Aviation Investigation Final Report

Location:	Honolulu, Hawaii	**Accident Number:**	WPR16FA072
Date & Time:	February 18, 2016, 10:20 Local	**Registration:**	N80918
Aircraft:	Bell 206B	**Aircraft Damage:**	Substantial
Defining Event:	Sys/Comp malf/fail (non-power)	**Injuries:**	1 Fatal, 3 Serious, 1 Minor
Flight Conducted Under:	Part 91: General aviation - Aerial observation		

Analysis

The commercial pilot of the helicopter was performing a local air tour around the island with four passengers onboard. During the flight, he noticed a vibration throughout the cabin. The pilot diverted toward the destination airport; however, when the vibration stopped shortly thereafter, he decided to initiate a turn so the passengers could see a nearby landmark. The vibration returned shortly thereafter, and the pilot began to maneuver toward the destination airport a second time. The pilot stated that the vibration developed into a grinding sensation, which was followed by illumination of the main rotor low rpm warning light and an increase in engine rpm to the point where the engine and rotor RPM needles were no longer matched on the power turbine gauge. The pilot initiated an approach to a grassy area near the shoreline; however, due to the presence of people nearby, he turned the helicopter slightly left to land in the water as close to shore as possible. The pilot said that, about 20 ft above the water, it felt like the main rotor stalled, the helicopter lost lift, and it "fell out of the sky." The helicopter descended rapidly into the water and sank about 20 ft from the shoreline.

Three of the passengers were able to egress the helicopter following impact; however, the middle aft seat passenger was trapped inside. A first responder stated that he and another person repeatedly dove underwater to cut the passenger's seatbelt straps and extract him. The first responder reported that the passenger's life preserver appeared to be entangled with the seatbelts. Postaccident examination of the life preserver revealed signatures of inflation and cut waist straps, with no other damage noted. It could not be determined when or how the life preserver was inflated; the first responder could not recall whether it was inflated and the nurse providing CPR said it was not inflated. Review of treatment records for the passenger revealed evidence consistent with drowning, and no traumatic injuries to the head or neck. It could not be determined whether the passenger was unable to extricate himself from the restraint, or if he had a period of unconsciousness resulting from the impact that contributed to his drowning. The helicopter's doors were not installed at the time of the accident and all five seat restraints were found to be in working order and undamaged.

Postaccident examination of the helicopter revealed that the engine-to-transmission drive shaft was separated at the transmission side. Metallurgical examination of the engine-to-transmission drive shaft components revealed that the forward coupling did not appear to be lubricated and that there were multiple indications of exposure to elevated temperature, such as heat tinting and loss of the temperature plates on the forward outer coupling, high-temperature cadmium-induced brittle fracture of two forward attachment bolt heads, and a loss of hardness of the bolt head material due to high-temperature tempering. The external spline teeth on the forward spherical coupling were worn down to the bottom landings, while comparatively minor wear marks were observed on the mating internal spline teeth of the forward outer coupling. The asymmetry in the wear pattern between the spherical coupling and the outer coupling combined with the observations consistent with elevated temperatures indicate that the assembly likely failed by overheating due to lack of lubrication. This resulted in softening and subsequent failure of the spring that limits and centers the spherical coupling. When the spring failed, the coupling shifted forward, damaging the forward end of the outer coupling, fracturing the forward cover plate, and wearing the external spline teeth down to the bottom landings. Following the failure of the drive shaft, the engine would have continued to operate, but would not have been able to drive the main rotor.

Interviews with the pilot, the owner of the company, and a non-mechanic rated maintenance assistant indicated that maintenance had recently been conducted on the engine-to-transmission drive shaft, even though this was not recorded in the helicopter's maintenance records. In addition, the owner, who was a rated mechanic, was not present the entire time throughout the removal, inspection, and subsequent reinstallation of the engine-to-transmission drive shaft.

It is likely that, when this maintenance was conducted, grease was not applied to the forward coupling as specified in the manufacturer's maintenance manual. Further review of maintenance records revealed no entries pertaining to a current annual inspection or 100-hour inspection. Additionally, a component inspection sheet provided by the operator revealed that several required component inspections were overdue and had not been completed at the time of the accident.

Although the FAA was conducting oversight in accordance with their guidance, increased inspections may have uncovered the inadequate maintenance and documentation, which in turn, may have prevented the accident.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The in-flight failure of the engine-to-transmission drive shaft due to improper maintenance, which resulted in low main rotor rpm and a subsequent hard landing to water.

Findings

Aircraft	Engine/transmission coupling - Failure
Personnel issues	Installation - Maintenance personnel
Organizational issues	Oversight of maintenance - Operator
Environmental issues	Water - Contributed to outcome
Personnel issues	Qualification/certification - Maintenance personnel
Personnel issues	Scheduled/routine maintenance - Maintenance personnel
Aircraft	Scheduled maint checks - Not serviced/maintained

Factual Information

History of Flight

Prior to flight	Aircraft maintenance event
Enroute-cruise	Sys/Comp malf/fail (non-power) (Defining event)
Enroute-cruise	Emergency descent initiated
Enroute-cruise	Collision with terr/obj (non-CFIT)

HISTORY OF FLIGHT

On February 18, 2016, about 1020 Hawaii-Aleutian standard time, a Bell 206BIII, N80918, was substantially damaged when it impacted water during a forced landing near Honolulu, Hawaii. The commercial pilot and two passengers sustained serious injuries, one passenger sustained minor injuries, and one passenger was fatally injured. The helicopter was privately owned and operated by Genesis Helicopters as a commercial air tour flight under the provisions of Title 14 *Code of Federal Regulations* (CFR) Part 91. Visual meteorological conditions prevailed and a company flight plan was filed for the local flight, which originated from Honolulu International Airport (HNL) about 0935.

The pilot reported that, after arriving at work the day of the accident, the helicopter was pulled out of the hangar and that he began his preflight with the company's mechanic's assistant. The pilot stated that they completed "a pretty good preflight," because the flight was the first tour flight since replacement of the tail rotor drive shaft. The pilot further stated that he confirmed fuel quantity and checked other fluids before he retrieved and inspected the life preservers. The pilot then went upstairs to the company's office, met the passengers, showed them the safety video, and stored their belongings.

After he boarded the passengers, whose seat positions were determined by weight and balance calculations, he put the passenger's life preservers on them and secured their seatbelts, the pilot conducted a final walkaround of the helicopter before boarding and starting the engine. After departure, the flight proceeded to fly the Shoreline 6 departure procedure to crossover to the east side of Oahu Island. The pilot then flew along the shoreline before flying toward Sacred Valley, then North Shore before turning south to fly down Central Valley, over Wheeler Army Airfield, and on to Pearl Harbor. The pilot said that, as he began the approach to Ford Island, he noticed a vibration throughout the cabin of the helicopter that seemed "different." He decided to return directly to HNL; however, the vibration stopped, and he made a left turn so the passengers could see the USS Arizona Memorial.

Shortly thereafter, the vibration returned, and the pilot called the air traffic control tower at HNL to advise that the flight would be returning to the airport. The controller instructed the pilot to fly to the prison and hold for other inbound helicopters. The pilot stated that, at this point, the vibration developed into a grinding sensation. Then the main rotor low rpm warning light illuminated, and engine rpm began to rise; the point where the engine and rotor RPM needles were no longer matched on the power turbine gauge. The pilot then lowered the collective, reduced the throttle and realized the engine and main rotor were no longer connected as he began to look for a place to land; he selected the grassy area at the Pearl

Harbor Memorial visitor's center. Due to his altitude, he said he tried to increase his sink rate to make the selected landing area and put the helicopter "back in trim to land" before he noticed people disembarking from the USS Arizona Memorial ferry vessel in his selected landing area. To avoid the people, the pilot turned the helicopter slightly left to land in the water as close to shore as possible, with hopes that people would come out to help. He stated that when the helicopter was about 20 ft above the water, it felt like the rotor stalled, the helicopter lost lift, and it "fell out of the sky." The helicopter descended rapidly into the water about 20 ft from the shoreline.

Witnesses located at various locations at the World War II (WWII) Valor in the Pacific National Monument reported seeing the helicopter at a low altitude before it suddenly descended into the water.

A review of video captured by a witness revealed that the helicopter was approaching the Contemplation Circle area of the World War II Valor in the Pacific National Monument. The helicopter's forward airspeed appeared to decrease, the nose pitched up, and the helicopter began to rotate to the left in a slightly nose-up attitude then descended rapidly into the water. At the time of impact, the helicopter appeared to be in a slightly nose-high, left bank attitude.

PERSONNEL INFORMATION

The pilot held a commercial pilot certificate with rotorcraft-helicopter and instrument helicopter ratings. In addition, the pilot held a flight instructor certificate with a rotorcraft-helicopter rating. The pilot held a Federal Aviation Administration second-class medical certificate issued on November 6, 2015, with no limitations. The pilot reported that he was unable to locate his logbook after he was released from the hospital; he estimated that at the time of the accident, he had accumulated about 900 total hours of flight experience, with 151 hours in the accident helicopter make/model and 125 hours within the previous 90 days.

AIRCRAFT INFORMATION

The accident helicopter was a Bell Helicopter model 206, serial number 2687. The helicopter was powered by a Rolls-Royce Allison model 250-C20B turboshaft engine, serial number CAE-832146, with maximum takeoff and maximum continuous power ratings of 420 shaft horsepower. The helicopter was not equipped with an emergency float system.

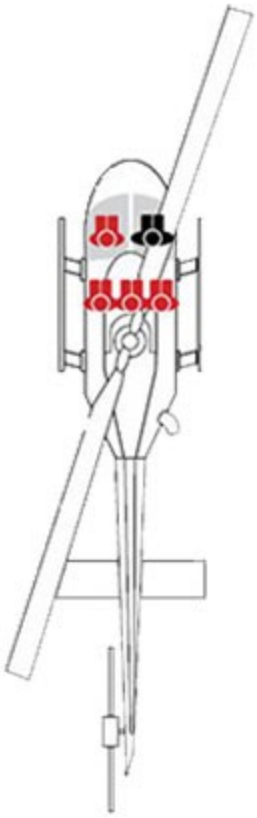

Figure 1: Helicopter Seating Diagram

The helicopter was equipped with 5 seats, two in the front, and 3 in the aft section of the cabin. The helicopter is flown from the front right seat, with passenger seating in the remaining seats as referenced in figure 1.

According to Bell Helicopter Textron (BHT) representative, an integral part of the helicopter's power train system is the engine-to-transmission drive shaft, located between the transmission and freewheeling drive. The drive shaft (as installed) is comprised of two identical couplings, which are located on either end of the shaft. The internal components consist of two flanges positioned on the ends of the tubular, hollow drive shaft. The assembly requires a retainer ring and packing seal to be positioned against the flange. A drive shaft coupling seal is situated against the packing seal, impeding grease from egressing the coupling assembly.

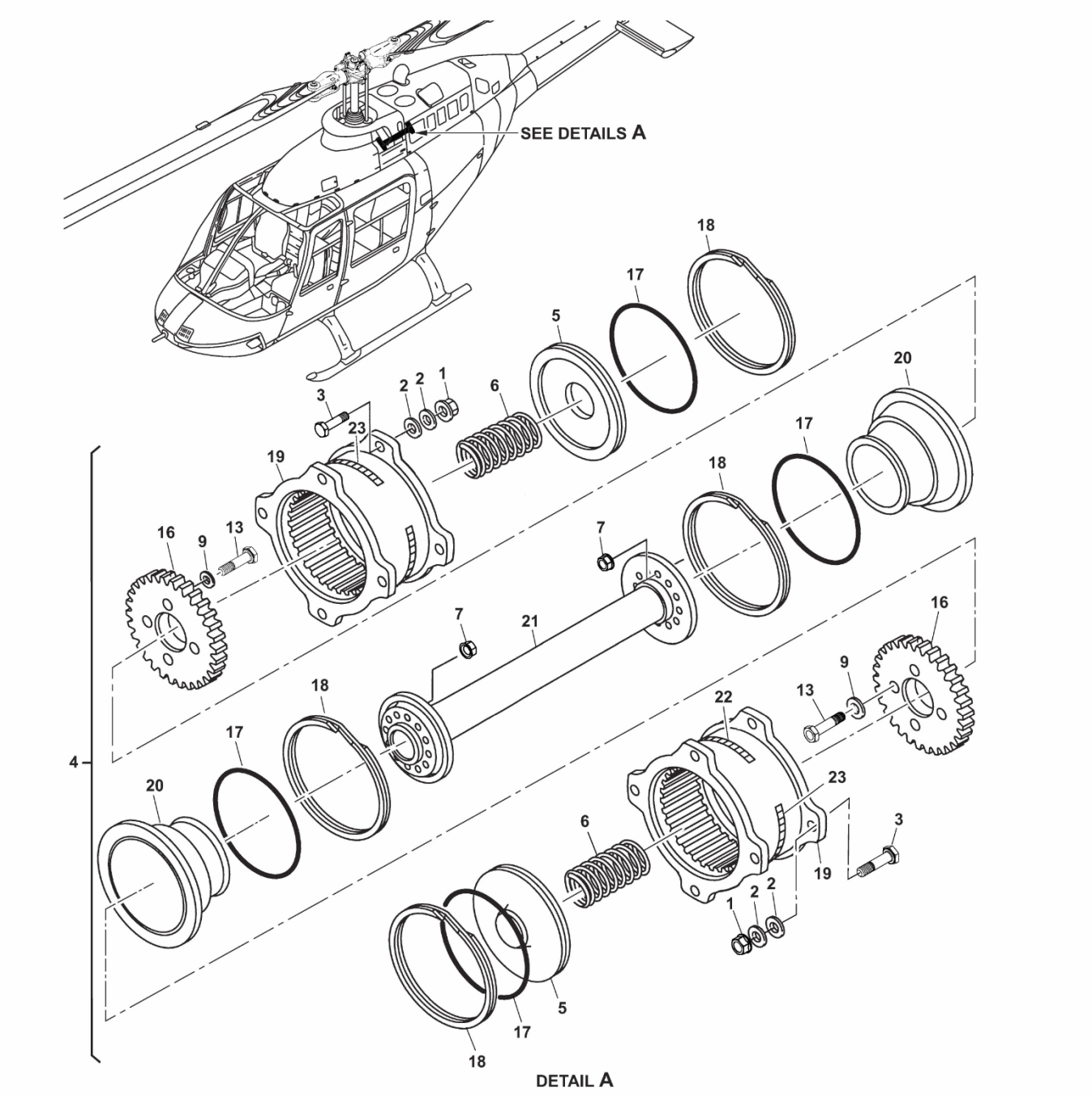

Figure 2: Engine-to-transmission-driveshaft diagram.

The drive shaft contains a gear sprocket affixed to the shaft flange via 4 bolts (bolt heads positioned on the inside of the coupling). The donut-shaped gear has a hollow area in the middle that aligns with the hollow tube situated between the couplings; a slight lip surrounds the hollow area. The outer coupling gear surrounds the drive gear where it is splined, and torque is transmitted. Inside the coupling, the assembly is equipped with a shaft centering spring. The spring (item 6 in figure 2) is positioned between

the lip and the end cap of the coupling (grease retainer plate). A retainer ring and packing seal rest against the back plate.

The BHT maintenance manual recommends that, before reassembly, the engine-to-transmission drive shaft couplings be hand-packed with lubricant (C-015 grease) over the top of the internal spline teeth to a depth of 0.2-0.3 inch.

Maintenance Records

Review of maintenance records provided by the operator revealed the following recent inspections.

Table: Recent Helicopter Inspections

No entries referencing a current annual inspection, current 100-hour inspection, or the recent maintenance on the engine-to-transmission drive shaft were located within the airframe and engine logbooks. The most recent maintenance entry was the replacement of a tail rotor drive shaft segment on February 17, 2016, at an airframe total time of 15,516.5 hours.

Maintenance Interviews

Owner of Genesis Helicopters

The owner of the company held a commercial pilot certificate with a rotorcraft rating and a mechanic certificate with airframe and powerplant ratings. He reported that the accident pilot was present during maintenance of the engine-to-transmission drive shaft to observe and pass tools to the mechanics assistant. The owner stated that he witnessed the initial buildup of the shaft, then left the hangar for about an hour to an hour and a half. When he returned, the mechanics assistant had already begun installing the shaft into the helicopter. The owner recalled asking specific questions about the bolts going into the shaft, to include if there was friction on the nuts, to which the assistant responded that there was.

The owner recalled that the helicopter was grounded on January 23 because the rubber seal (which is located at the base of the short shaft) had come apart, and remnants were found on the (engine) deck. Replacement parts were ordered on January 25, and the helicopter was flying again on January 28. The owner estimated that the helicopter had flown 31 hours from the time the seals on the short shaft were replaced to the time of the accident.

When the owner was questioned about the timeframe of the maintenance performed on the short shaft and presented with the helicopter logbooks, he responded that he "can't find them in the logs" and that it "must not have gotten put in the logbooks." When asked what manual was utilized to conduct the maintenance on the short shaft seal, the owner stated that they used the maintenance manual from Bell Helicopters.

When asked how often maintenance looked at the helicopter, the owner stated that there was a daily inspection and he was personally "laying eyes on it every night." After the last flight of the day, the helicopter would be parked outside and looked at before being placed in the hangar for the night. He said the inspection would included checking the security and mounting, checking all the fluids, and visually inspecting the rotor head, lights and seatbelts. He would also examine the grips, bolts, doublers,

and the tail rotor and gearbox security and mounting. When asked if he ever looked in the area of the engine-to-transmission drive shaft, he stated that he was supposed to, but when asked if he recalled doing it, he paused before stating, "I think the last time that I laid eyes on the short shaft, trying to think back, probably 3 or 4 days before the accident. There was a span prior to [February] 18th that we hadn't been flying. We were waiting on parts for the tail rotor."

The owner further reported that inspections and airworthiness directives (ADs) were not reviewed on a daily basis. The 100-hour inspection information would have been written in the manual, but there would not have been anything like a countdown to an inspection. He stated that a status sheet for inspections or AD compliance was not kept in the helicopter.

When asked how pilots ensured compliance with maintenance requirements, he said they had to rely on maintenance personnel to tell them that something was due or close to being due. He said sometimes the pilots would take initiative and see in the front of the book that a 100-hour inspection had been completed. He said that if the pilot saw something unsafe or observed a maintenance issue, then they could cancel the trip on their own without his approval. He said that people who wanted to come work for him knew that he would never push them to fly.

The owner provided a component status sheet on February 21, 2016. There were several items that indicated negative time remaining before an inspection was due. Several of these items were annotated with check marks; the owner indicated that these inspections had been completed, but the sheet had not yet been updated. When asked about the negative-time items that were not checked, he replied that the engine installed in the helicopter at the time of the accident was a loaner engine and that the compressor and turbine listed on the component sheet were not even in the aircraft. Those components "had gone to the shop to get all that stuff up to date."

When asked about the inspections of the main rotor mast assembly and the tension torsion (TT) straps, which were overdue according to the status sheet, the owner replied that the tail rotor blade had been inspected and the TT straps had not been inspected. He said the overhaul was coming up and that they were in the process of ordering parts. His intention was to take the helicopter out of service for maintenance, which would have included the TT straps. When asked if he knew they were due at the time of the accident, he stated that he knew they were coming due, but did not know that the helicopter had flown that extensively, and did not know they were due until he printed the status sheet for the investigation.

Pilot

During an in-person interview with the pilot, he was asked to describe the last few maintenance issues experienced with the helicopter. The pilot recalled a vibration with the tail rotor drive shaft, which had been fixed. In addition, he recalled the helicopter going through either a 50-hour or 100-hour inspection around January 15, 2016, at which time all the panels were removed, the insides were scrubbed, and all bearings were re-greased. He said everything that had a grease nozzle or tip received grease. He recalled one of the hanger bearings on the tail rotor drive shaft had loosened, which was found on the 100-hour inspection. When asked about the engine-to-transmission shaft, he recalled the short shaft seal failing and its subsequent replacement, but he could not recall the date of the replacement. He said the rubber boot from the short shaft had unseated and grease had slung around inside the panel. He recalled that the

owner called him on a Saturday to inform him that flying for Monday had been cancelled so the boot could be replaced.

The pilot stated that he was present when the work was being done on the short shaft seal and that the owner of the company was teaching the maintenance assistant how to press the seals. While the work was being done, the owner was quizzing the maintenance assistant. He remembered the owner and assistant referring to the maintenance manuals. Toward the end of January, he watched the owner grease the engine-to-transmission drive shaft and saw the splines on the gear when the work was being accomplished.

Mechanic's Assistant

The mechanics assistant, who had been employed with Genesis Helicopters for 8-9 years, did not hold a Mechanics Certificate with airframe or powerplant ratings. He reported that the "short shaft" had been removed due to leaking grease on January 25. Once they had received the new parts and the short shaft was removed, stripped down, and cleaned, the owner of the company inspected everything before reassembly. The assistant stated that, during the reassembly, one half of the engine-to-transmission drive shaft was put back together, followed by the other half. Once the work was completed, they conducted an engine run-up, a leak check, and a test flight before returning the helicopter to service. The assistant recalled that, during the installation of the short shaft, the accident pilot was present. Although the owner of the company was not present the entire time, he was checking the process and quizzed him on the parts and the type of grease used, and he was present to verify that the proper amount of grease was used before installing the shaft. The assistant further reported that he had re-used the same nuts, bolts, and washers to reassemble and reinstalled the short shaft.

METEOROLOGICAL INFORMATION

A review of recorded data from the HNL automated weather observation station, located about 3 miles southeast of the accident site, revealed the conditions at 0953 included wind from 050° at 12 knots with gusts to 18 knots, visibility 10 statute miles, few clouds at 3,200 ft, scattered clouds at 4,100 ft, temperature 26°C, dew point 13°C, and an altimeter setting of 30.13 inches of mercury.

WRECKAGE AND IMPACT INFORMATION

Examination of the accident site revealed that the helicopter was submerged about 40 ft under water about 20 ft from the shoreline. The helicopter was removed from the water the day following the accident and was subsequently rinsed with fresh water. The wreckage was moved to a secure location for further examination.

Examination of the recovered wreckage revealed that the main rotor blades, mast, transmission, engine, tailboom, tail rotor gearbox, and tail rotor blades remained attached to their respective mounts. The aft portion of the fuselage under the aft baggage compartment and behind the aft skid cross tube was compressed upward. The windshield and both lower bubble windows were impact damaged and mostly separated. The forward right doorpost was fractured at the upper area of its mount and partially fractured at the lower mount. None of the doors were installed on the helicopter at the time of the accident.

The tail rotor hub and blades exhibited damage from water impact. Both blades were bent away from the tail near the tail rotor hub. Tail rotor drive continuity was established from the tail rotor forward through

a torsional fracture in the #3 tail rotor drive segment to the oil cooler blower shaft, the forward short shaft, and the freewheeling shaft. The tail rotor anti-torque pedals on the pilot's side exhibited a fracture of the control tube and the linkages could not be moved. Moving the pitch of the tail rotor blades demonstrated continuity forward via the pitch change control tube to the fractured control tube at the pedals. The tail rotor gearbox was turned by hand with no binding or unusual sounds. The tail rotor gearbox was shifted aft due to impact.

Continuity was observed from the mast through the transmission when the main rotor blades were turned by hand, though the forward end of the engine-to-transmission drive shaft was not rotating properly. The four bolts holding the outer coupling were loose with no torque stripe present. Additionally, two of the four bolts holding the inner coupling were missing. Two sheared bolt heads were located; the remainder of the bolts and nuts were not recovered. When removed, the forward retaining ring was still in place; however, only the center of the retainer plate was found, and the centering spring was fractured/deformed. The outer coupling was missing the three temperature plates. No visible evidence of any grease on the inner/outer coupling was observed. The gear teeth on the inner gear coupling were worn away. The aft inner/outer couplings were still attached and had minor damage. The engine-to-transmission drive shaft was sent to the NTSB Materials Laboratory for further examination.

The transmission remained attached to the upper deck via 4 of the 5 mounts. When the input shaft was rotated from the engine, a clicking noise was heard. The transmission was removed and shipped to Bell Helicopters for further examination.

No preimpact anomalies were observed with the main rotor assembly. Both main rotor blades were present and had minor damage on one leading edge. The hub assembly appeared unremarkable.

The cyclic moved freely in all quadrants with corresponding pitch movement at the main rotor hub. The collective was moved freely by hand and free pitch change was observed.

Examination of the recovered engine revealed that the engine remained secured within the engine bay with no visible external impact damage noted.

Although the airframe and engine were rinsed with fresh water following recovery from the salt water, visible signs of corrosion were noted on areas of the accessory gear box and scroll area of the engine. Manual rotation of the N1 (gas producer) drive train at the starter generator pad resulted in smooth and continuous rotation to the compressor, confirming drive train continuity. Manual rotation of the N2 (power turbine) drive train at the power take-off pad resulted in smooth and continuous rotation to the stage four turbine wheel, confirming drive train continuity. Visual and tactile examination of all engine pneumatic, fuel, and oil lines revealed no evidence of damage, and all "B" nuts were finger-tight with no evidence of damage or leakage. Engine and airframe interface oil and fuel lines and fittings were undamaged and secure with no evidence of leakage.

The compressor displayed no evidence of impact damage. The compressor rotor blades and vanes, as well as inlet guide vanes, revealed no evidence of foreign object debris damage. The exhaust collector support appeared normal and undamaged. The turbine module was in position and displayed no damage. The outer combustion case was in normal position and displayed no damage. Both the left and right compressor air tubes were undamaged and were properly seated in both their forward and aft ends.

The power turbine governor was in normal position and appeared undamaged. The governor arm was manually rotated from stop to stop. The fuel control was in normal position and appeared undamaged. The throttle arm was manually rotated from stop to stop. The upper chip detector was void of any metal debris.

No evidence of mechanical anomalies was noted that would have precluded normal operation of the engine.

The transmission was examined by the NTSB IIC at Bell Helicopter's facilities in Fort Worth, Texas. The internal transmission components were heavily corroded as a result of the time spent submerged in saltwater. The teeth of each gear were intact and displayed a wear pattern typical of normal operation. No evidence of any preimpact malfunction was observed with the transmission.

SURVIVAL ASPECTS

A witness, who was a Federal Police Officer at the WWII Valor in the Pacific National Monument, reported that, following the accident, 3- 4 people dove into the water to rescue a 16-year-old passenger trapped inside the helicopter, who was seated in the aft middle seat. The officer reported that he and a Navy diver took turns with a knife, going underwater to cut the straps off the passenger. After about 5- 6 attempts, they were able to bring the passenger to the surface and CPR was immediately administered by nurses and doctors who were visiting the memorial. The officer added that an AED was also used. The officer did not remember if the passenger's life preserver was inflated or not; however, he recalled seeing yellow while underwater. In addition, the officer stated that the life preserver was tangled with the seatbelts, which, coupled with poor underwater visibility, made it difficult to extract the passenger.

Another witness reported that the helicopter was underwater for about 15 minutes before the passenger was extracted from the wreckage.

A registered nurse who assisted in treatment of the passenger reported that he removed an uninflated floatation device during initial treatment.

Review of treatment records for the passenger revealed evidence consistent with drowning and no traumatic injuries to the head or neck.

Examination of the passenger's life preserver revealed that it was an Adult Life Preserver, model BRAVO, manufactured in January 2009 by Eastern Aero Marine, Miami, Florida. The two straps on the back of the vest, which connected to the waist band, were cut. The plastic waist band clasp functioned normally. No visible damage was noted to the inflatable portion of the vest. The carbon dioxide air cartridge used to inflate the vest was found punctured, consistent with it being used to inflate the vest. No inspections were recorded in the periodic maintenance inspection record tag on the vest.

It could not be determined when or how the life preserver was inflated.

Review of the safety video provided by Genesis Helicopters revealed that their staff was responsible for seat belting the passengers into the helicopter. In addition, the video reviewed seatbelt unbuckling procedures and life preserver use instructions. The instructions included how to inflate the vest by either pulling the red tab, which activates the air cartridge, or manually by blowing into the inflation tube. Their instructions stated, "at no time deploy the vest while you are in the helicopter."

Three of the passengers reported that they watched the safety video before boarding the helicopter. The passenger who was seated in the front left seat stated they boarded the helicopter with their life preservers on and, one-by-one, were buckled into place by either the pilot or ground crew. The three passengers all stated that that the seatbelts were difficult to unlatch following the accident sequence.

Examination of the helicopter revealed that all five seats were equipped with 4-point seatbelt restraints, which included 2 shoulder belts and a left and right lap belt. The front left and right seat restraint buckles were equipped with a rotary buckle, which required rotation of the buckle to release the seat belt clasps. The rotary buckle attached to the shoulder restraints and opposing lap belt by sliding the clasp of the respective belt into the respective port on the buckle. The front right seat was intact. The restraints were intact, remained attached to their respective mounts, and the seat belt latch functioned normally. The inertia reel functioned normally. The front right seat exhibited downward compression damage to the seat frame and structure underneath the seat frame.

The front left seat was intact. The restraints were intact, and the seat belt latch functioned normally. The inertia reel functioned normally. The front left seat exhibited downward compression damage of the seat frame and structure underneath the seat frame.

The aft 3 seats were equipped with standard seatbelt buckles, which required one to lift upward on the tab to release the clasps. The shoulder harnesses were connected to the aft seat restraints by two metal connectors, which slid over the clasp before the seatbelt was buckled.

The aft seats were mostly intact. The aft left seat was missing the seat back cushion. The bottom of the seats exhibited an upward bow in the center, consistent with impact damage to the bottom of the fuselage. All three sets of restraints were intact. The shoulder harness inertia reels functioned normally. All of the aft seat belt latches functioned normally. The seat structure on the aft right side was damaged consistent with downward compression.

ORGINIZATIONAL INFORMATION

Company Overview

At the time of the accident, Genesis Helicopters employed 4 people; the owner, the pilot, a receptionist, and a maintenance assistant who performed various duties, including assisting the owner with maintenance, cleaning the helicopter, etc. They operated one helicopter, the accident helicopter, under a Letter of Authorization (LOA) from the FAA to conduct air tours within 25 statute miles of the departure airport.

FAA Oversight Requirements and Interviews

FAA surveillance of all 14 *CFR* Part 91 and 91 Section 147 air tour operations is outlined in FAA Order 1800.56P, National Flight Standards Work Program Guidelines. The guidance states that FAA inspectors should conduct inspections of 10 percent of all of the air tour operators that have authorizations annually. These inspections may include ramp inspections, spot inspections, review of aircraft records, or airworthiness directive compliance inspections.

The Honolulu Flight Standards District Office (FSDO) had 24 employees assigned to the office at the time of the accident, of which 2 were front line managers (FLM). During the investigation, the two FLMs and the principal maintenance inspector (PMI) assigned to Genesis Helicopters were interviewed.

One FLM stated that, at the time of the accident, each Part 91 LOA had three inspectors assigned for oversight as a certificate management team; a principal operations inspector (POI), a principal avionics inspector (PAI), and a PMI. The FML further stated that the national work program required the HNL FSDO conduct an aircraft records inspection or an aircraft ramp inspection on only 10 percent of the Part 91 LOA holders assigned to their office each year, and POI involvement was not required. Of the 27 LOA holders overseen by the FSDO, only 3 had specific operations that allowed for conducting air tours below 1,500 ft above ground level (agl), which required an annual flight check. The second FLM reported that the HNL FSDO was exceeding the minimum of required inspections according to the data he had recently reviewed.

The PMI reported that he was assigned to the Genesis Helicopters LOA around December 2015 following his on-the-job training (OJT) for ramp inspections and records inspections. The inspector stated that he was qualified for oversight of Part 91.147 LOA holders and was assigned to other operators in addition to Genesis; he was still completing OJT for oversight of Part 135 operators.

When asked how many inspectors comprised the certificate management team for Genesis, he stated that he was the PMI and was unaware of an assigned principal avionics inspector.
The PMI stated that he had not completed a ramp inspection with Genesis Helicopters since he was assigned to them; however, was trying to schedule a visit. He added that, on the morning of the accident, he called the owner to schedule a records inspection but was unable to reach anyone and left a voicemail.

The last recorded ramp or records inspection performed by the FAA on the operator that was conducted on January 3, 2013, on a different aircraft (N110JC) operating under the Genesis LOA at that time.

Owner of Genesis Helicopters

The owner of Genesis Helicopters was asked how often he was visited by representatives from the FAA. The owner replied, "kind of a lot." He added that there was no official POI to his company but that he was visited by the FAA and had a good working relationship with them. When asked when he last received a visit from the FAA, he said it had been "a while," and could not recall a specific date.

TESTS AND RESEARCH

An NTSB Senior Materials Engineer examined the engine-to-transmission drive shaft along with the associated couplings and attachment hardware.

The design of the drive shaft is that each spherical coupling has an external spline profile that meshes with a matching internal spline profile on a corresponding outer coupling. Aluminum alloy cover plates are installed at the forward end of the forward outer coupling and aft end of the aft outer coupling, and springs (compressed upon installation) are placed between each cover plate and the corresponding spherical coupling. The spline couplings are grease-lubricated during assembly.

The spline teeth on the forward (transmission side) spherical coupling were worn down to the bottom landings. Two of the attachment bolts had fractured at the transition from the bolt shank to the bolt head. The forward compression spring and forward cover plate were both fractured into multiple pieces and the spring pieces were deformed from their original shape. A comparison of the spring and cover plate fragments with their respective aft counterparts indicated that only a portion of each item was recovered. The spring and cover plate fragment fracture surfaces were examined visually with the aid of a stereomicroscope and all fractures exhibited features consistent with either overstress or rubbing/smearing due to post-separation damage.

The forward outer coupling had a dark tint consistent with exposure to elevated temperatures, and the temperature plates, which were supposed to be on the forward outer coupling, were missing. The forward end of the forward outer coupling exhibited mechanical damage around the perimeter of the forward opening. The internal spline profile exhibited comparatively minor wear marks near the middle of the spline teeth when compared to the wear on the forward spherical coupling.

Neither the forward spherical coupling nor the forward outer coupling exhibited indications of residual grease lubrication. By comparison, the aft outer coupling and spherical coupling were covered by a lubricant that was brown/black in color and viscous. The aft coupling did not exhibit any notable wear features.

The attachment bolt head fractures were examined in detail and determined to be consistent with cadmium-induced embrittlement of the steel at elevated temperature. The bolts were type NAS 1304-10 and were made of a low alloy steel with a cadmium-plated coating. Both bolt heads were examined using a scanning electron microscope (SEM). The fracture surface had a faceted appearance, consistent with intergranular fracture. Energy dispersive x-ray spectroscopy (EDS) of the fracture surface and a portion of the bolt indicated the presence of oxygen and cadmium in addition to the elements associated with the base metal.

An EDS spectrum indicated of a portion of the bolt revealed the presence of oxygen and cadmium in addition to other elements in the steel bolt. The observations were consistent with cadmium-induced embrittlement of the steel at elevated temperature. The hardness of the sectioned bolt head and of a bolt head from the aft coupling were measured. The results indicated that the forward coupling bolt head had been tempered, consistent with exposure to elevated temperatures.

For more information, see the Materials Laboratory Report within the public docket for this accident.

ADDITIONAL INFORMATION

FAA Regulations

According to the FAA LOA for Genesis Helicopters, the operator must follow 14 *CFR* 91.147, and air tour flights for compensation or hire must remain within 25sm of the departure point. The operator must also comply with 14 *CFR* Part 136, subpart A, which outlines requirements for passenger safety briefings and the use of PFDs.

Genesis Helicopters was also required to comply with 14 *CFR* 91.409 Section B, which states that no person may operate an aircraft carrying any person (other than a crewmember) for hire unless within the preceding 100 hours of time in service the aircraft has received an annual or 100-hour inspection and

been approved for return to service in accordance with 14 *CFR* Part 43 or has received an inspection for the issuance of an airworthiness certificate in accordance with 14 *CFR* Part 21.

Title 14 *CFR* 91.417, Section 1, item 1, which also applied to Genesis Helicopters, states that records of the maintenance, preventive maintenance, and alteration and records of the 100-hour, annual, progressive, and other required or approved inspections, as appropriate, for each aircraft (including the airframe) and each engine, propeller, rotor, and appliance of an aircraft should be maintained.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	35,Male
Airplane Rating(s):	None	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	November 6, 2015
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 900 hours (Total, all aircraft), 151 hours (Total, this make and model), 151 hours (Last 90 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	**Registration:**	N80918
Model/Series:	206B B	**Aircraft Category:**	Helicopter
Year of Manufacture:	1979	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	2687
Landing Gear Type:	N/A; Skid	**Seats:**	
Date/Type of Last Inspection:	March 22, 2014 Annual	**Certified Max Gross Wt.:**	3201 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo shaft
Airframe Total Time:	14211.7 Hrs as of last inspection	**Engine Manufacturer:**	ALLISON
ELT:	Installed, not activated	**Engine Model/Series:**	250-C20B
Registered Owner:	Jeffery Gebhard	**Rated Power:**	420 Horsepower
Operator:	Genesis Helicopters	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	PHNL,7 ft msl	**Distance from Accident Site:**	3 Nautical Miles
Observation Time:	19:53 Local	**Direction from Accident Site:**	166°
Lowest Cloud Condition:	Few / 3200 ft AGL	**Visibility**	10 miles
Lowest Ceiling:		**Visibility (RVR):**	
Wind Speed/Gusts:	12 knots / 18 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	50°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.12 inches Hg	**Temperature/Dew Point:**	26°C / 13°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Honolulu, HI (HLN)	**Type of Flight Plan Filed:**	Company VFR
Destination:	Honolulu, HI (HLN)	**Type of Clearance:**	None
Departure Time:	09:35 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Fatal, 2 Serious, 1 Minor	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal, 3 Serious, 1 Minor	**Latitude, Longitude:**	21.366666,-157.940277

Administrative Information

Investigator In Charge (IIC):	Cawthra, Joshua
Additional Participating Persons:	Merritte H Wilson; Federal Aviation Administration; Honolulu, HI Dave Riser; Rolls Royce; Indianapolis, IN Gary Howe; Bell Helicopter; Fort Worth, TX Jefferey Gebhard; Genesis Helicopters; Honolulu, HI
Original Publish Date:	February 22, 2018
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=92743

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

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.