overload and or thermal damage. The servo to swashplate push/pull tubes were bowed. All rod ends for the tail rotor flight controls were accounted for and secure to their mounting device, other than at bellcranks that were destroyed by fire. The disconnects in the push/pull tubes were consistent with overload and or thermal damage.

The sprag clutch was subjected to fire and did not rotate. The engine output flex coupling was intact but bent. The F642-1 engine to main rotor gearbox driveshaft was separated at both ends at the yoke weld. The main rotor gearbox input coupling was intact. The main rotor gearbox exhibited thermal damage and had two holes in the case. The output shaft could only be rotated a few degrees. The main rotor gearbox oil filter was not located. In addition, the gearbox rubber mounts were consumed by fire.

The main rotor had separated approximately 8 inches below the teeter bolt. The main rotor hub was intact and both blade roots remained attached to it via the coning bolts. Both droops stops were in place. Both elastomeric teeter stops were split horizontally through the middle. The droop stop "tusk" for main rotor blade SN 0049 appeared straight while the "tusk" for blade SN 0067 was bent down approximately 10 degrees. There were small arc shaped scores on the main rotor hub just inboard of both rotor blade pitch change housings.

Main rotor blade SN 0067 was found intact with an upward and aftward bend approximately 108 inches from the coning bolt. The lower surface of the blade had a pattern of scratches centered on the bend area and compression buckling of the trailing edge. Main rotor blade SN 0049 was bent downward and aftward, and the skins and honeycomb were separated from the spar over the span between 72 inches and 180 inches from the coning bolt. The spar was fractured approximately 141 inches and 174 inches from the coning bolt. The most outboard portion of spar remained attached to the skins and honeycomb. A swap sample was taken from a piece of the separated rotor blade skin and honeycomb and was sent to the Smithsonian National Museum of Natural History for DNA and Microscopic analysis.

The engine driveshaft was disconnected at both ends at the flex coupling flanges and compressed at both ends. The edges of the shaft at the disconnects were angular and jagged. Both flex plates were bent slightly. The forward tail rotor driveshaft was disconnected at the intermediate flex coupling flange and compressed at both ends. The edges of the shaft at the disconnect were angular and jagged. Both flex plates were bent slightly. The aft tail rotor driveshaft was disconnected approximately 4 inches aft of the flex coupling. The edges of the forward section of the shaft at the disconnect were angular and jagged. The edges of the aft section of the shaft at the disconnect appeared melted. The driveshaft hanger bearing was damaged by fire. The damper linkage was exposed to fire and did not rotate. The aft flex plate was bent and one arm of the tail rotor gearbox flange was disconnected, and one of the flexplate arms was torn. The edges of the disconnect were angular and jagged.

The tail rotor gearbox contained oil and was free to rotate, but rotation was limited by the bent input yoke contacting the input cartridge hardware. The output shaft and hub were intact. The slider bearing was free to rotate but rotation was limited as described above. Both tail rotor blades were damaged by fire and were bent to the left. One tail rotor blade was bent approximately 30 degrees to the left, and the other tail rotor blade was bent approximately 90

degrees to the left with a separated trailing edge.

The engine was found disconnected from the aircraft structure. The compressor front support, engine air inlet, and the first stage compressor were free of visible damage. The compressor left-hand compressor scroll arm flange was bent inward. The N1 and N2 rotor system were bound. The power turbine governor, fuel pump and filter assembly, and the accessory gearbox were consumed in the post-crash fire. The N1 and N2 coupling shafts were fractured at the turbine portion of the shaft and were sent to the NTSB materials lab for examination. No anomalies were noted to the P/T- 4 turbine wheel as viewed through the exhaust collector. The gas producer fuel control unit was damaged by fire at the mounting base. Control linkage rigging was found in the closed position. The exhaust collector received crushing deformation during the accident sequence. The right air guide tube was unremarkable. The left air guide received crushing deformation during the accident sequence. The fuel cutoff arm on the fuel control unit was in the closed position. The throttle arm on the fuel control unit was in the idle position.

The Rolls-Royce RR300 Engine Monitoring Unit (EMU) was removed and sent to the National Transportation Safety Board's (NTSB) vehicle recorder laboratory for an attempted data extraction.

#### MEDICAL AND PATHOLOGICAL INFORMATION

The Clinical Laboratory of the Black Hills, located in Rapid City, South Dakota, performed an autopsy on the pilot on October 3, 2011. The autopsy concluded that the cause of death was due to "blunt trauma injuries" and the report listed the specific injuries.

The FAA, Toxicology Accident Research Laboratory, located in Oklahoma City, Oklahoma, conducted toxicological testing on the specimens that were submitted. Carbon monoxide and cyanide tests were not performed. Tests for ethanol were negative. Losartan, a blood pressure medication, was detected in the liver.

#### TESTS AND RESEARCH

The main rotor mast, hub, and gear box assemblies were sent to the NTSB Material Laboratory in Washington, DC, for further examination. The inboard end of each main rotor blade was attached to the hub. The enclosure for the gear box assembly and the mast were made from non-ferrous metal. The enclosure for the gear box and other nonferrous pieces in the general area of the gear box showed sagging deformation features consistent with heat damage from exposure to fire. The wall portion of the gear box in certain areas exhibited globule-like features consistent with re-solidified metal. The mast in the area of the fracture exhibited severe bending deformation. The cover for the mast in the area between the hub and gear box also showed evidence of bending deformation and contained a longitudinal fracture in the wall. Portable binocular microscope examination of the ferrous pieces such as the main structural tubes, attachment points for the control surfaces (clevis bolts) and non-ferrous pieces revealed the fracture faces were on slant plane relative to their longitudinal axes and contained dimpled features consistent with overstress separation. The noted signatures were consistent with a mast bump event.

The Rolls-Royce RR300 Engine Monitoring Unit (EMU) was examined at the NTSB vehicle recorder laboratory. The EMU records the engine's gas temperature, torque, N1, and N2 speeds. Due to the extreme heat and fire damage, no data was recovered from the device.

A teardown examination of the engine was conducted, under the oversight of the NTSB investigator-in-charge (IIC), at Roll-Royce Corporation in Indianapolis, Indiana. The examination revealed the compressor backplate assembly stationary seals, and the impeller rotating seals, exhibited 360 degree rotational scoring. In addition, the P/T-4 nozzle exhibited localized rub area on both the P/T-3 and P/T-4 blade tracks. The inspection of the engine did not reveal any pre impact failures or conditions that would prevent the engine from normal operation.

The engine's N1 and N2 coupling adapters were sent to the NTSB Materials Laboratory for further examination. The N1 coupling adapter contained an internal spline at each end. A circumferential fracture split the part into two pieces. The smaller piece contained a longitudinal fracture. The circumferential and longitudinal fractures intersected the internal spline portion at one end of the shaft. The N2 coupling adapter contained only a circumferential fracture. The pieces were ultrasonic cleaned and examination of the fracture faces revealed that they were on a slant plane relative to their longitudinal axes and contained dimpled features consistent with overstress separation.

On February 21, 2012, Robinson Helicopter Company released, R66 Service Bulletin SB-03. This service bulletin addressed the possibility of machining burrs being present in certain helicopter hydraulic servos. NTSB investigators removed and examined the three hydraulic control servos from the accident helicopter at Robinson Helicopter Company on November 1, 2012. The examination did not reveal any preimpact anomalies.

Multiple swab samples were taken from the wreckage and sent to the Smithsonian National Museum of Natural History for DNA and Microscopic analysis. All samples were negative for bird remains.

## History of Flight

<b>Enroute-cruise</b>	Unknown or undetermined (Defining event) Aircraft structural failure
<b>Uncontrolled descent</b>	Part(s) separation from AC Collision with terr/obj (non-CFIT)

## Pilot Information

<b>Certificate:</b>	Private	<b>Age:</b>	64
<b>Airplane Rating(s):</b>	Multi-engine Land; Single-engine Land	<b>Seat Occupied:</b>	Right
<b>Other Aircraft Rating(s):</b>	Helicopter	<b>Restraint Used:</b>	
<b>Instrument Rating(s):</b>	Airplane	<b>Second Pilot Present:</b>	No
<b>Instructor Rating(s):</b>	None	<b>Toxicology Performed:</b>	Yes
<b>Medical Certification:</b>	Class 3 With Waivers/Limitations	<b>Last Medical Exam:</b>	11/03/2009
<b>Occupational Pilot:</b>	No	<b>Last Flight Review or Equivalent:</b>	05/05/2010
<b>Flight Time:</b>	(Estimated) 3600 hours (Total, all aircraft), 22 hours (Total, this make and model), 60 hours (Last 90 days, all aircraft)		

## Aircraft and Owner/Operator Information

Aircraft Manufacturer:	ROBINSON HELICOPTER CO	Registration:	N266CY
Model/Series:	R66	Aircraft Category:	Helicopter
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Normal	Serial Number:	0010
Landing Gear Type:	Skid	Seats:	5
Date/Type of Last Inspection:	06/06/2011, 100 Hour	Certified Max Gross Wt.:	
Time Since Last Inspection:	83 Hours	Engines:	1 Turbo Shaft
Airframe Total Time:	120 Hours	Engine Manufacturer:	ROLLS-ROYC
ELT:	Installed, not activated	Engine Model/Series:	RR300
Registered Owner:	P P & J LLC	Rated Power:	300 hp
Operator:	P P & J LLC	Air Carrier Operating Certificate:	None

## Meteorological Information and Flight Plan

Observation Facility, Elevation:	PHP, 2209 ft msl	Observation Time:	1255 MDT
Distance from Accident Site:	3 Nautical Miles	Condition of Light:	Day
Direction from Accident Site:	40°	Conditions at Accident Site:	Visual Conditions
Lowest Cloud Condition:	Clear	Temperature/Dew Point:	29° C / 4° C
Lowest Ceiling:	None	Visibility	10 Miles
Wind Speed/Gusts, Direction:	6 knots, 150°	Visibility (RVR):	
Altimeter Setting:	30 inches Hg	Visibility (RVV):	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Gillette, WY (GCC)	Type of Flight Plan Filed:	None
Destination:	Winner, SD (ICR)	Type of Clearance:	None
Departure Time:	1105 MDT	Type of Airspace:	

## Wreckage and Impact Information

Crew Injuries:	1 Fatal	Aircraft Damage:	Destroyed
Passenger Injuries:	N/A	Aircraft Fire:	On-Ground
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	1 Fatal		

## Administrative Information

<b>Investigator In Charge (IIC):</b>	Timothy LeBaron	<b>Adopted Date:</b>	04/10/2014
<b>Additional Participating Persons:</b>	Gary Soldwisch; Federal Aviation Administration; Rapid City, SD Matthew Rigsby; Federal Aviation Administration; Fort Worth, TX Thom Webster; Robinson Helicopter; Torrance, CA Michael Weber; Rolls Royce; Indianapolis, IN		
<b>Publish Date:</b>	04/10/2014		
<b>Investigation Docket:</b>	<a href="http://dms.nts.gov/pubdms/search/dockList.cfm?mKey=81955">http://dms.nts.gov/pubdms/search/dockList.cfm?mKey=81955</a>		

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