



AVIATION



HIGHWAY



MARINE



RAILROAD



PIPELINE

Aviation Investigation Final Report

Location:	Mammoth, California	Accident Number:	WPR10LA458
Date & Time:	September 16, 2010, 13:30 Local	Registration:	N2153S
Aircraft:	ROBINSON HELICOPTER COMPANY R44 II	Aircraft Damage:	Substantial
Defining Event:	Dynamic rollover	Injuries:	2 Serious
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot departed on the final leg of a helicopter cross-country flight. About 30 minutes after departure he began to experience stomach cramps. He landed the helicopter in a level meadow on the slopes of a mountain, at an altitude close to the helicopter's maximum Hover Out of Ground Effect altitude ceiling. The pilot left the engine running, locked the flight controls, and instructed the passenger to hold the controls steady. He departed the helicopter, reentered, confirmed all systems were in order, and lifted it to a low hover. Cognizant of the helicopter's performance limitations at altitude, he departed toward descending terrain. During the initial low-altitude takeoff phase, and prior to reaching translational lift, the pilot observed an auxiliary fuel pump warning light. He elected to discontinue the departure and land. During the landing, the skid made contact with the ground and vegetation and the helicopter experienced a dynamic rollover. The pilot did not recall a change in engine tone after receiving the warning, but did recollect a loss of rotor speed indication prior to impact. During the rollover sequence, the occupants were engulfed in fuel, which then ignited causing serious injury to both.

The helicopter remnants, ground scars, and the pilot's recollection of the accident sequence indicated relatively low impact forces during the accident. Arcing signatures on an electrical wire located next to both fuel tanks could indicate a potential ignition source for the fuel; however, thermal damage to the helicopter structure, and the location of the fuel tanks above the engine compartment, precluded a definitive confirmation of the ignition source. The helicopter's manufacturer had issued a service letter recommending installation of fuel tank bladders in an effort to reduce the likelihood of a postaccident fuel leak. This service letter had not been complied with; however, compliance was not required per Federal Aviation Administration regulations.

The engine and fuel system sustained considerable thermal damage, and as such a complete examination was not possible. Examination of the engine and fuel system remnants did not result in any findings that would have indicated a loss of engine power or the observed auxiliary fuel pump warning. The helicopter's manufacturer issued a safety alert recommending restricting high-temperature and high-altitude operations due to the potential for development of fuel vapor within the fuel system. While illumination of the auxiliary fuel pump warning was an indication of the possible formation of fuel vapor, the investigation was unable to conclusively determine the reason for the auxiliary fuel pump warning.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: Dynamic rollover of the helicopter during a precautionary landing.

Findings	
Personnel issues	Illness/injury - Pilot
Environmental issues	High density altitude - Effect on equipment
Aircraft	Lateral/bank control - Not attained/maintained
Aircraft	Fuel pressure - Not specified

Factual Information

History of Flight

Enroute-cruise	Miscellaneous/other
Enroute-cruise	Off-field or emergency landing
Takeoff-rejected takeoff	Dynamic rollover (Defining event)

HISTORY OF FLIGHT

On September 16, 2010, about 1330 Pacific daylight time, a Robinson Helicopter Company (RHC) R44 II, N2153S, collided with terrain and rolled over during an emergency landing near Mammoth, California. The pilot was operating the helicopter under the provisions of Title 14 Code of Federal Regulations Part 91. The certificated private pilot and passenger sustained serious injuries. The helicopter sustained substantial damage. The cross-country flight departed Eastern Sierra Regional Airport, Bishop, California, about 1300, with a planned destination of Truckee-Tahoe Airport, Truckee, California. Visual meteorological conditions prevailed, and no flight plan had been filed for the accident leg.

The pilot reported that at 0600 on the day of the accident he and his passenger departed in the helicopter from their residence in Benson, Arizona. He had serviced the helicopter with 100 LL aviation gasoline at a local airport the day prior, and subsequently filled the tanks to capacity that morning using additional aviation fuel stored in a gas can. They departed with the intention of performing intermediate fuel stops at Lake Havasu and Bishop. According to the pilot, the first leg of the trip took about 2.5 hours. About 5 miles from Lake Havasu he observed the low fuel warning indicator illuminate. He made a straight-in approach to land, and according to fuel receipts, at 0907 he serviced the helicopter with 45.9 gallons of 100 low-lead aviation gasoline. After refueling, he visually examined the fuel quality at the fuel drain points, and checked the helicopter for fuel leaks but did not observe any anomalies. The airport manager stated that he heard the pilot declaring a fuel emergency over the UNICOM (the common traffic advisory frequency) prior to landing at the airport.

The pilot reported that the fuel consumption was higher than he had experienced on prior flights, and for that reason he elected to continue the flight, but make a second intermediary fuel stop at Jean, Nevada. He canceled his VFR flight plan due to the additional stop, and then departed for Jean. After arrival, he serviced the helicopter with 14.86 gallons of fuel, and again checked for both fuel leaks and fuel quality at the fuel drain points with no anomalies noted.

While at Bishop they serviced the fuel tanks to capacity with the addition of 26.42 gallons of fuel, ate lunch at a restaurant located on the airfield, and departed.

About 30 minutes after takeoff, at an altitude of 8,500 feet mean sea level (msl), the pilot

began to experience stomach cramps. He landed the helicopter about 8,600 feet in a meadow on a flat area of the southern slopes of Glass Mountain. He reported that the winds were calm in the landing area. He applied the control friction locks, asked the passenger to monitor the controls, and with the engine still running, he exited. After relieving himself, he entered the helicopter and prepared for departure.

The pilot raised the helicopter into a 2-3 foot hover, rotated it to the left, and began to initiate a departure downhill while following the shallow descending terrain. He held the helicopter between 2-3 feet agl and began to build airspeed to about 8 knots in anticipation of entering translational lift. He reported that the helicopter appeared to be performing normally, and he was able to maintain between 23.5 and 24 inches of manifold pressure. The helicopter continued to accelerate through to 10 knots and shortly thereafter, prior to entering translational lift, he observed the auxiliary fuel pump warning indicator illuminate with a simultaneous reduction in rotor rpm. He then lowered the collective and raised the nose with the intention of performing a run-on landing. He observed a sage-brush off the nose as the helicopter skids made contact with the ground. The helicopter then tipped slightly forward, and then rolled to the right, in a manner that he described as consistent with a dynamic rollover. The main rotor blades then struck the ground and were followed by several loud bang sounds. The cabin then became engulfed in fuel, which continued to spray forward about 10 feet. The entire cabin was then consumed in fire. The pilot extricated himself from the helicopter and assisted the passenger. They were both partially engulfed in flames and rolled around in the dirt in an attempt to extinguish themselves. A few seconds later a surge of flames erupted from the helicopter, re-igniting the pilot and his passenger. The pilot extinguished the flames on his passenger, who now appeared to be more seriously injured, and secured her upwind.

The flight became the subject of an ALNOT after a friend reported that they had not arrived in Truckee. Records from the sheriff's department indicated that a fire truck was dispatched to the vicinity of Glass Mountain at 1412 following a report of fire by a hiker. No indications of a fire were observed by the crew. The pilot reported that at 1430 he observed a truck on a ridgeline above the accident site, the truck occupants appeared to be searching the area, but they did not see him. The truck then departed, and the pilot decided to leave the site to search for assistance.

Search and rescue teams were subsequently dispatched, and at 2130, after walking 10 miles, the pilot reached a campsite and summoned help.

PERSONNEL INFORMATION

A review of Federal Aviation Administration (FAA) airman records revealed that the pilot held a private pilot certificate with ratings for rotorcraft-helicopter. The pilot's flight logbooks were destroyed in the post accident fire. He estimated a total of 250 flight hours in helicopters at the time of the accident.

The pilot participated in the RHC Flight Instructor Safety Refresher Clinic in December 2008. At

the conclusion of the course he reported a total time in helicopters of 80 flight hours, 60 of which were in the R44. His evaluation indicated above average performance for simulated engine out, with average performance for low rpm recovery, settling with power, straight autorotations, 180-degree autorotations, overall handling and maneuvering, attitude, and knowledge. He scored below average for his performance of hovering autorotations.

AIRCRAFT INFORMATION

The helicopter was manufactured in November 2002, and was equipped with its original Lycoming fuel injected IO-540-AE1A5 engine, serial number L-28454-48A. A review of the maintenance logbooks revealed that the helicopter had undergone an annual inspection on February 11, 2011, at a total airframe time of 728.9 flight hours. According to the logbooks, the last maintenance item performed included an engine oil and filter change by the pilot at 775 flight hours on the day prior to the accident. Fire damage precluded an exact determination of the helicopters total flight time.

The helicopter was equipped with an interconnected main and auxiliary fuel tank, with a combined capacity of 50.1 gallons, 48.9 of which was usable fuel.

METEOROLOGICAL INFORMATION

The closest weather reporting facility to the accident site was Mammoth Yosemite Airport, Mammoth Lakes, California, 11 miles south, at an elevation of 7,135 feet. The airport was equipped with an Automated Weather Observation System (AWOS-3) and reported the following conditions at 1329: Wind from 110 degrees at 10 knots; visibility unrestricted at 10 miles; skies clear; temperature 25 degrees Celsius (C); dew point -8 degrees C; altimeter 30.23 inches of Mercury.

At 1256, the Automated Surface observation System (ASOS), located at Bishop Airport reported wind from 170 degrees at 11 knots gusting to 18; visibility unrestricted at 10 miles; clear skies; temperature 32 degrees C; dew point -9 degrees C; altimeter 30.00 inches of Mercury.

The density altitude at the accident site, based on the weather conditions reported at both airports, was calculated to range from 11,110 to 11,578 feet.

The forecasted 9,000 feet winds aloft for the area of the accident site indicated winds from 150 at 11 knots.

WRECKAGE AND IMPACT INFORMATION

The helicopter was located in a flat meadow at an elevation of 8,700 feet msl. The area consisted of dried grass, dispersed with knee-high brush and scrub. The helicopter came to rest on its right side, on a heading of 350 degrees magnetic.

The entire cabin area, forward of the firewall was consumed by fire. The tail cone aft of the cabin sustained thermal damage at the airframe mounts, but remained largely intact. The horizontal stabilizer sustained a 90 degrees upward bend, 12 inches from the tip. The tail rotor blades appeared intact and connected to the tail rotor gearbox, the vertical stabilizer was undamaged. The landing gear remained attached to the main helicopter frame and had sustained minimal damage with the exception of the right toe, which had separated at the forward strut. Buckling was noted on the upper fracture surfaces of the failure area consistent with upwards overload of the toe.

Fragmented remains of both main rotor blades were located strewn in all directions about 30 feet around the fuselage. The ground in the immediate area of helicopter exhibited fresh ruts, groves, and excavations. Two ground indentations on a heading of 020/200 degrees, similar in dimension to both landing skids, were noted about 150 feet south of the main wreckage.

TESTS AND RESEARCH

Airframe

Thermal damage precluded a complete examination of all helicopter systems. Examination of the remnants of the flight control, drive train, and rotor systems did not reveal indications of pre-existing failure or malfunction. A complete examination report is included within the docket for this accident.

The helicopter was equipped with a rotor brake system located within the gearbox deck area, adjacent to and in-between both fuel tanks. The system is incorporated with the tail yoke drive assembly. Both the main and auxiliary fuel tanks are located directly above the engine compartment.

A 28-volt electrical starter inhibit/warning system is actuated through the use of a micro switch located on the brake lever assembly within the bay. With the rotor brake engaged, the switches normally closed contact allows current to pass from the main power buss to the rotor brake warning light. Releasing the rotor brake, and thus engaging the switches normally open contact, allows current to pass from the main power buss through to the starter system.

The micro switch and associated electrical wiring are positioned about 2 inches from the rotating tail rotor drive yoke.

Examination of the yoke revealed that it had become bent upwards, and towards the micro switch, presumably during impact. The remnants of the main rotor gearbox cooling duct coil had become entangled with the yoke. The rotor brake wiring had sustained thermal damage, destroying its insulators and separating it from the frame. Examination of the rotor brake electrical wiring in the area adjacent to the fuel tanks and yoke revealed that the common and normally open wires had fused together about 0.5 inches from the switch's crimped

connection. The wire bundle was sent to the NTSB Materials Laboratory for examination. Examination revealed that the two wires had become fused together in a manner consistent with electrical arcing.

Fuel Supply System

The fuel system sustained extensive thermal damage. The main fuel tank forward bulkhead was thermally destroyed, the fuel filler cap remained in place at the filler neck. The majority of the auxiliary fuel tank was consumed by fire, with the outer skin, and a section of the aft bulkhead remaining. The fuel filler cap remained in place at the filler neck. The auxiliary fuel tank screen and fitting were found within the wreckage and noted to be free of obstructions and debris.

Remnants of all stainless steel braided fuel hoses were located in the debris. The fire sheathing for all of the hoses were removed to facilitate examination. The inner rubber material was fire consumed, and examination of the braid revealed no indications of rupture or breach.

The fuel shutoff valve had become separated from the firewall, and had melted into a glob with other unidentifiable parts. The selector input shaft remained exposed, and set to the open position. The fuel line from the valve to the gascolator remained in place through the firewall where it remained attached to the gascolator. All remaining fuel lines appeared intact at their respective fittings through to the fuel injection servo inlet.

The gascolator and auxiliary pump assembly was removed for examination. Safety wire was noted at the casing collar and gascolator housing. Removal of the sediment bowl revealed the internal surfaces to be yellow in color, and free of debris. The sealing gasket was noted in place, and free of cracks. The elbow fitting connecting the gascolator to the auxiliary fuel pump remained finger tight at both ends, and was free of obstructions. The auxiliary fuel pump housing had become partially consumed, with its motor section separated from the housing. The fuel pressure switch had melted away from the pump assembly outlet T-fitting. The pressure transducer section of the switch was thermally damaged, and had separated from its diaphragm.

No breaches or failures were noted in any of the remaining fuel supply components. A complete examination report is included within the docket for this accident.

Engine

The engine remained attached at its mounts within the airframe, and had sustained thermal damage to the case and all ancillary components. The engine case appeared to be intact with no holes or perforations observed. The exhaust system was observed to have sustained ductile bending and crushing, and exhibited ash grey deposits and discoloration to its visible internal surface. The ignition harnesses and magnetos remained in place and sustained

thermal damage which precluded a test of the ignition system components.

The top spark plugs were removed; no mechanical damage was noted. All spark plug electrodes exhibited varying degrees of discoloration consistent with post accident fire. The electrodes were oval in shape, corresponding to normal service life when compared with the Champion Aviation Check-A-Plug AV-27 Chart.

The engine's internal mechanical continuity was established through to the accessory case by rotation of the crankshaft, during which thumb compression was attained in all cylinders, and the engine driven fuel pump cam follower was observed to move up and down.

The external surfaces of the engine driven fuel pump had sustained thermal damage, which had consumed the internal pump diaphragm. The pump lever and plunger appeared intact and continuous, and the two valves remained in place.

No failures were noted with any of the engine systems that would have precluded normal operation. A complete examination report is included within the docket for this accident.

Fuel Injection System

The fuel flow divider cover had sustained thermal damage, exposing the inner cavity. Removal of the cover revealed the diaphragm to be thermally destroyed; no other debris was noted within the cavity.

The fuel injector nozzles appeared free of blockage. Examination of the fuel servo inlet screen revealed it to be free of obstructions.

An examination of the fuel servo system was conducted at the facilities of Precision Airmotive. No anomalies or failures were noted that would have precluded normal operation. A complete examination report is included within the docket for this accident.

ADDITIONAL INFORMATION

At the time of the accident, RHC had published both a service letter (SL) and a service bulletin (SB) regarding modifications intended to reduce the likelihood of post accident fuel leaks. Additional service bulletins and a safety notice (SN) were published regarding the integrity of fuel system components, and the need for all occupants to wear fire-retardant flight suits.

SB-68: Rigid Fuel Line Replacement, recommended replacing rigid fuel lines with flexible hoses. According to RHC, this modification reduces the likelihood of a post accident fuel leak. Examination of the helicopter's logbooks and remnants of the fuel system revealed that this service bulletin had been complied with.

SL-36: Bladder Fuel Tank Factory Modification, recommended retrofitting both fuel tanks with

internal bladders, again to reduce the likelihood of a post accident fuel leak. The helicopter was not equipped with bladder tanks. Compliance with SL's are not required per FAA regulations. RHC replaced this service letter 3 months after this accident, upgrading it to service bulletin (SB-78). The service bulletin recommends compliance no later than December 31, 2014.

SB-69: Gascolator Assembly, recommended replacing the clip-type gascolator with a threaded top, collar, and ring. Examination of the helicopter's logbooks and remnants of the fuel system revealed that this service bulletin had been complied with.

SN-40: Post Crash Fires, referenced examples of where occupants have survived an accident, only to receive serious burns by post-accident fires. The notice recommends that all occupants wear fire-retardant Nomex flight suits. The occupants were not wearing Nomex suits at the time of the accident; compliance with safety notices is not mandated by FAA regulations.

Hot Weather Operation

The fuel system is equipped with an auxiliary fuel pump warning indicator. The system consists of a pressure switch located at a T-fitting on the output side of the auxiliary fuel pump. The switch is designed to activate should the fuel pressure at the output of the auxiliary fuel pump drop below 23 psi.

Based on a report of an unexplained engine power loss in a new R44 Raven II during its ferry flight from the factory, RHC issued Safety Alert (SA) 44. The safety alert recommends restricting operations to temperatures below 40.5 degrees C, and notes, "Pilots should be aware of the potential for fuel system vapor in high ambient temperatures. Also, higher altitude increases the likelihood of fuel system vapor. An intermittent or flickering auxiliary fuel pump warning light may be an early indication of vapor formation. If vapor formation is suspected, decrease altitude and/or discontinue operations until cooler conditions exist."

Performance

According to the R44 II Pilot Operating Handbook (POH), In Ground Effect (IGE) hover ceiling, based on full throttle, zero wind, and a gross weight of 2,235 pounds, would be about 12,200 feet pressure altitude.

No fuel consumption or range figures for the R44 II are published in the POH. According to RHC documentation regarding the estimated operating costs for the R44 II, 'average' fuel consumption ranges between 14 and 16 gallons per hour.

Emergency Procedures

The POH states that the auxiliary fuel pump warning light indicates low auxiliary fuel pressure, and if no other indication of a problem is present, the pilot should land as soon as practical

and if the illumination is accompanied by erratic engine operation, the pilot should land immediately. Additionally, the low fuel warning indicator illuminates when about 3 gallons of usable fuel remains.

Pilot Information

Certificate:	Private	Age:	52, Male
Airplane Rating(s):	None	Seat Occupied:	Right
Other Aircraft Rating(s):	Helicopter	Restraint Used:	
Instrument Rating(s):	None	Second Pilot Present:	No
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 3 With waivers/limitations	Last FAA Medical Exam:	September 30, 2009
Occupational Pilot:	No	Last Flight Review or Equivalent:	December 15, 2008
Flight Time:	(Estimated) 275 hours (Total, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	ROBINSON HELICOPTER COMPANY	Registration:	N2153S
Model/Series:	R44 II	Aircraft Category:	Helicopter
Year of Manufacture:		Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	10004
Landing Gear Type:	Skid	Seats:	4
Date/Type of Last Inspection:	February 11, 2010 Annual	Certified Max Gross Wt.:	2500 lbs
Time Since Last Inspection:	48 Hrs	Engines:	1 Reciprocating
Airframe Total Time:	729 Hrs as of last inspection	Engine Manufacturer:	LYCOMING
ELT:	C91A installed, not activated	Engine Model/Series:	IO-540-AE1A5
Registered Owner:	On file	Rated Power:	260 Horsepower
Operator:	On file	Operating Certificate(s) Held:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:	MMH,7135 ft msl	Distance from Accident Site:	11 Nautical Miles
Observation Time:	13:29 Local	Direction from Accident Site:	180°
Lowest Cloud Condition:	Clear	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	10 knots / None	Turbulence Type Forecast/Actual:	/
Wind Direction:	110°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	30.22 inches Hg	Temperature/Dew Point:	25°C / -8°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Bishop, CA (BIH)	Type of Flight Plan Filed:	None
Destination:	Truckee-Tahoe, CA (TRK)	Type of Clearance:	None
Departure Time:	13:00 Local	Type of Airspace:	

Airport Information

Airport:	Bishop BIH	Runway Surface Type:	
Airport Elevation:	4124 ft msl	Runway Surface Condition:	
Runway Used:		IFR Approach:	None
Runway Length/Width:		VFR Approach/Landing:	None

Wreckage and Impact Information

Crew Injuries:	1 Serious	Aircraft Damage:	Substantial
Passenger Injuries:	1 Serious	Aircraft Fire:	On-ground
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	2 Serious	Latitude, Longitude:	37.787223,-118.841392(est)

Administrative Information

Investigator In Charge (IIC):	Simpson, Elliott
Additional Participating Persons:	Thom Webster; Robinson Helicopter Company; Torrance, CA Harry R Smith; Federal Aviation Administration; Reno, NV Mark Platt; Lycoming Engines; Williamsport, PA Peter Nielson; Precision Airmotive ; Marysville, WA
Original Publish Date:	August 30, 2011
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=77325

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