National Transportation Safety Board

FACTUAL REPORT AVIATION

NTSB ID: CHI08GA028	Aircraft Registration Number: N556CP
Occurrence Date: 10/29/2007	Most Critical Injury: None
Occurrence Type: Accident	Investigated By: NTSB

Location/Time

Nearest City/Place	State	Zip Code	Local Time	Time Zone	
Columbus	OH	43215	1736	EDT	

Airport Proximity: Off Airport/Airstrip

Distance From Landing Facility:

Aircraft Information Summary

Aircraft Manufacturer	Model/Series	Type of Aircraft
McDonnell Douglas Helicopter	369E	Helicopter

Revenue Sightseeing Flight: No

Air Medical Transport Flight: No

Narrative

Brief narrative statement of facts, conditions and circumstances pertinent to the accident/incident:

*** Note: : NTSB investigators either traveled in support of this investigation or conducted a significant amount of investigative work without any travel, and used data obtained from various sources to prepare this public aircraft accident report. ***

HISTORY OF FLIGHT

On October 29, 2007, at 1736 eastern daylight time, a McDonnell Douglas helicopter model 369E, N556CP, operated by the City of Columbus Police Department and piloted by a commercial pilot, was substantially damaged during a forced landing following a total loss of engine power while maneuvering over Columbus, Ohio. Visual meteorological conditions prevailed at the time of the accident. The public-use flight was operating under the provisions of 14 Code of Federal Regulations (CFR) Part 91. The pilot and his observer reported no injuries. The local area flight departed at 1556 from the Columbus Heliport (OH52), Columbus, Ohio.

The flight crew was conducting a routine patrol flight over the Columbus area when they were dispatched to an automobile accident to provide aerial support for responding ground units. As they approached the accident site, the pilot decelerated to 60-70 knots indicated airspeed (KIAS) and entered an orbit maneuver at an altitude of 1,300 feet mean sea level (msl). While the helicopter orbited the accident site, it experienced a sudden loss of engine power. The pilot reported that the helicopter shuddered and exhibited a pronounced left yaw. The engine reportedly made a loud squealing, grinding, and sucking sound. In addition to the low rotor speed and engine power output (EPO) aural warnings, several annunciator panel warnings illuminated.

After searching for a suitable landing spot, the pilot performed an autorotation to an island peninsula located on the Scioto River. The pilot noted that his landing flare eliminated the helicopter's forward movement and that the touchdown was made on both skids. The helicopter remained upright momentarily before the right skid sank down into the muddy terrain. The helicopter subsequently rolled over onto its right side. The pilot performed an emergency shutdown of the helicopter before he and his observer egressed the helicopter through the left pilot door. They proceeded to the rear of the helicopter with a hand-held Halon fire extinguisher, but upon further inspection, there was no engine compartment fire to be extinguished. The flight crew then used a cellular-device to contact their police dispatch and heliport.

PERSONNEL INFORMATION

According to Federal Aviation Administration (FAA) records, the pilot of N556CP, age 56, held a commercial pilot certificate with a rotorcraft-helicopter rating. He was not instrument rated. His last aviation medical examination was completed on May 16, 2007, when he was issued a second-class medical certificate with the limitation that he wear corrective lenses during flight. The FAA had also issued a medical waiver for his Type-II diabetes, which was adequately managed with oral medication.

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The pilot reported having 1,924.8 hours total flight time, all of which was flown in rotorcraft. He had accumulated 1,856.7 hours as pilot-in-command (PIC) and 1,265 hours in a McDonnell Douglas Helicopter model 369E. His last flight review was completed on November 8, 2005, in a McDonnell Douglas Helicopter model 369E.

During the previous 90 days, 30 days, and 24 hours, the pilot had flown 46.6 hours, 27.3 hours, and 3.7 hours total flight time, respectively. The flight time accumulated during those periods was completed in a McDonnell Douglas Helicopter model 369E.

AIRCRAFT INFORMATION

The City of Columbus Police Department used the 2004 McDonnell Douglas Helicopter model 369E, serial number 0567E, as a public-use helicopter. The helicopter had a five-blade main rotor system, a four-bladed tail rotor system, and was powered by a single 420 shaft horsepower Rolls-Royce model 250-C20B, serial number CAE 837051, turbo-shaft engine. The helicopter's maximum gross weight was 3,000 pounds and was configured to accommodate a pilot and three passengers. At the time of the accident, the airframe had accumulated 3,094 hours since new. The engine had been installed in the helicopter since new, except when it had been temporarily removed during 2005 for a low-output power condition. The engine had accumulated 2,918.7 hours and 1,718 cycles since new. The last turbine section inspection was completed on November 10, 2006, at 1,748.7 total hours. The helicopter had accumulated 99.1 hours since the last maintenance inspection, which was completed on October 4, 2007.

At the time of departure, the helicopter had 64 gallons of Jet-A fuel on board, and weighed 2,432 lbs, with a center-of-gravity location of 100.1 inches aft of datum.

A review of the maintenance logbook records found no history of unresolved airworthiness issues.

METEOROLOGICAL INFORMATION

The closest weather reporting facility was at the Port Columbus International Airport (KCMH), about 7 miles northeast of the accident site. The airport was equipped with an ASOS.

At 1751, the KCMH ASOS reported the following weather conditions: Wind 200 degrees true at 9 knots; visibility 10 miles; scattered clouds at 20,000 feet agl; temperature 13 degrees Celsius; dew point -1 degrees Celsius; altimeter setting 30.40 inches of mercury.

FLIGHT RECORDERS

The accident helicopter was not equipped, nor was it required to be equipped, with a cockpit voice recorder or flight data recorder.

WRECKAGE AND IMPACT INFORMATION

An on-site inspection was performed by representatives from the FAA, Columbus Police Department, and Rolls-Royce Corporation. The National Transportation Safety Board did not dispatch an investigator to the accident site. The helicopter was found lying on its right side, with a majority of the right skid submerged in the soft terrain. The tailboom was deformed/creased about 1 foot forward of the vertical stabilizer assembly. The vertical stabilizer was rotated about 10 degrees to the left. All five main rotor blades were damaged. There was dark colored oil observed in the engine compartment and on the exterior of the compartment's clamshell doors. The engine intake was not damaged and no obstructions or foreign object debris were noted within the intake assembly. A small penetration hole was noted in the upper right section of the engine bay panel. The aircraft exhaust assembly was dented in several areas from internal object impact. The exhaust stack was loose at its interface with the engine's exhaust collector. Aircraft driveshaft continuity was established from the engine output to the main and tail rotors. The tail rotor driveshaft exhibited slight binding when rotated. The engine control rigging was properly connected and appeared undamaged. The magnetic chip detecting system did not illuminate when auxiliary power was applied.

Narrative (Continued)

The magnetic plugs were removed and both were covered with ferrous particles. Electrical continuity of the magnetic chip detecting system was established by shorting the plugs to a metallic object.

The engine was removed and shipped to the manufacturer for disassembly and examination.

TEST AND RESEARCH

The engine was disassembled at the Rolls-Royce Corporation facility in Indianapolis, Indiana, on November 14, 2007, under the supervision of the National Transportation Safety Board (NTSB) investigator-in-charge. Teardown inspection revealed that one airfoil (blade) had separated near the rim of the fourth-stage turbine wheel and additional secondary damage to three adjacent airfoils. The fourth-stage turbine wheel (part number 23055944, serial number X524614) and other selected engine components were submitted to the Rolls-Royce Materials Technology Laboratory for a detailed metallurgical evaluation. The liberated airfoil from fourth-stage turbine wheel had fractured and separated in high-cycle fatigue. The fracture initiated at the airfoil trailing edge root fillet and propagated approximately 0.495-inch before finally separating in mechanical overload. No machining anomalies were noted at the fracture origin area. Scanning electron microscopy analysis of all the observed fractures revealed no metallurgical or geometric anomalies at the fracture origin. Microstructure, hardness, and chemical composition of samples taken near the fracture origin were consistent with the manufacturer's specifications as defined by the applicable engineering drawing. All additional damage throughout the engine was secondary to the airfoil separation from the fourth stage turbine wheel.

The fourth stage turbine wheel had accumulated 2,918.7 hours and 1,718 cycles since new. The turbine wheel (p/n 23055944) was the current design used in the Series II "Enhanced" Power Turbine assembly. The enhanced power turbine design was used in a variety of fixed-wing and rotorcraft aircraft. There have been five known airfoil separations with the enhanced power turbine design, four of which occurred in a McDonnell Douglas Helicopter model 369 aircraft.

A root cause investigation of the airfoil failure was conducted by Rolls-Royce engineering personnel. Updated three-dimensional heat transfer and structural analysis models revealed the possibility of a higher stress state in the turbine wheel airfoil trailing edge root fillet than was originally modeled when the turbine wheel was released in 1999. This elevated stress state, which was modeled to occur during engine startup, was the result of a thermal gradient in the turbine airfoil geometry. This thermal gradient could result in a residual stress condition in the airfoil hub trailing edge, and potentially lead to the initiation of fatigue crack. If a crack was initiated, operation of the engine in a wheel resonance mode may propagate the existing crack in high-cycle fatigue and ultimately result in an airfoil separation. The wheel resonance mode occurred during sustained engine operations between 75 and 88 percent N2. This engine speed avoidance range had been previously communicated to operators in the form of a Commercial Engine Bulletin (CEB-1400) that was originally issued in December 2006, approximately 10 months before the accident. According to the helicopter operator, upon the bulletin's release, they had adhered to the specified speed avoidance range during all flight and maintenance operations.

On November 29, 2010, Rolls-Royce issued Commercial Engine Bulletin No. CEB-1407 that required a one-time inspection of the third and fourth stage turbine wheels for possible airfoil cracks. The bulletin was applicable to McDonnell Douglas Helicopter models equipped with a Series II "Enhanced" Power Turbine Design. The bulletin stated that prolonged engine operation in the 75-88 percent N2 speed avoidance range could result in airfoil fracture and possible separation. The inspection was to be completed at the next 1,750 hour overhaul and required the removal of the applicable turbine wheels for fluorescent-penetrant and visual inspections. The bulletin called for the replacement of any wheel that contained a fracture of an airfoil trailing edge near the rim where the fillet engages the trailing edge.

To mitigate future turbine wheel airfoil fractures, Rolls-Royce has redesigned the turbine wheel to adequately accommodate the higher thermal gradient encountered during engine startup. As of January 2011, the required design changes have been approved and the required Fixed Process Approval (FPA) was progressing to release the wheel into service. The FPA requires dimensional inspections, a metallurgical review, and fatigue testing be completed prior to final approval.

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Rolls-Royce estimated that the FPA would be completed by the end of the fourth quarter of 2011.
Updated on May 19 2011 2:18PM

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Landing Facility/Approach Information

Airport Name	Airport ID:	Airport Elevation	Runway Used	Runway Length	Runway Width
		Ft. MSL	N/A		

Runway Surface Type:

Runway Surface Condition:

Approach/Arrival Flown: NONE

VFR Approach/Landing: Forced Landing

Aircraft Information

Aircraft Manufacturer	Model/Series	Serial Number
McDonnell Douglas Helicopter	369E	0567E

Airworthiness Certificate(s): Normal

Landing Gear Type: High Skid

Amateur Built Acft?	Number of Seats:	Certified Max Gross Wt.	Number of Engines:
No	4	3000 LBS	1

Engine Type:	Engine Manufacturer:	Model/Series:	Rated Power:
Turbo Shaft	Rolls-Royce	250-C20B	420 HP

- Aircraft Inspection Information

Type of Last Inspection	Date of Last Inspection	Time Since Last Inspection	Airframe Total Time
100 Hour	10/2007	99 Hours	3094 Hours

- Emergency Locator Transmitter (ELT) Information

ELT Installed?/Type	ELT Operated?	ELT Aided in Locating Accident Site?
No	No	No

Owner/Operator Information

Registered Aircraft Owner	Street Address	City	State	Zip Code
City of Columbus Police Department	120 Marconi Blvd.	Columbus	OH	43215

Operator of Aircraft	Street Address	City	State	Zip Code
City of Columbus Police Department	120 Marconi Blvd.	Columbus	OH	43215

Operator Does Business As:

Operator Designator Code:

- Type of U.S. Certificate(s) Held: None

Air Carrier Operating Certificate(s):

Operating Certificate:

Operator Certificate:

Regulation Flight Conducted Under: Part 91: General Aviation

Type of Flight Operation Conducted: Public Aircraft - Local

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First Pilot Information

Name	City	State	Date of Birth	Age
On File	On File	On File	On File	56

Sex: M | Seat Occupied: Left | Occupational Pilot? Yes | Certificate Number: On File

Certificate(s): Commercial

Airplane Rating(s): None

Rotorcraft/Glider/LTA: Helicopter

Instrument Rating(s): None

Instructor Rating(s): None

Current Biennial Flight Review? 11/2005

Medical Cert.: Class 2 | Medical Cert. Status: With Waivers/Limitations | Date of Last Medical Exam: 05/2007

- Flight Time Matrix	All A/C	This Make and Model	Airplane Single Engine	Airplane Mult-Engine	Night	Instrument Actual	Instrument Simulated	Rotorcraft	Glider	Lighter Than Air
Total Time	1925	1265			1521			1925		
Pilot In Command(PIC)	1857							1587		
Instructor										
Instruction Received										
Last 90 Days	47	47			2			47		
Last 30 Days	27	27						27		
Last 24 Hours	4	4						4		

Seatbelt Used? Yes | Shoulder Harness Used? Yes | Toxicology Performed? No | Second Pilot? No

Flight Plan/Itinerary

Type of Flight Plan Filed: None

Departure Point	State	Airport Identifier	Departure Time	Time Zone
Columbus	OH	OH52	1556	EDT

Destination	State	Airport Identifier
Local Flight		

Type of Clearance: None

Type of Airspace: Class G

Weather Information

Pilot's Source of Wx Information:

Automated Report

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Weather Information

WOF ID	Observation Time	Time Zone	WOF Elevation	WOF Distance From Accident Site	Direction From Accident Site
CMH	1751	EDT	815 Ft. MSL	6 NM	45 Deg. Mag.

Sky/Lowest Cloud Condition: Scattered 20000 Ft. AGL

Condition of Light: Day

Lowest Ceiling: None Ft. AGL

Visibility: 10 SM

Altimeter: 30.40 "Hg

Temperature: 13 °C

Dew Point: -1 °C

Weather Conditions at Accident Site: Visual Conditions

Wind Direction: 200

Wind Speed: 9

Wind Gusts:

Visibility (RVR): Ft.

Visibility (RVV) SM

Precip and/or Obscuration:

No Obscuration; No Precipitation

Accident Information

Aircraft Damage: Substantial

Aircraft Fire: None

Aircraft Explosion None

- Injury Summary Matrix	Fatal	Serious	Minor	None	TOTAL
First Pilot				1	1
Second Pilot					
Student Pilot					
Flight Instructor					
Check Pilot					
Flight Engineer					
Cabin Attendants					
Other Crew					
Passengers				1	1
- TOTAL ABOARD -				2	2
Other Ground					
- GRAND TOTAL -				2	2

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Administrative Information

Investigator-In-Charge (IIC)

Andrew T. Fox

Additional Persons Participating in This Accident/Incident Investigation:

Kevin Tyree
Federal Aviation Administration - Columbus FSDO
Columbus, OH

Lt. Michael Elkins
City of Columbus Police Department
Columbus, OH

Jon-Adam Michael
Rolls-Royce Corporation
Indianapolis, IN