NATIONAL TRANSPORTATION SAFETY BOARD
Public Meeting of March 28, 2017
(Information subject to editing)

Loss of Control at Takeoff, Air Methods Corporation, Airbus Helicopters AS350 B3e, N390LG Frisco, Colorado
July 3, 2015
NTSB/AAR-17/01

This is a synopsis from the NTSB's report and does not include the Board's rationale for the conclusions, probable cause, and safety recommendations. NTSB staff is currently making final revisions to the report from which the attached conclusions and safety recommendations have been extracted. The final report and pertinent safety recommendation letters will be distributed to recommendation recipients as soon as possible. The attached information is subject to further review and editing to reflect changes adopted during the Board meeting.

Executive Summary

On July 3, 2015, about 1339 mountain daylight time, an Airbus Helicopters AS350 B3e helicopter, N390LG, registered to and operated by Air Methods Corporation, lifted off from the Summit Medical Center Heliport, Frisco, Colorado, and then crashed into a parking lot; the impact point was located 360 feet southwest of the ground-based helipad. The pilot was fatally injured, and the two flight nurses were seriously injured. The helicopter was destroyed by impact forces and a postcrash fire. The flight was conducted under the provisions of 14 *Code of Federal Regulations* Part 135 on a company flight plan. Visual meteorological conditions prevailed at the time of the accident.

The AS350 B3e has a dual hydraulic system. The upper and lower hydraulic systems provide hydraulic assistance to the main rotor flight controls. This dual-hydraulic setup provides redundancy to the main rotor servo controls in case one of the hydraulic systems were to fail. The lower hydraulic system provides hydraulic assistance to the tail rotor flight controls. Because the tail rotor system has only a single-cylinder servo control, a yaw load compensator provides continuous hydraulic power assistance to the pedal controls in the event of a loss of pressure to the lower hydraulic system.

Operational procedures for the AS350 B3e required the pilot to perform a preflight hydraulic check to ensure that the yaw load compensator was functional. The steps of the check involved (1) moving the yaw servo hydraulic switch to the "OFF" position (which cuts off hydraulic pressure to the tail rotor hydraulic circuit) and then ensuring that pedal forces remained low; (2) depressing a test button on the cockpit center console, thereby releasing (depleting) the hydraulic pressure in the yaw load compensator accumulator by opening its solenoid valve, and then ensuring that loads were felt on the pedals; (3) resetting the test button, thereby closing the solenoid valve; and (4) restoring hydraulic pressure by moving the yaw servo hydraulic switch to the "ON" position.

The National Transportation Safety Board's (NTSB) investigation determined that the pilot most likely did not return the yaw servo hydraulic switch to its "ON" position before takeoff, resulting in no hydraulic pressure in both the tail rotor servo control and the yaw load compensator accumulator, a lack of hydraulic boost to the pedals, and significantly increased pedal loads. Surveillance videos capturing the liftoff showed the helicopter yaw to the left and rotate counterclockwise several times before descending and impacting a recreational vehicle and the parking lot. Video evidence also showed that the pilot did not perform a hover check, as required by operational procedures, which could have allowed the pilot to verify the helicopter's controllability.

A surveillance video capturing the helicopter's descent and ground impact showed fuel flowing from the wreckage just after impact and then the onset of a postcrash fire. The postcrash fire consumed or severely damaged most of the helicopter and resulted in extensive thermal injuries to the pilot and one of the flight nurses. Although the helicopter was manufactured in March 2013, it was not subject to the improved crashworthiness requirements regarding crash-resistant fuel systems that became effective in November 1994. The helicopter was not subject to these requirements because it was certificated according to the regulations that were in effect in December 1977, when the Federal Aviation Administration (FAA) provided initial type certificate design approval for AS350-series helicopters. In addition, although the helicopter was not required to be equipped with a flight recorder system, Air Methods voluntarily equipped the helicopter with an onboard image recorder. However, this recorder did not comply with the crash-resistance provisions of an FAA technical standard order addressing the minimum performance standards for lightweight flight recorder systems, and the NTSB was unable to recover data from the recorder due to impact and postcrash fire damage.

The NTSB identified the following safety issues as a result of this accident investigation:

- **Lack of a cockpit alert to pilots to indicate the loss of hydraulic boost to the pedal controls for AS350-series helicopters with a dual hydraulic system.** In February 2015, Airbus Helicopters issued a service bulletin for AS350-series helicopters to incorporate a light on the caution and warning panel that would flash if the yaw servo hydraulic switch were in the "OFF" position. The modification had not yet been incorporated in the accident helicopter. As a result, the pilot would not have seen any abnormal indications on the caution and warning panel before and during takeoff and during the left yaw rotation. In addition, although the caution light modification provides a pilot with a visual indication of the yaw servo hydraulic switch position, the modification does not alert the pilot to reduced or no hydraulic pressure to the tail rotor hydraulic circuit.

- **Need for changes to the tail rotor flight controls of AS350-series helicopters with a dual hydraulic system to ensure pedal control hydraulic assistance and mitigate the possibility of pilot error during hydraulic system checks**. The design of the tail rotor hydraulic circuit of AS350-series helicopters does not ensure continuous pedal control hydraulic assistance and mitigate the possibility of pilot error during hydraulic systems checks. For example, a pilot checks the functionality of the yaw load compensator after a flight is completed, and this functional assessment depends on the

pilot's ability to reliably discriminate among pedal forces to determine whether the yaw load compensator accumulator is pressurized. A solution to achieve these safety benefits could be to use the design philosophy of the main rotor flight control system (which includes dual-cylinder main rotor servo controls) and incorporate a dual-cylinder tail rotor servo control in the tail rotor hydraulic circuit. A dual-cylinder tail rotor servo control would consistently provide hydraulic assistance redundancy and would mitigate the possibility of pilot error during any hydraulic system check because the yaw load compensator and its associated check would no longer be necessary. Solutions other than a dual-cylinder tail rotor servo control might also achieve these safety benefits.

- **Lack of readily available information for helicopter operators and customers regarding safety equipment and systems that would enhance a helicopter's crashworthiness**. As previously stated, the FAA improved crashworthiness standards by issuing new fuel system crashworthiness requirements for helicopters certificated after November 1994. In addition, the FAA issued new occupant safety requirements for emergency landing conditions for helicopters certificated after December 1989. These new standards were not retroactive and thus did not apply to existing and newly manufactured helicopters with type certificates that were approved before the effective dates of the regulations. The distinction between a helicopter's type certificate date and manufacture date relative to the improved crashworthiness requirements might not be clear to helicopter operators and customers; as a result, they might not be making fully informed purchasing and leasing decisions regarding a helicopter's crashworthiness. Guidelines identifying the equipment and systems that would meet the latest helicopter crashworthiness standards could result in an increased awareness about the availability of crash-resistant fuel systems and energy-absorbing seats and the lack of these safety features in many existing and newly manufactured helicopters.

- **Need for crash-resistant fuel systems for helicopters not covered by the November 1994 fuel system crashworthiness requirements**. Because the fuel systems on newly manufactured helicopters with type certificates approved before November 1994 were not subject to the fuel system crash resistance regulations, they might pose a fire hazard to occupants if the systems were breached during a crash that was otherwise survivable. In July 2015, the NTSB issued Safety Recommendation A-15-12 to the FAA to require, for all newly manufactured rotorcraft regardless of the design's original certification date, that the fuel systems meet the crashworthiness requirements of the regulations. The FAA responded that it started the rulemaking process by sending a tasking statement to the Aviation Rulemaking Advisory Committee's Rotorcraft Occupant Protection Working Group. The NTSB continues to monitor the FAA's progress in implementing the recommended action.

- **Lack of requirements to install, on smaller aircraft, flight recorder systems that protect recorded data from crash impact damage and postcrash fire damage**. The NTSB issued a series of recommendations to the FAA between 1999 and 2013 regarding the need for crash-resistant flight recorder systems on new and existing aircraft that were not already required to have such recorders. The FAA stated that rulemaking to mandate recorders on such aircraft was not a viable option because of significant costs and the limited ability to assess benefits. As a result, the FAA began promoting the voluntary equipage of onboard image recorders for these aircraft. Most smaller aircraft involved in the NTSB's investigations do not have a crash-resistant flight recorder. Although the NTSB has investigated accidents in which aircraft were voluntarily equipped with image recorders, the data were not recovered during some of these investigations because the recorders did not comply with the FAA's related technical standard order, which addresses crash resistance to protect recorded data from impact and postcrash fire damage. These situations have affected the NTSB's ability to fully identify the safety issues involved in accidents and the actions to prevent the accidents from recurring.

Findings

1. The helicopter was properly certificated, equipped, and maintained in accordance with federal regulations. None of the available evidence indicated any preimpact structural, engine, or system failures.

2. The pilot was properly certificated and qualified in accordance with federal regulations. Pilot fatigue and the pilot's medical conditions and prescribed medications were not factors in this accident.

3. The wind conditions at the time of the accident would not have prevented the pilot from maintaining yaw control of the helicopter.

4. The pilot most likely did not return the yaw servo hydraulic switch to its correct ("ON") position before takeoff, resulting in a lack of hydraulic pressure to the tail rotor servo control and the yaw load compensator accumulator.

5. A lack of hydraulic boost to the pedals, resulting in significantly increased pedal loads, was the most likely cause of the loss of tail rotor control, which led to the left yaw that occurred simultaneously with takeoff.

6. A salient alert for insufficient hydraulic pressure in the tail rotor hydraulic circuit could have cued the pilot to the incorrect configuration of the tail rotor hydraulic circuit, the lack of hydraulic boost to the pedal controls, and the resulting increased pedal loads.

7. Although not required to do so, Air Methods did not aggressively take action to comply with Airbus Helicopters' Service Bulletin No. AS350-67.00.64, which called for installing a flashing light on the cockpit caution and warning panel to alert pilots that the yaw servo hydraulic switch was in the incorrect position. If this nonmandatory service bulletin had been complied with, the pilot might have noticed that the switch was not in the correct ("ON") position before takeoff.

8. The design of Airbus Helicopters dual-hydraulic AS350-series helicopters did not account for the possibility of pilot error in configuring the tail rotor hydraulic circuit or assessing the functionality of the yaw load compensator, and efforts to address these safety issues have thus far been insufficient.

9. Despite the significantly increased pedal loads, the pilot continued the takeoff to climb the helicopter above nearby obstacles and gain forward airspeed to counter the left yaw rotation, but his efforts were unsuccessful.

10. If the pilot had performed a hover check, he would have identified the pedal control anomaly at an altitude that could have afforded a safe landing on the helipad.

11. The flight nurse in the left aft seat had likely been restrained in his seat and was likely ejected from the helicopter with his seat during the accident sequence.

12. The impact forces of this accident were survivable for the helicopter occupants.

13. If the helicopter had been equipped with a crash-resistant fuel system, the potential for thermal injuries to the occupants would have been reduced or eliminated.

14. Those who purchase, lease, and contract for helicopter services and those who operate or fly aboard helicopters as part of their job are likely unaware that the designs of most existing and newly manufactured helicopters do not include the improved crashworthiness standards required of newly certificated helicopters, which could compromise occupant protection if an accident were to occur.

15. Data to better understand the safety issues involved in this accident could likely have been recovered from a flight recorder system that complied with the provisions of Federal Aviation Administration Technical Standard Order C197, "Information Collection and Monitoring Systems."

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of this accident was Airbus Helicopters' dual hydraulic AS350 B3e helicopter's (1) preflight hydraulic check, which depleted hydraulic pressure in the tail rotor hydraulic circuit, and (2) lack of salient alerting to the pilot that hydraulic pressure was not restored before takeoff. Such alerting might

have cued the pilot to his failure to reset the yaw servo hydraulic switch to its correct position during the preflight hydraulic check, which resulted in a lack of hydraulic boost to the pedal controls, high pedal forces, and a subsequent loss of control after takeoff. Contributing to the accident was the pilot's failure to perform a hover check after liftoff, which would have alerted him to the pedal control anomaly at an altitude that could have allowed him to safely land the helicopter. Contributing to the severity of the injuries was the helicopter's fuel system, which was not crash resistant and facilitated a fuel-fed postcrash fire.

RECOMMENDATIONS

New Recommendations

As a result of this investigation, the National Transportation Safety Board makes the following new safety recommendations:

To the Federal Aviation Administration:

1. Require that existing Airbus Helicopters dual-hydraulic AS350-series helicopters be equipped with a visual and an aural alert for the loss of hydraulic boost to the pedal controls, which would result in increased pedal loads.

To Airbus Helicopters:

2. For newly manufactured dual-hydraulic AS350-series helicopters, assess and implement changes to the dual hydraulic system that would both ensure pedal control hydraulic assistance and mitigate the possibility of pilot error during any check of the hydraulic system.

3. For existing dual-hydraulic AS350-series helicopters, assess and implement changes to the dual hydraulic system that would both ensure pedal control hydraulic assistance and mitigate the possibility of pilot error during any check of the hydraulic system.

To the Federal Aviation Administration and the European Aviation Safety Agency:

4. After the actions requested in Safety Recommendation [3] are completed, require operators of Airbus Helicopters dual-hydraulic AS350-series helicopters to incorporate changes to the dual hydraulic system to both ensure pedal control hydraulic assistance and mitigate the possibility of pilot error during any check of the hydraulic system.

To the Association of Critical Care Transport:

5. In collaboration with the Association of Air Medical Services and the Air Medical Operators Association, establish a working group to develop and distribute guidelines, for those who purchase, lease, and contract for helicopters, regarding the equipment and systems that would enhance the helicopters' crashworthiness, including, at a minimum, a crash-resistant fuel system and energy-absorbing seats.

To the Association of Air Medical Services and the Air Medical Operators Association:

6. Work with the Association of Critical Care Transport to establish a working group to develop and distribute guidelines, for those who purchase, lease, and contract for helicopters, regarding the equipment and systems that would enhance the helicopters' crashworthiness, including, at a minimum, a crash-resistant fuel system and energy-absorbing seats.

Previously Issued Recommendations

As a result of this accident investigation, the National Transportation Safety Board previously issued the following recommendations:

To the Federal Aviation Administration:

Once Airbus Helicopters completes development of a retrofit kit to incorporate a crash-resistant fuel system into AS350 B3e and similarly designed variants, prioritize its approval to accelerate its availability to operators. (A-16-8) (Open—Acceptable Response)

Issue a special airworthiness information bulletin (SAIB) informing all owners and operators of AS350 B3e and similarly designed variants of the availability of a crash-resistant fuel system retrofit kit and urging that it be installed as soon as practicable. To encourage helicopter owners and operators to retrofit existing helicopters with a crash-resistant fuel system, the SAIB should also discuss the helicopter accidents cited in this report. (A-16-9) (Open—Acceptable Response)

Issue a special airworthiness information bulletin that is periodically updated to inform all helicopter owners and operators about available modifications to improve fuel system crashworthiness and urge that they be installed as soon as practicable. To encourage helicopter owners and operators to retrofit existing helicopters with a crash-resistant fuel system, the SAIB should also discuss the helicopter accidents cited in this report. (A-16-10) (Open—Acceptable Response)

To the European Aviation Safety Agency:

Once Airbus Helicopters completes development of a retrofit kit to incorporate a crash-resistant fuel system into AS350 B3e and similarly designed variants, prioritize its approval to accelerate its availability to operators. (A-16-11) (Open—Acceptable Response)

Previously Issued Recommendations Reiterated in This Report

The National Transportation Safety Board reiterates the following recommendations to the Federal Aviation Administration:

Require the installation of a crash-resistant flight recorder system on all newly manufactured 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 *Code of Federal Regulations* 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 Technical Standard Order C197, 'Information Collection and Monitoring Systems.' (A-13-12)

Require all existing turbine-powered, nonexperimental, nonrestricted-category aircraft that are not equipped with a flight data recorder or cockpit voice recorder and are operating under 14 *Code of Federal Regulations* Parts 91, 121, or 135 to be retrofitted with a crash-resistant flight recorder system. 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 Technical Standard Order C197, 'Information Collection and Monitoring Systems.' (A-13-13)