# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

**Date:** June 1, 2000

**In reply refer to:** A-00-46 through -50

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On April 15, 1997, at 1737 eastern daylight time, a Eurocopter[1] MBB-BK117-B-2 (BK117) helicopter, N909CP, operated by the Colgate-Palmolive Company, experienced a loss of control and crashed into the East River during takeoff from the 60th Street Heliport in New York, New York.[2] One passenger was killed, and the helicopter was destroyed. The pilot and a second passenger received serious injuries, and the copilot received minor injuries. Visual meteorological conditions prevailed for the corporate flight, destined for White Plains, New York. The flight was operated on a visual flight rules flight plan and was conducted under 14 Code of Federal Regulations (CFR) Part 91.

During takeoff, the helicopter climbed to approximately 30 feet and produced a loud bang. The helicopter rotated nose right, descended, struck the edge of the heliport pier, and crashed into the adjacent East River. Both pilots evacuated the aircraft underwater; however, the two passengers were found free of their restraints and unconscious in the cabin when rescued by divers.

Fatigue Cracking in the BK117 Vertical Fin

The accident investigation revealed that the upper half of the helicopter's vertical fin had completely separated from the remainder of the vertical fin. The separated sections, including the tail rotor gearbox and portions of the tail rotor blades, were found approximately 50 feet from the point of initial impact of the helicopter with the pier.

[1] Eurocopter Deutschland GmbH (formerly Messerschmitt, Bölkow - Blohm [MBB] ).

[2] For more information, see NTSB Brief of Accident NYC97FA076 (enclosed).

Metallurgical examination of the wreckage established that the separation was caused by fatigue cracking in multiple components of the vertical fin structure, including the skin and spar. Fatigue cracking was discovered at five locations in the vertical fin skin beneath the lower edge of the left-hand yaw stability augmentation system (SAS) servo mount support.[3] Fatigue cracks were also discovered in the vertical fin spar, which in effect partially severed the spar immediately adjacent to the noted skin cracks. The fatigue cracking in the skin originated at rivet holes common to the yaw SAS servo mount support and grew undetected to a length of approximately 5 1/2 inches before the ultimate separation of the vertical fin. The fatigue crack propagation in the skin was concealed by the installation of the yaw SAS servo mount support (see figures 1 and 2).

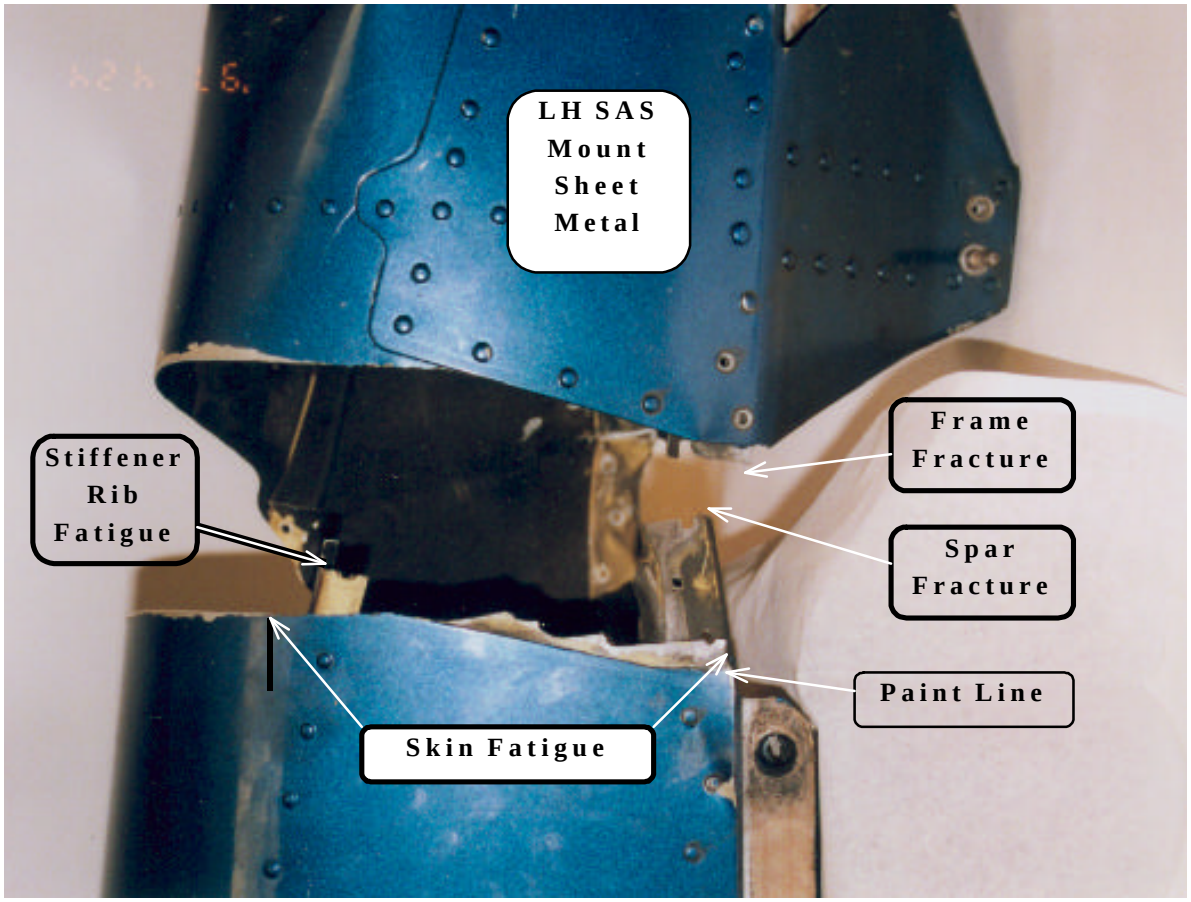


Figure 1. A left-side view of the fatigue area with the individual component fractures denoted. "Paint Line" arrow denotes the original position of the lower edge of the left-hand sheet.

[3] This structure is composed of .040-inch thick, 11- by 14-inch aluminum sheet metal plates that are fastened to both sides of the vertical fin skin midway between the intermediate gearbox and the tail rotor gearbox.

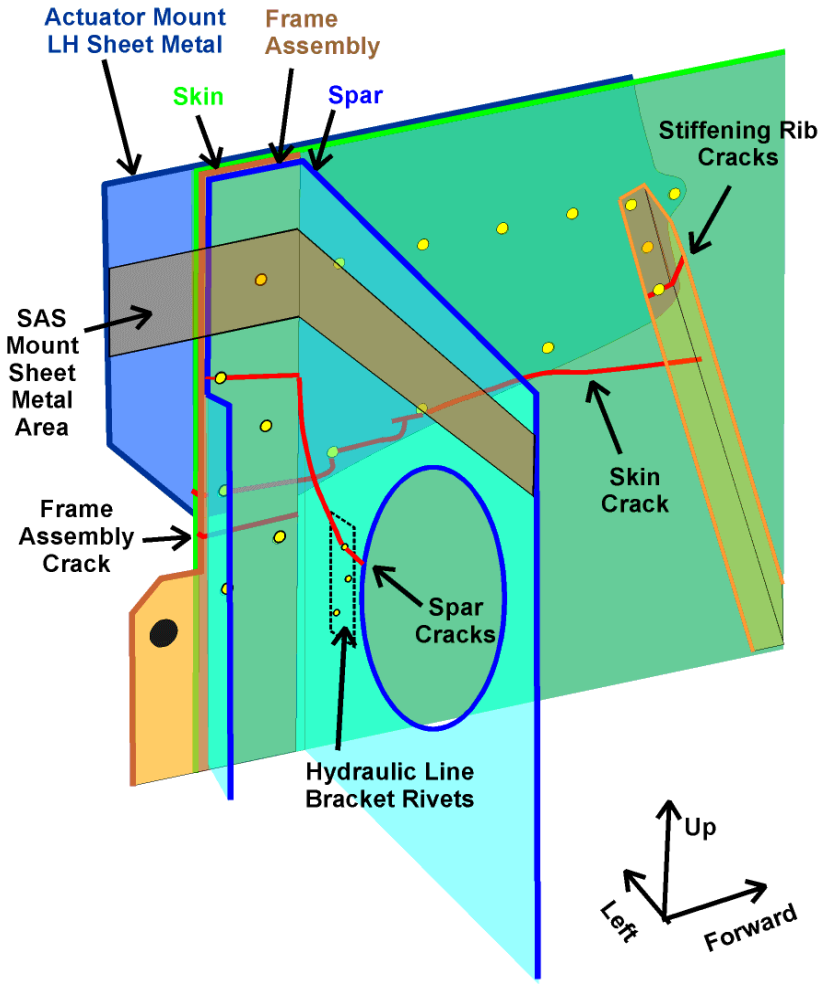


Figure 2. An illustration of the fin components in the area of the preexisting cracks. Of particular interest are the relative positions of the cracks in each member. Overlapping members are shown partially transparent to expose hidden detail. (Not to scale.)

Following this accident, Eurocopter released Alert Service Bulletin (ASB)-MBB-BK117-30-106, and the FAA issued priority letter Airworthiness Directive (AD) 97-09-16 (effective April 25, 1997) requiring immediate and repetitive visual inspections of both surfaces of the vertical fin spar on all BK117s for cracks, loose rivets, and other anomalies. The AD also instructed operators to visually inspect the skin and the left- and right-hand frames for cracks, loose rivets, or other anomalies. Revision 3 of the ASB, dated May 5, 1997, provided repair procedures applicable only for cracks found in the vertical fin spar and the left- and right-hand frames. Revision 3 of the ASB also instructed operators to modify the BK117 by reinforcing the vertical fin spar, frames, and adjacent skin within 600 flight hours and provided additional repetitive inspection criteria for the vertical fin structure.

The FAA issued AD 97-20-16 (effective October 24, 1997), which superseded AD 97-09-16, to mandate the structural repairs, modifications, and repetitive inspection

requirements recommended in ASB-MBB-BK117-30-106, Revision 3. Eurocopter then issued Revision 4 to the ASB on December 19, 1997, deleting a reference that previously allowed the use of blind rivets during the repair/modification of the vertical fin spar. With the issuance of AD 98-24-13 (effective December 4, 1998), which superseded AD 97-20-16, the FAA changed its reference from Revision 3 to Revision 4 of the ASB, thereby prohibiting the use of blind rivets during the repair/modification of the vertical fin spar.

Inspections of BK117s resulting from the FAA (and foreign) ADs revealed that at least four other helicopters worldwide had developed fatigue cracks in the vertical fin spar. In addition, Eurocopter reports indicate that before the Colgate-Palmolive accident, seven helicopters had developed fatigue cracking at various cross-sections of the vertical fin spar. However, several of the fatigue cracks were found in areas not specifically addressed by the inspection requirements of AD 98-24-13. Therefore, the Safety Board remains concerned that there may be additional incidents of fatigue cracking of BK117 vertical fins. Further, on the basis of its design review of the BK117 vertical fin, the Safety Board is also concerned that normal visual inspection techniques, for example, via spar lightening holes, may not be adequate to detect cracking damage in the underlying areas of the spar or leading-edge skin. Therefore, the Safety Board believes that the FAA should perform a fatigue evaluation/damage tolerance analysis of the Eurocopter BK117 vertical fin structure to ensure that the inspection requirements of AD 98-24-13 are adequate to detect crack growth in the underlying areas of the modified spar and leading-edge skin and to verify that the BK117 vertical fin spar is not susceptible to fatigue failure beyond those areas specifically identified by AD 98-24-13. If the susceptibility is not so limited or the inspection requirements are not adequate, the AD should be superseded to ensure that all fatigue cracks will be detected.

Manufacturer and Federal Aviation Administration Instructions on Rivet Use

An examination of the accident helicopter's maintenance history revealed that Colgate-Palmolive maintenance personnel had replaced the left-hand yaw SAS servo mount support in December 1992 because it was cracked. The BK117 design drawings specify that LN9198 solid rivets[4] must be used when installing the mount support to the vertical fin skin; however, CherryMax blind rivets,[5] part number CR3243-4, had been installed instead.[6] The Safety Board's investigation determined that the BK117 maintenance manual does not contain any repair instructions regarding the substitution of blind for solid rivets. Instead, it refers the operator to

[4] Solid rivets are one-piece rivets on which the shank is upset, that is, formed, into a head used to join sheet metal components. This is usually accomplished by placing a heavy steel "bucking bar" against the rivet shank while impacting the manufactured head to "buck" the rivet. Both sides of the joint must be accessible to install solid rivets.

[5] Although many variations of blind rivets exist, nearly all blind rivets rely upon the principle of drawing a stem through a sleeve to accomplish the forming of a bucked head. Blind rivets are typically used to connect sheet metal structure where only one side of the structure is accessible or where limited space will not permit the use of a bucking bar.

[6] The mechanic who replaced the yaw SAS servo mount support reported that he had used blind rivets instead of solid rivets because he believed there was a lack of working space within the vertical fin for bucking solid rivets.

FAA Advisory Circular (AC) 43.13-1A,[7] "Acceptable Methods, Techniques, and Practices—Aircraft Inspection and Repair," which indicates that blind rivets may be used in blind locations in accordance with certain conditions listed in Chapter 5 of the AC. Chapter 5 states in part:

> …the mechanically locked stem NAS [National Airspace Standard] 1398, 1399, 1738, and 1739 rivets may be substituted for solid rivets in accordance with the blind rivet or aircraft manufacturer's recommendations. They should not be used where the looseness or failure of a few rivets will impair the airworthiness of the aircraft.

The Safety Board notes that although the CherryMax CR3243 blind rivet is generally accepted as a replacement for the NAS 1738B blind rivet, no FAA guidance confirms the interchangeability of these rivets. AC 43.13-1B, issued September 8, 1998, to supersede -1A, contains similar information regarding the use of blind rivets. However, neither version of the AC provides any information regarding the joint fatigue life of materials when joined with blind rivets. Postaccident testing conducted by Textron Aerospace Fasteners (TAF) and earlier testing conducted by Eurocopter consistently demonstrated that the joint fatigue life of materials fastened with blind rivets is less than the joint fatigue life of the same materials fastened with solid rivets.[8] The Safety Board is concerned that other maintenance personnel may install blind rivets in applications where solid rivets are required, thereby reducing the structural fatigue life of an airframe. Therefore, the Safety Board believes that the FAA should issue a maintenance alert to all certificated airframe mechanics and inspectors to notify them of the circumstances of this accident and to inform them of the hazards associated with the installation of blind rivets.

The Safety Board notes that 14 CFR Part 43, Appendix A, Subpart (b), "Major Repairs," defines airframe repairs that are considered major and, therefore, requires that they be performed in accordance with technical data approved by the FAA. Although Appendix A states that repairs involving the substitution of material are considered major, it does not specifically address repairs involving the substitution of fastener types, such as rivets. Because the circumstances of this accident demonstrate that the substitution of fasteners can have a significant effect on airframe fatigue life, repairs involving such substitutions should be considered major. Therefore, the Safety Board believes that the FAA should revise 14 CFR Part 43, Appendix A to state that repairs involving the substitution of fastener types are considered major repairs. Further, because some manufacturers, such as Eurocopter, only refer operators to AC 43.13-1B without providing them with more detailed airframe structural repair instructions, such as those involving the substitution of fastener types, the Safety Board believes that the FAA should revise AC 43.13-1B to indicate that operators may substitute fastener types only when the application has been specifically authorized by the airframe manufacturer or a representative of the FAA.

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[7] This AC contains methods, techniques, and practices acceptable to the Administrator for the inspection and repair of civil aircraft when there are no manufacturer repair or maintenance instructions. According to the AC, it generally pertains to minor repairs; however, it may also be used as a basis for FAA approval of major repairs.

[8] TAF Test Report No. C99-279, dated March 1, 1999. Eurocopter Hausmitteilung (Memo) D/EE56-55/97, dated July 22, 1997.

Passenger Briefings

During the investigation, no passenger briefing cards were found onboard the helicopter. The chief pilot confirmed during an interview that briefing cards were not carried in the helicopter for the accident flight. Because the main cabin door on the left side of the helicopter was destroyed, it could not be determined if the passengers had attempted to open the door. There was no sign that any attempt had been made to open the emergency exit on the right side of the helicopter.

Interviews with the surviving passenger, who had been a passenger on several previous flights in the same helicopter, and with passengers on prior flights operated by Colgate-Palmolive disclosed that passenger briefings were not conducted on all flights. Many passengers revealed that they were unaware of the operational procedures for opening the main cabin door, the location and procedures for opening emergency exits, and the location and procedures for use of personal flotation equipment, although several remembered hearing passenger briefings in the past.[9]

The Safety Board notes that 14 CFR 91.107 requires that passengers be briefed on how to fasten and unfasten safety belts. Section 91.519 contains additional passenger briefing requirements for flights conducted under Part 91 but is applicable only to large and turbine-powered multiengine airplanes, not helicopters. Section 91.519 requires that passengers be briefed on the use of safety belts and shoulder harnesses; the location and means for opening passenger entry doors and emergency exits; location of survival equipment; ditching procedures and the use of flotation equipment; and the use of oxygen equipment installed on the airplane. Section 91.519 also provides that the oral briefing may be supplemented by passenger briefing cards if the pilot-in-command determines that the passengers are familiar with the contents of the briefing.

The Safety Board is concerned that there is no requirement for similar passenger briefings on large and turbine-powered multiengine helicopters; if the passengers on the accident flight had received such a briefing, both might have been able to escape and survive the accident. Therefore, the Safety Board believes that the FAA should require that passengers onboard large and turbine-powered multiengine helicopters receive passenger briefings similar to those required by 14 CFR 91.519 for passengers on large and turbine-powered multiengine airplanes.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

> Perform a fatigue evaluation/damage tolerance analysis of the Eurocopter BK117 vertical fin structure to ensure that the inspection requirements of Airworthiness Directive (AD) 98-24-13 are adequate to detect crack growth in the underlying

[9] Shortly after the accident, Colgate-Palmolive modified its passenger briefing standards and provided passenger briefings on emergency exits and flotation devices on all flights. The company has since shut down its flight operations department and no longer provides flight services.

areas of the modified spar and leading-edge skin and to verify that the BK117 vertical fin spar is not susceptible to fatigue failure beyond those areas specifically identified by AD 98-24-13. If the susceptibility is not so limited or the inspection requirements are not adequate, the AD should be superseded to ensure that all fatigue cracks will be detected. (A-00-46)

Issue a maintenance alert to all certificated airframe mechanics and inspectors to notify them of the circumstances of this accident and to inform them of the hazards associated with the installation of blind rivets. (A-00-47)

Revise 14 Code of Federal Regulations Part 43, Appendix A to state that repairs involving the substitution of fastener types are considered major repairs. (A–00-48)

Revise Advisory Circular 43.13-1B to indicate that operators may substitute fastener types only when the application has been specifically authorized by the airframe manufacturer or a representative of the Federal Aviation Administration. (A-00-49)

Require that passengers onboard large and turbine-powered multiengine helicopters receive passenger briefings similar to those required by 14 Code of Federal Regulations 91.519 for passengers on large and turbine-powered multiengine airplanes. (A-00-50)

Chairman HALL and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

*[original signed]*

By: Jim Hall
Chairman

Enclosure