Accident Rpt# WPR17LA177 07/31/2017 1140 PDT	**Regis# N70LA**	**Wells, NV**	**Apt: Wells Muni/harriet Field LWL**
Acft Mk/Mdl AIR TRACTOR INC AT 802A	**Acft SN 802A-0102**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl PRATT AND WHITNEY PT6A-67AG	**Acft TT 3653**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR PUBU**
Opr Name: HENRY'S AERIAL SERVICE, INC.	**Opr dba:**		**Aircraft Fire: NONE**
			AW Cert: SPR

Summary

The commercial pilot reported that at the conclusion of the flight, he entered the left downwind leg of the airport traffic pattern, and observed about 10 knot winds from the north. He subsequently configured the airplane for a wheel landing to runway 26. The tailwheel had been in the "locked" position from the time he departed on the accident flight. Shortly after the main landing gear touched down, the airplane began to veer to the right. As the tailwheel came down, the airplane suddenly departed the right side of the runway in a hard right turn. The left main landing gear impacted an imperfection in the runway, the airplane then rotated spinning 180 degrees to the right before it came to rest.

The pilot, experienced in the accident airplane make and model, reported no mechanical anomalies with the control system before the accident. Postaccident examination of the control system revealed no abnormalities with the rudder and aileron. The pilot further stated that he departed with the tailwheel in the "locked" position, and only disengaged the locking mechanism during the landing roll to regain control of the airplane. The manufacturer reported that landing with the tailwheel in the "unlocked" position will typically result in a tailwheel shimmy, and may not have led to a further loss of directional control. A weather study indicated an absence of fronts and weather systems and a presence of variable winds consistent with local circulations and thermals at the time of the accident. Additionally, the airport manager reported that thermal activity is prevalent at her airport, and that multiple runway excursions occur each year due to variable wind conditions and other phenomena. With the presence of variable winds in the morning and subsequent thermal activity at the time of the accident, it is likely that a sudden wind shift or thermal activity overwhelmed the pilot, which resulted in a loss of directional control and the airplane's subsequent excursion from the runway.

Cause Narrative

THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: The pilot's failure to maintain directional control during a period of thermal activity, which led to a runway excursion and impact with terrain.

Events

1. Landing-landing roll - Other weather encounter
2. Landing-landing roll - Loss of control on ground
3. Landing-landing roll - Collision with terr/obj (non-CFIT)

Findings - Cause/Factor

1. Environmental issues-Conditions/weather/phenomena-Wind-Sudden wind shift-Ability to respond/compensate - C
2. Personnel issues-Task performance-Use of equip/info-Aircraft control-Pilot - C
3. Aircraft-Aircraft oper/perf/capability-Performance/control parameters-Directional control-Not attained/maintained - C

Narrative

On July 31, 2017, about 1140 Pacific daylight time, an Air Tractor AT-802A, N70LA, was substantially damaged during a landing roll at Wells Municipal Airport/Harriet Field (LWL), Wells, Nevada. The commercial pilot was not injured. The airplane was registered to Custom Air, Inc., operated by Henry's Aerial Service, Inc., and under contract with the Department of the Interior to provide aerial firefighting services. Visual meteorological conditions prevailed and a company flight plan was filed for the cross-country flight that departed Battle Mountain, Nevada, about 1042 as a Public Aircraft flight.

According to the pilot, after an uneventful flight he entered the airport through the left downwind leg of the traffic pattern for runway 26, which was the active runway at the time of the accident. He observed winds from the north about 10 mph based on the position of the midfield windsock and configured the airplane for a wheel landing. The airplane touched down on the main landing gear at approximately 85 mph on the runway centerline. As the airspeed bled off and the tailwheel began to settle down to the runway surface, the pilot lost all rudder and aileron authority. After the airplane entered a hard right turn and began to depart the right side of the runway, the pilot unlocked the tailwheel to regain directional control. Runway tire marks show the airplane begin to slowly veer to the right of the runway centerline, followed by a rapid departure to the right side of the runway. The left main landing gear collided with an imperfection in the asphalt surface and separated. The left wing then impacted the ground and the airplane rotated 180 degrees before it came to rest on the north side of the runway. The pilot reported that he had never experienced a loss of rudder and aileron control in his 3,787 total flight hours of experience in the airplane make and model.

In a subsequent statement, the pilot reported that he did not encounter any mechanical anomalies with the powerplant or control system that could have

precluded normal operation during the entire flight, except for the landing phase of flight when he lost rudder and aileron authority. The pilot further stated that he confirmed continuity and function of the rudder and part of the aileron control after the airplane came to rest.

A representative of the Department of the Interior reported that he observed a build-up of fire retardant inside the porthole of the tailwheel lock. He further stated that he confirmed function of the rudder, elevator and partial movement of the aileron, which had been damaged at the accident site.

The airplane manufacturer reported that landing with the tailwheel unlocked can manifest as a noticeable shimmy, but is not likely to result in a loss of directional control. Additionally, the pilot is not likely to observe any unusual flying characteristics or vibrations if the tailwheel remains unlocked during flight. If the airplane touches down with the tailwheel in the "unlocked" position, the pilot's attempt to move the lock lever to the "locked" position may or may not successfully lock the tailwheel.

An NTSB weather study did not show any surface frontal boundaries near the accident site around the time of the accident. In addition, a 500-hectopascal (hPa) chart, around 18,000 feet msl, showed a large ridge of high pressure over the western United States at 0500 PDT on the accident day. These two charts indicated that with no strong surface, mid-, or upper-level features, the daily valley/mountain breezes and thermals would be the main weather interactions on the accident day. These daily circulations include variable winds during the morning hours, with a more consistent wind around lunchtime through sunset. Visible imagery from 1830 UTC and 1845 UTC showed isolated cumulus clouds around the accident site, likely indicating that the thermals were the biggest driver in up and down motions around the terrain of the accident site. The upper air sounding using a weather model for the accident site for 1100 PDT did not indicate any low-level wind shear or turbulence below 10,000 feet msl, with an east to northeast wind around 5 to 10 knots from the surface through 10,000 feet msl.

According to the LWL airport manager, the airport is equipped with two windsocks; both located south of runway 26 about midfield. She further remarked that in the summertime the area is occupied with thermals and other weather phenomena. Each year she receives reports from pilots who experience unforeseen rapid yaw moments, and losses of directional control, both in the airport traffic pattern and on the ground, sometimes accompanied by an impact with a runway light. These sudden changes in flight performance are reported during times of wind circulation and thermal activity.

Accident Rpt# WPR15LA177	**06/01/2015 1948 MST**	**Regis# N73AW**	**Dewey, AZ**	**Apt: N/a**
Acft Mk/Mdl BELL 206 L4-L4		**Acft SN 52115**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl ALLISON/ROLLS ROYCE 250-C30P		**Acft TT 4092**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 091**
Opr Name: AIRWEST HELICOPTERS		**Opr dba:**		**Aircraft Fire: NONE**
				AW Cert: STN

Summary

The commercial pilot was conducting a cross-country ferry flight. He reported thatÿthe engine chip detector caution light briefly illuminated while the helicopter was in cruise flight about 750 ft above ground level. The pilot chose to make a precautionary landing and initiated a descent. During the descent, theÿdetector light illuminated again, followed shortly thereafter by a "loud bang" and the engine losing power. The pilot initiated an autorotation emergency landing. During the landing sequence, the main rotor blades struck the tailboom.

Examination of the engine revealed that the No. 2 bearing separator had fractured through both rails at the forward and aft sides of the bearing. The ball bearings were retained in the separator; however, half of them exhibited damage consistent with smearing and material transfer between the raceway and balls, which resulted in the failure of the No. 2 bearing and the subsequent engine power loss.

Cause Narrative

THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: A total loss of engine power due to the failure of the No. 2 bearing, which resulted from a fractured separator.

Events

1. Enroute-cruise - Loss of engine power (total)
2. Landing-flare/touchdown - Mast bumping

Findings - Cause/Factor

1. Aircraft-Aircraft power plant-Engine (turbine/turboprop)-Turbine section-Failure - C

Narrative

On June 1, 2015, about 1948 mountain standard time, a Bell 206 L-4, N73AW, sustained substantial damage during an emergency landing following a loss of engine power, near Dewey, Arizona. The commercial pilot, the sole occupant of the helicopter, was not injured. The helicopter was registered to Air Medical Services LLC and operated by Airwest Helicopters as a Title 14 Code of Federal Regulations Part 91 ferry flight. Visual meteorological conditions prevailed and a company visual flight rules, company flight plan, was filed. The cross country flight, departed Valle Airport (40G), Grand Canyon, Arizona about 1905 with a planned destination of Glendale Municipal Airport (GEU), Glendale, Arizona.

The operator reported that several weeks prior to the accident, the helicopter's engine chip detector caution light momentary illuminated during a routine maintenance engine run. The engine was shut down and the magnetic chip detectors (MCDs) were examined. A small amount of debris, that was determined to be within the manufacturer's limits, was observed. The MCDs were cleaned and re-installed and then a 30-minute engine run was conducted. Afterward, no further debris was found and the helicopter was returned to service. During a subsequent flight, a couple of weeks later, the engine chip detector caution light momentary illuminated. The helicopter landed and the MCDs were once again inspected, and a small flake and metallic paste on the lower MCD was observed. The oil system was drained, flushed, changed, and a new filter was installed. A 30-minute ground engine run was accomplished, and the MCDs were inspected afterwards and free of debris. The helicopter was then flown about 30 minutes, to a location where an oil sample could be drawn from the original oil removed. The oil sample was sent out for analysis and the helicopter was not operated for about 2 weeks, while awaiting results. The oil analysis was received, and the operator was satisfied with the result of no metal detected, and attempted to ferry the helicopter back to its home base.

During the flight, the pilot reported observing a momentary illumination of a caution light that he could not identify, prior to it extinguishing. About 10 minutes later, the engine chip detector caution light briefly illuminated, while the helicopter was in cruise flight, about 750 ft above ground level. The pilot elected to make a precautionary landing and initiated a descent. During the descent, the engine chip detector light illuminated again and shortly thereafter, was followed by a loud bang. Immediately, the engine lost power and an emergency autorotation landing was accomplished. During the landing sequence, the main rotor blades struck the tail boom and resulted in substantial damage.

Postaccident examination of the helicopter, revealed control continuity with the cockpit controls to the engine and flight controls. Besides the tail boom damage, the remainder of the fuselage was relatively intact. Initial visual examination of the engine revealed no obvious damage. The inlet, exhaust section, and turbine blades, were clear of obstructions and observed to be undamaged. The engine was removed to facilitate an examination. The compressor could not be rotated

by hand but the power turbine could be rotated by hand, with resistance. The magnetic chip detectors were removed and observed to have accumulated ferrous debris. The engine was shipped to Rolls-Royce for further examination.

The engine was examined and disassembled under the supervision of the National Transportation Safety Board, investigator-in-charge, at the Rolls-Royce facility near Indianapolis, Indiana. The compressor module was separated from the accessory gearbox by removing the compressor discharge tubes and the Compressor Turbine Drive Shaft (CT shaft). Thermal damage and cooked oil was observed on the CT shaft. The turbine module was removed for examination. On the first and second stages of the turbine, thermal and blade tip damage was observed. All the bearings were examined and were unremarkable, except for the No. 2 bearing.

The aft end of the compressor module revealed damage to the No. 2 bearing. The No. 2 bearing was fractured and exhibited thermal damage. Examination of the No. 2 bearing oil delivery tube revealed it was properly installed with no obvious blockage of the oil jets. The tube was removed and x-rayed for internal contamination of the oil passages with negative results. Further, the tube was flow checked and verified to flow oil at the specified rate.

The accessory gearbox was disassembled and observed to be intact and functional. Metal debris was observed throughout the gearbox. The oil pump screen, oil delivery tubes and engine mounted oil filter had minor contamination but no obstructions to flow.

A detailed examination of the No. 2 bearing revealed that its composition was consistent with the manufacture material types required. The bearing separator was fractured completely through both rails, at the forward and aft sides, of the bearing. All 10 of the ball bearings were retained in the separator, however half of them exhibited damage consistent with smearing and material transfer between the raceway and balls.

The No. 2 bearing is the primary means of support of the compressor impellor. Failure of the No. 2 bearing will allow the impellor to migrate forward, where it will eventually contact the compressor shroud. According to the manufacturer, only minor contact between the impeller and shroud is acceptable, however, examination of the compressor impellor revealed that the shroud and its vanes had considerable rubbing damage.

Accident Rpt# GAA17CA402 06/30/2017 1400 CDT	**Regis# N60KH**	**Uniontown, KY**	**Apt: N/a**	
Acft Mk/Mdl BELL 206-B	**Acft SN 1326**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual**	**Prob Caus: Pending**
Eng Mk/Mdl ALLISON (ROLLS ROYCE) 250-C20B	**Acft TT 16139**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 137**	
Opr Name: KASH HELICOPTER SERVICES LLC.	**Opr dba:**		**Aircraft Fire: NONE**	
			AW Cert: SPR	

Events

1. Maneuvering-low-alt flying - Low altitude operation/event

Narrative

The pilot of the helicopter reported that while maneuvering low around power lines during an agricultural spray, he "pulled up" and the right spray boom contacted a power line. He added that, the "fuselage pitched forward and the main rotor blade cut the tail boom off just aft of the horizontal stabilizer." Subsequently, the helicopter began to rapidly spin, and after 1 or 2 rotations, the pilot "closed the throttle which stopped the rotation" and "cushioned the impact."

The fuselage and tail boom sustained substantial damage.

The pilot reported that there were no preaccident mechanical malfunctions or failures with the helicopter that would have precluded normal operation.

Accident Rpt# ERA15LA374	**09/20/2015 1900 EDT**	**Regis# N165BH**	**Thomaston, GA**	**Apt: N/a**
Acft Mk/Mdl BELL 206-L1		**Acft SN 45249**	**Acft Dmg: DESTROYED**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl ALLISON 250-C28 SER		**Acft TT 7977**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 137**
Opr Name: DAH AIRCRAFT		**Opr dba:**		**Aircraft Fire: NONE**
				AW Cert: STN

Summary

The commercial pilot performed a right pedal turn to land the helicopter on a truck-mounted platform, and, just before touchdown, a pin that connected a push-pull tube to the left anti-torque pedal broke resulting in a loss of directional control. The pilot maneuvered the helicopter away from the truck to avoid striking his employees and tried unsuccessfully to land back on the truck's platform. He then repositioned away from the truck, closed the throttle, and lowered the collective to land, and the main rotor blades struck the side of the truck.

Although this make and model of helicopter is typically flown from the right seat, the accident helicopter was equipped with a left-hand "command" kit, and the pilot was flying it from the left seat. In addition, the helicopter was equipped with a tail rotor pedal lockout kit, which was designed to disconnect and lockout the tail rotor pedals to prevent interference by a passenger seated in the copilot's seat, which was, in this helicopter, the right seat. Photographs of the tail rotor pedal assembly revealed that the left expandable pin, which was a part of the tail rotor pedal lockout kit, had fractured, which disconnected the left anti-torque pedal from the tail rotor control system. Fracture analysis could not be performed on the broken pin because the pin was lost in shipping. Therefore, the failure mode for the pin could not be determined; however, it is built to the same strength as the bolts that it is intended to replace.

Cause Narrative

THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: The loss of tail rotor control due to a fractured pin in the tail rotor control system; the reason the pin fractured could not be determined as the fractured pin was lost in shipping.

Events

1. Landing - Flight control sys malf/fail

Findings - Cause/Factor

1. Aircraft-Aircraft propeller/rotor-Rotorcraft flight control-Tail rotor control system-Damaged/degraded - C
2. Aircraft-Aircraft oper/perf/capability-Performance/control parameters-Yaw control-Attain/maintain not possible - C

Narrative

On September 20, 2015, about 1900 eastern daylight time, a Bell 206L-1, N165BH, was destroyed during a collision with a ground vehicle and terrain following a flight control malfunction and subsequent loss of control near Thomaston, Georgia. The commercial pilot was not injured. Visual meteorological conditions prevailed, and no flight plan was filed for the local aerial application flight, which was conducted under the provisions of 14 Code of Federal Regulations Part 137.

In a telephone interview, the pilot said that the accident occurred at a job site. The purpose of the flight was to establish spray patterns and flow rates and to have the GPS and spray equipment calibrated for the contracted job. He said that he departed from the platform-equipped "mix" truck about 10 minutes before the accident and returned to land on the truck to clean the windscreen of the helicopter.

The pilot said that he performed a right pedal turn to land on the truck, and, just before touchdown, a pin that connected a push-pull tube to the left anti-torque pedal broke resulting in a loss of directional control. The pilot maneuvered the helicopter away from the truck to avoid striking his employees and then tried unsuccessfully to land back on the truck's platform. He repositioned away from the truck, closed the throttle, and lowered the collective to land, and the main rotor blades struck the side of the truck.

The pilot held a commercial pilot certificate with ratings for airplane multi-engine land and rotorcraft/helicopter. His most recent second-class Federal Aviation Administration medical certificate was issued on July 2, 2015. The pilot reported 11,409 total hours of flight experience of which 40 hours were in the accident helicopter make and model.

The helicopter was manufactured in 1979, and at the time of the accident it had been operated for about 16 hours since its most recent annual inspection was completed on September 7, 2015, at 7,977.2 total aircraft hours. The helicopter was equipped with a left-hand "command" kit, and the pilot was flying it from the left seat at the time of the accident.

In addition, the helicopter was equipped with a tail rotor pedal lockout kit, which was designed to disconnect and lockout the tail rotor pedals at the copilot's

seat to prevent passenger interference. For this make and model helicopter, the left seat would typically be the copilot's seat; however, as the accident helicopter was equipped with a left-hand command kit, the right seat was the copilot's seat. The kit, which was manufactured by Aeronautical Accessories and installed in accordance with supplemental type certificate SR00513AT, could be in either "Lockout" mode to prevent use of the pedals or "Engaged" mode for pedal control.

Examination of photographs provided by the operator revealed that the main transmission and the engine were torn from their mounts, and the aft fuselage was destroyed. The tail boom was separated just aft of its mount. Photographs of the tail rotor pedal assembly revealed that the left expandable pin, which was a part included in the tail rotor pedal lockout kit, had fractured and disconnected from the left anti-torque pedal to the tail rotor control system. The expandable pin connecting the right pedal to the tail rotor control system remained intact and engaged.

The operator shipped the pin by commercial carrier to the NTSB Eastern Region Headquarters in Ashburn, Virginia, for further examination as requested, but mislabeled the package with the wrong street address. The carrier shipped the package to a delivery center in Vienna, Virginia, and then redirected the package to a delivery center in San Francisco, California, where it was lost. Consequently, fracture analysis on the fractured pin could not be performed. Photographs of the fracture were not of sufficient quality to perform a visual fracture analysis.

The pilot/operator suggested that the accident could have been prevented if the lockout kit were not authorized for use concurrent with the left-hand command kit.

A review of the design and materials of the expandable pin by the FAA Aircraft Certification Office responsible for the kit and the kit manufacturer revealed that the pins were designed to replace the "original bolts and are stressed as such." The kit's instructions for continued airworthiness mandated both daily and 300-hour interval inspections for condition and security of the pins.

Accident Rpt# ERA15LA138 02/15/2015 1500 EST	**Regis# N3176L**	**Sevierville, TN**	**Apt: Sixty Six 6TN3**	
Acft Mk/Mdl BELL 206-L1	**Acft SN 45648**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual**	**Prob Caus: Pending**
Eng Mk/Mdl ALLISON 250-C28B	**Acft TT 8586**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 091**	
Opr Name: GREAT SMOKY MOUNTAIN HELICOPTER INC	**Opr dba:**		**Aircraft Fire: GRD**	
			AW Cert: STN	

Events

2. Takeoff - Uncontained engine failure

Narrative

HISTORY OF FLIGHT

On February 15, 2015, about 1500 eastern standard time, a Bell 206 L-1, N3176L, was substantially damaged by an uncontained engine failure and fire during takeoff from the Sixty Six Heliport (6TN3), Sevierville, Tennessee. The commercial pilot and five passengers were not injured. Visual meteorological conditions prevailed, and no flight plan was filed. The helicopter was registered to a private individual and was operated by Great Smoky Mountains Helicopter, Inc., for the local aerial sightseeing flight, which was conducted under the provisions of 14 Code of Federal Regulations Part 91.

According to the pilot, the helicopter had been operating since about 0830, and the engine was operating during the boarding of the five passengers. After the passengers were seated and had fastened their seat belts, he increased the engine power to 100%, raised the collective, and felt a shudder through the airframe. He immediately lowered the collective, verified that the passengers were in their seats, and again raised the collective. Immediately, he again felt a shudder, lowered the collective, subsequently heard "a loud bang followed by a loud whine" and saw smoke. He attempted to roll off the throttle, but it would not move. He subsequently turned off the fuel to shutdown the engine. Ground personnel helped evacuate the passengers and extinguish the fire.

According to photographs provided by a Federal Aviation Administration inspector who examined the helicopter, the upper deck and engine had substantial thermal and impact damage. The main rotor blades exhibited dents, score marks, and punctures on their bottom surfaces. Multiple fragments of engine turbine section components were found resting in the engine bay, on the ground around the helicopter, and embedded in the rotor blades.

PERSONNEL INFORMATION

The pilot, age 34, held a commercial pilot certificate with ratings for rotorcraft-helicopter and instrument helicopter; he also held a second-class medical certificate issued January 26, 2015, with no limitations. The pilot reported 1,385 total flight hours with 859 hours in the accident helicopter make and model.

AIRCRAFT INFORMATION

The seven-seat helicopter, serial number 45648, was manufactured in 1983. It was powered by a 500-shaft-horsepower Allison 250-C28B engine. According to maintenance records and pilot-provided information, the most recent 100-hour inspection was completed on February 2, 2015, at a recorded airframe total time of 8,586.1 hours and an engine time since major overhaul of 854.9 hours. At the time of the accident, the engine had accumulated 12.5 hours since the most recent inspection, 867.4 hours since major overhaul, 8,204.4 hours since new, and 6,633 cycles since new.

METEOROLOGICAL INFORMATION

The 1455 recorded weather observation at Gatlinburg-Pigeon Forge Airport, Sevierville, Tennessee, located about 3 miles from 6TN3, included wind from 020ø at 7 knots, 10 miles visibility, clear skies, temperature minus 4øC, dew point minus 22øC, and an altimeter setting of 30.32 inches of mercury.

AIRPORT INFORMATION

The private helipad was owned by the operator and did not have an operating control tower. The turf helipad was 200 ft long by 200 ft wide and was about 1,010 ft above mean sea level.

TEST AND RESEARCH

Postaccident examination of the engine revealed that a majority of the exhaust collector support was missing along the top half of the engine, and the remaining sections exhibited punctures and tears. The compressor air discharge tubes had multiple penetrations and were missing material. The power turbine 3rd and 4th stage disks (wheels) and nozzles as well as the power turbine shaft and coupling had separated from the engine. All the 4th stage turbine blades were separated at the blade roots, and the disk hub had substantial impact damage. The 4th stage nozzle was fractured into three 120ø sections. One 120ø section of the 3rd stage disk was recovered near the helicopter, and all blades were separated at the blade roots. The remainder of the 3rd stage disk was not located. The 3rd stage nozzle was fractured into two pieces. The power turbine coupling splines exhibited thermal damage and spline deformation. The No. 4 bearing race surfaces and rollers were plastically deformed and thermally damaged. The aft end of the power turbine pinion gear exhibited rub wear 360ø around, consistent with the No. 4 bearing inner race spinning on the pinion surface that functions as a bearing journal. Multiple components exhibited carbon buildup including the filter screen of the oil supply nozzle that supplied lubricating oil to the Nos. 4 and 5 bearings, the No. 8 bearing sump in the gas producer support, and the power turbine shafting.

The turbine components were examined by the Rolls Royce Materials Lab under NTSBsupervision. The examination indicated that the turbine components that separated from the engine during the failure sequence failed due to overload, and there was no evidence found of fatigue.

Accident Rpt# ERA16LA015	**10/15/2015 1500 CDT**	**Regis# N206CJ**	**Dickinson, AL**	**Apt: N/a**
Acft Mk/Mdl BELL 206L 3		**Acft SN 51579**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl ALLISON 250-C20 SER		**Acft TT 6550**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 137**
Opr Name: COUCH HELICOPTER SERVICES, INC.		**Opr dba:**		**Aircraft Fire: NONE**
				AW Cert: STN

Summary

During an aerial application flight, the helicopter was flying between 70 and 120 ft above trees, and the pilot heard a "pop" sound followed by an immediate loss of tail rotor thrust. He lowered collective and descended into trees, and the helicopter came to rest on its left side. Examination of the helicopter determined that the loss of tail rotor thrust was precipitated by a disconnect in the tail rotor drive system. A self-locking nut securing one of the two bolts that attached the aft end of the first tail rotor driveshaft (shaft S1) aft of the oil cooler blower to the disc pack coupling was missing. The nut and the bolt that it secured were not recovered at the accident site. The separated hardware allowed misalignment of the driveshaft with the axis of rotation, which led to the fracture of shaft S1 and of the second tail rotor driveshaft (shaft S2) aft of the oil cooler blower. The prevailing or tare torque on two out of the remaining three self-locking nuts securing the forward and aft ends of shaft S1 to the disc pack couplings were below the minimum torque specified in the helicopter manufacturer's standard practices manual. The prevailing torque is a measure of the turning resistance of a lock nut, and the turning resistance generally decreases as nuts are reused.

About 490 hours earlier, the operator had performed a modification to the helicopter that required in part, removal of shaft S1 and the tailboom assembly. Since this modification, the helicopter had been subjected to four 100-hour inspections. Three lots of defective nuts of the type used to secure components of the tail rotor drive system had been identified; however, the operator could not determine whether they had previously had any of the suspect nuts in stock. Although the possibility of a defective nut resulting in the driveshaft disconnect could not be eliminated, given the insufficient prevailing torque on 2 of the remaining 3 self-locking nuts securing shaft S1 to the disc pack couplings, it is more likely that the separated nut also had insufficient prevailing torque. And it was that insufficient prevailing torque of the missing self-locking nut that had been removed and improperly re-installed by the operator's maintenance personnel, which allowed the self-locking nut to back-off. This accident and six previous accidents involving the same make and model of helicopter illustrate an in-service issue with hardware used to secure the tail rotor driveshafts. As a result of these accidents, Transport Canada issued a safety alert notifying maintenance personnel of the need to check the prevailing or tare torque of hardware securing the tail rotor drive system.

Cause Narrative

THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: The improper installation by company maintenance personnel of the securing hardware of a tail rotor driveshaft section, which resulted in that section of tail rotor driveshaft disconnecting and a complete loss of tail rotor thrust.

Events

1. Maneuvering-low-alt flying - Flight control sys malf/fail
2. Emergency descent - Collision with terr/obj (non-CFIT)

Findings - Cause/Factor

1. Aircraft-Aircraft propeller/rotor-Tail rotor drive system-Tail rotor drive shaft-Malfunction - C
2. Aircraft-Aircraft propeller/rotor-Tail rotor drive system-Tail rotor drive shaft-Incorrect service/maintenance - C
3. Personnel issues-Task performance-Maintenance-Replacement-Maintenance personnel - C

Narrative

On October 15, 2015, about 1500 central daylight time, a Bell 206L-3, N206CJ, experienced a loss of tail rotor thrust and contacted trees during an emergency descent near Dickinson, Alabama. The commercial pilot was not injured, and the helicopter was substantially damaged. The helicopter was registered to CB Couch, Inc., and operated by Couch Helicopter Service, Inc., as an aerial application flight under the provisions of 14 Code of Federal Regulations Part 137. Visual meteorological conditions prevailed in the area at the time, and no flight plan was filed for the local flight that originated about 5 minutes earlier from a nearby field.

The operator reported that, toward the end of the flight, during a left turn while flying at an airspeed less than 15 knots and between 70 and 120 ft above trees, the pilot heard a "pop" sound followed by a loss of tail rotor thrust. The pilot added full left anti-torque pedal input but that was not effective. He then lowered the collective but did not reduce throttle. As the helicopter descended, the main rotor blades, mast, and a portion of the tailboom contacted trees and fractured. The helicopter descended to the ground and came to rest on its left side.

Examination of the helicopter by a Federal Aviation Administration operations inspector revealed that the tailboom with attached tail rotor had separated but was found near the main wreckage. The tail rotor blades were intact and showed little damage except for scratches from contact with trees. Examination of the

tail rotor drive system revealed that the first driveshaft assembly (shaft S1) aft of the oil cooler blower, and the second driveshaft assembly (shaft S2) aft of the oil cooler blower, were both fractured about midspan. One of the fasteners used to attach shaft S1 to the disc pack coupling at the shaft's aft end was missing, and the securing hardware was not located. The third tail rotor driveshaft (shaft S3) aft of the blower was not fractured. The forward flange of the fourth tail rotor driveshaft (shaft S4) aft of the blower was fractured on one side, and the fractured section remained attached to the disc pack coupling. The opposite side bolt remained trapped in the disk pack coupling, and the bolt was bent and fractured. Components of the tail rotor drive system consisting of fractured shafts S1 and S2, non-fractured shaft S3, and the fractured section of the forward end of shaft S4 with disc pack couplings and securing hardware were sent to the NTSB Materials Laboratory located in Washington, DC.

According to the NTSB Materials Laboratory report, the fracture surface of shaft S1 showed irregular fracture features with postfracture damage and inward deformation consistent with an overstress fracture, and the fracture features on shaft S2 were on slant planes and matte gray, which is consistent with overstress. There was no evidence of preexisting damage to either fracture surface. Examination of the fractured section of shaft S4 revealed fracture features consistent with an overstress fracture under shear loading.

Examination of the flange of the aft portion of shaft S1 associated with the missing hardware revealed wear in the hole bore corresponding to contact with the threads of the missing fastener. The outside face of the flange of the aft end of shaft S1 diametrically opposite from the flange with the missing fastener displayed circumferential sliding contact marks, and no torque paint was observed on the flange, washer, or bolt threads. At the missing attachment location, the forward plate in the disc pack coupling was cracked across the width of the plate between the inner and outer diameter, and the crack intersected the middle of the attachment hole. Contact marks were observed at the aft end of shaft S1 at the sides approximately orthogonal to the flanges. The shape and location of the contact marks were consistent with contact with the heads of the bolts attaching shaft S2 to the disc pack coupling and shaft S1 as it rotated about the remaining attachment bolt.

The prevailing or tare torque for one nut at the forward end and of the remaining nut at the aft end of shaft S1 were below the minimum torque specified in Bell Helicopter's Standard Practices Manual (SPM), and the prevailing or tare torque for the remaining fasteners were above the minimum torque specified in the SPM. (The prevailing torque is a measure of the turning resistance of a lock nut, and the turning resistance generally decreases as nuts are reused.) Returning torque measurements were conducted on each of the coupling attachments, which revealed that only the two fasteners on the forward end of shaft S1 were within limits.

According to the helicopter's maintenance records, on March 15, 2015, at helicopter total time 6,059.9 hours, the helicopter was modified in accordance with Bell Helicopter Technical Bulletin 206L-07-226 dated October 8, 2007. The modification included installation of an improved upper left longeron/fitting assembly, P/N 206-031-314-217B, and aft fuselage bulkhead, P/N 407-030-027-103. According to the technical bulletin accomplishment instructions, preparation included, in part, removal of: the tail rotor driveshaft between the engine and oil cooler, the oil cooler and oil cooler blower assemblies, the engine, the tail rotor drive shaft segment aft of the oil cooler blower, and the tailboom assembly. The maintenance record entry returning the helicopter to service after the modification did not specify whether new hardware was used during reinstallation of the tail rotor drive shaft segments or if the old hardware was re-installed. Since the modification was performed, the helicopter had undergone four 100-hour inspections, the latest of which was completed on September 10, 2015. The helicopter total time at its last 100-hour inspection was 6,456.5 hours, and the total time at the time of the accident was reported to be 6,550 hours.

In May 2002, Bell Helicopter issued Revision A to Operations Safety Notice (OSN) 206L-02-43, which required a 100-hour recurring torque check for the tail rotor disc pack coupling hardware as well as the application of torque stripes after torqueing. The OSN also indicated that the 206L maintenance manual (MM) would be revised to incorporate the new torque check and torque stripe requirement and reminded mechanics of the need to include tare torque of the nut in the torque value. Postaccident review of the 206L maintenance manual revealed no reference to adding torque stripes to the disc coupling fasteners following torque check. As a result, Bell Helicopter changed the MM to incorporate application of torque stripes after torque check of the disc pack coupling fasteners.

On May 25, 2015, Transport Canada issued Revision 1 to Civil Aviation Safety Alert (CASA) 2013-04, which identified certain defective MS21042-4 nuts, which are the type of nuts used to secure components of the tail rotor drive shaft system. The alert indicated that failures of nuts due to hydrogen embrittlement had occurred, and the defective nuts were from 3 lots produced by a single manufacturer in 2009 and 2010. According to the operator, they could not determine whether they had ever had in their inventory any nuts from the suspected lots of nuts specified in Revision 1 of CASA 2013-04.

On March 29, 2017, Transport Canada issued CASA 2017-02, titled "Loss of Hardware - Tail Rotor Drive Shaft Couplings," which called attention to six previous NTSB investigations of Bell 206 helicopters involving in-flight loss of tail rotor authority. The recommended action section of the alert specified using a calibrated torque wrench when installing hardware pertaining to the tail rotor drive shaft system, avoiding re-use of the hardware, verifying that tare or run-on

torque of nuts meets the minimum specification, requiring torque checks per the maintenance manual, and finally, applying torque stripe material to the hardware after torque check.

Review of the six NTSB investigations cited in CASA 2017-02 revealed that all identified separation of a fastener securing one of the tail rotor driveshafts to a disc pack coupling. Of the six fastener separations, only one separated nut was found. The report prepared by Bell Helicopter concerning the separated nut indicated that the prevailing or tare torque was greater than the minimum specified in the SPM. The NTSB metallurgy reports for two of the investigations indicated that the remaining fasteners of the provided parts were not checked with an instrument of sufficient accuracy; therefore, it could not be determined whether they met the minimum prevailing or tare torque value specified in the SPM.

The accident helicopter was manufactured in 1992, but certificated in accordance with Civil Air Regulations (CAR) 6, dated December 20, 1956, Amendments 6-1 thru 6-4, CAR 6.307(b) and 6.637 of Amendment 6-5, special conditions dated October 2, 1962, as revised February 8, 1966. Review of CAR 6.303, titled "Standard Fastenings," revealed that it stated, "Self-locking nuts shall not be used on bolts which are subject to rotation in operation." According to Bell Helicopter and Transport Canada personnel, the bolts used to secure the tail rotor driveshaft disc pack couplings are in rotation, but do not serve as the axis of rotation itself. Therefore, CAR 6.303 was not applicable.

Incident Rpt# ENG16IA001	**10/02/2015 510 UTC**	**Regis# N662US**	**Russian Airspac, FN JA**	**Apt: N/a**
Acft Mk/Mdl BOEING 747-451		**Acft SN 23720**	**Acft Dmg: MINOR**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl P&W PW4056		**Acft TT 109167**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 121**
Opr Name: DELTA AIR LINES		**Opr dba: DELTA AIR LINES**		**Aircraft Fire: NONE**
				AW Cert: STT

Summary

The examination of the engine confirmed that there were three holes in the LPT case. But the holes were under the LPT cooling air manifolds and plenum that did not have any damage. In addition, there was no damage to the inside of the engine's cowlings nor did any debris fall out when the cowlings were opened. There was no damage to the LPT cooling air manifolds and plenum that were over the holes and was there was no debris in the cowlings indicating that no debris passed through the LPT case that made this a contained event rather than uncontained.

The disassembly of the engine revealed one 3rd stage turbine vane cluster, No. 29, was missing although the cluster's bolt hole tab with the retaining nut were still in place on the inner transition duct. The missing cluster's inner shroud was found in the bottom of the engine in the path of the 3rd stage turbine blades. The metallurgical examination of the inner shroud revealed fatigue, however the full extent of the fatigue could not be determined because the end of the fracture surface was smeared.

The examination of the remainder of the LPT revealed all the other turbine vane clusters were complete and in place or the inner and outer shrouds were in place with just the airfoils missing. All the LPT blades were fractured and the fracture surfaces were coarse and grainy indicating an overload fracture. The examination of the remainder of the engine between the fan and high-pressure turbine did not reveal any damage. The extensive damage to the LPT and the absence of damage throughout the remainder of the engine indicated that the damage to the engine originated within the LPT.

The visual examination and a dimensional inspection of the LPT case revealed the 3rd stage turbine vane hooks had extensive wear that varied significantly between adjacent hooks. The dimensional inspection revealed the hook for 3rd stage turbine vane cluster No. 29, the missing vane cluster, had the most wear and that wear was tapered. The tapered wear on the hook and indicates that the vane cluster's outer foot disengaged from the LPT case and tilted rearward. It was not possible to determine the cause of the tapered wear on the LPT case vane hook that led to the vane cluster disengaging. The finding of fatigue on the inner shroud further supports that the vane cluster's outer foot disengaged from the LPT case initially and fatigue was caused by either the transfer of the loads to the inner shroud or from the cluster being strummed by the passing 3rd stage turbine blades.

The review of the engine's maintenance showed that it had last been overhauled in October 2005 and since accumulated 35,545 hours and 3,532 cycles of service. Although the engine was overhauled in October 2005, the LPT module's maintenance records show that it had been swapped from another engine and accumulated 17,441 hours and 2,184 cycles since its previous overhaul. So, at that time of event, the LPT module accumulated 52,986 hours and 6,546 cycles since it had been last overhauled. Except for the low cycle fatigue life limits for specific rotating parts that are outlined in the engine manual, there is no prohibition for an engine or LPT module to have operated as long as this module had been in service. The review of the LPT module's maintenance records from the previous overhaul show that the LPT case modification to the anti-rotation slots had been previously complied with. In addition, the records show that the modification to the 3rd stage turbine vane clusters to remove material from the outer platform gussets had been complied with as well. Because of previous contained and uncontained PW4000 LPT events, P&W has revised the engine manual to add extensive inspections and repairs to LPT components as well as limiting the number of strip and recoat repairs that can be done to PW4000 LPT airfoils. The inspections and repairs that were subsequently adopted into an airworthiness directive (AD) included a visual and dimensional inspection of the LPT case's vane hooks. The tapered wear that was noted on the LPT case's 3rd stage turbine vane hooks occurred over time. The records do not list any work on the LPT case's vane hooks at the last overhaul, so it cannot be determined if the wear that resulted in the disengagement of the 3rd stage turbine vane cluster had existed only from the last overhaul or had existed prior to that overhaul. However, the revised inspection and repair procedures that are now mandated by an AD likely would have captured the wear and required it to be repaired or the case replaced.

Cause Narrative

THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: The PW4056 engine experienced an in-flight loss of power because of damage to the low-pressure turbine (LPT) because of the inadequate overhaul inspection and repair instructions that existed at the time of the LPT module's last overhaul. A vane hook in the LPT case wore to the point to allow a 3rd stage turbine vane cluster to disengage and eventually fall into the path of the 3rd stage turbine blades causing extensive downstream damage to the LPT module.

Events

1. Enroute - Loss of engine power (partial)
2. Enroute - Engine shutdown

Findings - Cause/Factor

1. Aircraft-Aircraft power plant-Engine (turbine/turboprop)-Turbine section-Fatigue/wear/corrosion - C

Narrative

History of Flight

On October 2, 2015, at about 0510 UTC, a Boeing 747-451 airplane, N662US, operated by Delta Air Lines as flight 158, experienced a loss of power from the No. 3 engine, a Pratt & Whitney (P&W) PW4056, while in cruise flight at FL330. About 3:40 hours after taking off from Incheon International Airport (ICN), Seoul, Korea, while operating in Russian airspace on the B241 airway near the GITRU navigation fix, the pilots reported hearing a loud bang that was followed by the No. 3 engine's N1 rpm decreasing while the exhaust gas temperature (EGT) increased. The pilots shutdown the No. 3 engine and declared an emergency with Russian air traffic control in addition to requesting a descent to FL290. The pilots contacted the dispatcher at Atlanta and discussed options for diverting. The pilots considered diverting to Seattle, but the weather for their expected arrival time was forecast to be 800 foot overcast and 2 miles visibility. The weather forecast for Tokyo, Japan was scattered clouds and 25 miles visibility. The airplane diverted to Tokyo-Narita International Airport (NRT), where it made a 3-engine landing without further incident. The airplane was operating on an instrument flight rules flight plan under the provisions of 14 Code of Federal Regulations Part 121 as an international passenger flight from ICN to Detroit Metropolitan Wayne County Airport (DTW), Detroit, Michigan.

Injuries to Persons

There were no reported injuries to the 4 pilots, 13 flight attendants, and 341 passengers on board.

Damage to Airplane

The airplane sustained minor damage in the forms of nicks and dents to the underside of the right wing and inboard aileron as well as to the leading edge of the right horizontal stabilizer.

There was no damage to the inside of the No. 3 engine's nacelle.

Other Damage

There was no other damage reported.

Personnel Information

The captain, age 59, held at Air Transport Pilot certificate with airplane single-engine land, multi-engine land, and airplane instrument ratings. The captain was type rated in the Boeing 747-400 as well as the Boeing 727, 737, 757, and 767 airplanes. The captain held a Federal Aviation Administration (FAA) first class medical certificate that was dated September 2, 2015, with no reported limitations. The captain's most recent proficiency check was dated March 21, 2015, and was accomplished in a Boeing 747-400 airplane. The captain's reported flight time was 10,617 hours with 4,449 hours being in the Boeing 747-400 airplane and 154 hours in the previous 90 days. The captain occupied the left seat and was the pilot monitoring.

The first officer (FO), age 58, held an Air Transport Pilot certificate with airplane single-engine land, multi-engine land, and airplane instrument ratings. The FO was type-rated in the Boeing 747-400 airplane. The FO held an FAA first class medical certificate that was dated July 20, 2015, with no reported limitations. The FO's most recent proficiency check was dated May 14, 2015, and was accomplished in a Boeing 747-400 airplane. The FO's reported flight time was 9,683 hours with 5,628 hours being in the Boeing 747-400 airplane and 257 hours in the previous 90 days. The FO occupied the right seat and was the pilot flying.

Airplane Information

The airplane was a Boeing 747-451, serial number (SN) 23720, registered as N662US, and operated by Delta Air Lines. The Boeing 747-451 airplane is a four-engine transport category airplane. The airplane has a maximum takeoff gross weight of 873,000 pounds and the airplane's takeoff weight from ICN was 837,600 pounds. The airplane was loaded with 49,120 gallons of fuel. The airplane was manufactured in 1988 and was originally delivered to Northwest Airlines. Delta Air Lines acquired the airplane in the merger with Northwest Airlines. According to Delta Air Lines' records, at the time of the incident, the airplane had accumulated 109,167 hours of flying time.

The No. 3 engine was a PW4056, SN P717530. The PW4056 is a dual-spool, axial-flow, high-bypass turbofan engine that features a 1-stage 94-inch diameter fan, a 4-stage low-pressure compressor (LPC), an 11-stage high-pressure compressor (HPC), annular combustor, a 2-stage high-pressure turbine (HPT) that drives the HPC, and a 4-stage LPT that drives the fan and LPC. The PW4056 engine has a takeoff thrust rating of 56,750 pounds, flat-rated to 92øF (33øC). When the PW4056 engine is installed on a Boeing 747 airplane, it has a maximum continuous thrust rating of 47,970 pounds, flat-rated to 86øF (30øC). The PW4056 engine can also be installed on a Boeing 767 airplane where it has a maximum continuous thrust rating of 49.530 pounds, flat-rated to 77øF (25øC). According to Delta Air Lines' maintenance records, engine SN 717530 had accumulated 94,778 hours and 11,814 cycles since new, 35,545 hours and 4,362 cycles since the last heavy maintenance, and 29,194 hours and 3,532 cycles since the last shop visit. The last heavy maintenance on the engine was accomplished in 2005 at P&W's Cheshire Engine Center, Cheshire, Connecticut. P&W's Cheshire Engine Center was an FAA-certificated repair station that ceased operations in 2011.

The LPT module was SN D17579. According to Delta Air Lines' maintenance records, LPT module SN D17579 had accumulated 95,180 hours and 11,623

cycles since new and 52,986 hours and 11,623 cycles since the last heavy maintenance, which had been accomplished at the Cheshire Engine Center in 2005. Engine 717530 had been received at Cheshire with LPT module SN D17531 installed. The records show that Cheshire swapped out LPT module D17531 for D17579 from Northwest Airlines PW4056 engine P717684 to expedite the engine build. The records further show that at the time LPT module D17579 was installed in engine P717530, it had already accumulated 59,635 hours and 7,261 cycles since new and 17,441 hours and 2,184 cycles since the last heavy maintenance.

Flight Recorders

The airplane was equipped with a cockpit voice recorder (CVR) and a digital flight data recorder(DFDR), which was returned to the NTSB's Recorder Laboratory for readout. The CVR was not removed from the airplane for readout because of the elapsed time from when the event occurred to when the airplane landed at NRT would have resulted in the event being overwritten.

The DFDR recorded data for the incident flight as well as five previous flights. The DFDR data for the incident flight shows the No. 3 engine was started around subframe reference number (SRN, each subframe is equal to 1 second) that was followed 2 seconds later by the No. 4 engine being started. At around SRN 157079, both the No. 3 and 4 engines stabilized at idle power. Around 157080 and 157090, the Nos. 2 and 1 engines, respectively, were started with the No. 1 engine stabilizing at idle around SRN 157184 and the No. 2 engine stabilized at idle around SRN 157195. The DFDR recorded the following engine performance parameters: engine pressure ratio (EPR), which is a measure of engine power based on ratio of pressure of the exhaust gas in the tailpipe in comparison to the pressure of the air entering the inlet; high pressure rotor speed (N2) in percent; EGT in degrees Celsius (øC), and fuel flow (Wf) in pounds per hour (pph)/

After the engines had started and were stabilized at idle power, the engine's performance parameters were:

Engine power, stabilized idle power after start

No. 1: EPR - 1.014, N2 - 66 %, EGT - 350øC, Wf - 1,696 pph

No. 2: EPR - 1.023, N2 - 66 %, EGT - 343øC, Wf - 1,664 pph

No. 3: EPR - 1.016, N2 - 66 %, EGT - 368øC, Wf - 1,952 pph

No. 4: EPR - 1.016, N2 - 66 %, EGT - 346øC, Wf - 1,824 pph

Between about SRN 157184 and 157672, the Nos. 1 and 4 engine performance parameters: EPR, N2, EGT, and fuel flow intermittently increased and decreased consistent with the airplane taxiing from the ramp out to the runway. Around SRN 157673, the engines' performance parameters began to increase with the No. 3 engine's parameters lagging those of the other three engines by about 2 percent N2. At around SRN 157683, the engines stabilized at takeoff

power and the airplane had begun to accelerate. The airplane lifted off at around SRN 157726 at an airspeed of around 184 knots.

During takeoff, the engines' performance parameters were:

Engine power at takeoff

No. 1: EPR - 1.498, N2 - 98 %, EGT - 562øC, Wf - 21,856 pph

No. 2: EPR - 1.498, N2 - 98 %, EGT - 556øC, Wf - 21,248 pph

No. 3: EPR - 1.500, N2 - 97 %, EGT - 595øC, Wf - 22,048 pph

No. 4: EPR - 1,500, N2 - 98 %, EGT -464øC, Wf - 21,281 pph

At around SRN 158451, the airplane climbed through FL 180 and all four engines were at an EPR of 1.408. The engines' performance parameters in the climb through FL180 were:

Engine power at FL 180

No. 1: EPR - 1.408, N2 - 96 %, EGT - 506øC, Wf - 13,344 pph

No. 2: EPR - 1.408, N2 - 95 %, EGT - 492øC, Wf - 12,800 pph

No. 3: EPR - 1.408, N2 -95 %, EGT - 542øC, Wf - 13,888 pph

No. 4: EPR - 1.408, N2 - 95 %, EGT - 505øC, Wf - 13,280 pph

The airplane leveled off at FL 330 at around SRN 159399. Around SRN 159699, about 5 minutes after the airplane had leveled off at FL 330, all four engines were at an EPR of 1.363. The engines' performance parameters at FL330 were:

Engine power at FL 330

No. 1: EPR - 1.363, N2 - 94 %, EGT - 459øC, Wf - 7,488 pph

No. 2: EPR - 1.363, N2 - 93 %, EGT - 449øC, Wf - 7,206 pph

No. 3: EPR - 1.363, N2 - 92 %, EGT - 491øC, Wf - 7,964 pph

No. 4: EPR - 1.363, N2 - 93 %, EGT - 461øC, Wf - 7,552 pph

Between about SRN 159699 and 170166 while the airplane continued to maintain FL 330, the engines' EPRs and N2 speeds varied in unison between 1.273 and 1.359 and 91 and 93 percent, respectively. The engines' EGT and Wf also varied in unison with the EPR and N2 speed.

At around SRN 170166, the No.3 engine's performance indications were: EPR 1.281, N2 91 percent, EGT 458øC, and Wf 7,022 pph. At around SRN 170167, with the EPR remaining at 1.281 and N2 at 91 percent, the EGT began to increase and the fuel flow began to decrease. The EGT continued to increase until around SRN 170813 when it peaked at 659øC before it began to decrease. Concurrently, the EPR decreased from 1.297 to 0.92 in 2 seconds, the N2 began to decrease from 92%, and the Wf continued to decrease. At around SRN 170199, while the EPR was at 0.631 and the N2 and EGT continued to decrease, the Wf began to increase from 3,520 to 18,144 pph in 4 seconds before decreasing down to zero in the next 6 seconds. There was no increase in the N2 rpm or EGT associated with the increase in Wf.

The DFDR contained data from five previous flights. The data show that No. 3 engine's performance indications were comparable to those of the other three engines.

Fire

There was no fire damage.

Tests and Research

The engine was removed from the airplane and shipped to Delta's Technical Operations Center, Atlanta, Georgia for disassembly and examination in the presence of the Powerplants Group. The disassembly revealed one 3rd stage turbine vane cluster, No. 29 that was located at about 8 o'clock, was missing. (Photo No. 1) A portion of the missing vane cluster's inner shroud was found at the bottom of the engine in the 3rd stage turbine blades' plane of rotation. (Photo No. 2) The piece of the 3rd stage turbine vane cluster inner shroud had three circumferential grooves that corresponded to the geometry of the 3rd stage turbine rotating inner air seal.

Photo No. 1: View of missing 3rd stage turbine vane cluster from front of LPT. (Delta)

Photo No. 2: View of missing 3rd stage turbine vane cluster with piece of 3rd stage turbine vane cluster inner shroud lying in bottom of engine in location of missing cluster. (P&W)

Although the vane cluster was missing, the cluster's bolt hole tab with the nut remained in place attached to the inner transition duct. (Photo No. 3) During the disassembly of the 3rd stage turbine vane area, the torque on the retaining nuts were checked and all including that for the missing vane cluster were found to be tight.

Photo No. 3: Close up of the bolt hole tab with the retaining nut in place for the

No. 29 3rd stage turbine vane cluster. (P&W)

The remaining 3rd stage turbine vane clusters' were all in place and the airfoils were heavily battered with nicks and dents on the trailing edges. (Refer to Photo No. 2)

The LPT case with the inner transition ducts and all of the 3rd stage turbine vane clusters including the No. 29 vane cluster inner shroud fragment were sent to P&W, East Hartford, Connecticut for metallurgical examination and dimensional inspections that were accomplished under NTSB oversight. The metallurgical examination of the No. 29 3rd stage turbine vane cluster's inner shroud revealed remnants of fatigue on the counterclockwise side of the forward flange. The fatigue had progressed forward from multiple origins along the aft surface of the flange to a maximum depth of 0.026 inches. The fracture surface beyond the fatigue was smeared, so it could not be determined if the fatigue had progressed further. The examination of the fragment also revealed two wear patterns that were consistent with contact with the No. 28 3rd stage turbine vane cluster in the normal installed position as well as having moved out of position. The dimensional inspection of the LPT case revealed wear on the 3rd stage turbine vane cluster hooks with the most extensive wear that was also tapered being on the hook for the No. 29 cluster. The examination of the No. 29 inner transition duct revealed wear patterns from the No. 29 3rd stage turbine vane cluster that were consistent with the cluster having moved inward and aft.

The initial report of this event from NRT was that it was an uncontained LPT event because there were several holes in the LPT case. The examination of the LPT case confirmed that there were three small holes, largest about 0.69 x 0.44 inches, in the LPT case, all under the LPT case cooling air tubes. The examination of the cooling air tubes did not show any impact damage and it was reported from NRT that there was no damage to the inside of the No. 3 engine cowling nor did any debris fall out of the cowling when it was opened.

Accident Rpt# GAA17CA191	**03/11/2017 830 HST**	**Regis# N865MA**	**Kalaupapa, HI**	**Apt: Kalaupapa LUP**
Acft Mk/Mdl CESSNA 208		**Acft SN 208B0996**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl P&W PT6A SER			**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 135**
Opr Name: SCHUMAN AVIATION CO. LTD		**Opr dba: MAKANA KAI AIR**		**Aircraft Fire: NONE**
				AW Cert: STC

Summary

The pilot of the commuter airplane reported that she was going to establish an approach and landing on runway 05 at an airport with a single runway and no taxiways. While on a 7-mile final, she communicated with the pilot of an airplane that was on short final for the same airport. The pilot that was on short final reported that he would report when he was clear of the runway, and he did. The commuter pilot acknowledged the other pilot's clear-of-runway transmission and initiated the approach.

As the pilot descended through 150 ft above ground level, she noticed that the airplane that she had communicated with was not clear of the runway. The airplane on the ground was near the runway 23 numbers with the propeller turning facing toward her landing airplane. She aborted the landing, but the airplane did not climb. The airplane impacted the runway hard and bounced. She reported that, when the airplane touched down after the bounce, she "applied left rudder pedal to steer the aircraft off the runway and out of the way of the other aircraft's possible flight path." The airplane exited the left side of the runway and ground-looped to the left. The airplane sustained substantial damage to the right side of the fuselage and the right wing. ÿ

After the groundloop, the pilot of the airplane near the runway 23 numbers attempted to take off. He was contacted via radio transmission by the airport manager and told that the runway was closed until further notice.

Examination of the accident airplane by Federal Aviation Administration Aviation Safety Inspectors determined that there were no preimpact mechanical anomalies with the airplane that would have prevented normal operation.

Cause Narrative

THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: The pilot's loss of directional control during the aborted landing, which she conducted due to another airplane, whose pilot had reported being clear of the runway, still being on the runway, and resulted in a hard landing and ground loop.

Events

1. Approach-VFR pattern final - Attempted remediation/recovery
2. Approach-VFR go-around - Loss of control in flight
3. Landing - Collision with terr/obj (non-CFIT)

Findings - Cause/Factor

1. Aircraft-Aircraft oper/perf/capability-Performance/control parameters-Directional control-Not attained/maintained - C
2. Personnel issues-Task performance-Use of equip/info-Aircraft control-Pilot - C
3. Environmental issues-Physical environment-Object/animal/substance-Aircraft-Effect on operation - C
4. Aircraft-Aircraft oper/perf/capability-Aircraft capability-Climb capability-Capability exceeded

Narrative

The pilot of the commuter airplane reported that she was going to establish an approach and landing to runway 05 at an airport with a single runway and no taxiways. While on a seven-mile final, she communicated with the pilot of an airplane that was on short final for the same airport. The pilot that was on short final reported that he would report when he was clear of the runway, and he did. The commuter pilot acknowledged the other pilot's clear of runway transmission, and initiated the approach.

As the pilot descended through 150 feet above ground level, she noticed that the airplane that she had communicated with was not clear of the runway. The airplane on the ground was near the runway 23 numbers with the propeller turning, facing toward her landing airplane. She aborted the landing but the airplane did not climb. The airplane impacted the runway hard and bounced. She reported that when the airplane touched down after the bounce, she "applied left rudder pedal to steer the aircraft off the runway and out of the way of the other aircraft's possible flight path." The airplane exited the left side of the runway and ground-looped to the left. The airplane sustained substantial damage to the right side of the fuselage and the right wing.

After the ground-loop, the pilot of the airplane near the runway 23 numbers attempted to takeoff. He was contacted via radio transmission by the airport manager and vehemently told that the runway was closed until further notice.

Examination of the accident airplane by Federal Aviation Administration, Aviation Safety Inspectors, determined that there were no preimpact mechanical anomalies that would have prevented normal flight operation.

Accident Rpt# ERA16LA042	**11/06/2015 1710 EST**	**Regis# N731LT**	**Atlanta, GA**	**Apt: Dekalb-peachtree PDK**
Acft Mk/Mdl CESSNA P210-N		**Acft SN P21000436**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl ALLISON 250-B17F/2		**Acft TT 4809**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 091**
Opr Name: HORST AVIATION LLC		**Opr dba:**		**Aircraft Fire: NONE**
				AW Cert: STN

Summary

The private pilot reported that he was conducting an instrument flight rules cross-country flight and set up for an RNAV approach; however, he was subsequently cleared for an instrument landing system approach. He added that he continued to the airport, recalled lowering the landing gear, but because he was setting up for a different approach, he did not verify that the landing gear were down and locked. He added that the landing was normal but that, during the landing roll, he heard a "snap" and felt the airplane drop and veer left. The airplane departed the left side of the runway and came to rest with the nose landing gear (NLG) down and locked but with both main landing gear (MLG) collapsed.

Postaccident examination revealed no damage to either MLG downlock hook assembly. Testing of the landing gear system revealed that it functioned normally during multiple gear cycles, including an emergency extension. A check of the landing gear warning horn revealed that it was mis-set about 0.3 inch higher than specified, which reduced timely warning that the gear were not down and locked. Given there was no damage to either MLG downlock hook assembly, it is likely that neither MLG were down and locked at touchdown because the pilot extended the landing gear late during the approach and did not verify that they were down and locked, which only allowed sufficient time for the NLG, which extends and locks first, to fully extend and lock before touchdown. If the landing gear warning horn had been properly set, it is likely the pilot would have been warned in time to either go around or to allow for complete gear extension before landing.

Cause Narrative

THE NATIONAL TRANSPORTATION SAFETY BOARD DETERMINED THAT THE CAUSE OF THIS OCCURRENCE WAS: The pilot's delayed extension of the landing gear and his failure to ensure that the main landing gear (MLG) were down and locked before touchdown, which resulted in the collapse of both MLG. Contributing to the landing gear collapse was the mis-set landing gear warning horn, which prevented timely notification that the landing gear were not down and locked.

Events

1. Landing-landing roll - Landing gear collapse

Findings - Cause/Factor

1. Personnel issues-Action/decision-Action-Delayed action-Pilot - C
2. Aircraft-Aircraft systems-Landing gear system-Gear position and warning-Incorrect service/maintenance - F

Narrative

On November 6, 2015, about 1710 eastern standard time, a Cessna P210N, N731LT, was substantially damaged while landing at DeKalb-Peachtree Airport (PDK), Atlanta, Georgia. The private pilot and one passenger were not injured. The airplane was registered to Horst Aviation, LLC, but operated by an individual under the provisions of 14 Code of Federal Regulations Part 91 as a business flight. Visual meteorological conditions prevailed at the time of the accident, and the flight was operating on an instrument flight rules flight plan. The flight originated from Smoketown Airport (S37), Smoketown, Pennsylvania, about 1330, and was destined for PDK.

The pilot stated that he expected and was set up for an RNAV approach, but was cleared for the ILS approach to runway 21L. He continued inbound to PDK and upon reaching the final approach fix, he recalled lowering the landing gear, but because of the approach distraction he did not verify that the landing gear was down and locked. He continued the approach, and reported breaking out of the clouds at 2,000 feet. When the airplane was at 200 feet above ground level, he reduced power and did not hear any warning horn. He indicated the landing was normal and very smooth, and after rolling about 400 feet, he heard a "snap" and felt the airplane drop and veer to the left. The airplane rolled off the runway onto grass and came to rest with the nose landing gear down and locked but both main landing gear collapsed. The airplane was raised, and both main landing gear were extended for towing to the ramp.

Following recovery of the airplane, examination of both main landing gear actuators revealed no evidence of leaks or hydraulic residue. A test gauge was plumbed into the aircraft's landing gear hydraulic system and held pressure (1,500+ psi) in the up and down position for more than 10 minutes. The airplane was placed on jacks and several fault-free gear cycles were performed including an emergency extension. The single landing gear down and locked light functioned normally, and left main landing gear down limit switch which felt, "a little sticky", was replaced. There was no report of any damage to either main landing gear downlock hook assembly. A check of the landing gear warning horn revealed it was set 0.3 inch above the flight idle gate, while it is specified to be set 0.6 inch above the flight idle gate. It was adjusted to the specified amount, and although a flight check of the landing gear warning system was not performed during a postaccident maintenance flight check, the repair facility reported it was performed by the owner on the first flight after completion of repairs

and no discrepancy was reported.

The airplane's landing gear was hydraulically controlled, and by design the nose landing gear extended aft while the main landing gears extended forward. A representative of the airplane manufacturer reported that during landing gear extension, the nose landing gear locked into place followed by the main landing gear. This was because the nose landing gear extended aft and was assisted by airloads, while the main landing gear extend forward against airloads. During retraction of the main landing gear, the wheel assembly drops about 12 inches below the position when fully extended. Fully locking down of the main landing gear actuator occurs with a downlock hook assembly installed on each main landing gear.

The airplane's last annual inspection was completed on February 26, 2015. There were no reported discrepancies during cycling of the gear that was performed during the inspection. The airplane had accrued about 66 hours since the inspection was performed.

Accident Rpt# GAA18CA012	**10/12/2017 2330 CDT**	**Regis# N140SF**	**Canton, IL**	**Apt: Ingersoll CTK**
Acft Mk/Mdl EUROCOPTER DEUTSCHLAND GMBH		**Acft SN 9389**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Prelim** **Prob Caus: Pending**
			Fatal 0 **Ser Inj 0**	**Flt Conducted Under: FAR 091**
Opr Name: OSF AVIATION LLC.		**Opr dba:**		**Aircraft Fire: NONE**

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Prepared From Official Records of the NTSB By:
Air Data Research
9865 Tower View, Helotes, Texas 78023
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Accident Rpt# ERA15LA328 04/10/2015 1845 EDT	**Regis# N450KK**	**Caribbean Sea, CB UN**	**Apt: N/a**
Acft Mk/Mdl GULFSTREAM AEROSPACE G	**Acft SN 1225**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl ROLLS-ROYC TAY 611SER	**Acft TT 7473**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 091**
Opr Name: LA VENEZOLANA DE SEGUROS CA	**Opr dba:**		**Aircraft Fire: NONE**
			AW Cert: STT

Events

1. Enroute-cruise - Pressure/environ sys malf/fail

Narrative

HISTORY OF FLIGHT

On April 10, 2015, about 1845 eastern daylight time, a Gulfstream Aerospace G-IV airplane, N450KK, experienced a cabin overpressurization event over the Caribbean Sea. The airline transport pilot and copilot were not injured, and the airplane sustained substantial damage. The airplane was being operated by a private company as a 14 Code of Federal Regulations Part 91 positioning flight. Day, visual meteorological conditions prevailed, and an instrument flight rules flight plan was filed. The flight originated at Sim¢n Bol¡var International Airport (SVMI), Maiquetia, Venezuela, about 1645 and was destined for Fort Lauderdale Executive Airport (FXE), Fort Lauderdale, Florida.

The pilot reported that the purpose of the flight was to fly the airplane to Boca Raton Airport (BCT), Boca Raton, Florida, for scheduled maintenance with a planned stop at FXE to clear US Customs. While approaching to start the descent to FXE, at flight level 430, the pilots observed a red "9.8 CABIN DFRN" warning message on the crew advisory system (CAS), indicating a maximum cabin differential pressure of 9.8 pounds per square inch differential (psid) or greater, followed by a red "DOOR MAIN" warning message. According to the digital flight data recorder (DFDR), this was preceded 21 seconds by the illumination of the amber Master Caution switch. The pilots then donned oxygen masks and referenced the airplane's quick reference handbook (QRH) for the emergency checklist. The pilots then heard a loud "bam" sound in the cabin and immediately initiated a descent in accordance with the QRH. The pilots manually opened the cabin pressure outflow valve and leveled the airplane at 12,000 ft mean sea level. The DFDR also showed that the 9.8 CABIN DFRN warning illuminated a second time, at 1858:38, and remained illuminated until 1904:14. This was not reported by the flight crew. The pilots continued the flight to FXE unpressurized and landed without further incident. Examination of the airplane the next day revealed structural airframe damage.

AIRPLANE INFORMATION

According to Gulfstream, "The pressurization system controls, regulates and monitors the amount of conditioned air within the pressure vessel to achieve and maintain a safe and comfortable cabin pressure (cabin altitude), up to the airplane's maximum operating altitude. While normally preprogrammed, cabin altitude can also be controlled manually. Cabin conditioned air is also exchanged at regular intervals for occupant comfort."

Normally, the cabin pressurization system limits the cabin pressurization differential to 9.55 +0.1 psid. As differential pressure reaches 9.55 psid, an amber "CABIN DFRN 9.6" caution message is displayed on the CAS. If the pressurization system malfunctions and cannot limit the maximum cabin pressurization differential to 9.55 +0.1 psid, the cabin pressurization relief/safety valve (CPRV) limits pressure differential to 9.7 +0.1 psid. As differential pressure reaches 9.8 psid, a red "CABIN DFRN 9.8" warning message is displayed on the CAS.

FLIGHT RECORDERS

The airplane was equipped with a digital flight data recorder (DFDR), and the entire accident flight was captured on the DFDR. The DFDR was not designed to record cabin pressure or cabin altitude; however, it recorded CAS messages associated with cabin differential pressure anomalies.

The following is a chronological sequence of events based on the DFDR data with estimated times:

1645:00 - Flight took off from SVMI.
1844:41 - Amber Master Caution switch illuminated (the DFDR did not record the type of message).
1845:02 - A red "9.8 CABIN DFRN" CAS warning message and red Master Warning switch illuminated; the CAS message remained on for 11 minutes 44 seconds.
1846:10 - Pilots acknowledged the amber and red CAS messages (89 seconds after the first CAS illumination).

1847:17 - The airplane began to descend.
1848:28 - Amber Master Caution switch illuminated (the DFDR did not record the type of message); pilots extinguished 5 seconds later.
1853:50 - Red Master Warning switch illuminated (the DFDR did not record the type of message); pilots extinguished 10 seconds later.
1855:18 - Amber Master Caution switch illuminated (the DFDR did not record the type of message); pilots extinguished 24 seconds later.
1856:46 - Red "9.8 CABIN DFRN" message extinguished. Airplane was level at 20,000 ft.
1857:55 - Amber Master Caution switch illuminated (the DFDR did not record the type of message); pilots extinguished 1 second later.
1858:38 - Red "9.8 CABIN DFRN" CAS warning message and red Master Warning switch illuminated.
1904:14 - Red "9.8 CABIN DFRN" extinguished and remained off for the remainder of flight.
1905:52 - "Cabin Pressure Low" CAS message illuminated and remained on for 27 minutes; airplane descended through 13,000 ft.
1905:53 - Red Master Warning switch illuminated (the DFDR did not record the type of message); pilots extinguished 45 seconds later.
1905:59 - Emergency checklist activated for Cabin Pressure Low.
1932:53 - Cabin Pressure Low message extinguished and stayed off for the remainder of flight.
1947:27 - Airplane landed at FXE, 62.7 minutes after the first amber CAS message illuminated in the cockpit.

POSTACCIDENT EXAMINATION

The day after the accident, the airplane was repositioned to BCT, about 20 miles from FXE, for scheduled maintenance. During the scheduled maintenance, several damaged floor beams on the left side of the fuselage and a damaged frame under the right galley door were noted. Gulfstream maintenance and engineering personnel then examined the airplane and found structural airframe damage, including a cracked floor beam, dimpled areas in the floor boards, damaged structure between ribs, and damaged wing links.

An examination of the outer fuselage revealed that the CPRV static port, located above the CPRV, was completely plugged with a foreign material resembling dried dirt from a mud dauber. According to Gulfstream, a blocked CPRV static port would render the CPRV inoperative due to its inability to measure the cabin-to-atmosphere pressure differential. However, the cabin pressure could still be controlled independently by manual operation of the outflow valve. The cabin could also be depressurized by using ram air, which would shut off bleed air for pressurization. No other mechanical anomalies were found with the pressurization system. The airplane was not repaired and returned to service.; therefore, the reason for the initial overpressurization event could not be determined. According to Gulfstream, an obstructed CPRV static port would be difficult to detect on a preflight walk-around inspection.

Examination of the aural warning system speaker showed evidence of deterioration, and the speaker volume was not functioning properly. An aural caution (double chime) and an aural warning (triple chime) should have accompanied the amber and red cabin differential pressure messages on the CAS. There was no evidence that the flight crew received any aural cautions or warnings.

Abnormal Procedures

The abnormal procedures in the G-IV QRH addressed both the 9.6- and 9.8-psid scenarios. The 9.6-psid procedure instructed the crew to raise cabin altitude and increase cabin climb rate, if required, and to switch to manual pressurization control in the event that automatic pressurization control was lost. The procedure cautioned the crew to closely monitor the cabin differential pressure and not allow it to exceed 9.8 psid. If cabin psid exceeded 9.8, then the ram air switch should be placed to "RAM" to use ram air, and air from both air conditioning packs should be shut off for pressurization.

Accident Rpt# WPR15LA165 05/16/2015 1548 PDT	**Regis# N505SP**	**Carlsbad, CA**	**Apt: Mc Clellan-palomar CRQ**
Acft Mk/Mdl RAYTHEON AIRCRAFT COMPANY	**Acft SN BB-1538**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl PRATT & WHITNEY PT6A-52	**Acft TT 3962**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 091**
Opr Name: JAMES P PREVITI	**Opr dba:**		**Aircraft Fire: NONE**
			AW Cert: STN

Events

1. Enroute-climb to cruise - Electrical system malf/failure
2. Enroute-climb to cruise - Electrical system malf/failure

Narrative

HISTORY OF FLIGHT

On May 16, 2015, at 1548, Pacific daylight time, a Beech King Air B200, N505SP, was substantially damaged when the airplane landed with the landing gear retracted at Mc Clellan-Palomar Airport (CRQ), Carlsbad, California. The airplane was registered to and operated by the commercial pilot under the provisions of 14 Code of Federal Regulations Part 91. The pilot was not injured. The cross-country personal flight departed Palm Springs (PSP), California, about 1515 with a planned destination of Santa Ana, California. Visual meteorological conditions prevailed, and no flight plan had been filed.

The pilot reported that 10 minutes into the flight, he received an instrument flight rules flight plan from air traffic control (ATC). The cloud tops were at 8,500 feet and he was cleared to 6,000 ft, which put him in the clouds.

Within minutes of entering the clouds, the airplane lost all electrical power, and the pilot lost contact with ATC. He climbed back out of the clouds and proceeded to the west; he found a hole in the clouds over the Pacific Ocean, descended, and turned southbound. He said partial electrical power was restored, and he tried to advise ATC of his problems. His transmissions were not understood, but he flew to CRQ, and received a green light from the tower personnel. He extended the landing gear and flaps but had no airspeed indicator. When the airplane touched down, the pilot realized that his landing gear had not extended.

Witnesses reported that the airplane approached the runway and was faster than a normal landing, and the gear was still retracted.

The pilot reported during an initial telephone interview with the National Transportation Safety Board investigator-in-charge, that after the loss of electrical power he did not perform any emergency procedures as the checklist was in a cabinet and not reachable; he was just trying to fly the airplane. The pilot stated that when he departed from PSP, the generators were on. When asked if he attempted to reset the generators, he again stated that he did not do any emergency procedures except to fly the airplane. In a later interview, the pilot stated that he may have accidently turned on the starter switches, which would have turned off the generators and accounted for the loss of electrical power.

A mechanic was dispatched to help defuel the airplane about 30 minutes after the accident. He reported that fuel was leaking from the right wing so he disconnected the battery. He opened an access panel but was unable to mechanically turn off the fuel selector valve (FSV). He reconnected the battery and went into the cockpit. He saw that the landing gear handle was in the down position, and the flap handle was in the full up position. The battery switch was in the OFF position with the battery gang bar down, which turned off the battery, generator 1, and generator 2. After lifting up the gang bar and turning on the battery switch, he saw nothing on the cockpit displays but heard the airplane power up. He located the FSV, turned it off, and confirmed with a firefighter that the solenoid in the wing audibly closed. The mechanic turned the electrical power off and disconnected the battery. The fuel leak from the right engine filter bowl stopped.

It took the mechanic about 30 minutes to gather the equipment needed to defuel the airplane, and he decided to start with the right side by connecting to the engine supply line. He reconnected the battery and entered the cockpit to turn on the electrical power. With power on, the cockpit displays illuminated, and he heard the landing gear try to operate to the down position. After another mechanic pulled the circuit breaker for the avionics, he defueled the airplane.

During recovery, the airplane was lifted off the ground, and the landing gear were successfully extended to the down and locked position.

ADDITIONAL INFORMATION

The pilot checklist emergency procedures for a dual generator failure identifies the first step to reset the generators, then on.

If the generators do not reset, the checklist identifies for landing, to extend the landing gear manually.

Incident Rpt# WPR15IA080	**12/29/2014 1900 MST**	**Regis# N7041X**	**Phoenix, AZ**	**Apt: Phoenix-mesa Gateway IWA**
Acft Mk/Mdl ROBINSON HELICOPTER R22 BETA II		**Acft SN 4663**	**Acft Dmg: NONE**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl LYCOMING O-360-J2A		**Acft TT 337**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 091**
Opr Name: QUANTUM HELICOPTERS		**Opr dba:**		**Aircraft Fire: NONE**
				AW Cert: STN

Events

1. Approach-VFR pattern downwind - Sys/Comp malf/fail (non-power)

Narrative

HISTORY OF FLIGHT

On December 29, 2014, about 1900 mountain standard time, a Robinson Helicopter Company R22 Beta, N7041X, made an autorotation landing at the Phoenix-Mesa Gateway Airport, Phoenix, Arizona. Quantum Helicopters was operating the helicopter under the provisions of 14 Code of Federal Regulations (CFR) Part 91. The private pilot was not injured, and the helicopter was not damaged. The local instructional flight departed Chandler, Arizona, at an undetermined time. Visual meteorological conditions, and no flight plan had been filed.

The pilot was practicing for the commercial pilot helicopter examination and was operating in the taxiway Charlie pattern. While entering downwind for runway 30, the pilot stated that he climbed to 1,900 ft and was accelerating the helicopter to 75 knots when he felt an abnormal vibration and smelled something burning. The low rotor rpm light illuminated, and the low rotor rpm horn sounded. He entered an autorotation, made an emergency call, and landed successfully off the runway in the dirt.

An examination on site determined that the fanshaft fractured circumferentially. The helicopter had a total time of 337 hours.

TESTS AND RESEARCH

Fanshaft Examination

The roll pin alignment mark remained aligned, which indicated no movement between the shaft and the fanwheel. The fanwheel to fanshaft mating surfaces exhibited no galling or evidence of slipping.

Investigators checked the fanwheel balance. The forward face registered 10.2 grams (maximum limit was 0.5), and the aft face registered 6.42 grams (maximum limit was 0.50). There were no indications of modifications or repairs since the part was new.

A crack was observed in the base of the fanwheel. Cutting the base in a non-affected area exposed both surfaces of the crack. A visible beach marks appeared to run from the bearing surface of the shaft out/down to the mounting surface.

The roller bearings and the bearing surfaces of the races had minor surface damage. After cutting the bearing and race away from the fanshaft, a v-shaped fracture surface that had two cracks emanating from it was observed. This area sustained damage from the two halves contacting each other with every rotation of the crankshaft, and some material was missing. A definite origin could not be determined.

The bearing surface on the fanshaft and the inner diameter of the inner bearing race were discolored (reddish/brown), and the inner race had an area of material buildup adjacent to the fractures in the shaft.

Accident Rpt# WPR16FA130 06/23/2016 1425 MST	**Regis# N117TW**	**Wikieup, AZ**	**Apt: N/a**	
Acft Mk/Mdl ROBINSON HELICOPTER CO R66	**Acft SN 0042**	**Acft Dmg: DESTROYED**	**Rpt Status: Factual**	**Prob Caus: Pending**
Eng Mk/Mdl ROLLS ROYCE 250-C300A1	**Acft TT 662**	**Fatal 2 Ser Inj 0**	**Flt Conducted Under: FAR 091**	
Opr Name: GUIDANCE AIR SERVICES LLC	**Opr dba: GUIDANCE AIR SERVICES**		**Aircraft Fire: GRD**	
			AW Cert: STN	

Events

1. Enroute-cruise - Mast bumping
2. Enroute-cruise - Mast bumping

Narrative

HISTORY OF FLIGHT

On June 23, 2016, about 1425 mountain standard time, a Robinson Helicopter Company R66, N117TW, broke up in flight near Wikieup, Arizona. The commercial pilot and the pilot-rated passenger sustained fatal injuries; the helicopter was destroyed. Guidance Air Service LLC was operating the helicopter under the provisions of 14 Code of Federal Regulations Part 91. The cross-country positioning flight departed Prescott, Arizona, about 1338 with a planned destination of Riverside, California. Visual meteorological conditions prevailed, and no flight plan had been filed.

According to the operator, the pilot, who was seated in the right seat, was going to Riverside to take a Part 135.293 check ride with an inspector from the Federal Aviation Administration (FAA) Flight Standards District Office located there. The pilot-rated passenger, who was seated in the left seat, was the operator's Part 141 chief pilot.

The helicopter was reported overdue when it did not arrive at the destination, and the wreckage was located about 0430 on June 24. There were no witnesses to the accident, no recorded radar data, and no recorded radio transmissions from the pilot.

A SPOT device, which is a handheld GPS tracking device that uses a satellite network enabling text messaging and GPS tracking services, was present on the helicopter. Records provided by the operator listed 19 location fixes beginning at Prescott at 1338 and proceeding on a southwesterly heading. The last data point at 1425 was in the vicinity of the accident site.

PERSONNEL INFORMATION

AIRCRAFT INFORMATION

METEOROLOGICAL CONDITIONS

The southwest section of the National Weather Service surface analysis chart depicted a thermal low pressure system west of the accident site. The closest upper air sounding from Yuma, Arizona, about 90 miles south of the accident site, depicted thermal profiles that supported strong thermals through 8,500 ft. The lifted index (a common measure of atmospheric instability) and the K-index (a measure of thunderstorm potential) indicated conditions conducive to development of significant updrafts or thermals of rising air and dust devils. Other weather products supported strong thermals to 11,000 ft.

Two people near the accident site reported seeing numerous large dust devils. One person was an airframe and powerplant mechanic driving on a highway, and he saw as many as five dust devils simultaneously. The other person was the pilot of an R44 who was performing aerial survey work immediately north of the accident site. He stated that beginning at 1130 the winds became stronger and gustier. Over the next couple of hours, he observed numerous dust devils, and experienced a significant updraft in excess of 1,000 ft per minute. About 1515, he decided to discontinue operations and encountered a significant wind shift while returning to his base.

A dust devil is a strong, well-formed whirlwind that can range from a few feet to hundreds of feet wide, and can reach heights of several hundred feet. In the United States, dust devils have been reported in every state with Arizona reporting the highest frequencies of occurrence, and they are most frequent between June and August. They have been implicated as a cause or contributing factor in about 50 aircraft accidents between 2000 and 2015 according to the NTSB

database.

WRECKAGE AND IMPACT INFORMATION

The helicopter came to rest in hilly desert terrain. The debris field was about 750 yards long and 150 yards wide. One of the first pieces identified was the outboard 5 ft of a main rotor blade afterbody that had separated from the leading edge spar and displayed black paint transfer marks near the tip. It was located on the top of a small ridgeline. The inboard section of this main rotor blade was about 600 yards into the debris field and 85 yards left of the debris path centerline.

The left side of the helicopter was more fragmented than the right; left side cabin pieces and instruments were distributed throughout the early part of the debris field. The tail boom was about midway into the debris field. The left side/nose cabin, which was located near the tail boom had a straight separation line or slice across one side, and some floor panels at the aft end of the slice were crushed in an accordion pattern. The cabin came to rest inverted about 600 yards into the debris field, and was destroyed by a postcrash fire. The engine remained attached to the cabin.

The transmission, mast, and second main rotor blade separated as a unit, and were about 100 yards past the cabin area in the direction of the centerline of the debris field. The coning bolt of the separated blade was bent, and the teeter stops for both blades had impact marks across their centers. The attached blade was bent midspan about 10ø to 20ø opposite the direction of rotation. The main rotor driveshaft was bent about 15ø at the swashplate.

MEDICAL AND PATHOLOGICAL INFORMATION

Pilot

The Mohave County Medical Examiner's Office completed an external exam autopsy of the pilot. The cause of death was determined to be multiple injuries due to a helicopter crash.

Toxicology testing of the specimens from the pilot by the FAA's Bioaeronautical Science's Research Laboratory, Oklahoma, City, Oklahoma, were negative for ethanol and tested drugs in the muscle.

Pilot-Rated Passenger

The Mohave County Medical Examiner's Office completed an autopsy of the pilot-rated passenger. The cause of death was determined to be multiple injuries due to a helicopter crash.

Toxicology testing of the specimens from the pilot-rated passenger by the FAA's Bioaeronautical Science's Research Laboratory were negative for tested drugs in the liver.

The testing detected 80 (mg/dL, mg/hg) ethanol in muscle, and Propanol (N-) was detected in muscle; no ethanol was detected in the brain. The report noted that putrefaction of the specimens had occurred.

ADDITIONAL INFORMATION

Robinson Safety Notice SN-32 discusses flight in high winds and turbulence and explains how improper application of control inputs in response to turbulence can increase the likelihood of a mast bumping accident. It recommends that pilots reduce airspeed below normal cruise speed to 60 to 70 knots for flight in significant turbulence. It suggests techniques to avoid overcontrol of the helicopter, and says to avoid flying on the downwind side of hills and ridges.

Accident Rpt# GAA17CA457 07/28/2017 1115 CDT	**Regis# N541GF**	**Hondo, TX**	**Apt: South Texas Rgnl At Hondo HDO**
Acft Mk/Mdl SWEARINGEN SA26-AT	**Acft SN T26-173**	**Acft Dmg: SUBSTANTIAL**	**Rpt Status: Factual Prob Caus: Pending**
Eng Mk/Mdl HONEYWELL TPE331-6-252	**Acft TT 7205**	**Fatal 0 Ser Inj 0**	**Flt Conducted Under: FAR 091**
Opr Name: FMG AVIATION LLC	**Opr dba:**		**Aircraft Fire: NONE**
			AW Cert: STN

Events

1. Landing - Landing gear not configured

Narrative

The pilot of a retractable landing gear equipped airplane reported that he landed with the landing gear extended. He added that during the landing, the airplane bounced and the "landing gear retracted and the aircraft settled onto its belly".

The airplane sustained substantial damage to the fuselage.

The pilot reported that there were no preaccident mechanical failures or malfunctions with the airplane that would have precluded normal operation.

The pilot reported that he "may have failed to deploy the landing gear" and does not recall hearing the gear warning horn.

A flight instructor witness reported that, while his student was performing an engine run-up, he saw the airplane on final about 400 ft from the threshold with the landing gear retracted. He added that he thought the airplane was going to do a low approach, so he turned to check on his student, but when he looked back up, he saw "the [airplane] was on the runway" sliding.

The Federal Aviation Administration Inspector reported that when he arrived on scene, he observed the gear handle in the up position.