



# Aviation Investigation Final Report

<b>Location:</b>	Bountiful, Utah	<b>Accident Number:</b>	WPR15FA051
<b>Date &amp; Time:</b>	December 2, 2014, 14:00 Local	<b>Registration:</b>	N3234U
<b>Aircraft:</b>	ROBINSON HELICOPTER COMPANY R44	<b>Aircraft Damage:</b>	Substantial
<b>Defining Event:</b>	Flight control sys malf/fail	<b>Injuries:</b>	2 Fatal
<b>Flight Conducted Under:</b>	Part 91: General aviation - Personal		

## Analysis

Before the accident flight, the commercial helicopter pilot, who was also a mechanic, had re-installed the main rotor blades, which had just been reworked, on the helicopter. The accident flight was a test flight to adjust the track and balance of the rotor blades. A mechanic, who spoke with the pilot a few weeks before the accident, stated that they had a discussion about an elongated pitch change link attachment hole on the accident helicopter and how to address it. On the night before the accident flight, they spoke again; the pilot was having trouble tracking the blades on the accident helicopter. The pilot stated that he could not get the blades to track any better, and that he was trying to change the track with the trim tabs.

Witnesses in the area of the accident site heard "popping" or "banging" sounds, then saw the main rotor and empennage separate from the helicopter. Several of the witnesses then saw the helicopter tumble in flight and impact the roof of a building. The main rotor and empennage came to rest on the ground a few hundred feet from the building. Witness statements and wreckage documentation were consistent with a main rotor blade striking the tail and subsequently, a mast bump, which resulted in the helicopter descending uncontrollably.

The damage observed on the components of the main rotor system was consistent with an in-flight separation of the pitch change link for the red blade, with separation occurring at the location where the pitch change link attached to the swashplate. The swashplate was free of contact marks corresponding to contact with the red pitch change link, which contrasted with the area around the blue blade pitch change link attachment, where multiple contact marks corresponding to contact with the blue pitch change link were observed. Also, the red pitch change link was intact and relatively straight, indicating that separation occurred under loads less than that required to buckle or fracture the pitch change link. The slight bending in the red pitch change links was likely secondary to the separation of the attachment at the lower end as evidenced by the location of the corresponding thread contact marks on the pitch horn. Finally, a series of impressions corresponding to contact with threads on the red blade pitch change link

attachment bolt were observed on the attachment hole bore through the swashplate in an area that should have only contacted the grip portion of the bolt. Thus, it is likely that the intact bolt separated from the attachment due to loss of the lock nut and palnut.

Torque measurements were obtained on the locknuts installed on the three recovered pitch change link attachment bolts. All measured torque values were lower than that specified in the helicopter's maintenance manual, indicating that the fasteners were improperly torqued before the accident. While torque for the missing attachment bolt could not be measured, the torque measured on the remaining pitch change link attachment bolts and witness marks on the attachment hole bore in the swashplate suggest that the bolt likely separated due to insufficient torque applied at the time of installation, which led to the loss of the locknut and palnut due to vibrational loads under normal operation.

## Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot/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 a subsequent loss of control.

### Findings

<b>Aircraft</b>	Main rotor mast/swashplate - Incorrect service/maintenance
<b>Personnel issues</b>	Replacement - Maintenance personnel
<b>Personnel issues</b>	Incorrect action performance - Maintenance personnel

## Factual Information

### History of Flight

<b>Maneuvering-low-alt flying</b>	Flight control sys malf/fail (Defining event)
<b>Maneuvering-low-alt flying</b>	Mast bumping

### HISTORY OF FLIGHT

On December 2, 2014, about 1400 mountain standard time, a Robinson R44 II helicopter, N3234U, impacted a two-story building while maneuvering near Skypark Airport (BTF), Bountiful, Utah. The commercial pilot/mechanic and passenger were fatally injured, and the helicopter was substantially damaged. The helicopter was registered to Native Range Capture Services, Inc., Elko, Nevada, and operated by Native Range, Inc, Ventura, California. Visual meteorological conditions prevailed for the area, and no flight plan was filed for the local, post-maintenance test flight, which was conducted under the provisions of 14 Code of Federal Regulations Part 91. The flight departed from BTF shortly before the accident.

According to the owner of the helicopter, the pilot/mechanic was performing maintenance on the main rotor assembly and the purpose of the post-maintenance flight was part of the procedure to "track and balance" the main rotor blades. This maintenance spanned over several days.

Several witnesses in the area of the accident site heard "popping" or "banging" sounds then saw the main rotor and empennage separate from the helicopter. Some of the witnesses then saw the helicopter tumble in flight and impact the top of a building. The main rotor and empennage came to rest on the ground a few hundred feet from the impacted building. Security camera video footage from a nearby business captured the helicopter in the air shortly after the separation of the main rotor and empennage.

### PERSONNEL INFORMATION

The pilot, age 65, held a commercial pilot certificate with rotorcraft, airplane single-engine land, multi-engine land, and instrument ratings. The pilot held a Federal Aviation Administration (FAA) second-class medical certificate, which was issued on April 1, 2014, with no limitations. The pilot reported on his most recent medical certificate application that he had accumulated 5,500 total hours of flight experience. The pilot was issued a mechanic certificate on August 17, 2012, with ratings for airframe and powerplant. He attended the Robinson Helicopter Company's maintenance course in December 2008.

The passenger, age 63, held a private pilot certificate with a rating for airplane single-engine land. He held an FAA third-class medical certificate, issued on October 26, 2006, with the limitations that he must have available glasses for near vision, and not valid for any class after. The pilot reported on his most recent medical certificate application that he had accumulated 250 total hours of flight experience. He was issued a mechanic certificate on September 9, 2008, with ratings for airframe and powerplant. He had not attended the Robinson Helicopter Company's maintenance course.

## AIRCRAFT INFORMATION

The four-seat helicopter was manufactured in February 2007. It was powered by a Lycoming IO-540-AE1A5 reciprocating engine rated at 205 horsepower.

The helicopter's owner stated that, during a flight in the accident helicopter the month before the accident, the helicopter "had a bit of a vertical [vertical vibrations]". The blades also had noticeable slop and movement in the pitch change link bolt attachment to the swashplate. During a 100-hour inspection, on November 2, 2014, at 582 hours of helicopter total time, the owner and pilot/mechanic recommended sending the blades out for rework. According to airframe records, the [red] main rotor blade pitch horn was replaced, and the pilot-rated mechanic declined repainting of the blades. When the blades returned, the owner hired the pilot-rated mechanic to install the blades and track them in a heavier configuration.

According to a mechanic who spoke with the pilot a few weeks before the accident, they discussed an elongated pitch change link attachment hole on the accident helicopter and how to address it. On the night before the accident flight, they spoke again, and the pilot said he was having trouble tracking the blades on the accident helicopter. He reported that the blades could not track any better than a 1/2-inch separation, and that he was using the trim tabs to change the track. The mechanic suggested that the pilot use the fine adjustments on the pitch change links, then fly through all flight regimes, and fine tune with the trim tabs. He recommended to the pilot to look at the entire rotor system and thought that something was amiss.

Review of the helicopter's maintenance records showed that on September 12, 2007, at 87.3 hours total time, the hub and blades were rebuilt by Robinson Helicopter Company. The spindles, which include the pitch horns, were reused during the rebuild.

## METEOROLOGICAL INFORMATION

The 1353 weather observation at Salt Lake City International Airport (SLC), Salt Lake City, Utah, located 5 miles south of the accident site, reported wind from 320 degrees at 3 knots, visibility 10 statute miles, scattered clouds at 15,000 feet above ground level, broken clouds at 19,000 above ground level, temperature 8 degrees C, dew point 2 degrees C, and an altimeter setting of 30.05 inches of mercury.

## WRECKAGE AND IMPACT INFORMATION

Examination of the accident site by the National Transportation Safety Board (NTSB) investigator-in-charge (IIC) revealed a wreckage debris field about 880 ft in length, about 400 ft in width, and oriented on a 277° magnetic heading. The main rotor and empennage separated from the main wreckage before impact and were found within the wreckage debris field. The main rotor assembly was found near a parking lot about 188 ft from the main wreckage. The empennage separated from the main wreckage and was found near a parking lot about 430 ft from the main wreckage. Several sections of the tail rotor drive shaft were found throughout the debris field. A large section of the tail rotor drive shaft pierced the roof about 90 ft from where the fuselage entered the roof. Both pitch change links and transmission housing material were found throughout the debris field. Plexiglas sections were found throughout the debris field. A 4-ft section of the main rotor blade tip was found in a retention pond and was furthest from the main wreckage.

The main wreckage impacted and penetrated the roof of a two-story building about 2,000 ft southwest of the approach end of runway 34 at BTF. A postimpact fire occurred; however, the building's sprinkler system was activated, and an overhead sprinkler pressure line was separated near the main wreckage, releasing water and limiting the postimpact fire to the main wreckage. The main wreckage displayed impact damage and was partially damaged by the fire.

The wreckage was recovered to a secure facility for further examination. The main wreckage, consisting of the cabin area and a 5-ft section of the tailboom, exhibited impact and thermal damage. The left side of the cabin was crushed inward towards the center, and the right side near the firewall was crushed inward. The rear seat area had minor thermal damage.

The cabin area was crushed and distorted. Both forward seat structures were crushed inward and slightly forward. The front of the fuselage was crushed inward and the windshield was shattered. First responders cut the left forward seat belts. The right forward seat belts were unbuckled.

The top side of the airframe had several disconnects and separations, and was bent to the right side. The tail cone separated aft of the number seven bay, and bay numbers 4, 5 and 6 separated into several sections, consistent with a main rotor strike. The left side of the number 1, 2 and 3 tail cone bays were flattened inward.

The flight controls had several disconnects between the cyclic/collective and swashplate. All fractures exhibited signatures consistent with overload. The tail rotor flight controls had several disconnects from the pedals to the tail rotor, and all separations exhibited overload signatures.

The fuel tanks remained attached to the airframe. The crossover hose fitting at the main tank was separated. The fuel vent hoses pulled apart from vent line fittings. The hoses and lines were clear of debris. Both fuel tank skins sustained impact damage, and the bladders remained intact. Both fuel caps remained secured to the filler neck.

The empennage was fractured about 32 inches from the tail rotor gearbox mount. The tail rotor blades sustained minor impact damage. The tail rotor driveshaft exhibited an impact about 4 inches from the empennage separation. The curvature of the impact mark was consistent with the curvature of the main rotor blade leading edge. The tail rotor drive shaft separated in four places. The tail rotor blades exhibited signatures consistent with low rotor RPM at ground impact.

The v-belts remained attached to the upper sheave and were split between the vees. The belts had thermal damage. The intermediate flex plate was distorted.

The upper sheave forward and aft faces had rotational scoring around the entire circumference. The upper frame tubes adjacent to the forward face had scoring running in the direction of rotation of the upper sheave. The clutch centering strut had rotational scoring on its forward face adjacent to the aft face of the upper sheave running in the direction of rotation. The oil cooler had rotational scoring adjacent to the starter ring gear. The alternator cooling fan was distorted around its entire circumference.

The main rotor gearbox (MRGB) separated at the gearbox housing. The MRGB mast tube fractured near its midsection. The MRGB drive shaft was bent below the swashplate and bent and separated at the teeter stop.

The red blade remained attached to the main rotor hub. The separated sections of the outboard end were found in the debris field. The tip cap was broken, with the attachment bolts still integral to the main rotor blade. The blade tip and about 43 inches of the leading edge spar were found near the beginning of the debris field. Two afterbody sections measuring about 45 inches in length separated the tip. Gray paint transfer marks, about 2 inches wide and 4 inches long, were observed on the upper surface about 25 inches from the tip. The blade spar was bent forward about 15° beginning about 54 inches from the tip. The leading edge was damaged about 4 ft from the hub. Red transfer marks on the leading edge were found about 42 inches from the center of rotation of the blade. The pitch horn separated from the blade grip and the fractured surface was consistent with overload. Thread imprints were observed above the pitch change link upper rod end. The pitch change link remained attached to the pitch change horn and had multiple bends. The counterweights and hardware for the lower red blade pitch change link to swashplate attachment was not found. The blade droop stop was bent downward and remained attached to the grip.

The blue blade remained attached to the main rotor hub. The tip cap separated from the blade and was found in the main wreckage. The blade spar was continuous from the inboard to the outboard end. The blade afterbody was fractured from the spar to the tip end to about 72 inches inboard. The spar was bent opposite the direction of rotation about 72 inches from the tip end, bent about 15° aft. The blade afterbody wrinkled aft of the spar attachment area from the tip end to 96 inches inboard of the tip end. The blue blade had impact marks on the leading edge, about 20 inches from the center of rotation. The curvature of the impact marks was consistent with the curvature of damage on the blue blade's pitch horn. The pitch horn was fractured at the blade grip, and the fracture surface was consistent with overload. Thread imprints were observed on the pitch horn above the pitch change link upper rod end. The droop stop was bent downward but remained integral to the grip. The pitch change horn was recovered in the debris field. The upper rod end remained attached to the pitch change horn but was fractured at the threads beneath the upper rod end bearing. The midsection of the pitch change link was recovered loose but was fractured at the pitch change link barrel. The lower section of the pitch change link remained attached to the swashplate. The threads adjacent to the lower rod end were bent.

The main rotor hub hardware, including the bolts, shims, nuts, and safeties, remained intact. The hub exhibited impact marks of the blue blade grip contacting the hub, consistent with flapping exceedance. Similar impact marks of less severity were observed on the red blade grip side. A small upper section of the main rotor drive shaft remained attached to the hub via the teetering bolt. The small upper section separated a few inches below the hub, and was severely bent inward on the side of the red blade spindle. Coarse thread imprints were found on the lower edge of the hub immediately beneath the red blade coning bolt, consistent with a pitch change link. On the upper surface of the hub, adjacent to the teetering bolt on the red blade side, an impact mark was consistent with the impact from a pitch change rod link end bearing.

The swashplate red blade pitch change link bolt hole exhibited dark surface markings on the outboard edge and about midway down the bore. Thread impact marks were found on the swashplate adjacent to the lower rod end bearing of the blue blade pitch change link attachment location.

The landing skids were fractured in multiple locations. The aft crosstube separated from the main wreckage. The forward crosstube remained attached to the cabin. Both the forward left and aft left struts were bent aft.

The engine remained attached to the fuselage. Thermal damage was noted to the wiring harness and ignition leads. The engine was covered in a sooty residue. The firewall and fuel pump housing exhibited impact damage. The magneto ignition leads exhibited impact damage near the distributor cap, and thermal damage near the cylinders. The lower sparkplugs were removed and revealed normal wear conditions with light gray deposits. Two of the spark plugs were saturated in oil. The crankshaft was rotated by hand, and cylinder compression was obtained. The ignition leads were cut near the thermal damage, and spark was obtained from all leads during crankshaft rotation. The magnetos were not removed during the examination. Rotational scoring was evident on the fan wheel assembly. The starter ring gear separated from the flywheel. The oil pickup screen was removed and was clear of debris. The exhaust assembly was crushed upwards.

A detailed report of a follow-up examination is contained in the NTSB public docket.

#### MEDICAL AND PATHOLOGICAL INFORMATION

Postmortem examinations were performed on the pilot and passenger by the Utah Department of Health, Medical Examiner's office. The cause of death for each was reported as total body blunt force injuries.

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

#### TEST AND RESEARCH

The main rotor blades (both inboard sections), hub, upper mast section, upper drive shaft section, droop stops (2), yoke, pitch change links (2), main rotor blade pitch change horns (2), and swashplate were sent to the NTSB Materials Laboratory for further examination. The examination revealed that all fractures consisted with overstress failure, and no preexisting cracking was noted. The examination also revealed that the pitch change link attachment hole for the red blade appeared intact and free of damage. The red blade pitch link was intact and relatively straight. The counterweights and the lower red blade pitch change link attachment hardware were missing. Torque measurements were taken on nuts installed on the three recovered pitch change link attachment bolts. The torque values for all three nuts were lower than that required by the manufacturer's maintenance manual. A detailed report of the examination is contained in the NTSB public docket.

#### ADDITIONAL INFORMATION

According to manufacturer's maintenance instructions, the attachment bolts used at the upper and lower ends of the pitch change links are NAS6605 series bolts. The locknuts for the NAS6605 series bolts should be fastened to a dry torque value of 240 lb-in  $\pm$  24 lb-in, and palnuts used on NAS6605 series bolts should be applied with a dry torque of 20 lb-in to 40 lb-in. During installation, the palnuts are installed over the top of the locking nut.

## Pilot Information

<b>Certificate:</b>	Commercial; Flight instructor	<b>Age:</b>	65
<b>Airplane Rating(s):</b>	Single-engine land; Multi-engine land	<b>Seat Occupied:</b>	Right
<b>Other Aircraft Rating(s):</b>	Helicopter	<b>Restraint Used:</b>	3-point
<b>Instrument Rating(s):</b>	Airplane; Helicopter	<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>	Instrument airplane; Instrument helicopter	<b>Toxicology Performed:</b>	Yes
<b>Medical Certification:</b>	Class 2 With waivers/limitations	<b>Last FAA Medical Exam:</b>	April 1, 2014
<b>Occupational Pilot:</b>	Yes	<b>Last Flight Review or Equivalent:</b>	
<b>Flight Time:</b>	5500 hours (Total, all aircraft)		

## Pilot-rated passenger Information

<b>Certificate:</b>	Private	<b>Age:</b>	63
<b>Airplane Rating(s):</b>	Single-engine land	<b>Seat Occupied:</b>	Left
<b>Other Aircraft Rating(s):</b>		<b>Restraint Used:</b>	3-point
<b>Instrument Rating(s):</b>		<b>Second Pilot Present:</b>	Yes
<b>Instructor Rating(s):</b>		<b>Toxicology Performed:</b>	Yes
<b>Medical Certification:</b>	Class 3 With waivers/limitations	<b>Last FAA Medical Exam:</b>	October 26, 2006
<b>Occupational Pilot:</b>	No	<b>Last Flight Review or Equivalent:</b>	
<b>Flight Time:</b>	(Estimated) 250 hours (Total, all aircraft)		



## Aircraft and Owner/Operator Information

<b>Aircraft Make:</b>	ROBINSON HELICOPTER COMPANY	<b>Registration:</b>	N3234U
<b>Model/Series:</b>	R44 II	<b>Aircraft Category:</b>	Helicopter
<b>Year of Manufacture:</b>	2007	<b>Amateur Built:</b>	
<b>Airworthiness Certificate:</b>	Normal	<b>Serial Number:</b>	11654
<b>Landing Gear Type:</b>	N/A; Skid	<b>Seats:</b>	4
<b>Date/Type of Last Inspection:</b>	October 19, 2014 100 hour	<b>Certified Max Gross Wt.:</b>	
<b>Time Since Last Inspection:</b>		<b>Engines:</b>	1 Reciprocating
<b>Airframe Total Time:</b>	582 Hrs as of last inspection	<b>Engine Manufacturer:</b>	LYCOMING
<b>ELT:</b>	Installed	<b>Engine Model/Series:</b>	IO-540-AE1A5
<b>Registered Owner:</b>	NATIVE RANGE CAPTURE SERVICES INC	<b>Rated Power:</b>	205 Horsepower
<b>Operator:</b>	Native Range Inc.	<b>Operating Certificate(s) Held:</b>	None

## Meteorological Information and Flight Plan

<b>Conditions at Accident Site:</b>	Visual (VMC)	<b>Condition of Light:</b>	Day
<b>Observation Facility, Elevation:</b>	KSLC, 4227 ft msl	<b>Distance from Accident Site:</b>	5 Nautical Miles
<b>Observation Time:</b>	20:53 Local	<b>Direction from Accident Site:</b>	203°
<b>Lowest Cloud Condition:</b>	Scattered / 15000 ft AGL	<b>Visibility</b>	10 miles
<b>Lowest Ceiling:</b>	Broken / 19000 ft AGL	<b>Visibility (RVR):</b>	
<b>Wind Speed/Gusts:</b>	3 knots /	<b>Turbulence Type Forecast/Actual:</b>	/ None
<b>Wind Direction:</b>	320°	<b>Turbulence Severity Forecast/Actual:</b>	/ N/A
<b>Altimeter Setting:</b>	30.04 inches Hg	<b>Temperature/Dew Point:</b>	8°C / 2°C
<b>Precipitation and Obscuration:</b>	No Obscuration; No Precipitation		
<b>Departure Point:</b>	BOUNTIFUL, UT (BTF )	<b>Type of Flight Plan Filed:</b>	
<b>Destination:</b>	BOUNTIFUL, UT (BTF )	<b>Type of Clearance:</b>	None
<b>Departure Time:</b>	14:00 Local	<b>Type of Airspace:</b>	Class E

## Airport Information

<b>Airport:</b>	SKYPARK BTF	<b>Runway Surface Type:</b>	Asphalt
<b>Airport Elevation:</b>	4234 ft msl	<b>Runway Surface Condition:</b>	Dry
<b>Runway Used:</b>	34	<b>IFR Approach:</b>	None
<b>Runway Length/Width:</b>	4700 ft / 70 ft	<b>VFR Approach/Landing:</b>	Traffic pattern

## Wreckage and Impact Information

<b>Crew Injuries:</b>	1 Fatal	<b>Aircraft Damage:</b>	Substantial
<b>Passenger Injuries:</b>	1 Fatal	<b>Aircraft Fire:</b>	On-ground
<b>Ground Injuries:</b>	N/A	<b>Aircraft Explosion:</b>	None
<b>Total Injuries:</b>	2 Fatal	<b>Latitude, Longitude:</b>	40.857776,-111.923889(est)

## Administrative Information

<b>Investigator In Charge (IIC):</b>	Swick, Andrew
<b>Additional Participating Persons:</b>	David Odekirk; FAA-FSDO; Salt Lake City, UT Thom Webster; Robinson Helicopter Company; Torrance, CA Troy Helgeson; Lycoming Engines; Denver, CO
<b>Original Publish Date:</b>	April 4, 2017
<b>Last Revision Date:</b>	
<b>Investigation Class:</b>	<a href="#">Class</a>
<b>Note:</b>	The NTSB traveled to the scene of this accident.
<b>Investigation Docket:</b>	<a href="https://data.nts.gov/Docket?ProjectID=90447">https://data.nts.gov/Docket?ProjectID=90447</a>

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The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, “accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties ... and are not conducted for the purpose of determining the rights or liabilities of any person” (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB’s statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available [here](#).