National Transportation Safety Board

Washington, DC 20594

Safety Recommendation Report

Use of Recording Devices During Experimental Flight Test Activities

Accident/Incident Number:	DCA16FA199
Operator:	Bell Helicopter Textron, Inc.
Aircraft:	Bell 525, N525TA
Location:	Italy, Texas
Date:	July 6, 2016
Adopted:	January 9, 2018

The National Transportation Safety Board (NTSB) is providing the following information to urge the Flight Test Safety Committee (FTSC) and Bell Helicopter Textron to take action on the safety recommendations in this report. These recommendations are derived from our investigation of a July 6, 2016, accident involving an experimental research and development Bell 525 helicopter, N525TA, which broke up in flight and impacted terrain near Italy, Texas. The two test pilots received fatal injuries, and the helicopter was destroyed.[1] The helicopter was being operated under the provisions of Title 14 *Code of Federal Regulations* (*CFR*) Part 91 as a developmental flight test. As a result of this investigation, the NTSB is issuing one safety recommendation to the FTSC and one safety recommendation to Bell Helicopter Textron.

Background and Analysis

The accident helicopter was undergoing developmental flight tests before type certification. On the day of the accident, the helicopter test crew was performing a series of OEI tests at increasing airspeeds with a heavy, forward center-of-gravity configuration. (For the OEI tests, the pilots used OEI special training mode software to reduce the power of both engines to a level that simulated the loss of one engine.) The crew initiated the final planned OEI test at a

[1] The NTSB determined that the probable cause of the accident was a severe vibration of the helicopter that led to the crew's inability to maintain sufficient rotor rotation speed (Nr), leading to excessive main rotor blade flapping, subsequent main rotor blade contact with the tail boom, and the resultant in-flight breakup. Contributing to the severity and sustainment of the vibration, which was not predicted during development, were (1) the collective biomechanical feedback and (2) the attitude and heading reference system response, both of which occurred due to the lack of protections in the flight control laws against the sustainment and growth of adverse feedback loops when the 6-hertz (Hz) airframe vibration initiated. Contributing to the crew's inability to maintain sufficient Nr in the severe vibration environment were (1) the lack of an automated safeguard in the modified one-engine-inoperative (OEI) software used during flight testing to exit at a critical Nr threshold and (2) the lack of distinct and unambiguous cues for low Nr. More information about this accident, NTSB case number DCA16FA199, can be found in the Aviation Accident Database at www.ntsb.gov.

speed of 185 knots. After the crew engaged OEI special training mode, Nr decayed from 100% to about 91%, and the crew began lowering the collective to stop Nr decay and increase Nr to 103% (the target Nr for recovery). About 5.5 seconds into the test, the crew stopped lowering the collective, and Nr only recovered to about 92%. About 6 to 7 seconds into the test, the helicopter began vibrating at a frequency of 6 Hz. The vibration was evident in the main rotor and tail rotor, the airframe, the pilot seats, and the control inputs; the vertical vibration amplitude at the pilot seat peaked about 3 G.[2] Nr remained between about 90% and 92% until about 12 to 13 seconds into the test, then began fluctuating consistent with collective control inputs; subsequent collective control input increases led to further decay in Nr. Nr decayed to about 80% as the collective was raised, and the main rotor blades began to flap out of plane. About 21 seconds into the test, the main rotor blades flapped low enough to impact the tail boom, severing it and causing the in-flight breakup of the helicopter.

As an experimental research and development helicopter configured to carry two pilots and with no passenger seating, the accident helicopter was not required to be equipped with either a flight data recorder (FDR) or cockpit voice recorder (CVR) under the provisions of 14 *CFR* 91.609.[3] When certified as a transport-category rotorcraft under 14 *CFR* Part 29, the Bell 525 will be equipped with both CVR and FDR recording capabilities. The accident helicopter was heavily instrumented with airborne and ground-based recording systems, including a streaming telemetry system. A combination CVR and FDR (CVFDR) was installed in the flight test helicopter but was not operational at the time of the accident.

In this accident, as well as in an October 30, 2015, flight test accident in Tronzano Vercellese, Italy, involving an AgustaWestland AW609 tiltrotor, telemetry data was successfully streamed to a ground station up until the in-flight breakup.[4] In both accident investigations, the telemetry data, which was also recorded on an airborne recording system, was critical in determining the circumstances leading up to the in-flight breakup.

During the AgustaWestland AW609 accident flight, cockpit audio was streamed to, and recorded at, the ground station in Italy, which provided insight into when the crew of the tiltrotor first mentioned roll and yaw oscillations, the latter of which diverged and ultimately resulted in an in-flight breakup, as well as the crew's assessment of the roll and yaw oscillations before the in-flight breakup. The ANSV proposed a recommendation to the International Civil Aviation Organization (ICAO) after the AgustaWestland AW609 accident to require the installation of

[2] G is a unit of measurement of acceleration; 1 G is equivalent to the acceleration caused by the earth's gravity (about 32.2 ft/sec^2).

[3] Title 14 *CFR* 91.609 addresses equipage and operational requirements for FDRs and CVRs for aircraft operating under Part 91.

[4] (a) AgustaWestland was renamed to Finmeccanica Helicopters in January 2016, which was renamed to Leonardo Helicopters in January 2017. (b) On October 30, 2015, an experimental AgustaWestland AW609 tiltrotor, N609AG, broke up in flight in Tronzano Vercellese, Italy. The Agenzia Nazionale per la Sicurezza del Volo (ANSV), the Italian aviation safety investigative agency, led the accident investigation. The NTSB appointed an accredited representative to this investigation, with technical advisors from the Federal Aviation Administration (FAA), AgustaWestland Philadelphia Corporation (a wholly owned subsidiary of AgustaWestland), and Bell Helicopter. For more information, see the English version of the ANSV final report for N609AG.

flight data recorders (FDRs and CVRs) on experimental aircraft that will be equipped with such devices at the completion of the certification process.[5]

In the Bell 525 accident flight in Texas, there were no communications between the crew and either the ground station or the chase helicopter after OEI test initiation. Although investigators were able to examine and analyze telemetry data, a properly functioning CVFDR would have recorded any discussions between the accident pilots that could have offered more information about potential abnormal conditions, distractions, or reasons for their stop in recovery after initiation of the OEI test. Additionally, cockpit image recording capability would have recorded any pilot actions and interactions with the aircraft systems including avionics button presses, warning acknowledgements, and any other physical response to the aircraft. Cockpit audio and imagery could have provided insight into when the crewmembers first felt or detected the 6-Hz vibration, how they may have verbalized their assessment of an observed anomaly, and whether they attempted any specific corrective action because of the vibration, such as disengagement of the OEI training mode. Thus, the lack of cockpit audio or image data precluded access to data needed to fully determine why the crew may have momentarily stopped the collective pitch reduction to recover Nr and any corrective actions the crew may have attempted as a result of the 6-Hz vibration.

The NTSB concludes that recorded cockpit audio and images, whether recorded on flight recorders or ground-based telemetry systems, from experimental flight test aircraft such as the Bell 525 and the AgustaWestland AW609 would help give manufacturers more information about experimental flight tests and would also help manufacturers and investigators better understand the circumstances of an accident. This understanding could be used to develop improvements to the aircraft and/or procedures. Guidance for the use of recording devices during experimental flight test activities could help an organization incorporate these tools during development and planning of future flight testing. We note that the FTSC has expertise in this area and could provide expeditious guidance to manufacturers that will be conducting experimental flight testing.

The NTSB believes that final action by ICAO on the ANSV recommendation is likely to take several years, and any action by the FAA to apply the ICAO action to the United States will take additional time. On issues such as this in which regulatory action must pass several difficult hurdles, industry organizations, such as the FTSC, can develop best practices and make these available to the public. According to its website (www.flighttestsafety.org), the FTSC was formed by members of the Society of Experimental Test Pilots, the Society of Flight Test Engineers, and the American Institute of Aeronautics and Astronautics. The FTSC is a flight test-related organization intended to promote test flight safety, reduce the risk of mishaps, promote risk reduction management, and continually improve the profession's communication and coordination. Therefore, the NTSB recommends that the FTSC develop and issue guidance for the use of recording devices for parametric data, cockpit audio, and cockpit images during experimental flight test activities.

Further, we note that Bell Helicopter independently addressed this deficiency before the return to flight of the 525 program. For the 525 helicopter, cockpit audio is now being recorded by an onboard CVFDR, and communications to and from the ground monitoring station are recorded

[5] See Safety Recommendation ANSV-11/3173-15/3/A/16 in the ANSV final report for N609AG.

by the CVFDR and the telemetry system during all flights. Cockpit video is also being recorded by the instrumentation system and archived at the ground station. Additionally, Bell Helicopter issued a company-wide business directive to ensure that cockpit audio is recorded during all telemetered flight test activities across their flight test sites. The NTSB concludes that flight test safety would be enhanced if manufacturers and flight test industry groups had knowledge of the lessons learned from this accident specific to the use of recorders during experimental flight test activities. We note that Bell Helicopter is in the unique position to share the benefits of having operating recorders during flight test activities with other manufacturers and flight test industry groups. Therefore, the NTSB recommends that Bell Helicopter provide information about the lessons learned from the July 6, 2016, accident specific to the benefits of recording devices for parametric data, cockpit audio, and cockpit images during experimental flight test activities to interested manufacturers, flight test industry groups, and other appropriate parties.

Recommendations

To the Flight Test Safety Committee:

Develop and issue guidance for the use of recording devices for parametric data, cockpit audio, and cockpit images during experimental flight test activities. (A-18-1)

To Bell Helicopter Textron:

Provide information about the lessons learned from the July 6, 2016, accident specific to the benefits of recording devices for parametric data, cockpit audio, and cockpit images during experimental flight test activities to interested manufacturers, flight test industry groups, and other appropriate parties. (A-18-2)

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