Aviation Investigation Final Report

Location:	Fort McDowell, Arizona	**Accident Number:**	WPR19FA109
Date & Time:	April 16, 2019, 07:06 Local	**Registration:**	N61PH
Aircraft:	Bell 206	**Aircraft Damage:**	Destroyed
Defining Event:	Mast bumping	**Injuries:**	2 Fatal
Flight Conducted Under:	Part 91: General aviation - Flight test		

Analysis

The pilot and flight engineer were conducting a flight test to evaluate developmental main rotor blades that had been installed on the helicopter. The flight consisted of multiple autorotations at maximum gross weight, entered following a 1-second delay after a simulated loss of engine power. A witness saw the helicopter falling from the sky and saw several other objects descending to the ground before losing sight of it behind trees.

Examination of the wreckage revealed damage to the main rotor mast, consistent with a mast bumping event. Cyclic controls were installed in both the pilot's seat and the left seat, where the flight test engineer sat with equipment used for recording flight parameters, including an 8-lb laptop computer. In order for the engineer to operate the computer or take notes on the clipboard, he would have to hold the computer with one hand while using the other to enter commands or take notes. The installation of the cyclic in the engineer's position represented a deviation from company procedures by both the pilot and the flight test engineer. Examination revealed no evidence of mechanical malfunctions or failures that would have precluded normal operation of the helicopter prior to the mast bumping.

The flight engineer's fatigue of holding the 8-lb computer over his lap, the awkwardness of entering commands with one hand, or taking notes single-handedly may have allowed the computer to suddenly shift and strike or block the cyclic during the simulated loss of power test at the critical low-G flight condition.

Probable Cause and Findings

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

The separation of the main rotor head from the mast as a result of a sudden displacement of the cyclic stick during a low-G maneuver, leading to mast bumping. Contributing to the accident were the unsecure positioning of the flight test engineer's laptop computer and the deviation from standard operating procedures to leave the left seat cyclic control installed during the test flight.

Findings

Personnel issues	Identification/recognition - Pilot
Aircraft	Control column section - Incorrect use/operation
Personnel issues	Use of equip/system - Pilot
Aircraft	Engine out control - Attain/maintain not possible
Environmental issues	Positioning/available space - Effect on equipment

Factual Information

History of Flight

Maneuvering	Mast bumping (Defining event)

On April 16, 2019, about 0706 mountain standard time, an experimental Bell 206B helicopter, N61PH, was destroyed when it was involved in an accident near Fort McDowell, Arizona. The commercial pilot and flight test engineer were fatally injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 91 test flight.

The operator reported that the purpose of the flight was to evaluate the developmental main rotor blades that had been installed on the helicopter. The helicopter was fueled for two test flight legs. The helicopter departed at 0545 for the first leg and returned about 0620, parked on the ramp with the engine at idle, and 100 lbs of ballast was added to the helicopter. Radar data showed that the helicopter departed at 0632 to continue the second leg of the test flight. The test flight consisted of multiple autorotations at maximum gross weight following a simulated loss of engine power. The operator reported that the commercial pilot who was in control of the helicopter would perform all the flight maneuvers and the flight test engineer would perform several tasks during the test flight, which included holding a 17-inch, 7.72-lb engineering laptop with his left hand above the cyclic control while simultaneously using and stowing a clipboard and pencil to manage data collection. A corded event marker that was connected to equipment in the aft cabin area was also used to identify the beginning and end of a flight test maneuver and would normally be draped over the laptop when not in use. The clipboard was normally stowed between the center console and the flight engineer's seat. Flight cards are prepared for each test flight and listed the maneuvers to be performed during the flight. The accident flight was to be the last test flight of the main rotor blades before their certification process.

A review of the radar data revealed that the accident flight duration was about 34 minutes. The pilot executed multiple turns and descent maneuvers near the area of the accident site. The airplane's final radar-recorded altitude was 4,400 ft mean sea level (msl), or about 3,000 ft above ground level (agl).

A witness who was walking to a bus stop about 1/3-mile northwest of the accident site heard a loud bang southeast of her position. She saw the helicopter falling from the sky and used her phone to video record the helicopter and several other objects descending to the ground before losing sight of it behind trees along the road.

Pilot Information

Certificate:	Commercial; Flight instructor; Private	**Age:**	52,Male
Airplane Rating(s):	Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	Unknown
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	Yes
Instructor Rating(s):	Helicopter; Instrument helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	May 8, 2018
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	1200 hours (Total, all aircraft)		

Pilot-rated passenger Information

Certificate:	Private	**Age:**	28,Male
Airplane Rating(s):		**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	Unknown
Instrument Rating(s):		**Second Pilot Present:**	Yes
Instructor Rating(s):		**Toxicology Performed:**	Yes
Medical Certification:	Class 3 None	**Last FAA Medical Exam:**	August 23, 2018
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:			

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	**Registration:**	N61PH
Model/Series:	206 B	**Aircraft Category:**	Helicopter
Year of Manufacture:	1981	**Amateur Built:**	
Airworthiness Certificate:	Experimental (Special)	**Serial Number:**	3282
Landing Gear Type:	Skid	**Seats:**	2
Date/Type of Last Inspection:	January 25, 2019	**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	1 Turbo shaft
Airframe Total Time:		**Engine Manufacturer:**	Rolls-Royce Corporation
ELT:		**Engine Model/Series:**	M250-C20B
Registered Owner:	Tre Aviation Corp	**Rated Power:**	
Operator:	Van Horn Aviation	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KFFZ,1380 ft msl	**Distance from Accident Site:**	10 Nautical Miles
Observation Time:	13:54 Local	**Direction from Accident Site:**	197°
Lowest Cloud Condition:	Clear	**Visibility**	
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots /	**Turbulence Type Forecast/Actual:**	None / None
Wind Direction:	130°	**Turbulence Severity Forecast/Actual:**	N/A / N/A
Altimeter Setting:	29.88 inches Hg	**Temperature/Dew Point:**	18°C / 1°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Mesa, AZ (FFZ)	**Type of Flight Plan Filed:**	None
Destination:	Mesa, AZ (FFZ)	**Type of Clearance:**	VFR
Departure Time:	05:45 Local	**Type of Airspace:**	Class G

Wreckage and Impact Information

Crew Injuries:	2 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	On-ground
Ground Injuries:		**Aircraft Explosion:**	Unknown
Total Injuries:	2 Fatal	**Latitude, Longitude:**	33.623611,-111.67555

The examination of the accident site revealed postcrash fire and impact damage consistent with a right side-down, nose-level attitude during ground impact. The main rotor hub assembly, vertical fin stabilizer, tail rotor assembly, tail rotor driveshaft, and forward induction cowl fairing separated from the main wreckage and was found in the debris field. One main rotor blade was found furthest from the main wreckage. The other main rotor blade was found near the main wreckage. The debris field was about 1 mile long and 1,000 ft wide, covering an area of wooded desert terrain and flood-irrigated alfalfa fields.

Examination of the wreckage revealed thermal and impact damage. Both the left and right seat cyclic controls were installed. Both the main rotor blades separated approximately 4 ft outboard of the blade grips. Both blades exhibited witness marks consistent with the tail boom or tail rotor contact. The main rotor mast revealed damage consistent with a mast bumping

event. The examination of the airframe and engine revealed no evidence of preaccident mechanical malfunctions or anomalies that would have precluded normal operation.

A tail rotor blade, main rotor blades, and main rotor hub were sent to the NTSB Materials Laboratory for further examination. The components exhibited features consistent with overstress fractures. There were no indications of pre-existing damage or failures.

Additional Information

The operator stated that the flight test engineer's cockpit position cyclic control stick was typically removed during test flights.

The two rotor blades installed on the helicopter were developmental prototype blades that were being used to collect data for certification requirements. The main rotor blade was an aftermarket replacement main rotor blade for the Bell model 206B helicopter. The blade was constructed using carbon fiber/epoxy pre-preg woven fabric and unidirectional tape. The blade interfaced with the existing Bell main rotor hub using two titanium grip plates. The grip plates were bolted to the composite sub-assembly. The blade incorporated a NASA-developed laminar flow airfoil. The tip was tapered in both chord and thickness directions. No modifications were required to the helicopter to install the blades.

One of the blades was instrumented using strain gages to measure blade loads during the test flight. The measured loads were flap bending, chord bending, and torsion at several locations along the span of the blade. The information obtained during the test flight was stored on the test equipment in the helicopter's passenger compartment and the engineer's laptop.

The flight test engineer's laptop computer remained largely intact, and files of the accident flight were obtained from the hard drive. Data from near the time of the accident were not recovered. The data from the obtained files showed multiple maneuvers performed during the flight, during which the blade displayed consistent load behavior. The maneuvers from the flight cards that were not identified in the data were a simulated power failure involving a one-second delay before the pilot reacts to the maneuver, and two autorotations with lateral reversals.

The simulated power failure maneuver procedure required the pilot to initiate the maneuver from level flight at 100 kts. The pilot then reduced the engine power to flight idle by using the collective twist grip, allowing a one-second delay. The pilot then lowered the collective, applied right pedal to maintain directional control, and entered an autorotative descent. The purpose of this maneuver is to represent a realistic reaction of a pilot when confronted with a sudden

loss of engine power. It is possible to impart a low-G condition on the helicopter during the execution of this maneuver if the collective is lowered rapidly.

The FAA Helicopter Flying Handbook (FAA-H-8083-21B), in part, stated:

Low-G Conditions and Mast Bumping

Helicopters rely on positive G to provide much or all of their response to pilot control inputs. The pilot uses the cyclic to tilt the rotor disk, and at one G, the rotor is producing thrust equal to aircraft weight. The tilting of the thrust vector provides a moment about the center of gravity to pitch or roll the fuselage. In a low-G condition, the thrust and consequently the control authority are greatly reduced…helicopters with two-bladed teetering rotors rely entirely on the tilt of the thrust vector for control. Therefore, low-G conditions can be catastrophic for two-bladed helicopters.

Administrative Information

Investigator In Charge (IIC):	Swick, Andrew
Additional Participating Persons:	Michael Moyer; FAA-FSDO; Scottsdale, AZ Nick Shepler; Rolls-Royce; Indianapolis, IN James Van Horn; Van Horn Aviation; Tempe, AZ
Original Publish Date:	April 6, 2022
Last Revision Date:	
Investigation Class:	Class 3
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=99264