National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: May 3, 2011

In reply refer to: A-11-35 and -36

The Honorable J. Randolph Babbitt
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On July 7, 2007, about 1651 eastern daylight time, a Eurocopter EC-130-B4 helicopter, N453AE, operated by Liberty Helicopters, Inc., experienced an in-flight separation of a section of one of the main rotor blades during flight and sustained substantial damage during an emergency descent and subsequent autorotation into the Hudson River, New York, New York.[1] The commercial pilot and seven passengers were uninjured. No flight plan was filed with the Federal Aviation Administration (FAA) for the 14 *Code of Federal Regulations* Part 135 and 136 sightseeing flight, nor was one required.[2] Visual meteorological conditions prevailed at the time of the accident.

The National Transportation Safety Board (NTSB) determined that the probable cause of this accident was the fatigue fracture and in-flight separation of a section of the composite main rotor blade trailing edge aft of the spar, due to inadequate manufacture, and the manufacturer's failure to detect an out-of-specification deviation in the rotor blade's trailing-edge roving.[3]

The main rotor blades on certain Eurocopter helicopters[4] are manufactured from glass fiber-reinforced composite material skin and skin reinforcement layers that overlap a spar, foam core, trailing-edge roving, and trailing-edge tab (see figure). The trailing-edge roving is comprised of unidirectional fibers aligned parallel to each other in a spanwise direction. A transition area (of about 2 inches long) exists at the trailing edge of the blade between blade station (BS) 1265 and BS 1315 where the trailing-edge roving narrows toward the trailing-edge tab.

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[1] More information regarding this accident, National Transportation Safety Board case number MIA07FA116, is available online at <http://www.ntsb.gov/aviationquery/index.aspx>.

[2] A visual flight rules flight plan was filed with Liberty Helicopters.

[3] A roving is a collection of fibers in a parallel bundle with little or no twist.

[4] Eurocopter helicopter models (and their variants) AS-350, AS-550, AS-355, AS-555, EC-130, and SA-342 are equipped with main rotor blade part numbers (P/N) 355A11-0020 or 355A11-0030. (The AS-350-B3, AS-355-NP, EC-130, and AS-550-C3 are equipped with only main rotor blade P/N 355A11-0030.)

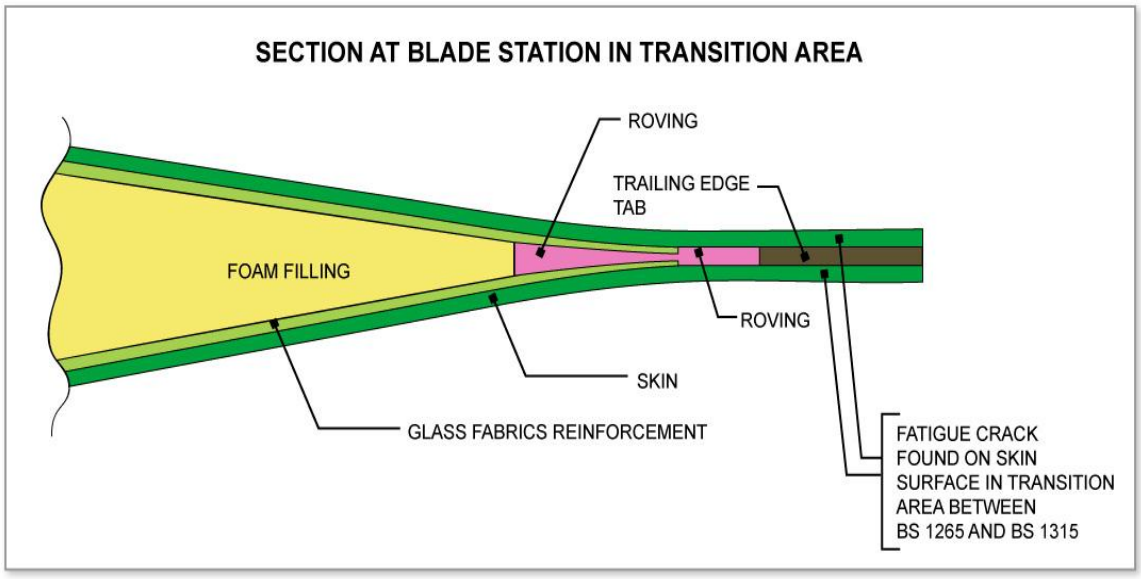

Figure. Trailing edge of blade.

The NTSB determined that the main rotor blade part number (P/N) 355A11-0030, serial number (S/N) 22312,[5] of the accident helicopter fractured due to fatigue cracks in the trailing-edge skin that initiated within the transition area due to the misalignment of the unidirectional fibers in the trailing-edge roving.[6] The NTSB's materials laboratory examined fragments of the trailing-edge roving and found that the fibers of the roving fractured at a stress lower than what would typically cause them to fracture. Thus, the strength of the roving was less than what was expected. Eurocopter also found that the trailing-edge skin adjacent to the misaligned trailing-edge roving fibers in the transition area showed evidence of fatigue cracking, and the trailing-edge roving showed evidence of a compression fracture. Further, erosion was found locally along the crack, indicating that the crack traversed through the trailing-edge skin and was visible on the outside of the blade.

The NTSB notes that the misalignment of the trailing-edge roving fibers[7] occurred during manufacturing, when the fibers likely shifted during the curing process. Because the unidirectional fibers of the roving were not properly aligned (were not parallel) in the spanwise direction of the blade, a localized stiffness change occurred at the trailing edge. The misalignment of the fibers reduced the local load-carrying capacity of the roving, and the loads were transferred to the skin,

[5] The total time on the S/N 22312 blade was about 8,077 hours. None of the main rotor blades on the accident helicopter had been replaced.

[6] Following the accident, Eurocopter examined all three blades on the accident helicopter and found that only the blade that fractured exhibited misalignment of the trailing-edge roving fibers.

[7] A review of Eurocopter's manufacturing records showed that, after a postcuring visual inspection, the S/N 22312 blade was sent for radiographic inspection of the transition area of the trailing edge. No misalignment of the trailing-edge roving fibers was detected.

which started cracking. According to a stress calculation conducted by Eurocopter, the skin is more susceptible to cracks than the trailing-edge roving and will start to fracture before the roving. The blades on the accident helicopter had not previously had any cracking issues.

Eurocopter's EC-130 aircraft maintenance manual (AMM) specifies visual inspection of the main rotor blades as part of the daily flight-related check for "security, general coating, tabs, and polyurethane protection condition (visual check for de-bonding, scratches, crack, impact and distortions). No erosion holes on leading edge steel strip, no gaps nor impact." Similarly, Liberty Helicopters' Approved Aircraft Inspection Program (AAIP)[8] specifies visual inspections of the main rotor blades every 3 days for security and general condition of the skin, tabs, and polyurethane protection condition for debonding, scratches, cracks, impacts, and distortions. The AAIP also mentions a check for erosion holes on the leading-edge steel strip. While the daily flight-related check described in the AMM and the 3-day check detailed in the AAIP mention the leading edge, they do not specifically recommend that maintenance personnel check the trailing edge of the blades for any cracks and the trailing edge of the blades' skin surface for any surface deterioration/disfiguration. The accident helicopter's daily maintenance record indicates that a Liberty Helicopters mechanic visually inspected the blades as part of the (3-day) AAIP inspection on the morning of the accident and noted no discrepancies. The NTSB determined that the mechanic conducted the inspection according to the AAIP guidelines; however, because the 3-day AAIP inspection does not specifically mention inspecting the trailing edge of the blades for cracks, it is likely that the mechanic did not focus on the trailing edge and instead conducted a general visual inspection of the entire blade. The cracks in the transition area were most likely present during the inspection but were not detected.

Both Eurocopter and Liberty Helicopters recommend more thorough inspections of the main rotor blades at longer intervals. Eurocopter's master servicing manual (MSM) specifies a detailed inspection of the main rotor blades (as described in AMM 62-11-00, 6-1) every 110 hours for a "check of the skin and check for cracks"; this inspection specifically mentions and includes the trailing edge of the blade. Similarly, Liberty Helicopters' AAIP specifies a 100-hour inspection of the blades that is similar to the 110-hour inspection described in the MSM. The last 100-hour inspection of the main rotor blades was performed on June 23, 2007 (14 days before the accident) for any skin and leading-edge delaminating and cracks. At that time, the total time on the blade was 7,992.5 hours. The inspection did not reveal any discrepancies.

As a result of this accident, on November 30, 2007, Eurocopter issued Telex Information No. 00000426, "Main Rotor Blades—Check of the Skin on the Blade Trailing Edge," to all operators of specified AS, EC, and SA model helicopters equipped with main rotor blades P/N 355A11-0020 and 355A11-0030, asking the operator to pay attention to the blades' upper and lower trailing-edge surfaces during periodic inspections, as stated in the MSM. This Telex is advisory in nature.

The NTSB concludes that, although the daily flight-related check specified in the AMM and the 3-day AAIP inspection occur frequently, they do not specifically focus on the trailing edge of the blades for cracks and the blades' skin for surface deterioration/disfiguration and simply mention inspecting the "general coating" or "general condition of the skin"; therefore, the

[8] The AAIP is approved by the FAA.

inspections are likely not adequate to detect fatigue cracks in the trailing-edge area. While the 110-hour inspection detailed in the MSM and the 100-hour inspection described in Liberty Helicopters' AAIP are periodic, they do not occur often enough to ensure early detection of fatigue cracks in the blades' skin surfaces in the trailing edge before catastrophic main rotor blade failure occurs. Although no other main rotor blades have fractured due to the misalignment of the trailing-edge roving fibers, the NTSB is concerned that other helicopters may currently be operating with fiber misalignment in the roving and may develop fatigue cracks in the trailing-edge skin. If the fatigue cracks are not detected in a timely manner, they will cause the blade to fail, leading to a serious and/or fatal accident. Therefore, the NTSB recommends that the FAA require Eurocopter to revise its AMM for all helicopters equipped with P/N 355A11-0020 and/or 355A11-0030 main rotor blades to include, as part of the daily flight-related check, specific visual inspections of the trailing edge of the blades' upper and lower skin surfaces for cracks and surface deterioration/disfiguration. Further, the NTSB recommends that, once the Eurocopter AMM is revised as described in Safety Recommendation A-11-35, the FAA require operators of all Eurocopter helicopters equipped with P/N 355A11-0020 and/or 355A11-0030 main rotor blades to revise their maintenance manuals to include specific daily visual inspections of the trailing edge of the blades' upper and lower skin surfaces for cracks and surface deterioration/disfiguration.

Therefore, the National Transportation Safety Board makes the following safety recommendations to the Federal Aviation Administration:

> Require Eurocopter to revise its aircraft maintenance manual for all helicopters equipped with part number 355A11-0020 and/or 355A11-0030 main rotor blades to include, as part of the daily flight-related check, specific visual inspections of the trailing edge of the blades' upper and lower skin surfaces for cracks and surface deterioration/disfiguration. (A-11-35)

> Once the Eurocopter aircraft maintenance manual is revised as described in Safety Recommendation A-11-35, require operators of all Eurocopter helicopters equipped with part number 355A11-0020 and/or 355A11-0030 main rotor blades to revise their maintenance manuals to include specific daily visual inspections of the trailing edge of the blades' upper and lower skin surfaces for cracks and surface deterioration/disfiguration. (A-11-36)

The National Transportation Safety Board made two recommendations to the European Aviation Safety Agency.

In response to the recommendations in this letter, please refer to Safety Recommendations A-11-35 and -36. If you would like to submit your response electronically rather than in hard copy, you may send it to the following e-mail address: correspondence@ntsb.gov. If your response includes attachments that exceed 5 megabytes, please e-mail us asking for instructions on how to use our secure mailbox. To avoid confusion, please use only one method of submission (that is, do not submit both an electronic copy and a hard copy of the same response letter).

Chairman HERSMAN, Vice Chairman HART, and Members SUMWALT, ROSEKIND, and WEENER concurred in these recommendations.

[Original Signed]

By: Deborah A.P. Hersman
Chairman