Aviation Investigation Final Report

Location:	Miami, Florida	**Accident Number:**	ERA13FA186
Date & Time:	April 3, 2013, 16:00 Local	**Registration:**	N3101H
Aircraft:	Robinson R44	**Aircraft Damage:**	Destroyed
Defining Event:	Part(s) separation from AC	**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Flight test		

Analysis

The pilot, who also owned the helicopter company, hired a mechanic to change the main rotor blades on the helicopter. The main rotor blade change also required several adjustments to the pitch change rods on the rotor system followed by test flights. The accident flight was the second maintenance flight of the day and occurred about 1 hour of operation after the main rotor blade replacement.

Witnesses observed the helicopter flying and heard a loud "pop" sound followed by components separating from the helicopter. They then observed the tail section separate from the helicopter and the helicopter crash to the ground. Witness statements and wreckage documentation were consistent with a main rotor blade rotating upward during the accident flight, which was followed by a tail strike and the helicopter rolling inverted. Subsequently, the mast bumped and the helicopter descended uncontrolled to the ground.

A witness, who had flown the helicopter numerous times, stated that he observed the mechanic make adjustments to the pitch change rods on the rotor system during the maintenance procedure. He also stated that the mechanic told him that the owner of the helicopter was upset and that the helicopter manufacturer installed refurbished spindles onto the new blades. The owner's frustration likely distracted the mechanic and/or applied pressure for the mechanic to return the helicopter to service and revenue operations as soon as possible.

On-scene examination of the wreckage revealed that the pitch-link-to-swash-plate connection for one of the main rotor blades was missing. The pitch link and horn were found about 90 feet away. Metallurgical examination of the main rotor system revealed that the attaching hardware for the pitch-link-to-swash-plate connection was most likely not secured properly and separated after about 1 hour of flight following the maintenance. All other failures were consistent with overstress and no preexisting cracking was noted. No other anomalies with the helicopter structure, systems, or engine were found.

Probable Cause and Findings

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

The mechanic's failure to properly secure the pitch link hardware of one main rotor blade to the rotating swash plate, which resulted in the pitch link separating in flight and the pilot's subsequent loss of control. Contributing to the accident was the pilot's/owner's pressure on the mechanic to return the helicopter to revenue service.

Findings

Aircraft	Main rotor mast/swashplate - Incorrect service/maintenance
Personnel issues	Replacement - Maintenance personnel
Personnel issues	Motivation/respond to pressure - Pilot

Factual Information

History of Flight

Prior to flight	Aircraft maintenance event
Initial climb	Part(s) separation from AC (Defining event)
Initial climb	Flight control sys malf/fail
Initial climb	Mast bumping
Initial climb	Loss of control in flight
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On April 3, 2013 about 1600 eastern daylight time, Robinson R44, N3101H, had components separate in flight and the helicopter impacted the ground shortly after takeoff from Kendall Tamiami Executive airport (TMB), Miami, Florida. The helicopter was registered to and operated by Bravo Helicopters, LLC, of Miami, Florida. The commercial pilot and pilot-rated mechanic incurred fatal injuries. The maintenance test flight was conducted under the provisions of 14 Code of Federal Regulations Part 91. Visual meteorological conditions prevailed and no flight plan was filed for the local flight that departed a few minutes before the accident.

Multiple witnesses in the vicinity of the crash site reported hearing a loud "pop" noise and seeing parts separate from the helicopter as the helicopter flew overhead. Witnesses were also consistent in reporting that the empennage section of the helicopter then departed the aircraft before impact with the ground. One witness, standing about 20 feet from the impact, stated that the helicopter was inverted over the industrial buildings before it impacted two palm trees about 25 feet above ground level, a pickup truck, and then the ground. Another witness stated that the postcrash fire started after the pilot and passenger were extracted from the helicopter or about 5 minutes after the initial impact. He also stated that the helicopter was inverted over the industrial buildings.

Pilot Information

Certificate:	Commercial	**Age:**	53
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	3-point
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 1 With waivers/limitations	**Last FAA Medical Exam:**	February 23, 2013
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	February 25, 2013
Flight Time:	6840 hours (Total, all aircraft), 999999 hours (Total, this make and model)		

According to Federal Aviation Administration (FAA) records, the pilot held a commercial pilot certificate with ratings for helicopter and airplane single-engine land, issued on October 23, 2003. The pilot was issued a mechanic certificate on October 23, 2003, with ratings for airframe and power plant. The pilot was issued a first-class medical certificate on February 25, 2013, with the medical restriction "must wear corrective lenses for distant and possess glasses for near vision." FAA records also indicated that in February of 2013, the pilot reported 6,840 total flight hours and 76 flight hours in the previous 6 months. The pilot's logbooks were not retrieved.

Aircraft and Owner/Operator Information

Aircraft Make:	Robinson	**Registration:**	N3101H
Model/Series:	R44	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	1610
Landing Gear Type:	Skid	**Seats:**	4
Date/Type of Last Inspection:	December 4, 2012 Annual	**Certified Max Gross Wt.:**	2500 lbs
Time Since Last Inspection:	11 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	760 Hrs at time of accident	**Engine Manufacturer:**	Lycoming
ELT:	Not installed	**Engine Model/Series:**	O-540-F1B5
Registered Owner:	Bravo Helicopters LLC	**Rated Power:**	225 Horsepower
Operator:	Bravo Helicopters LLC	**Operating Certificate(s) Held:**	None

The four-seat, skid-type landing gear helicopter, serial number 1610, was manufactured in 2006. The helicopter was powered by a Lycoming O-540-F1B5, 225 horsepower engine, serial number L-26556-40A. Review of the aircraft and engine logbooks revealed the last annual inspection was conducted on December 04, 2012 at an hour meter time of 749.4 total hours of operation. The hour meter was located at the crash site and read 760.2 hours. According to FAA records, the helicopter was issued a standard airworthiness certificate on October 21, 2011.

According to the helicopter logbook, the manufacturer's order form indicated that both spindle bearings were replaced, refurbished, and installed on the new rotor blades. When this was completed, the new rotor blades automatically incurred a reduced service life when installing used spindles. The remaining time on the new rotor blades was reduced from 2,200 hours or 12 years, whichever comes first, to match the used spindles which had about 1,439 hours or 5 years remaining, whichever came first. The rotor blades and spindles expire as a pair.

The mechanic was hired to conduct the re-installation of the main rotor blades on the helicopter on April 3, 2013. The course of the day was spent installing the blades, making adjustments to the pitch change

links, and performing a track and balance procedure that adjusts the rotor blades for the smoothest operation on the rotor system. An approximate, uneventful 1 hour test flight was conducted prior to the accident flight.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KTMB,10 ft msl	**Distance from Accident Site:**	2 Nautical Miles
Observation Time:	13:53 Local	**Direction from Accident Site:**	90°
Lowest Cloud Condition:	Scattered / 3000 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	12 knots / 6 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	120°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30 inches Hg	**Temperature/Dew Point:**	29°C / 20°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Miami, FL (TMB)	**Type of Flight Plan Filed:**	None
Destination:	Miami, FL (TMB)	**Type of Clearance:**	None
Departure Time:	15:55 Local	**Type of Airspace:**	Class C

The TMB 1553 weather observation, located 1.5 miles west of the accident site, reported wind from 120 degrees at 12 knots, gusting to 18 knots, visibility 10 statute miles, scattered clouds at 3,000 feet above ground level, temperature 29 degrees Celsius, dew point 20 degrees Celsius, and an altimeter setting of 30.00 inches of mercury.

Airport Information

Airport:	Kendall Tamiami Executive Airp TMB	**Runway Surface Type:**	
Airport Elevation:	10 ft msl	**Runway Surface Condition:**	Unknown
Runway Used:		**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Fatal	**Latitude, Longitude:**	25.642221,-80.388053

The helicopter was located upright in a parking lot on the corner of southwest 128th street and southwest 122nd avenue in Miami, Florida, and came to rest on a heading of 105 degrees magnetic (M). The debris field was 110 degrees at a distance of about 500 feet. A postcrash fire had consumed a majority of the wreckage. Several helicopter components were located on the roofs of several industrial buildings.

The red main rotor blade exhibited thermal damage about 7 feet from the hub outward towards the rotor tip, and the entire blade was upside down. The red main rotor blade data plate was missing and the alternate number was found on the inside of the tip cap as blade 3043. There was a paint scuff on the top surface of the spindle adjacent to the hub. There were impact marks on the hub from the pitch horn boot and impact marks from the pitch horn to the hub leading edge face with the leading edge, 60 degrees upward from normal orientation. The spindle was torn and there was deformation of the leading edge of the spindle bolt hole. There was a fracture from the leading edge aft, to 2.7 inches with the aft face having a journal impression. The pitch horn was fractured and deformed with impact marks immediately adjacent to the fracture surface. The pitch change link assembly remained attached to the pitch horn by the appropriate hardware. There was a torque stripe on one side of the pal nut. The rod end at the opposite end of the link assembly was unremarkable. The blade was cut 13 feet 7 inches inboard of the rotor tip for recovery. The spindle was connected and rotated roughly.

The blue main rotor blade exhibited thermal damage from the hub outward about 8 feet towards the rotor tip and the entire blade was bowed down. The data plate was found installed on the blade as number 3034. Blade delamination was consistent with thermal damage. There was impact damage 4 feet 6 inches, 6 feet 6 inches, and 10 feet 10 inches from the blade tip. The blade was cut 13 feet inboard of the rotor tip for recovery. The blade tip cover and weight was in place with no chord wise scoring noted from the tip inboard on the lower surface. There was compression wrinkles on the lower surface 1 foot 7 inches inboard from the rotor tip. The blade was displaced aft about the mid span and was bowed up 3 feet inboard from the tip. There was a compression wrinkle on the upper surface 6 feet 8 inches inboard from the rotor tip. The leading edge of the upper surface exhibited chord wise scratches from the tip inboard to 7 feet that corresponded to a ground scar in the asphalt at the crash site. The upper skin was delaminated from the root of the rotor to 9 feet outboard. Upward bending started 14 feet inboard of the blade tip. The spindle was connected and rotated roughly.

The upper swash plate fork remained connected to the swash plate. The yolk remained connected to the fork by the dog bone. The yolk was connected to the dog bone on both sides. The yolk was fractured on the weighted sides and was recovered from the roof top of a building. The weights were in place but damaged due to impact with the gravel roof of the industrial park building.

The tail boom exhibited a vertical scuff with white paint transfer 25.25 inches forward of the aft

bulkhead, adjacent to the tail rotor blade tip arch. The intermediate flex coupling was deformed slightly, but still connected. There was rotational contact by the flex coupling with the upper frame. The tail cone was severed by the main rotor system between bays five and six during flight and came to rest 275 M about 300 feet from the initial impact point. The empennage remained attached to a 32-inch section of the tail boom, and exhibited damage to the trailing edge of the horizontal stabilizer. The tail rotor blades remained attached to the tail rotor gear box with one blade partially severed 9 inches outboard from the attachment point. The tail rotor rotated freely. There was fragmentation of bays five, six, and seven, at the left side where the danger sticker was adhered. This was consistent with a leading edge strike from a main rotor blade.

The tail rotor driveshaft was cut 8 inches aft of the flex coupling. The tail rotor gearbox rotated freely with no abnormal noise. Tail rotor flight control continuity was examined from the pedals to the tail rotor. Several separations were noted due to overload and fire damage with no connections compromised. Main rotor flight control continuity was examined from the cyclic and collective to the main rotor blades. Several separations were noted due to overload and fire damage with no connections compromised, with the exception of the pitch link to swash plate connection for blade number 3043. The pitch link/horn departed the helicopter and was found 260 degrees M and 90 feet from the initial impact point.

The instrument panel showed crushing damage and was ripped out of the helicopter during rescue operations. All canopy screens were destroyed and fragments were found at the beginning of the debris path, on the roof of four buildings, and at the initial impact point.

The carburetor mixture knob was full rich and the carburetor heat was unlocked and on. All crew and passenger seats were destroyed by postcrash fire. The pilot and passenger restraints were cut to recover the victims and were intact before the postcrash fire ensued. All restraint system harnesses were destroyed due to postcrash fire with the buckles fire damaged

The alternator was attached to the engine and fire damaged. The alternator belt was consumed by fire. The starter was fire and impact damaged and remained attached to the engine. No vacuum pump was installed on the engine. The magnetos and ignition harness were fire damaged. The top and bottom spark plugs were removed and exhibited light gray combustion deposits and a normal wear condition with one covered in oil. The engine was rotated by hand and compression and suction was noted on all cylinders. Crankshaft and valve train continuity were confirmed to the rear gears. All cylinders were examined using a lighted bore scope and no anomalies were noted.

The carburetor was destroyed by impact and fire. The carburetor fuel inlet screen was removed, fire damaged, and absent of debris. All fuel lines were fire damaged. The fuel line between the fuel valve and gascolator was compromised due to impact as was the fuel inlet fitting to the carburetor. The gascolator bowl and screen were clear of debris. No fuel was observed.

The lower swash plate interrupter was attached to the swash plate. The slider tube was sheared from the mount and was ripped around to the top. The swash plate rotated roughly by hand.

The swash plate assembly for the blue blade exhibited a pitch link that was bent in the center section and at the lower rod end. The upper rod end fractured in a bending overload at the threaded area and

remained safety wired.

The swash plate assembly for the red blade exhibited a disconnected lower rod end from the swash plate and the upper rod end remained attached to the pitch horn, which was fractured and the attached bolt was bent. The attaching hardware for the lower rod end was not recovered. There was no visible deformation damage to the pitch link mounting hole.

A detailed report of the airframe, systems, and power plant examination is contained in the NTSB public docket.

Medical and Pathological Information

Postmortem examinations were performed on the pilot and pilot-rated mechanic by the Miami-Dade Medical Examiner's office. The cause of death for each was reported as blunt force injuries.

The FAA's Civil Aerospace Medical Institute performed forensic toxicology on specimens from the pilot and pilot-rated mechanic. The tests were negative for carbon monoxide, cyanide, drugs, and ethanol.

Tests and Research

Several components from the rotor head system were harvested from the wreckage and sent to the NTSB Materials Laboratory in Washington, D. C. for further examination. The examination revealed that all fractures were consisted with overstress and no preexisting cracking was noted. The examination also revealed that the pitch change link attachment hole for the red blade appeared intact, free of damage, and was covered with black sooty deposits. The pitch link attachment hardware was missing from the attachment to the red blade side of the swash plate. A detailed report of the examination is contained in the NTSB public docket.

Additional Information

According to a pilot-rated witness, who was at the hangar during the maintenance procedure, the pilot was upset during the course of the day. The pilot had conducted conversations with the helicopter manufacturer over the installation of the refurbished spindles that were installed on the new blades and

that it was costing him $10,000 a month in lost revenues due to the helicopter not being in service. The pilot witness, who had flown the helicopter numerous times, stated that he observed the mechanic make adjustments to the pitch change rods on the rotor system during the maintenance procedure. He also stated that the mechanic told him that the owner of the helicopter was upset that the helicopter manufacturer installed refurbished spindles onto the new blades.

Administrative Information

Investigator In Charge (IIC):	Murray, Patrick
Additional Participating Persons:	Emil Ceril; FAA/FSDO; Miramar, FL Thom Webster; Robinson Helicopters; Torrence, CA Mike Childers; Lycoming Engines; WilliamsPort, PA
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