Aviation Investigation Final Report

Location:	Medford, New Jersey	**Accident Number:**	ERA17FA317
Date & Time:	September 8, 2017, 13:00 Local	**Registration:**	N204HF
Aircraft:	Schweizer 269C	**Aircraft Damage:**	Substantial
Defining Event:	Hard landing	**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The purpose of the flight was to provide an orientation/pleasure flight to the passenger, who was scheduled to perform in a concert on the airport later that evening. Several minutes after takeoff, the pilot reported over the airport UNICOM frequency that he was unable to control engine rpm with throttle inputs. He reported that he could "roll" the twist-grip; however, there was no corresponding change in engine power when he did so.

Three helicopter flight instructors, one a Federal Aviation Administration (FAA) inspector, one an FAA designated examiner, and a company flight instructor, joined the conversation on the radio to discuss with the pilot remedial actions and landing options. These options included a shallow, power-on approach to a run-on landing, or a power-off, autorotational descent to landing. The instructors encouraged the pilot to perform the run-on landing, but the pilot reported that a previous run-on landing attempt was unsuccessful. He then announced that he would shut down the engine and perform an autorotation, which he said was a familiar procedure that he had performed numerous times in the past. The instructors stressed to the pilot multiple times that he should delay the engine shutdown and autorotation entry until the helicopter was over the runway surface.

Video footage from a vantage point nearly abeam the approach end of the runway showed the helicopter about 1/4 to 1/2 mile south of the runway as it entered a descent profile consistent with an autorotation. Toward the end of the video, the descent profile steepened and the rate of descent increased before the helicopter descended out of view. Witnesses reported seeing individual rotor blades as the main rotor turned during the latter portion of the descent.

The increased angle and rate of descent and slowing of the rotor blades is consistent with a loss of rotor rpm during the autorotation. Despite multiple suggestions from other helicopter instructors that he initiate the autorotation above the runway, the pilot shut down the engine and entered the autorotation from an altitude about 950 ft above ground level between 1/4 and 1/2 mile from the end of the runway. Upon realizing that the helicopter would not reach the runway, the pilot could have landed straight ahead and touched down prior to the runway or performed a 180° turn to a field directly behind the helicopter; however, he continued the approach to the runway and attempted to extend the helicopter's glide by increasing collective pitch, an action that resulted in a decay of rotor rpm and an uncontrolled descent.

Examination of the wreckage revealed evidence consistent with the two-piece throttle control tie rod assembly having disconnected in flight. The internally threaded rod attached to the bellcrank and an externally threaded rod-end bearing attached to the throttle control arm displayed damage to the three end-threads of each. The damage was consistent with an incorrectly adjusted throttle control tie rod assembly with reduced thread engagement, which led to separation of the rod end bearing from the tie rod and resulted in loss of control of engine rpm via the throttle twist grip control.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:
The pilot's early entry into and failure to maintain rotor rpm during a forced landing autorotation after performing an engine shutdown in flight, which resulted in an uncontrolled descent. Contributing to the accident was the failure of maintenance personnel to properly rig the throttle control tie-rod assembly, which resulted in an in-flight separation of the assembly and rendered control of engine rpm impossible.

Findings

Personnel issues	Aircraft control - Pilot
Personnel issues	Decision making/judgment - Pilot
Aircraft	Main rotor blade system - Incorrect use/operation
Aircraft	Descent/approach/glide path - Not attained/maintained
Aircraft	Descent rate - Not attained/maintained
Aircraft	Power lever - Failure
Personnel issues	Scheduled/routine maintenance - Maintenance personnel

Factual Information

HISTORY OF FLIGHT

On September 8, 2017, about 1300 eastern daylight time, a Schweizer 269C-1 helicopter, N204HF, was substantially damaged during a collision with terrain while performing a forced landing to runway 01 at Flying W Airport (N14), Medford, New Jersey. The commercial pilot and passenger were fatally injured. The helicopter was owned by Herlihy Helicopters Inc and operated by Helicopter Flight Services under the provisions of Title 14 *Code of Federal Regulations* (*CFR*) Part 91. Visual meteorological conditions prevailed and no flight plan was filed for the personal flight.

According to the chief flight instructor for the operator, the purpose of the flight was to provide an orientation/pleasure flight to the passenger, who was scheduled to perform in a concert on the airport later that evening.

Several minutes after takeoff, the pilot reported over the airport UNICOM frequency that he was unable to control engine rpm with throttle inputs. He reported that he could "roll" the twist-grip but that there was no corresponding change in engine rpm when he did so.

The company flight instructor and another helicopter flight instructor, who was a designated pilot examiner (DPE), were monitoring the frequency and engaged the pilot in conversation about potential courses of action to accomplish a landing. A Federal Aviation Administration (FAA) inspector, who was also a helicopter instructor and examiner, joined the conversation on the radio.

Options discussed included a shallow approach to a run-on landing or a power-off, autorotational descent to landing. The instructors suggested that the pilot perform the run-on landing; however, the pilot reported that a previous attempt to perform a run-on landing was unsuccessful and announced that he would stop the engine and perform a power-off autorotation. The pilot stated that this was a familiar procedure he had performed numerous times in the past. When asked over the radio by the DPE when he had last performed an autorotation to touchdown, the pilot replied that 4 months had elapsed since his most recent touchdown autorotation. Subsequent attempts to convince the pilot to attempt a run-on landing were unsuccessful.

According to the DPE and the FAA inspector, the pilot was advised "multiple times" to aim to touch down "midfield" and not to initiate the engine shutdown and autorotation until over the runway. According to the DPE, his last reminder to the pilot came when the helicopter was on a 2-mile final approach.

A video forwarded to the NTSB by local police was recorded from a vantage point nearly abeam the approach end of runway 01. The video showed the helicopter about 1/4 mile south of the runway as it entered a descent profile consistent with an autorotation. Toward the end of the video, the descent profile became more vertical, and the rate of descent increased before the helicopter descended out of view. No sound could be heard from the helicopter.

During a postaccident interview with law enforcement, the company flight instructor reported that the helicopter entered the autorotation about 950 ft above ground level (agl) and that the helicopter was quiet during its descent "because the engine was off." During the descent, the rotor rpm decayed to the point where the instructor could see the individual rotor blades. The helicopter descended from view before reaching the runway threshold, and the sounds of impact were heard. Both the instructor and the FAA inspector reported that a high-pitched "whine" could be heard from the helicopter during the latter portion of the descent.

In a written statement, the flight instructor reported, "[the pilot] began the autorotative descent, but it was not long before it became apparent it was not being executed correctly. I began to see individual blades instead of a translucent disc. His vertical speed increased while his horizontal speed became almost non-existent. The nose of the [helicopter] rolled forward. Instead of being able to see the bottom of the [helicopter]… all I could see was the cockpit glass and rotor head."

PERSONNEL INFORMATION

The pilot held commercial and flight instructor certificates, each with ratings for rotorcraft-helicopter and instrument helicopter. His most recent FAA second-class medical certificate was issued April 12, 2017.

Excerpts of the pilot's logbook revealed that he had logged 480.9 total hours of flight experience, of which about 300 hours were in the accident helicopter make and model. The last entry logged was for 1.2 hours in the accident helicopter on the day of the accident.

Company training records indicated that the pilot had received the training required by the operator for employment as a flight instructor, and his last airman competency check was completed satisfactorily on April 19, 2017, in the accident helicopter.

AIRCRAFT INFORMATION

The helicopter was a single-engine, two-seat, light utility helicopter constructed primarily of aluminum alloy and powered by an air-cooled, Lycoming HO-360-C1A, 180-horsepower engine. 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.

According to FAA records, the helicopter was manufactured in 2000, delivered to the owner/operator, and had accrued about 7,899 total aircraft hours. Its most recent 100-hour inspection was completed on August 17, 2017, at 7,884 total aircraft hours.

A review of maintenance records revealed that the helicopter's engine was replaced with factory rebuilt or overhauled engines at the manufacturer's recommended overhaul intervals. Engine changes occurred in 2003, 2006, and most recently, on September 24, 2011.

The records reflected numerous entries regarding carburetor discrepancies. Carburetors were adjusted or removed and replaced with loaner carburetors then reinstalled following repairs. In February 2014, the carburetor was removed, sent out for repair, and reinstalled by the operator.

On August 31, 2016, the operator installed a throttle control cable manufactured by McFarlane Aviation Products, as documented on an FAA Form 337. A cable from the original equipment manufacturer was not available per the operator, and the FAA approved the manufacture and installation, which required the cable's inspection at 25-hour intervals. The inspections were documented; the most recent was completed concurrent with the annual inspection conducted 15 hours before the accident.

The operator was interviewed during a meeting with NTSB investigators and FAA inspectors regarding the maintenance history of the accident helicopter. He was later interviewed by telephone to gain more detail about the disassembly/reassembly and rigging of the throttle during carburetor/engine changes.

According to the operator, when the engine was changed for overhaul, the carburetor traveled with the engine, and the throttle control arm was removed at the carburetor splined shaft. The throttle control bellcrank was removed from the front of the carburetor, and the entire throttle control system remained with the helicopter. The throttle control arm, the throttle tie rod, the throttle control bellcrank, and the throttle cable all remained attached to each other and to the helicopter. He stated that, because of this, there was no need to disconnect or adjust the throttle tie rod that connected the bellcrank and the throttle control arm.

He also stated that, when a new engine was installed, the correct "angle" was measured for the installation of the throttle control arm on the carburetor. Adjustment of idle and mixture set screws was often required, as the carburetors were often set at the factory "for airplanes."

When asked about the most recent installation of the throttle control cable, the operator stated that the cable was a fixed measurement and changing the cable did not change the rigging of the throttle. He said that, when the cable was changed, no throttle rigging adjustments were necessary; the cable was disconnected at the bellcrank upstream of the tie rod and throttle control arm. He repeated that the cable installation was "plug and play" and that no adjustments were necessary to achieve/maintain proper throttle rigging.

The operator was asked specifically about the throttle rigging and the nominal measurement of the tie rod during the throttle rigging procedure following the most recent engine change. He stated, "I don't know if I did. I'm sure I did, because that's part of the procedure, but I'm not 100 percent [sure]."

According to the manufacturer's maintenance manual, actions that required compliance with the throttle rigging procedure included:

1. Installation of a new engine (Section 3-15, page 3-26)
2. Installation of a new throttle control cable (Section 4-19, page 4-19)
3. Installation of a new carburetor (Section 5-55, page 5-21)

METEOROLOGICAL INFORMATION

At 1254, the weather recorded at South Jersey Regional Airport (VAY), 2 miles west of N14, included clear skies and wind from 260° at 13 knots gusting to 18 knots. The temperature was 21°C, and the dew point was 9°C. The altimeter setting was 30.13 inches of mercury.

AIRPORT INFORMATION

N14 was at 49 ft elevation and was equipped with a single runway, oriented 01/19. The operator's hangar was positioned at the south end of the field, approximately abeam the numbers for runway 01. A creek, oriented east/west, crossed about 200 ft south of the approach end of runway 01. The creek bed was lined with small trees and low brush and bisected the area between the runway and an open field immediately south of the airport.

The field was about 1,400 ft long and 300 ft wide at its narrowest point and was oriented in the same general direction as the runway. The surface was mowed grass or "scraped" and flattened soil.

WRECKAGE AND IMPACT INFORMATION

The wreckage was examined at the accident site and all major components of the helicopter were accounted for at the scene. The initial ground scar was about 10 ft before the main wreckage, which was about 220 ft from the threshold of runway 01 and aligned with the runway.

The cockpit was significantly deformed by impact damage, and the tailboom was separated at the fuselage. The engine and main transmission remained mounted in the airframe, and all main rotor blades were secured in their respective grips, which remained attached to the main rotor head and mast. The pitch-change link for the yellow rotor blade was fractured and displayed signatures consistent with overstress. Each of the three blades was bent significantly at its respective blade root. The blades showed little to no damage along their respective spans toward the blade tips, which was consistent with low rotor rpm at ground contact.

Flight control continuity was established from the individual flight controls through breaks to the main rotor head and tail rotor. The pilot's and co-pilot's throttles both moved together when the pilot's throttle was actuated by hand. The movement was limited due to damage on the pilot's collective; during the continuity check, an internal component of the pilot's collective disconnected and continuity between the two throttles was lost.

Continuity of the throttle control cable was confirmed from the collective jackshaft to the throttle bellcrank assembly, to which it remained securely attached. The throttle bellcrank assembly was intact, but separated from its mount, which was fractured. The internally threaded portion of the two-piece throttle control tie rod was securely attached to the throttle bellcrank assembly. The internally threaded portion of the tie rod was filled with an organic material that resembled the roots in the impact crater.

Drivetrain continuity was established to the main and tail rotors. The main gearbox housing was intact and attached to the bottom of the main rotor mast and to the center frame. The main gearbox rotated freely and exhibited continuity from input to the main rotor driveshaft, and the free-wheeling (one-way) sprag clutch operated correctly.

The engine was rotated by hand at the cooling fan, and continuity was confirmed from the powertrain through the valvetrain to the accessory section. Compression was confirmed on all cylinders using the thumb method. The magnetos were removed and actuated with a drill, and spark was produced at all terminal leads. Borescope examination of each cylinder revealed signatures consistent with normal wear, with no anomalies noted.

The carburetor was separated from the engine, displayed impact damage, and was found near the initial ground scar. The externally-threaded portion of the two-piece throttle control tie rod was still attached to the throttle arm. The throttle and mixture arms were actuated by hand and moved smoothly through their respective ranges. The filter screen was removed and was absent of debris. The carburetor contained fuel, which appeared absent of water and debris.

The collective control and jackshaft assembly with the associated throttle cable and bellcrank assemblies, as well as each half of the throttle tie rod, were retained for further examination at the NTSB Materials Laboratory.

MEDICAL AND PATHOLOGICAL INFORMATION

The Office of Medical Examiner, County of Burlington, New Jersey, performed an autopsy on the pilot. The cause of death was listed as "multiple injuries."

The FAA Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma, performed toxicological testing on the pilot. The results were negative for the presence of drugs and alcohol.

TESTS AND RESEARCH

The throttle tie rod assembly was received separated at the threaded joint. The components were unbolted from the carburetor throttle arm and the throttle cable before receipt in the materials laboratory. The tie rod assembly consisted of an internally threaded rod attached to the bellcrank and an externally threaded rod-end bearing and jam nut attached to the throttle arm. The tie rod was separated at the threaded joint between the two pieces. The rod end jam nut was found about midway between the threaded end and the rod end bearing eye.

Magnified examinations of the externally threaded rod-end bearing threads revealed mechanical damage to the three end threads. The damage was consistent with thread-to-thread wear.

Visual examination of the internal threads in the rod revealed cellulose material (wood) imbedded into the threads. After brush cleaning, damage was visible to the three end threads. The damage included pock-marks and a reduced thread flank size, consistent with vibratory thread-to-thread wear. These three threads corresponded to the three worn threads on the bearing fitting. Threads further inside the rod were bright, shiny, and undamaged.

Once installed, each end of the throttle tie rod remained fixed and were unable to rotate.

An exemplar Schweizer 269C-1 helicopter was examined in Lancaster, Pennsylvania. The rigging of the throttle control arm and throttle tie rod (4.97 inches +/- .02 inch) was confirmed, and the helicopter was started and idled at a speed about 1,000 rpm. The engine was stopped, the throttle tie rod was disconnected and adjusted to the approximate operating length of the accident tie rod (5.5 inches) and reinstalled. The engine was started and idled at a speed about 1,100 rpm.

According to the Sikorsky maintenance manual for the Schweizer 269C-1 helicopter, after rigging the throttle control system, idle speed was adjusted to its prescribed rpm range (+/-200rpm) by idle/mixture screw adjustments of the carburetor.

The Sikorsky maintenance manual also required a 50-hour inspection of the engine in accordance with the engine manufacturer's publications and a 100-hour inspection of the fuel control linkage. The Sikorsky flight manual required an inspection of the general engine area before each flight.

On November 16, 2017, Sikorsky Aircraft Corporation issued Alert Service Bulletin ASB-C1B-048 for a one-time inspection of the throttle control tie rod assembly to verify the length of throttle control tie rod assembly dimension.

ORGANIZATONAL AND MANAGEMENT INFORMATION

The owner of Helicopter Flight Services held airline transport, commercial, and flight instructor certificates with multiple ratings for each. He also held a mechanic certificate with ratings for airframe, powerplant, and inspection authorization, and performed much of the maintenance of the accident helicopter, including the most recent throttle cable inspection.

ADDITIONAL INFORMATION

US Army Hughes TH-55A (Hughes/Schweizer 269) Manual (TM 55-1520-233-10) Chapter 9, Emergency Procedures, 9-12, Throttle Failure, stated, "If the throttle becomes inoperative in flight, continue to a landing area that will permit a shallow approach and running landing."

The manufacturer's Pilot's Flight Manual does did not contain an emergency procedure for throttle failure. An informal survey of two other manufacturers of piston-powered helicopters by the FAA inspector assigned to this accident revealed that neither published such a procedure in their flight manuals.

The US Army Training Circular (TC) 3-04.4, "Fundamentals of Flight," specified the following regarding autorotations:

1-123. During powered flight, rotor drag is overcome with engine power. When the engine fails or is deliberately disengaged from the rotor system, some other force must sustain rotor RPM so controlled flight can be continued to the ground. Adjusting the collective pitch to allow a controlled descent generates this force. Airflow during helicopter descent provides energy to overcome blade drag and turn the rotor. When the helicopter descends in this manner, it is in a state of autorotation. In effect, the aviator exchanges altitude at a controlled rate in return for energy to turn the rotor at a RPM [an rpm] that provides aircraft control and a safe landing. Helicopters have potential energy based on their altitude above the ground. As this altitude decreases, potential energy is converted into kinetic energy used in turning the rotor. Aviators use this kinetic energy to slow the rate of descent to a controlled rate and affect a smooth touchdown.

Circle of Action

1-139. The circle of action is a point on the ground that has no apparent movement in the pilot's field of view (FOV) during a steady-state autorotation. The circle of action would be the point of impact if the pilot applied no deceleration, initial pitch, or cushioning pitch during the last 100 feet of autorotation. Depending on the amount of wind present and the rate and amount of deceleration and collective application, the circle of action is usually two or three helicopter lengths short of the touchdown point.

Last 50 to 100 Feet

1-140. It can be assumed autorotation ends at 50 to 100 feet and landing procedures then begin. To execute a power-off landing for rotary-wing aircraft, an aviator exchanges airspeed for lift by decelerating the aircraft during the last 100 feet. When executed correctly, deceleration is applied and timed so rate of descent and forward airspeed are minimized just before touchdown. At about 10 to 15 feet, this energy exchange is essentially complete. Initial pitch application occurs at 10 to 15 feet. This is used to trade some of the rotor energy to slow the rate of descent prior to cushioning. The primary remaining control input is application of collective pitch to cushion touchdown. Because all helicopter types are slightly different, aviator experience in that particular aircraft is the most useful tool for predicting useful energy exchange available at 100 feet and the appropriate amount of deceleration and collective pitch needed to execute the exchange safely and land successfully.

FAA Advisory Circular (AC) 61-140, "Autorotation Training - Predominant Cause of Accidents/Incidents," states:

A review of NTSB reportable accidents and incidents during autorotation training/instruction indicates that the predominant probable cause is failure to maintain main rotor .... rpm (Nr) and airspeed within the Rotorcraft Flight Manual (RFM) or pilot's operating handbook (POH) specified range, resulting in an excessive and unrecoverable rate of descent."

According to the FAA Helicopter Handbook: "If too much collective pitch is applied too early during the final stages of the autorotation, the kinetic energy may be depleted, resulting in little or no cushioning effect available. This could result in a hard landing with corresponding damage to the helicopter."

The US Army Hughes TH-55A Manual (TM 55-1520-233-10) states in Chapter 9, Emergency Procedures, 9-12, Engine Failure – Cruise, "Collective pitch should never be applied to reduce rpm for extending glide distance because of the reduction in rpm available for use during touchdown.

History of Flight

Maneuvering	Powerplant sys/comp malf/fail
Autorotation	Hard landing (Defining event)

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	30,Male
Airplane Rating(s):	None	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter; Instrument helicopter	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	April 12, 2017
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	April 19, 2017
Flight Time:	480 hours (Total, all aircraft), 300 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Schweizer	**Registration:**	N204HF
Model/Series:	269C 1	**Aircraft Category:**	Helicopter
Year of Manufacture:	2000	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	0109
Landing Gear Type:	Skid	**Seats:**	2
Date/Type of Last Inspection:	August 17, 2017 100 hour	**Certified Max Gross Wt.:**	1750 lbs
Time Since Last Inspection:	15 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	7899.2 Hrs at time of accident	**Engine Manufacturer:**	Lycoming
ELT:	Not installed	**Engine Model/Series:**	HIO-360-C1A
Registered Owner:		**Rated Power:**	180 Horsepower
Operator:		**Operating Certificate(s) Held:**	Pilot school (141)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KVAY,53 ft msl	**Distance from Accident Site:**	2 Nautical Miles
Observation Time:	12:54 Local	**Direction from Accident Site:**	299°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	13 knots / 18 knots	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:	260°	**Turbulence Severity Forecast/Actual:**	/ N/A
Altimeter Setting:	30.12 inches Hg	**Temperature/Dew Point:**	21°C / 9°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Medford, NJ (N14)	**Type of Flight Plan Filed:**	None
Destination:	Medford, NJ (N14)	**Type of Clearance:**	None
Departure Time:	12:45 Local	**Type of Airspace:**	Class G

Airport Information

Airport:	FLYING W N14	**Runway Surface Type:**	Asphalt
Airport Elevation:	49 ft msl	**Runway Surface Condition:**	Dry;Vegetation
Runway Used:	01	**IFR Approach:**	None
Runway Length/Width:	3496 ft / 75 ft	**VFR Approach/Landing:**	Forced landing;Precautionary landing

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Fatal	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Fatal	**Latitude, Longitude:**	39.934165,-74.80722(est)

Administrative Information

Investigator In Charge (IIC):	Rayner, Brian
Additional Participating Persons:	Stephan Koza; FAA/FSDO; Philadelphia, PA Michael D Binder; Sikorsky; Coatesville, PA David Harsanyi; Lycoming; Williamsport, PA
Original Publish Date:	November 5, 2018
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=95968