Aviation Investigation Final Report

Location:	Eden, North Carolina	**Accident Number:**	ERA21FA195
Date & Time:	April 28, 2021, 13:24 Local	**Registration:**	N53DE
Aircraft:	BELL HELICOPTER TEXTRON CANADA 429	**Aircraft Damage:**	Destroyed
Defining Event:	Part(s) separation from AC	**Injuries:**	1 Fatal, 2 Serious
Flight Conducted Under:	Part 91: General aviation - Aerial observation		

Analysis

The helicopter departed and flew cross-country to begin a powerline patrol, which included flying adjacent to powerlines at an altitude of about 100 ft above ground level and with the helicopter gaining altitude during turns and when flying between line inspections.

During the final minutes of flight, the helicopter was traveling at an airspeed between 50 and 60 kts along powerlines at an altitude between 700 and 775 ft above mean sea level (msl). As the helicopter flew south, near the end of the north-south powerline's right of way, the helicopter began a climbing right turn towards the west. A utility lineman in the helicopter's front left seat recalled that the pilot was reversing course and the helicopter was in a banking turn to the right when he heard a very loud noise, "almost cannon-like, very deep, within a second or two we were heading into the trees." Onboard data recovered from the helicopter showed rotor speed suddenly increased to 107% about 1.5 seconds before the end of recorded data. Examination of the wreckage showed evidence the main rotor blades impacted the tail rotor drive system. Therefore, it is likely the loud noise heard by the onboard lineman was caused by the main rotor blades impacting the tail rotor drive system, resulting in a severance of the tail rotor drive shaft and subsequently a loss of directional control. Successful recovery of the helicopter after the loss directional control at a low altitude was unlikely and resulted in impact with terrain. Based on analysis of flight data and a scan of the local terrain, it is unlikely the helicopter impacted powerlines or nearby trees at the time the main rotor blades impacted the tail rotor drive system.The loss of clearance between the main rotor and the tail of the helicopter can be caused by sudden aft cyclic control inputs, usually in conjunction with a reduction in collective pitch that would reduce main rotor thrust and increase downward flapping of the blade. The lack of flight control parametric data precluded analysis of flight control inputs at the time the main rotor blade contacted the tail boom. However, it is likely the

pilot was not maneuvering to avoid trees based on the increasing distance between the accident helicopter and treetops near the end of the accident flight. Examinations of the helicopter wreckage found no evidence of any preimpact anomalies or malfunctions that would have precluded normal operation of the helicopter.

Probable Cause and Findings

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

The impact of the main rotor blades with the tail boom during low-altitude maneuvers, which severed the tail rotor drive shaft and resulted in a loss of control and impact with terrain.

Findings

Aircraft	Tail rotor drive shaft - Damaged/degraded
Aircraft	Directional control - Attain/maintain not possible

Factual Information

History of Flight

Uncontrolled descent	Part(s) separation from AC
Maneuvering-low-alt flying	Loss of control in flight
Maneuvering-low-alt flying	Part(s) separation from AC (Defining event)

On April 28, 2021, about 1324 eastern standard time, a Bell 429 helicopter, N53DE, was destroyed when it was involved in an accident near Eden, North Carolina. The commercial pilot was fatally injured, and two passengers were seriously injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 91 aerial observation flight.

The helicopter was equipped with a GPMS Foresight MX Health and Usage Monitoring System (HUMS), which captured data for the accident flight. The HUMS device recorded position, attitude, acceleration, rotor speed (Nr), and engine data.

The HUMS data showed the helicopter departed Danville, Virginia, about 1233 and flew cross-country south-west into North Carolina. By 1245, the helicopter was flying a powerline patrol around Eden, North Carolina. The powerline inspection was accomplished at an altitude of about 100 ft above the terrain with the helicopter gaining altitude during turns and when flying between line inspections.

During the final minutes of flight, the helicopter was traveling at an airspeed between 50 and 60 kts parallel to powerlines at an altitude between 700 and 775 ft msl (Figure 1). Nr was near 100%, torque varied between 15% and 25%, and the engine gas generator (N1) speeds were between 84 and 88%.

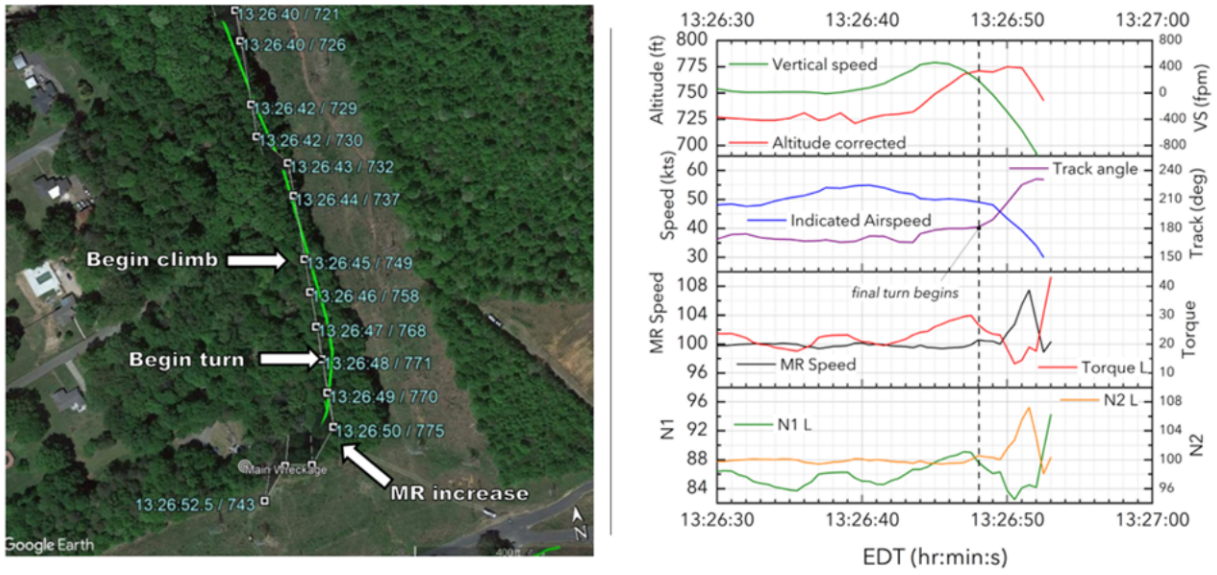

Figure 1- Combined map of flight track with corresponding flight parameters.

A utility lineman seated in the front left seat recalled that the pilot was reversing course and the helicopter was in a banking turn to the right when he heard a very loud noise, “almost cannon-like, very deep, [and] within a second or two we were heading into the trees.” Several ground witnesses nearby observed the accident flight. One witness driving westbound observed the helicopter cross the road heading southbound, flying low over the trees along the powerlines. The helicopter made a right turn before it disappeared behind trees. Two other witnesses observed the helicopter flying from east to west over the trees before making a steep “left turn” as seen from their vantage point; however, as the helicopter pointed toward the witnesses, it was in a right turn. The witnesses stated they could see the underside of the helicopter and skids before it “slid at an angle downward and disappeared into the woods.”

The Bell 429 is a light, twin-engine helicopter. It was maintained by the operator under the manufacturer’s recommended inspection program. Log sheet 1071, which was found at the accident site and, although undated, was presumably from the day of the accident, showed that at the start of the day the helicopter had an airframe total time of 283.5 hours and both engines had an engine total time of 283.5 hours.

There were abnormalities in the recovered HUMS data that led to the attitude and acceleration data being unreliable for use in this investigation. The accident helicopter was not equipped with, nor was it required to be equipped with a cockpit voice/flight data recorder (CV/FDR), which is an available option offered by Bell.

The flight was also recorded by Automatic Dependent Surveillance-Broadcast (ADS-B) data provided by the Federal Aviation Administration (FAA). ADS-B broadcasts an aircraft’s Global Positioning System (GPS) position and other data to the ground where it is recorded.

The helicopter impacted wooded terrain at an elevation of 570 ft and came to rest on a heading of about 251° magnetic and about 393 ft from the powerlines the crew was observing. All major components of the helicopter were accounted for at the accident site. A post-crash fire occurred and damaged the majority of the fuselage. The overall concentrated debris path was about 200 ft long on a 245° heading with several pieces scattered in multiple directions outside the main debris path. Remnant carbon fiber layup was present in the area of the upper cowlings, fuselage skin, and doors. The cockpit, cabin floor, and the transmission and engine deck were present but sustained heavy thermal damage. The avionics and wiring were strewn outside the nose section, with pieces of wood branches embedded within the wiring.

The main rotor hub remained attached to the main rotor mast. The two yoke assemblies remained installed with the mast nut intact. The main rotor blades remained installed to their respective grips via blade pins. All blade attachment hardware was present and secured. All four blade tips exhibited impact damage and their spars exhibited a “broom straw” appearance. Three separated leading edge pieces near the tip end, including the tip cap lap joint, were found in the debris field (surrounding the main wreckage). All four main rotor blade pitch horns remained intact, and all four pitch change links were connected to their respective pitch horns and the rotating swashplate. The main rotor transmission was partially separated from the airframe.

The tail boom had fractured into multiple pieces, the majority of which were found adjacent to and behind the fuselage. The tail rotor was hanging to one side of the gearbox due to fracturing of the output shaft and bending of the pitch control rod. The two tail rotor yokes remained installed on the tail rotor output shaft and were whole. All four tail rotor blades remained installed on the yokes. None of the tail rotor drive shaft covers remained installed on the tail boom. The horizontal stabilizer remained attached to a separated portion of the tail boom. The left horizontal stabilizer was generally whole with a puncture near the inboard side of its lower surface as well as a puncture near the outboard side of its upper surface. The left finlet remained attached with the lower portion intact and the upper portion fractured and partially separated. The right horizontal stabilizer was generally whole on its inboard end but was fractured at its outboard end. The lower portion of the right finlet was fractured and partially separated, remaining attached only by wiring. The upper portion of the right finlet was fractured and completely separated. The leading edge slats were present on the inboard portions of both left and right horizontal stabilizers but were fractured and separated on their outboard sections. Pieces of blue-colored composite fairing consistent with the tail rotor drive shaft cover were found in the flight path leading up to the main wreckage. The leading edge of the upper vertical fin showed evidence of impact deformation and separation above its attachment point.

The four main rotor blades were reconstructed in their respective positions and laid out by their designated colors, Green, Red, Orange, and Blue (Figure 2). Three separated leading edge pieces near the tip end, including the tip cap lap joint, were found in the debris field surrounding the main wreckage. Two swept tip ends, which were fractured and separated,

were reconstructed by the investigation team to the ‘blue’ and ‘orange’ main rotor blades. Two additional swept tip ends, also fractured and separated, exhibited impact damage with a width consistent with contact with the tail rotor drive system aft snubber and belonged to the ‘red’ and ‘green’ main rotor blades (Figure 3). All four swept tip ends were found in the debris field leading up to and around the main wreckage.

Figure 2- A reconstruction of the four main rotor blades; From top to bottom, Green, Red, Orange, and Blue.

Figure 3- An approximate reconstruction of rotor blade impact damage on the blade tip that is consistent with the dimensions of the snubber housing.

The yaw hydraulic actuator remained attached to both the airframe and its control bell crank within the tail boom. The lower portion of the right finlet was fractured and partially separated, remaining attached only by wiring. The upper portion of the right finlet was fractured and completely separated. The leading edge slats were present on the inboard portions of both left and right horizontal stabilizers but were fractured and separated on their outboard sections. Pieces of blue-colored composite fairing consistent with the tail rotor drive shaft cover were found along flight path leading up to the main wreckage.

The steel tail rotor drive shaft was continuous to the fan blower shaft. The fan blower shaft and oil cooler blower remained installed on the airframe but were crushed from impact forces. The drive shaft was attached at its forward end to the shaft segment running through the oil cooler blower assembly, one of the lobes (or “ears”) on the adapter assembly was fractured. The forward segmented drive shaft was fractured about 25 inches aft of its forward attachment flange. Two additional pieces from the forward segmented drive shaft were recovered: 1) the midsection of the forward segmented drive shaft, containing the stainless steel snubber sleeve, was found in the wreckage adjacent to the tail boom and 2) the aft section of the forward segmented drive shaft, about 40 inches in length, remained attached to a separated section of the tail boom and remained connected to a forward portion of the aft segmented drive shaft, about 23 inches in length, and the hanger bearing between them. The segmented drive shaft hanger bearing and its mount remained attached to the tail boom. A 34-inch -long section of the aft segmented drive shaft was found embedded near-vertically into the ground, with about 18 inches buried. The aft portion of the 34-inch section of the aft segmented drive shaft exhibited an angled cut (Figure 4).

Figure 4 - The 34-inch section of the aft segmented drive shaft, the aft end of which exhibited the angular cut.

A piece of a tail rotor drive shaft, semi-circular in its cross-section, was found about 172 ft from the main wreckage. Additional multiple smaller fragments of composite tail rotor drive shaft were found in the debris field along the flight path leading up to the main wreckage.

The helicopter was configured with only the pilot flight controls installed in the right cockpit seat. Various thermally degraded control clevis connections and bell cranks were found in the main wreckage site, but the majority of the cockpit flight control system was consumed by the post-crash fire. None of the connection points between linkages and bell cranks exhibited evidence of fastener disconnection or separation.

The three main rotor servo actuators were found separated on the ground near the forward end of the main transmission. All three main rotor servo actuators exhibited thermal damage. The hydraulic lines remained connected to the three servo actuators, allowing for identification of their positions. The tail rotor servo actuator was found in the tail boom wreckage and its hydraulic lines remained connected.

The right integrated hydraulic module (IHM) was found on the ground in front of the main transmission and was partially melted. The left IHM was found within the transmission deck wreckage, closer to the swashplate assembly, and was whole but covered in soot and otherwise exhibited no anomalies or debris in the reservoir.

The right hydraulic pump was partially melted but the splines and springs, although deformed due to thermal stress, did not show any anomalies. The left hydraulic pump was whole, and its exterior was thermally damaged but remained whole and showed no evidence of anomalous wear.

The lateral, longitudinal, and collective flight control servos exhibited thermal damage. The tail rotor servo actuator sustained no thermal damage. The flight control servo actuators were imaged and examined under the direction of the NTSB, and subsequently shipped to Woodward, Inc. for additional teardown examination. Examination of the four servo actuators revealed no preimpact or anomalous damage. All components within the valves were present and all O-rings and backup rings exhibited thermal degradation but were present and no scoring was noted.

The helicopter was equipped with two Pratt and Whitney PW207D1 engines, both of which remained installed on the engine deck. The No. 1 engine exhibited thermal damage, and the No. 2 engine exhibited thermal and impact damage. Both electronic engine controls (EECs) and data collection units (DCUs) for the Nos. 1 and 2 engines were removed for download but usable data could not be retrieved from either of the units due to thermal and impact damage. Postaccident examination of both engines and their respective components revealed no evidence of any preimpact mechanical malfunctions or failures that would have precluded their normal operation.

The North Carolina Department of Health and Human Services, Office of the Chief Medical Examiner performed the pilot's autopsy. According to the autopsy report, the cause of death was smoke inhalation and thermal injuries with blunt forces contributing.

The FAA Forensic Sciences Laboratory performed toxicological testing of postmortem specimens from the pilot. There were no findings of a contributory nature.

A performance study was accomplished utilizing the HUMS data along with ADS-B data, weather data, and published Bell performance data. The HUMS data did not record flight control inputs, so the pilot inputs during the final climb and maneuver at the time of the accident were unknown. The helicopter was not near the edge of its operating performance envelope for speed, altitude or temperature and reported weather at the time of the accident was clear with 10 statute miles visibility.

A LIDAR ("light detection and ranging" or "laser imaging, detecting, and ranging") scan was conducted in the area of the accident by Duke Energy to record the location of powerlines and surrounding terrain, including the trees. Analysis of the accident flight path using the HUMS data and the LIDAR scan showed the accident helicopter's distance from the treetops increasing near the end of recorded data.

Pilot Information

Certificate:	Airline transport; Commercial	**Age:**	47,Male
Airplane Rating(s):	None	**Seat Occupied:**	Front
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	January 4, 2021
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	January 12, 2021
Flight Time:	4520 hours (Total, all aircraft), 139 hours (Total, this make and model), 4476 hours (Pilot In Command, all aircraft), 120 hours (Last 90 days, all aircraft), 40 hours (Last 30 days, all aircraft), 8 hours (Last 24 hours, all aircraft)		

Other flight crew Information

Certificate:	None	**Age:**	Male
Airplane Rating(s):	None	**Seat Occupied:**	Front
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:			

Other flight crew Information

Certificate:	None	**Age:**	Male
Airplane Rating(s):	None	**Seat Occupied:**	Rear
Other Aircraft Rating(s):	None	**Restraint Used:**	
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	
Medical Certification:		**Last FAA Medical Exam:**	
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	
Flight Time:			

Aircraft and Owner/Operator Information

Aircraft Make:	BELL HELICOPTER TEXTRON CANADA	**Registration:**	N53DE
Model/Series:	429	**Aircraft Category:**	Helicopter
Year of Manufacture:	2019	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	57380
Landing Gear Type:	None; Skid	**Seats:**	3
Date/Type of Last Inspection:	March 10, 2021 Continuous airworthiness	**Certified Max Gross Wt.:**	7000 lbs
Time Since Last Inspection:	18.4 Hrs	**Engines:**	2 Turbo shaft
Airframe Total Time:	265.1 Hrs as of last inspection	**Engine Manufacturer:**	Pratt & Whitney Canada
ELT:	C126 installed, not activated	**Engine Model/Series:**	PW207D1
Registered Owner:	DUKE ENERGY BUSINESS SERVICES LLC	**Rated Power:**	572 Horsepower
Operator:	DUKE ENERGY BUSINESS SERVICES LLC	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	SIF,693 ft msl	**Distance from Accident Site:**	7 Nautical Miles
Observation Time:	13:15 Local	**Direction from Accident Site:**	241°
Lowest Cloud Condition:		**Visibility**	10 miles
Lowest Ceiling:		**Visibility (RVR):**	
Wind Speed/Gusts:	7 knots /	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	220°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	30.04 inches Hg	**Temperature/Dew Point:**	27°C / 15°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Danville, NC (DAN)	**Type of Flight Plan Filed:**	Company VFR
Destination:	Burlington, NC (BUY)	**Type of Clearance:**	None
Departure Time:	12:32 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	2 Serious	**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal, 2 Serious	**Latitude, Longitude:**	36.497132,-79.718455(est)

Administrative Information

Investigator In Charge (IIC):	Mccarter, Lawrence
Additional Participating Persons:	Hazen Rowe; FAA - FSDO; Greensboro, NC Nora Vallee; Transportation Safety Board of Canada; Gatineau Merryn Spielman; Pratt & Whitney Canada Mona Polson; Bell Flight Safety; Ft Worth, TX Philip Kangagy; Duke Energy Aviation; Charlotte, NC Jason Sponsel; Duke Energy Aviation; Charlotte, NC Allen Blankenship; Duke Energy Aviation; Charlotte, NC Garrett Scott; Duke Energy Aviation; Charlotte, NC
Original Publish Date:	August 30, 2023
Last Revision Date:	
Investigation Class:	Class 3
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=102994