National Transportation Safety Board

Washington, DC 20594

Safety Recommendation Report

Install Flight Data, Audio, and Image Recorder Systems on all Turbine-Powered Helicopters

Accident Number:	CEN17FA252 and others
Operator:	Air Methods Corporation and others
Aircraft:	Airbus Helicopters and others
Location:	Perryville, Missouri, and others
Date:	July 1, 2017 and others

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant accidents in other modes of transportation—railroad, highway, marine, and pipeline. We determine the probable cause of the accidents and issue safety recommendations aimed at preventing future accidents. In addition, we carry out special studies concerning transportation safety and coordinate the resources of the federal government and other organizations to provide assistance to victims and their family members affected by major transportation disasters. The following information warrants helicopter manufacturers to take action on the safety recommendations issued in this report.[1]

These recommendations address the need for crash-resistant flight recorder systems and crash-protected image recorder systems on existing and newly manufactured turbine-powered helicopters. These recommendations are derived from several NTSB investigations of turbine-powered helicopter accidents in which the lack of a crash-resistant or crash-protected flight recording system that records parametric data, cockpit audio, and images hindered our understanding of the accident circumstances and, thus, allowed potential safety issues to go unaddressed.[2] The NTSB is issuing four new recommendations to Airbus Helicopters, Bell, and Leonardo Helicopter Division; two new recommendations to MD Helicopters and Robinson Helicopter Company; and three new recommendations to Sikorsky.[3]

Background and Analysis

On July 1, 2017, about 2036 central daylight time, an Airbus Helicopters BK 117 B-2 helicopter, N238BK, landed hard and rolled over during an emergency landing to a field near Perryville, Missouri. The pilot, three medical personnel, and a patient received minor injuries, and

[1] The manufacturers receiving these recommendations comprise the majority of manufacturers of turbine-powered rotorcraft currently in operation in the United States and currently produce turbine-powered rotorcraft.

[2] The appendix at the end of this report contains a list of investigations that support these recommendations.

[3] In 2014, Eurocopter was renamed Airbus Helicopters. Bell Helicopter was rebranded to Bell in 2018. In 2016, AgustaWestland became Leonardo Helicopter Division. In 2015, United Technologies Corporation sold Sikorsky to Lockheed Martin.

the helicopter sustained substantial damage. The helicopter was owned and operated by Air Methods Corporation, doing business as Kids Flight, as a Title 14 *Code of Federal Regulations* (*CFR*) Part 135 helicopter air ambulance operation. Visual meteorological conditions prevailed at the time of the accident, and a company visual flight rules flight plan was filed. The flight originated from St. Francis Medical Center, Cape Girardeau, Missouri, and was en route to St. Louis Children's Hospital, St. Louis, Missouri.[4]

About 17 minutes after takeoff, while in cruise flight at dusk, both engines on the helicopter lost power. The investigation determined the pilot did not turn on the fuel transfer pump switches before takeoff, leading to fuel starvation and a dual-engine power loss in flight. The investigation also found, as a contributing factor, that the pilot's decision to activate the dimming function of the annunciator panel during dusk was improper because it prevented him from seeing the illuminated caution lights indicating low fuel in the supply tanks and that the fuel transfer pump was off. Due to the lack of a flight data, cockpit audio, or image recorder on the accident helicopter (none of which was required), the investigation could not determine why the pilot did not turn on the fuel transfer pump before takeoff despite his postaccident statement that he used a "do-verify" method to complete the preflight checklist.[5]

Specifically, the availability of recorder information would have confirmed the pilot's performance of the helicopter start-up procedures. This information also would have been valuable in confirming the fuel transfer pump switch position at the conclusion of the helicopter start-up procedures and the fuel gauge readings throughout the accident flight. Furthermore, an image recording of the cockpit showing the caution and warning annunciations during the start-up procedures, before the pilot reportedly turned on the cockpit instrument lighting dimming function, would have been helpful in understanding the visibility of these annunciations to the pilot.

If the pilot had not survived the accident, the lack of a recorder would have hindered the investigation's understanding of when the cockpit lights were dimmed and of how soon the second engine power loss occurred after the first. In addition, if evidence had been lost due to impact damage, such as the fuel transfer switches, the lack of a recorder would have hindered the investigation's understanding of why both engines lost power. Analysis of such information would have assisted investigators in identifying areas for improvement, such as possible gaps in company procedures and pilot training and the effectiveness of critical annunciations provided to the pilot before the dual-engine power loss. As it is, the investigation determined the probable cause as the mostly likely scenario and was unable to identify safety issues for follow-up.

On September 6, 2016, about 1340 eastern daylight time, a Sikorsky S-61N helicopter, N805AR, was destroyed when it impacted a field after experiencing a dual-engine power loss while in a hover near Palm Bay, Florida. The pilot, copilot, and a crewmember received fatal injuries. The helicopter was registered to EP Aviation LLC and was operated by AAR Airlift Group

[4] More information about this accident, NTSB case number CEN17FA252, is available from the NTSB's Aviation Accident Database web page.

[5] According to Federal Aviation Administration (FAA) Order 8900.1, *Flight Standards Information Management System*, using the "do-verify" method of checklist completion involves completing all of the action items on a checklist then reading the checklist again while each item is verified. The do-verify method allows a flight crew to use flow patterns from memory to accomplish a series of actions quickly and efficiently.

under Title 14 *CFR* Part 91 as a postmaintenance flight, which originated from Melbourne International Airport, Melbourne, Florida.[6]

The helicopter was equipped with a cockpit voice recorder (CVR) but was not equipped with a flight data recorder (FDR) or a cockpit image recording system. A sound spectrum analysis of the CVR provided investigators with parameters for engine and rotor drivetrain speeds. According to the CVR, the crew was performing a 20-knot rearward flight about 200 ft above ground level as part of a postmaintenance functional check flight. While recovering from the first rearward flight maneuver, the crew discussed hearing an unusual sound that they attributed to a compressor stall. The crew initiated a second attempt at the rearward flight maneuver. During the second attempt, the CVR recorded a 3-second span of overdriven audio followed by sounds consistent with the speeds of both engines and the rotor drivetrain decaying linearly and a subsequent sound of impact. Although an engine anomaly is likely related to the 3-second span of overdriven audio, a sound spectrum analysis could not be performed on the overdriven audio data.

Because no FDR or a cockpit image recording system was installed, the behavior of the engines during both rearward flight maneuvers, flight control inputs during the maneuvers, and the position of the cockpit engine control levers at the time of the dual-engine power loss could not be determined. Additionally, the lack of a cockpit image recording system prevented investigators from analyzing the roles and actions of the pilot and copilot during the rearward flight maneuvers, as well as their attempt to recover the helicopter from the dual-engine power loss. Analysis of such information would have assisted investigators in identifying factors leading to the dual-engine power loss, as well as safety actions to prevent similar accidents in the future. At least five other turbine-powered helicopter accident investigations over the last 7 years have involved various helicopter models for which identifying potential safety issues was impeded by the lack of valuable information that could have been provided by flight data, cockpit audio, and image recorders (see appendix).

When recorded data have been available, the data proved to be an invaluable source of information. For example, in 2005 and again in 2015, recovered information from the combination flight data and voice recorders installed on two Sikorsky S-76-series helicopters showed an abrupt loss of flight control in both instances, which prompted the investigations to focus on the helicopters' flight control systems.[7] Subsequent examination and testing of the main rotor hydraulic actuators from the helicopter involved in the 2005 accident revealed debris within an actuator that could lead to an uncommanded actuation and an abrupt loss of control in flight. The

[6] More information about this accident, NTSB case number ERA16FA311, is available from the NTSB's Aviation Accident Database web page.

[7] The Government of Estonia and the the Nigeria Accident Investigation Bureau, respectively, led the investigations of the 2005 and 2015 accidents. The NTSB participated in both investigations as an accredited representative under the provisions of Annex 13 to the Convention on International Civil Aviation, representing the State of Manufacturer and Design of the helicopter.

ability to timely identify this critical safety issue resulted in three urgent recommendations and would not have been possible without access to the recorded data.[8]

The investigation of the 2015 accident found a disconnected rod end at a servo actuator input linkage due to thread wear. The recorded data were crucial in understanding that the crew received no warning of the unanticipated and sudden loss of control due to the disconnected rod. Furthermore, the recorded data showed that the flight control system exhibited no evidence of anomalous behavior or trends that could have provided advanced warning of progressive thread wear before the sudden loss of control. These findings led the FAA to issue an emergency airworthiness directive (AD) requiring immediate inspections for the flight control linkage installations on Sikorsky S-76-series helicopters.[9]

In addition, recorded data and cockpit images successfully retrieved from Airbus Helicopters AS350-series helicopters equipped with the Appareo Vision 1000 cockpit imaging and flight data monitoring (FDM) device were crucial in understanding the circumstances of three accidents the NTSB has investigated, including crewmember actions and the cockpit environment.[10] Data recovered from an Appareo Vision 1000 installed on an Airbus AS350-B3e involved in a 2018 accident showed that, during normal cruise flight, the pilot intentionally moved the engine throttle to idle but did not decrease the collective sufficiently to maintain rotor speed after the engine was set to idle, resulting in a decay of rotor speed. The recorded images showed the pilot subsequently muted the aural annunciation for the low rotor speed condition.

During the helicopter's descent until water impact, the recorded data showed the pilot neither lowered the collective nor moved the engine throttle back into the flight position in time to recover engine power; either action would have recovered rotor speed. The pilot's actions would not have been known without the information from the installed recorder.[11]

Recovered data from an Appareo Vision 1000 installed on an Airbus AS350-B3 helicopter, operated by Papillon Airways, involved in a 2014 ground rollover accident showed that the pilot landed in a location where a direct buffeting crosswind was present. Recovered images showed that the pilot exited the helicopter with the engine throttle set at flight idle and airframe buffeting

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[8] The NTSB issued Urgent Safety Recommendations A-05-33 through -35 to the FAA on November 17, 2005. These recommendations asked the FAA to require Sikorsky S-76 helicopter operators to: 1) conduct an immediate internal leakage test of all main rotor actuators with more than 500 hours since new and/or overhaul; 2) conduct subsequent recurring tests at a period not to exceed 500 hours; 3) report the test results to the [FAA] and/or Sikorsky; and 4) correct any problems as necessary (A-05-33); require Sikorsky S-76 helicopter operators to: 1) conduct immediate visual and laboratory examinations of hydraulic fluid and filter elements in hydraulic systems with actuators with more than 500 hours since new and/or overhaul for plasma flakes or other contamination that exceeds the manufacturers' allowable limits of concentration and size; 2) conduct subsequent recurring tests at a period not to exceed 500 hours; 3) report findings of contamination and flakes to the [FAA] and/or Sikorsky and 4) correct any problems as necessary (A-05-34); and direct the principal operations inspectors of all Sikorsky S-76 helicopter operators to reemphasize the importance of and requirement for a preflight check of control movement smoothness and flight control "stick-jump" at every engine start (A-05-35).

[9] More information about these accidents, NTSB case numbers DCA05RA089 and DCA15RA171, is available from the NTSB's Aviation Accident Database web page.

[10] Airbus Helicopters, the type certificate holder for Type Certificate Data Sheet No. H9EU, voluntarily equips all new AS350-series and EC130-series helicopters with Appareo units.

[11] More information about this accident, NTSB case number, CEN18FA391, is available from the NTSB's Aviation Accident Database web page.

increased over the next several seconds. The helicopter subsequently rolled and yawed until the rotor blades impacted the ground. The circumstances of the rollover would not have been understood without the image recorder.[12]

The presence of an Appareo Vision 1000 installed on an Airbus AS350-B3 helicopter involved in a 2013 loss-of-control accident and postcrash fire is notable for two reasons. First, recovered parametric data showed that the helicopter flew normally at the beginning of the flight, but its flightpath became increasingly erratic and was consistent with an inadvertent encounter with instrument meteorological conditions. Icing conditions were likely present in the vicinity of the accident flight. Recovered images showed the pilot intentionally caging the attitude indicator as he flew into deteriorating weather conditions. Although icing conditions were likely present during the accident flight, the recovered images enabled the investigation to conclude the performance of the helicopter was not degraded at the time of the accident.[13] The helicopter's flight characteristics and the pilot's actions would not have been known without information from the installed image recorder.

The second notable aspect of the installed Appareo unit in this accident is that it was ejected from the cockpit at ground impact, thus sparing it from the postcrash fire. If the recorder had not been ejected, the recorded data likely would not have survived the postcrash fire because, as voluntarily installed equipment, these devices do not—and are not required to—meet the specifications for crash-resistant recorders in Technical Standard Order (TSO) C197, "Information Collection and Monitoring Systems," or crash-protected recorders in TSO-176a, "Cockpit Image Recorder Equipment." Therefore, as helpful as Appareo Vision 1000 recording devices have been to NTSB investigations, their data are at risk of being lost if they are involved in a severe ground impact or postcrash fire (as occurred in five of the accidents listed in the appendix).

A 2015 loss-of-control accident and postcrash fire involving an Airbus AS350-B3e helicopter is an example for which Appareo data were lost; the Appareo Vision 1000 sustained extensive heat damage and the recorded data were unable to be recovered.[14] Because of the lack of recorded data, the NTSB could not determine possible reasons that the accident pilot did not complete the last step of the yaw servo hydraulic check or perform a hover check. Also, the NTSB could not determine the duration of the pilot's full right pedal input before ground impact, his cyclic input, and any annunciations on the caution and warning panel. Although many of the events leading to this accident could be determined from surveillance videos at the accident site, such videos are not available for most NTSB investigations, and surveillance videos do not contain the audio, image, and parametric data provided by a crash-resistant flight recorder system.

Since 1999, the NTSB has issued a series of recommendations to the FAA regarding the need to require crash-resistant recorder systems on new and existing aircraft that are not already

[12] More information about this accident, NTSB case number WPR14FA195, is available from the NTSB's Aviation Accident Database web page.

[13] Caging an attitude indicator sets it to display a level flight attitude (0º pitch and 0º roll). This action is meant to be performed only when an aircraft is in a level attitude, such as on the ground or in straight-and-level, unaccelerated flight. More information about this accident, NTSB case number ANC13GA036, is available from the NTSB's Aviation Accident Database web page.

[14] More information about this accident, NTSB case number CEN15MA290, is available from the NTSB's Aviation Accident Database web page.

required to have such recorders.[15,16] The FAA has repeatedly replied that it did not intend to take the recommended actions and has been unable to find the needed quantifiable data demonstrating that the societal benefits of requiring crash-resistant recorder systems are greater than the cost.[17] As a result, the FAA has not mandated this equipment on normal- and transport-category helicopters (Part 27 and Part 29, respectively). Instead, the FAA has adopted a position of promoting and incentivizing the voluntary equipage of crash-resistant flight recording systems. The FAA has said that industry is already realizing the proliferation and benefits of crash-resistant flight recording systems without a forced mandate.

On November 17, 2014, the NTSB wrote to the FAA asking for more information about the voluntary programs being promoted. In particular, the NTSB asked that the FAA describe the incentives in these programs and provide any documentation that industry was already equipping its fleets. On May 23, 2016, the FAA provided a copy of "Helicopter Flight Data Monitoring - Industry Best Practices," an industry publication that the FAA cited as an "excellent resource for the rotorcraft community" containing additional information on FDM programs (as opposed to crash-resistant flight recorders) and describing the incentives of voluntary programs. The FAA did not describe any other programs for incentivizing voluntarily equipping aircraft with crash-resistant flight recorders. The FAA also said that it did not have any documentation that industry was already equipping its fleets, nor did it have a means to gather such data.

In an October 2, 2017, response to the FAA regarding Safety Recommendations A-13-12 and -13, the NTSB described that, between 2005 and 2017, we investigated 185 fatal accidents involving turbine-powered, nonexperimental, nonrestricted-category aircraft. This analysis included all fatal accidents involving aircraft addressed by Safety Recommendations A-13-12 and -13, including rotorcraft. Of these 185 investigations, 159 (86 percent) involved aircraft without any type of recording equipment installed. Thus, the NTSB concludes that FAA actions to

[15] In May 2013, the NTSB issued Safety Recommendations A-13-12 and -13, which asked the FAA to require the installation of a crash-resistant flight recorder system on all newly manufactured (A-13-12) and existing (A-13-13) turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder and a cockpit voice recorder and are operating under 14 *CFR* Parts 91, 121, or 135. The crash-resistant flight recorder system should record cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible, and parametric data per aircraft and system installation, all as specified in TSO-C197. These recommendations are currently classified "Open—Acceptable Response." The NTSB made similar recommendations to the FAA in 1999 (A-99-60), 2003 (A-03-62 through -65), and 2009 (A-09-09 through -11). These recommendations were closed in an unacceptable status because the FAA did not intend to take the recommended actions due to "significant costs and a limited ability to assess benefits."

[16] On January 22, 2015, the NTSB issued Safety Recommendations A-15-7 and -8. Safety Recommendation A-15-7, which superseded A-00-30, asked the FAA to require that all existing aircraft operated under Part 121 or 135 and currently required to have a CVR and an FDR be retrofitted with a crash-protected cockpit image recording system compliant with TSO-C176a or equivalent. The cockpit image recorder should be equipped with an independent power source consistent with that required for CVRs in 14 *CFR* 25.1457. Safety Recommendation A-15-8, which superseded A-00-31, asked the FAA to require the same equipment as recommended in A-15-7 for all newly manufactured aircraft operated under Part 121 or 135 and required to have a CVR or an FDR. These recommendations are classified "Open—Unacceptable Response" because rather than take the recommended actions, the FAA stated it would consider an alternative (requiring a system that records display and switch information after a planned amendment to Annex 6 to the Convention on International Civil Aviation becomes effective in 2023) that did not satisfy the recommendations' intent.

[17] The Office of Management and Budget reviews all proposed federal regulations and must concur with an agency's regulatory evaluation demonstrating that the societal benefits of a proposed regulation are greater than the costs of complying with the proposed regulation before it is allowed to be implemented.

encourage voluntary installation of recorders on rotorcraft and other turbine-powered, nonexperimental, nonrestricted-category aircraft have not been effective.

The NTSB is concerned that the persistent lack of a requirement for TSO-compliant crash-resistant recorders and the FAA's ineffective actions to encourage voluntary compliance for such equipage continue to hinder fully developed analyses of causal and contributing factors in investigations of accidents and incidents involving helicopters not equipped with a crash-resistant recorder system. Further, the accidents that we have investigated in which the helicopter had a recorder on board have allowed us to identify critical safety issues.

The NTSB concludes that the routine installation of crash-resistant flight recorder systems on newly manufactured and existing helicopters is necessary to identify and mitigate risks to public safety. The NTSB also concludes that the routine installation of crash-protected cockpit image recorders on newly manufactured and existing helicopters is necessary to identify and understand flight crew actions within the cockpit. The NTSB further concludes that, given the FAA's inability for more than 20 years to require the installation of TSO-compliant recorders and its sole reliance on voluntary programs proven to be ineffective to encourage such installation, manufacturers should voluntarily install this equipment.

Therefore, the NTSB recommends that Airbus Helicopters, Bell, Leonardo, MD Helicopters, and Robinson install, on their newly manufactured turbine-powered helicopters that are not equipped with an FDR and a CVR, a crash-resistant flight recorder system that records cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible and parametric data per aircraft and system installation, all as specified in TSO-C197.[18] The recorder system installation should be considered essential equipment that remains installed for the life of the helicopter and have provisions to ensure it remains operational during each flight.

The NTSB also recommends that Airbus Helicopters, Bell, Leonardo, and Sikorsky install, on their newly manufactured turbine-powered helicopters that are equipped with an FDR and a CVR, a crash-protected cockpit image recorder system compliant with TSO-C176a, or equivalent. The cockpit image recorder should be equipped with an independent power source consistent with that required for CVRs in 14 *CFR* 29.1457.[19] The recorder system installation should be considered essential equipment that remains installed for the life of the helicopter and have provisions to ensure it remains operational during each flight.

The NTSB further recommends that Airbus Helicopters, Bell, Leonardo, MD Helicopters, Robinson, and Sikorsky provide, on their existing turbine-powered helicopters that are not

[18] Newly manufactured turbine-powered helicopters that are not equipped with an FDR and a CVR (or a combination thereof) as standard equipment at manufacture include, but are not limited to, Airbus Helicopters AS350 (H125) series, EC130 series, EC135 series, BK117 (EC145) series, and EC155 series helicopters; Bell 407 series, 412 series, 429, and 505 helicopters; Leonardo AW109 series and AW119 series helicopters; MD Helicopters 369 (500) series, 600N, and 900 series helicopters; and the Robinson R66 helicopter.

[19] Newly manufactured turbine-powered helicopters that are equipped with an FDR and CVR (or a combination thereof) as standard equipment at manufacture include, but are not limited to, Airbus Helicopters EC175 (H175) series and EC225 series helicopters; Leonardo AW139, AW169, and AW189 helicopters; and Sikorsky S-76 series and S-92 series helicopters. When the Bell 525 helicopter and Leonardo AW609 tiltrotor receive type certification, they are expected to be equipped with an FDR and CVR as standard equipment at manufacture.

equipped with an FDR or a CVR, a means to install a crash-resistant flight recorder system that records cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible and parametric data per aircraft and system installation, all as specified in TSO-C197. The recorder system installation should be considered essential equipment that remains installed for the life of the helicopter and have provisions to ensure it remains operational during each flight.

Finally, the NTSB recommends that Airbus Helicopters, Bell, Leonardo, and Sikorsky provide, on their existing turbine-powered helicopters that are equipped with an FDR and a CVR, a means to install a crash-protected cockpit image recorder system that is compliant with TSO-C176a, or equivalent. The cockpit image recorder system should be equipped with an independent power source consistent with that required for CVRs in 14 *CFR* 29.1457. The recorder system installation should be considered essential equipment that remains installed for the life of the helicopter and have provisions to ensure it remains operational during each flight.

Recommendations

To Airbus Helicopters, Bell, Leonardo Helicopter Division, MD Helicopters, and Robinson Helicopter Company[20]

Install, on your newly manufactured turbine-powered helicopters that are not equipped with a flight data recorder and a cockpit voice recorder, a crash-resistant flight recorder system that records cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible and parametric data per aircraft and system installation, all as specified in Technical Standard Order C197, "Information Collection and Monitoring Systems." The recorder system installation should be considered essential equipment that remains installed for the life of the helicopter and have provisions to ensure it remains operational during each flight. (A-20-27)

To Airbus Helicopters, Bell, Leonardo Helicopter Division, and Sikorsky

Install, on your newly manufactured turbine-powered helicopters that are equipped with a flight data recorder and a cockpit voice recorder, a crash-protected cockpit image recorder system compliant with Technical Standard Order C176a, "Cockpit Image Recorder Equipment," or equivalent. The cockpit image recorder should be equipped with an independent power source consistent with that required for cockpit voice recorders in Title 14 *Code of Federal Regulations* 29.1457. The recorder system installation should be considered essential equipment that remains installed for the life of the helicopter and have provisions to ensure it remains operational during each flight. (A-20-28)

[20] Sikorsky is not a recipient of Safety Recommendation A-20-27 because its new manufacture product line, including S-76 and S-92 transport-category helicopters, is equipped with an FDR and a CVR; Sikorsky sold its light helicopter product line to Schweizer RSG in January 2018.

To Airbus Helicopters, Bell, Leonardo Helicopter Division, MD Helicopters, Robinson Helicopter Company, and Sikorsky

Provide, on your existing turbine-powered helicopters that are not equipped with a flight data recorder or a cockpit voice recorder, a means to install a crash-resistant flight recorder system that records cockpit audio and images with a view of the cockpit environment to include as much of the outside view as possible and parametric data per aircraft and system installation, all as specified in Technical Standard Order C197, "Information Collection and Monitoring Systems." The recorder system installation should be considered essential equipment that remains installed for the life of the helicopter and have provisions to ensure it remains operational during each flight. (A-20-29)

To Airbus Helicopters, Bell, Leonardo Helicopter Division, and Sikorsky

Provide, on your existing turbine-powered helicopters that are equipped with a flight data recorder and a cockpit voice recorder, a means to install a crash-protected cockpit image recorder system that is compliant with Technical Standard Order C176a, "Cockpit Image Recorder Equipment," or equivalent. The cockpit image recorder system should be equipped with an independent power source consistent with that required for cockpit voice recorders in Title 14 *Code of Federal Regulations* 29.1457. The recorder system installation should be considered essential equipment that remains installed for the life of the helicopter and have provisions to ensure it remains operational during each flight. (A-20-30)

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Report Date: May 19, 2020

Appendix

NTSB Case Number	Accident Date	Location	Helicopter Make/Model	Effects on Understanding the Accident Circumstances
CEN12FA001	10/01/2011	Philip, South Dakota	Robinson R66	Due to a lack of a crash-resistant flight recorder system, the investigation could not determine why the mast-bumping event initiated, leading to the in-flight separation of the main rotor mast.
WPR15FA072	12/31/2014	Benson, Arizona	Bell 206 L-4	Due to a lack of a crash-resistant flight recorder system, the investigation could not determine the circumstances the pilot was presented with as he encountered progressively degrading visual meteorological conditions or his actions as he continued flight into instrument meteorological conditions (IMC).
CEN16FA372	09/17/2016	Alexandria, Minnesota	Leonardo A109S	Due to a lack of a crash-resistant flight recorder system, the investigation could not confirm the uncommanded sharp left bank reported by the accident pilot, which led him to input excessive cyclic inputs during a missed approach maneuver in night IMC. Examination of the helicopter and its flight control system found no evidence of malfunctions or anomalies that would have precluded normal operation.
CEN17FA127	03/14/2017	Chalmers, Indiana	MD Helicopters 369FF	Due to a lack of a crash-resistant flight recorder system, the investigation could not determine the pilot's actions, as well as any distractions to the pilot, leading up to the helicopter's external load becoming caught on a power transmission tower during a wire-pulling operation.
ERA17FA190	05/25/2017	New Castle, Delaware	Airbus EC 135 P2	Due to a lack of a crash-resistant flight recorder system, the investigation could not determine the pilot's actions leading up to a missed approach while conducting practice instrument approaches into the airport in IMC. Additionally, the investigation could not determine his actions in executing procedures for the missed approach, which ultimately led to a loss of control.