Aviation Investigation Final Report

Location:	Piney Flats, Tennessee	**Accident Number:**	ERA12LA368
Date & Time:	May 24, 2012, 18:30 Local	**Registration:**	N760DA
Aircraft:	Schweizer 269C	**Aircraft Damage:**	Substantial
Defining Event:	Flight control sys malf/fail	**Injuries:**	2 None
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot reported that, while on short final for landing, he heard a "high pitched whine" and that the helicopter's tail rotor authority subsequently degraded. He immediately initiated a full autorotation to landing. During the landing in a field with uneven terrain, the helicopter was substantially damaged.

Postaccident examination revealed that, during the flight, the tail rotor driveshaft (TRDS) had become uncoupled from the drive assembly and main rotor belt transmission. The forward TRDS retention nut was found safety wired; however, it was less than hand tight. The main rotor transmission input aft pinion nut was found backed off the pinion; the nut and pieces of its fractured cotter pin were found captured in grease contained in the TRDS fitting grease cavity. The nut was intact, but it exhibited thread wear. The cotter pin was shorter and thinner than the cotter pin specified in the helicopter manufacturer's illustrated parts catalog. The grease in the aft pinion splines was discolored, caked, and dry, indicating that it had not been serviced in a long time.

The main rotor transmission input pinion exhibited significant wear on the forward spline set and the aft spline set that engaged the driving spline, which was normally retained by the aft pinion nut. The aft upper H-frame bearing was displaced on the driving spline. The driving splines' interior spline teeth exhibited severe wear matching the wear on the pinion, and rotation damage was found on the spline ends. Other areas of the pinion exhibited fretting corrosion.

According to the helicopter manufacturer's Handbook of Maintenance Instructions, during the 1,200-hour inspection, the mechanic was required to remove the upper pulley, inspect the pinion, and torque and safety wire the aft pinion nut during reassembly. The mechanic who performed the 1,200-hour inspection (and others) stated that, during the inspection, he had "never gotten into" the drive assembly, had not checked the torque on the aft pinion nut, and had not inspected the cotter pin.

Probable Cause and Findings

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

The mechanic's improper maintenance of the main transmission aft pinion nut and belt drive system, which resulted in the uncoupling of the tail rotor driveshaft and the subsequent loss of helicopter control.

Findings

Aircraft	(general) - Incorrect service/maintenance
Aircraft	(general) - Inadequate inspection
Aircraft	(general) - Damaged/degraded
Aircraft	(general) - Malfunction
Personnel issues	Scheduled/routine maintenance - Maintenance personnel
Personnel issues	Scheduled/routine inspection - Maintenance personnel
Personnel issues	Lack of action - Maintenance personnel

Factual Information

History of Flight

Approach-VFR pattern final	Flight control sys malf/fail (Defining event)
Autorotation	Off-field or emergency landing
Autorotation	Hard landing

On May 24, 2012, at approximately 1830 eastern daylight time, a Schweizer 269C, N760DA, was substantially damaged during a hard landing, after a loss of tail rotor effectiveness, in Piney Flats, Tennessee. The certificated commercial pilot and his pilot rated passenger were not injured. Visual meteorological conditions prevailed, and no flight plan was filed for the local personal flight operated under Title 14 Code of Federal Regulations (CFR) Part 91.

According to the pilot, the flight originated at his farm in Piney Flats, Tennessee. After the departure on the local sightseeing flight with his friend they did a visual approach and landing, at Elizabethton Municipal Airport (0A9), Elizabethton, Tennessee, then took off and returned to his farm for landing. While on a short final approach for landing he heard a "high pitched whine", and the tail rotor authority degraded. He immediately initiated a full auto-rotation to landing.

During the landing the helicopter touched down in a field approximately 100 yards from the pilot's hangar. Examination of the field revealed that it was grass covered, and that the point where the helicopter touched down was uneven and sloped away from the hangar and the helicopters direction of flight. The struts and main landing gear collapsed, and the tailskid assembly and vertical tail struck the ground. Prior to the event, the pilot did not see any warning lights or note any abnormalities.

Pilot Information

Certificate:	Commercial; Flight instructor; Private	**Age:**	53
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	June 4, 2010
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	May 30, 2011
Flight Time:	967 hours (Total, all aircraft), 586 hours (Total, this make and model), 798 hours (Pilot In Command, all aircraft), 17 hours (Last 90 days, all aircraft), 5 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

According to Federal Aviation Administration (FAA) and pilot records, the pilot held a commercial pilot

certificate with ratings for rotorcraft-helicopter, Private privileges for airplane single-engine land, and instrument airplane. He also held a flight instructor certificate with a rating for rotorcraft-helicopter. His most recent FAA third-class medical certificate was issued on June 4, 2010. He reported 967 hours of total flight experience, 586 of which was in the accident helicopter make and model.

According to FAA records, the pilot rated passenger held a commercial pilot certificate with ratings for airplane single-engine land, airplane multi-engine land, and instrument airplane. His most recent FAA second-class medical certificate was issued on October 1, 2008.

AIRCRAFT INFORMATION

The accident aircraft was a single-engine, three seat, light utility helicopter, powered by a 190 horsepower, air cooled, Lycoming HIO-360-D1A engine, constructed primarily of aluminum alloy. It was equipped with conventional collective and cyclic control sticks and tail rotor control pedals.

The main rotor was a fully articulated three- bladed, design and the tail rotor was a two bladed, semi-rigid, anti-torque rotor design. Power was transmitted from the engine to the rotor system through a V-belt drive which incorporated a free-wheeling (one-way) sprag clutch, a main drive transmission, a tail rotor transmission, and shafts.

The center section frame was constructed primarily of tubular steel. It supported the cabin and all major structural and drive train components of the helicopter. The landing gear assembly which was a skid type was also attached to the center section frame and utilized air-oil dampers, between the struts and cross beams to cushion landings.

The tailboom was composed of an aluminum alloy tube containing a center bulkhead and forward attachment fitting also of an aluminum alloy. The tailboom also served as a support structure to which the horizontal stabilizer, the vertical stabilizer, the tail rotor transmission driveshaft, and the control rod for tail rotor blade pitch control were attached to.

According to FAA and maintenance records, the helicopter was manufactured in 1988. It was maintained by a certificated airframe and powerplant mechanic under the provisions of Title 14 CFR Part 43. At the time of the accident, the helicopter had accrued 6523.4 total hours of operation.

The last recorded maintenance on the helicopter was cleaning and repacking of the lower pulley bearings at 6,494.5 total hours of operation. This was completed on December 29, 2011.

The helicopter's most recent annual inspection was completed on December 9, 2011, at 6488.6 total hours of operation.

The previous annual and 1200 hour inspection was completed on November 5, 2010 at 6,417.2 total hours of operation.

Aircraft and Owner/Operator Information

Aircraft Make:	Schweizer	**Registration:**	N760DA
Model/Series:	269C	**Aircraft Category:**	Helicopter
Year of Manufacture:	1988	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	S1326
Landing Gear Type:	N/A; Skid	**Seats:**	3
Date/Type of Last Inspection:	December 9, 2011 Annual	**Certified Max Gross Wt.:**	2050 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	6489 Hrs as of last inspection	**Engine Manufacturer:**	LYCOMING
ELT:	Not installed	**Engine Model/Series:**	HIO-360-D1A
Registered Owner:	TURBINATOR AVIATION LLC	**Rated Power:**	195 Horsepower
Operator:	TURBINATOR AVIATION LLC	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	TRI,1519 ft msl	**Distance from Accident Site:**	5 Nautical Miles
Observation Time:	18:53 Local	**Direction from Accident Site:**	315°
Lowest Cloud Condition:	Few / 6500 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/ N/A
Altimeter Setting:	29.95 inches Hg	**Temperature/Dew Point:**	27°C / 13°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Elizabethton, TN (0A9)	**Type of Flight Plan Filed:**	None
Destination:	Piney Flats, TN	**Type of Clearance:**	None
Departure Time:	18:15 Local	**Type of Airspace:**	Class G

The recorded weather at Tri-Cities Regional Airport (TRI), Bristol, Tennessee, located 6 nautical miles northwest of the accident site, at 1853, approximately 23 minutes after the accident, included: calm winds, 10 miles visibility, few clouds at 6,500 feet, scattered clouds at 10,000 feet, temperature 27 degrees C, dew point 13 degrees C, and an altimeter setting of 29.96 inches of mercury.

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 None	**Latitude, Longitude:**	36.410831,-82.351112(est)

Examination of the wreckage revealed that the helicopter was substantially damaged.

Fuel System

Examination of the fuel tanks revealed that they had not been compromised and that they were approximately half full and the right fuel tank was displaced outboard in its retention straps.

Cabin

The cabin was intact; however the aft cabin wall upper beam was distorted on both sides of the mast. The seat deck was straight with no apparent distortion on either side. The instrument panel had remained attached to the floor but, was tilted to the left. The instruments and glass that covered the instrument faces was undamaged.

Main Frame

The main frame was intact with no breaks but exhibited kinking and bending to several of the tubes which made up the frame's structure. The mast support struts were intact and attached but, the cabin floor support struts exhibited damage, the left side was bowed and the right side was kinked.

The aft cross beam center area exhibited upward bending and the ends were bent forward. The forward cross beam appeared intact and straight. The diagonal drag struts were damaged with the left side bowed, and the right side separated from the forward rod end bearing. The right aft landing gear damper had remained attached but was bent, and the remainder of the dampers, were separated at one or both ends. The right skid was separated at the forward side of the strut leg.

Tail Boom

The tail boom was intact and attached. The tail boom support strut tubes were intact and were attached at upper and lower fittings. The tailboom center attach fitting was intact. The forward tail boom bulkhead fitting was also intact. The horizontal stabilizer appeared undamaged but, the vertical stabilizer exhibited compression bending and was folded to the right.

Flight Control System

Examination of the flight control system revealed no evidence of any preaccident anomalies or failures. Control continuity existed from the cyclic pitch control and the collective pitch control to the swash plate assembly and main rotor pitch links and from the tail rotor pedals to the tail rotor blade pitch links.

Main and Tail Rotors

All three main rotor blades were still attached to the rotor head, and the main rotor hub, pitch housings, rotor blades, and dampers were still attached and were undamaged. The main rotor head was also intact and had remained attached to the main driveshaft, mast and transmission.

The tail rotor assembly was intact, attached, and was also undamaged. The tail rotor hub and fork were also intact and had remained attached to the tail gear box shaft.

Transmissions and Driveshafts

The transmissions and drive shafts were intact and attached. Drive system rotation was confirmed at the lower pulley shaft, and the sprag (overrunning) clutch operated correctly. The lower pulley drive shaft was engaged and found intact with no apparent damage. The forward and aft tail rotor drive shaft spline couplings were also intact and lubricated.

Examination of the drive train revealed however, that the tail rotor driveshaft (TRDS) had become uncoupled from the drive assembly and main rotor belt transmission, and the TRDS could be rotated freely by hand in both a clockwise and counterclockwise direction. Further examination also revealed that the main transmission input (pinion) shaft aft nut, was missing, along with its cotter pin.

Examination of the TRDS end fitting revealed that after coming off of the main transmission input shaft both the main transmission input shaft aft nut, and the cotter pin had been captured in the grease that was contained in the tail rotor drive shaft end fitting grease cavity. Further examination of the cotter pin revealed that it had fragmented into multiple pieces and that it was shorter and thinner than the 1½ inch long, 3/32 inch diameter, cotter pin that was specified in the Schweizer illustrated Parts Catalog. Examination of the grease in the TRDS coupling that captured the cotter pin revealed that it was soft and black. However the grease on the pinion was discolored, caked, and dry in the aft pinion splines.

The forward TRDS retention nut although safety wired was also found to be less than hand tight when the TRDS was removed for examination. The H-frame was removed from the pinion during the exam. The splines of the pinion were found worn at both the aft spline (TRDS driving spline) and at the forward drive spline, (pulley hub). The aft upper H-frame bearing was displaced on the driving spline and the interior spline teeth exhibited severe wear matching the wear on the pinion as well as signs of damage from rotation on the ends of the splines for both parts.

Examination of the main transmission input shaft aft nut revealed that it was intact but exhibited wear on the lands and grooves of the threads.

Examination of the main transmission input shaft, and splined drive sleeve revealed the existence of fretting wear, stepping on the faces of the splines, and steel gray colored particulate which when applied to a magnet would adhere to its surface.

The main rotor transmission input pinion exhibited significant wear on the aft spline set that engaged the driving spline, which was normally retained by the aft pinion nut. Other areas of the pinion exhibited fretting corrosion from movement of the upper pulley stack up (clutch hub and spacers), and the internal splines of the driving coupling, also exhibited significant wear on the tooth end faces.

Tests and Research

According to the mechanic who maintained the helicopter for the owner, he had been maintaining the helicopter for him since 2009.

Review of the helicopter's maintenance records revealed that the mechanic had performed the last three annual inspections, the last three 100 hour inspections, the last 1200 hour inspection, and the last maintenance action, which was cleaning and repacking of the lower pulley bearings.

According to the Handbook of Maintenance Instructions (HMI), the HMI required that during the 1200 hour inspection, the upper pulley had to be removed, the pinion had to be inspected, and the aft pinion nut had to be torqued and saftied during reassembly.

When shown the broken cotter pin, the aft pinion nut which had lost torque and backed off the threaded portion of the pinion, the pinion's damaged splines, the dried out grease, the visible fretting corrosion, and the tooth wear in the interior of the driving spline, the mechanic advised that during the inspections he performed, he had never gotten into the assembly and checked the torque on the aft pinion nut, or inspected the cotter pin.

Additional Information

In order to improve safety, on June 6, 2013, Sikorsky Aircraft Corporation issued Sikorsky Safety Advisory SSA-269-13-001 advising mechanics and pilots that improper maintenance of the main transmission aft pinion nut and belt drive system installation could cause decoupling of the tail rotor drive shaft and loss of tail rotor thrust, resulting in loss of aircraft control, loss of the aircraft, and injury to or death of the occupants.

Administrative Information

Investigator In Charge (IIC):	Gunther, Todd
Additional Participating Persons:	Mel Overton; FAA/FSDO; Nashville, TN Steven Gleason; Sikorsky Aircraft Corporation; Horseheads, NY
Original Publish Date:	December 15, 2014
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=83775