National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: June 9, 2008

In reply refer to: A-08-25 through -29

The Honorable Robert A. Sturgell
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

Several recent accidents and one incident have raised National Transportation Safety Board concern regarding the safe operation of Robinson Helicopter Corporation (RHC) main rotor blades. Safety Board Materials Laboratory examination of the rotor blades from the helicopters involved in these events indicates debonding (separation) of the rotor blade skin that, in the three accidents, led to fracture of the rotor blade. In all four cases, the debonding occurred before the rotor blade's retirement life of 2,200 hours or 12 years. The Safety Board is concerned that certification testing and inspection methods currently used by manufacturers may not be adequate to ensure the durability of the rotor blade, particularly in severe environments.

On October 11, 2006, an R44 helicopter, registered as HI-803CT, had an in-flight breakup over the Dominican Republic. Pieces from one of the main rotor blades, part number (P/N) C016-2, and the tail boom were found along the flightpath of the wreckage in an area that corresponded to the earliest stage of in-flight separation. The pilot, copilot, and two passengers sustained fatal injuries. Service records indicated that the main rotor blade had accumulated 1,800.3 hours time in service (TIS). At the request of the Aircraft Accident Investigation Board of the Dominican Republic, pieces of the in-service rotor blades were examined by the Safety Board.[1] The materials examination revealed that the fracture in the main rotor blade extended through most of the adhesive bond joints.

On December 5, 2006, another RHC R44 helicopter, registered as DQ-IHE, experienced an in-flight breakup and impacted the ocean off the coast of Nandi, Fiji Islands. The pilot sustained fatal injuries. On-site inspection of the helicopter by representatives of the Civil Aviation Authority of the Fiji Islands revealed that one of the two helicopter blades remained intact but the other fractured into multiple pieces, with extensive fractures along the adhesive bond joints. The rotor blade failed at 1,083 hours TIS. The investigation is ongoing and the cause of the accident has not been determined. The Safety Board is assisting in the investigation, pursuant to Annex 13. Both the fractured blade and the intact blade were shipped to the Board's Materials Laboratory, where investigators found extensive debonding at the adhesive bond joints

[1] The Safety Board is participating in this investigation under the provisions of Annex 13 to the Convention on International Civil Aviation.

of the fractured blade. The origin of the debonding could not be determined because fracture features appeared to emanate mostly from the tip area of the blade, which was not recovered. Investigators found that major portions of the fractures at the adhesive bond joints emanated from the leading edges of the skin in isolated areas that contained adhesive fracture features. The fracture faces in the remaining portions of the adhesive bond joints showed mixed cohesive and adhesive failure fracture features with a large percentage of adhesive failure, indicating that the bond strength deteriorated after the blade was manufactured.

Investigators disassembled the tip cover from the intact main rotor blade and found corrosion and a debond between the lower skin and the spar at the bond joint at the tip of the blade and between the lower skin and the tip cap. The total chordwise length of the debond was about 0.5 inch.

Investigators found that the fracture features in the Fiji and Dominican Republic helicopter blades were similar, prompting the Safety Board to request the Civil Aviation Safety Authority of Australia and the Civil Aviation Authority of New Zealand to send rotor blades from two helicopter events those agencies were investigating.[2] The Safety Board found the debond damage in the Australia rotor blade was markedly similar to the debond damage found on the blades from the Fiji and Dominican accidents. The rotor blade from the New Zealand accident also showed bond joint fracture features consistent with a degraded bond. See the table on the next page for a summary of these events.

Helicopter Information

RHC manufactures R22 and R44 helicopters. The R22 model is a two-seat helicopter first delivered in October 1979. The R44 model, a four-seat helicopter powered by a larger reciprocating piston engine, was first delivered in February 1993. Through 2007, RHC had manufactured at least 4,225 R22 helicopters and at least 3,785 R44 helicopters. Approximately 40 percent of all RHC helicopters are registered in the United States.

RHC Main Rotor Blade Design

The diagram on page 4 shows a cross-section of the outboard portion of an RHC main rotor blade. The tip portion of the blade shown contains a spar at the leading edge, skin overlying a honeycomb core structure trailing the spar, and a tip cap between the spar and the trailing edge doubler. A portion of the leading edge of the upper and lower skin approximately 0.5 inch wide is bonded to the upper and lower surfaces of the spar on the trailing side of the spar. The pieces on the blade are mostly bonded to each other with adhesive epoxy film, which is cured at elevated temperature, and RHC has not changed the adhesive or bonding process since the blades were introduced. A tip cover is secured to the tip of the blade by two attachment screws. On the

[2] (a) On March 15, 2007, a student pilot flying an R22, registered as VH-HPI, was performing an autorotation descent as part of a flight qualification test in Mareeba Aerodrome, Australia, and reported the onset of severe vibration. The pilot initiated a power recovery and landed safely with no injury to the crew. (b) On March 4, 2006, an R22, registered as ZK-HCL, crashed along the coast of Homestead Peak, New Zealand, as a result of an in-flight breakup. The pilot and one passenger sustained fatal injuries.

R22, the length of a main rotor blade between the hub and tip is about 151 inches; on the R44, the length is about 198 inches.

<table>
<tr><th>Location/Date of Accident/Incident</th><th>Model</th><th>Blade P/N</th><th>Skin/Spar Material</th><th>Time in service</th><th>NTSB Number</th><th>Materials Lab Report No.</th></tr>
<tr><td>New Zealand
3/4/06</td><td>R22</td><td>A016-4</td><td>Stainless Steel</td><td>470</td><td>LAX07WA057</td><td>08-026</td></tr>
<tr><td colspan="7">• Blade exhibited areas of porosity in the adhesive and mixed adhesive and cohesive fracture features with a high percentage of adhesive failure, an indication that the bond strength had degraded after the blade was manufactured.
• A failure analysis prepared for the CAA of New Zealand noted that the main rotor blade did not fail as a result of bond failure and concluded that a door from the helicopter separated in flight and probably impacted the main rotor blades, damaging them extensively.</td></tr>
<tr><td>Dominican Rep.
10/11/06</td><td>R44</td><td>C016-2</td><td>Stainless Steel</td><td>1800.3</td><td>DFW07WA002</td><td>07-008</td></tr>
<tr><td colspan="7">• Fracture in the main rotor blade extended through the majority of the adhesive bond joints.
• Fracture face of skin-to-spar adhesive bond joints showed adhesive failure at the leading edges of the skin and corresponding surface of the spar; the remaining areas of the bond joints showed mixed cohesive and adhesive fracture features with a high percentage of adhesive failure, an indication that the bond strength had deteriorated after the blade was manufactured.
• Adhesive fractures propagated from the general area at the tip of the blade.</td></tr>
<tr><td>Fiji Island
12/5/06</td><td>R44</td><td>C016-2</td><td>Stainless Steel</td><td>1083</td><td>LAX07WA057</td><td>07-058</td></tr>
<tr><td colspan="7">• Extensive separations at the adhesive bond joints.
• Origin of the adhesive bond fracture undetermined because fracture features emanated mostly from the tip area of the blade, which was not recovered. However, major portions of the fractures at the adhesive bond joints emanated from the leading edges of the skin.
• The fracture features in the adhesive bond joints were markedly similar to those in the Dominican Republic event.</td></tr>
<tr><td>Australia
3/15/07</td><td>R22</td><td>A016-4</td><td>Stainless Steel</td><td>596.7</td><td>LAX07WA057</td><td>07-120</td></tr>
</table>

- Leading edge of the lower skin at the tip was peeled back about 2.5 inches.
- Peel damage extended about 17 inches inboard from the tip.
- Lower skin in the area of the skin-to-spar bond joint showed evidence of paint erosion that exposed the bondline to the environment.
- Exposed fracture face of the lower skin at the adhesive bond joint between the skin and spar showed randomly mixed adhesive and cohesive failure fracture features with several isolated areas at the leading edge of the skins showing adhesive fracture, an indication that the bond strength had degraded, causing separation of the lower skin.
- The fracture features in the adhesive bond joints were markedly similar to those in the Dominican Republic and Fiji events.

Note: The New Zealand, Fiji Island, and Australia events are being investigated under accident number LAX07WA057.

The rotor blades on both the R22 and the R44 are made of stainless steel skin with an aluminum honeycomb core and stainless steel spar.[3] The blades on the R22 are designated as P/N A016-4, and the blades on the R44 are designated as C016-2 or C016-5.

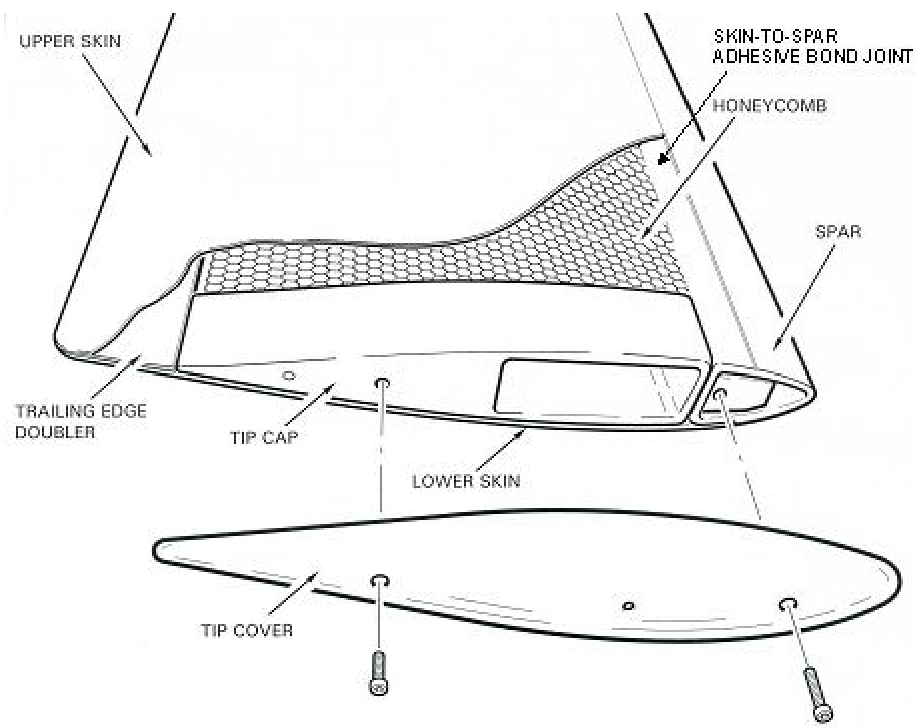

Figure. Cross-section of an RHC main rotor blade at the tip portion.

[3] The main rotor blades on the R22 were originally built with aluminum skin, which also exhibited debonding, and therefore have a part number different than the blades with stainless steel skin.

Cohesive vs. Adhesive Failure

When adhesive bond joints fail, the fracture face can exhibit three types of failure: cohesive failure, adhesive failure, or a mixture of both.

- Cohesive failure is a fracture[4] within the adhesive material; that is, adhesive material remains on both bonded substrates. A test showing this type of failure demonstrates that the failure is dominated by the strength of the adhesive material and not by the ability of the adhesive to hold to the substrates.

- Adhesive failure is a fracture at the interface between the adhesive material and substrate. This type of failure indicates that the joint will fail before the maximum strength of the adhesive material is reached.

- Mixed adhesive and cohesive failure is a fracture that occurs at a bond joint and contains many separate adhesive and cohesive failure regions. A bond joint containing randomly mixed adhesive and cohesive failures indicates that bond strength can fail well below the maximum strength of the adhesive. Mixed adhesive and cohesive failure bond strength is often quantified as the ratio of adhesive failure to cohesive failure.

RHC tests the strength of its adhesive bond joints at the time of manufacture using standardized lap and peel tests. For each lot of prepared adhesive, specimens are tested to failure and the level of stress that causes bond failure is recorded. The appearance of the adhesive bond fracture face is expressed as a percentage of cohesive and adhesive failures. A 100 percent cohesive failure indicates the strongest bond. RHC's adhesive process specification indicates that the fracture face of specimens that are tested to failure must have a minimum of 80 percent cohesive failure. If a lap or peel test specimen fails to meet the 80 percent criterion or the minimum level of strength specified in the RHC manufacturing process specification, that lot of adhesive material and the blades that were assembled from that lot are rejected and discarded.

The Safety Board determined that the fracture face of the bond joints from the fractured main rotor blade involved in the Fiji accident showed mixed cohesive and adhesive failure with a percentage of cohesive failure that was significantly less than the minimum 80 percent cohesive fracture appearance criterion permitted by RHC, indicating less than optimum bond strength.

In addition, the bond joints between the spar and skin of the fractured main rotor blade from the Fiji accident helicopter contained adhesive fracture features in many isolated areas of the leading edge of the skin, indicating a weak bond. A weak bond in this area could allow the leading edge of the skin to lift above the blade surface so that airflow during main rotor rotation could peel the skin back further. If peel damage to the skin is minor, the main rotor blade will vibrate irregularly, indicating that the helicopter must be landed immediately. However, if the degraded bond on the main rotor blade is significant when the skin begins to peel, a large portion of the skin may peel back suddenly, resulting in catastrophic fracture of the blade and complete loss of control of the helicopter.

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[4] Fracture and/or separation in adhesive bond joints is referred to in the literature and in industry as "debond" and "disbond."

The Safety Board has determined that the adhesive fractures in the main rotor blade from the Fiji accident helicopter propagated from the blade tip and leading edges and cannot rule out the possibility that the in-flight breakup was initiated by a bond failure at the tip of the blade. The indications of deteriorated bond strength uncovered in the main rotor blades highlight the need for RHC and the Federal Aviation Administration (FAA) to address durability testing and inspection of adhesive bonds in RHC helicopter blades.

Durability

The durability of a structure is its ability to maintain strength and stiffness throughout its service life and in a broad range of operational environments.[5] The Safety Board has learned that RHC does not perform long-term durability testing to determine bond joint degradation over time resulting from exposure to a broad range of operating environments, nor does the FAA require such tests for certification of the main rotor blades. A review of FAA Advisory Circular (AC)-27, "Certification of Normal Category Rotorcraft," and AC-29, "Certification of Transport Category Rotorcraft," revealed no guidance on how to perform long-term durability testing for adhesive bond joints between metal surfaces.

Appropriate long-term durability testing of the adhesive bond should simulate the most arduous environments that might be expected in order to quantify the potential extent of adhesive bond degradation over time. Arduous environments would include the hot and humid conditions typical of tropical sea and coastal operations like those in the accidents in Fiji, the Dominican Republic, and New Zealand, and the incident in Australia. Typical durability testing accounts for each adhesive material and process. Such testing should be performed on critical bond joints prior to issuance of the type or supplemental type certificate (STC), or when engineering review of a critical adhesive bond joint indicates that such testing was not required at time of manufacture. The Safety Board is concerned that the FAA does not require manufacturers to perform long-term durability tests of adhesive bond joints to ensure durability of rotor blades under arduous conditions, including exposure to warm sea and coastal operations. Therefore, the Safety Board recommends that the FAA revise AC-27, "Certification of Normal Category Rotorcraft," and AC-29, "Certification of Transport Category Rotorcraft," to include long-term durability testing of adhesive bond joints for helicopter blades to ensure safe operation throughout their design life in all environments and operating load spectrums that the blades will experience and to set service life limits accordingly.

Nondestructive Inspection of Adhesive Joints

At the time of manufacture, RHC inspects the adhesive joints of main rotor blades using the tap test method, a simple form of nondestructive inspection (NDI) to detect defects, such as porosity, debonds, and foreign inclusion. RHC does not use any other method of NDI testing on its rotor blades.

Tap testing involves tapping the surface of an adhesive joint with a coin or small hammer and listening for changes in pitch that reveal defects. RHC specifies a U.S. quarter or dollar coin

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[5] Definition of durability was found in ASM Handbook, Vol. 21, *Composites*, December 2001, ASM International, Materials Park, Ohio.

dated 1965 or later to perform its tap test. RHC indicated that many operators also use the RHC tap test to inspect their main rotor blades during maintenance. Most critical adhesive joints are located at the adhesive bond joints between the skin and spar, around the trailing edges of the blade, and on the tip portion of the blade. Noncritical adhesive joints are located between the skin and honeycomb core structure. The tap test is conducted on both critical and noncritical adhesive joints.

The Safety Board is concerned that tap testing is not adequate for detecting bond defects in critical bond joints of the main rotor blade, such as areas between the skin and spar at the tip of the blade and between the skin and tip cap. The intact main rotor blade from the Fiji helicopter was tap tested on site and at the Safety Board's Materials Laboratory. Neither tap test detected the 0.5-inch debond area that was visually detected at the tip of the intact Fiji blade. The investigation of this accident is ongoing, and the tip of the blade will be subjected to additional examination, including other NDI methods.

The Safety Board is also concerned that the reliability of a tap test will vary depending on the level of experience of the person performing the test and the conditions under which the test is performed. Bonding flaws at the edges of the skin may be very narrow and small and a difference in pitch may not be readily apparent, given the large structure underlying the area to be tested. In addition, tap tests can be extremely difficult to perform during maintenance or on site when they must be performed upside-down on the lower surface of an installed blade. Further, a possibility exists that the skin-to-spar bond joints at the edges of the skin on several main rotor blades are being manufactured with narrow adhesive debond regions.

The NDI industry has an array of methods for detecting bonding defects, such as voids and debond in adhesive bonded joints, but has struggled to find methods that consistently detect weak bonds (known as kissing bonds) in adhesive bond joints. However, the Safety Board is aware of tests developed for specific applications where kissing bonds have been detected using NDI. The Safety Board believes that NDI methods other than the coin tap test need to be developed to improve the evaluation of bond joints in the main rotor blade. Therefore, the Safety Board recommends that the FAA require RHC to develop an NDI technique or combination of techniques capable of consistently detecting bonding defects, such as voids, debonds, and weak (kissing) bonds, in bond areas between the skin and spar at the tip of the blade and between the skin and tip cap for R22 and R44 model helicopters.

Debond History

The Safety Board is aware that between July 2006 and January 2007, obvious areas where skin debonded from the adhesive bond joint between the skin and spar were found on 10 main rotor blades on RHC helicopters, all before the blades reached their 2,200 hour life limit. According to RHC, debonds of adhesive bond joints were found during routine maintenance and/or inspection. Seven of these blades had accumulated fewer than 1,000 hours TIS, and the remaining three had accumulated between 1,500 and 2,200 hours TIS. The blade with the earliest debonding[6] had accumulated only 331.2 hours TIS. These helicopters for the most part were exposed to operations in hot and humid conditions at or near the sea. Three of the 10 helicopters

[6] RHC model R22, registered as VH-LNS, operated in Australia.

operated in Texas, near the Gulf of Mexico. Seven helicopters operated in Australia, New Zealand, the United Kingdom, and Ecuador, and the helicopter that operated in the United Kingdom had been formerly owned and operated in Palm Beach, Florida.

In-Service Inspections

The discovery of the 10 RHC main rotor blades with debonded skin prompted both the FAA and RHC to issue guidance to operators to address the problem. On February 9, 2007, the FAA issued Special Airworthiness Information Bulletin (SAIB) SW-07-16, alerting owners and operators of R22 and R44 helicopters of the debonding issue. The SAIB applied to main rotor P/N A016-4, C016-2, and C016-5. The bulletin recommended a preflight inspection of the lower skin-to-spar joint area (especially the outboard 10 inches) for a visual indication of debond at the lower surface of the tip portion of the blade. If any area of the blade was suspected of having a debond, the bulletin indicated that a qualified mechanic perform a tap test prior to further flight to verify any indication of a debond that had been found during the visual inspection. The bulletin further stated that if any indication of unusual rotor system noise or vibration was detected in flight, the pilot was to land immediately and inspect the blades.

On March 29, 2007, RHC issued two service bulletins (SB) suggesting that operators perform a one-time visual inspection of the main rotor blades on R44 and R22[7] helicopters at the joint between the skin and spar for evidence of erosion at the bond line and to use the tap test if the adhesive bondline was exposed. If no indication of a void or separation was found, the exposed bondline could be refinished per RHC service letters (SL) and returned to service.[8] According to the SBs, unairworthy blades should be reported to RHC and documented in appropriate maintenance records. The Safety Board learned that three unairworthy blades were returned to RHC as a result of SB action that prompted a one-time visual inspection of the main rotor blade. Two of the three blades had accumulated approximately 1,280 hours TIS and were not among the 10 blades found to have debonded between July 2006 and January 2007. Details of the third blade were not known at the time this safety recommendation letter was prepared. RHC had not reported new cases of a blade that was associated with debond between the skin and spar after January 2007.

The FAA issued Airworthiness Directive (AD) 2007-26-12, effective January 18, 2008, which required the following of R22 and R44 helicopter operators:

- Perform a one-time visual inspection of the leading edge of any exposed (bare metal) blade skin aft of the skin-to-spar bond line on the lower surface of each blade; any evidence of skin separation found during the visual inspection would render the blade unairworthy.

[7] SB-61, which applies to the R44, and SB-96, which applies to the R22, are both titled “Main Rotor Blade Erosion.”
[8] SL-32, which applies to the R44, and SL-56, which applies to the R22, both titled “Main Rotor Blade Bond Inspection and Maintenance,” were issued in March 2007 and provided specific instructions on where to inspect the blade for corrosion and debond damage, how to perform a tap test, and how to apply a paint coating on exposed bond lines and bare metal surfaces. The SLs do not specify compliance time or intervals.

- Tap test the skin-to-spar bonded areas on the lower blade skin aft of the skin-to-spar bond line; any separation or void detected during the tap test would render the blade unairworthy.

- Remove the tip cover, visually inspect the exposed tip with a 10X magnifying glass, and tap test the skin-to-tip cap bond joints on the upper and lower surfaces; corrosion, separation, or any void in this area would render the blade unairworthy.

- Repaint exposed areas of the blade[9] per instructions in RHC SLs.

- Examine the skin-to-spar bond line on the lower surface near the tip before each flight for evidence of exposed (bare) metal.[10]

The Safety Board believes that the actions required by AD 2007-26-12 may result in the detection of some defects but will not detect hidden bond flaws at the spar-to-skin bond joint and the skin-to-tip cap bond joint. The investigator-in-charge of the Fiji accident reported that the main rotor blade from the helicopter involved in the event in Australia was tap tested prior to flight, but a bond defect at the skin-to-spar bond joint was not detected. This failure, as well as the Safety Board's tap testing of the intact Fiji blade, which did not detect the debonding, demonstrates that tap testing does not detect bond flaws in the main rotor blade consistently. Accordingly, it is necessary to conduct reliable inspections at intervals low enough to ensure that debond can be discovered before the skin can separate from the blade in flight. The lowest number of hours TIS at which an in-flight debonding event caused loss of control of a helicopter was 596 hours TIS. The Safety Board believes that an inspection interval of less than 596 hours TIS would provide an opportunity to detect debond before it causes an in-flight event. Therefore, the Safety Board recommends that the FAA require that all RHC main rotor blades be inspected using the effective and reliable NDI method(s) developed in response to Safety Recommendation A-08-26 at intervals appropriately less than 596 hours TIS, which investigations have shown to be the earliest known TIS at which debonding occurs, to evaluate the bond joints between the skin and spar at the tip of the main rotor blade and between the skin and tip cap to find bonding defects.

The Safety Board is also concerned that AD 2007-26-12 does not address visual inspection of potentially degraded blades that do not have exposed bare metal skin in the area of the skin-to-spar bond line. On blades where the skin-to-spar bondline is covered with paint, the surface of the paint in the general area of the bondline should be inspected for crack(s). A crack in the paint can indicate debond at the skin-to-spar bond joint. Since the tap test cannot consistently detect debond in all areas of the skin-to-spar bond joint, operators should not rely on this method to determine the presence/nonpresence of a debond at the skin-to-spar bond joints. The Safety Board believes that until an improved NDI method for detecting debond at the skin-to- spar joints is developed and implemented, blades that are found to contain a crack in the paint in the general area of the skin-to-spar bond joint should be declared unairworthy.

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[9] On October 25, 2007, the FAA issued STC SR02491CH, which allowed the alternative procedure of installing an adhesive-backed polymer tape over the bondline between the skin-to-spar joint to prevent erosion damage.

[10] On January 23, 2008, in response to a request by the Aircraft Owners and Pilots Association, the FAA issued an approval of alternate method of compliance for AD 2007-26-12, which reduced the preflight visual inspections to every 100 hours TIS or during annual inspection, whichever occurred first.

Therefore, the Safety Board recommends that the FAA amend AD 2007-26-12 and add requirements that the main rotor blades are to be inspected for crack(s) in the paint layer at the skin-to-spar bondline. Main rotor blades that contain a crack in the paint layer at the skin-to-spar bondline should be removed from service.

Other Manufacturers

Given the findings of the Fiji investigation to date, the results of the other investigations, and the lack of guidance provided for the manufacture of adhesive bonds in AC-27 and AC-29, the Safety Board is concerned that inadequate inspection and durability testing requirements may exist at other blade manufacturers. The Board also believes that the inspection interval for all main rotor blades should be based on the severity of the environment in which the helicopter is operating. For example, the main rotor blades of helicopters that operate in hot and humid climates should be inspected more frequently than those operated in dry environments. Therefore, the Safety Board recommends that the FAA review the manufacturing processes and continued airworthiness requirements for blades manufactured by companies other than RHC, and, for those using adhesive bonding, determine if sufficient durability testing and inspections of adhesive bonds are in place to ensure the safe operation of the blades without failure throughout their designed life expectancy in all environmental and operating load spectrums that the blades will experience.

Recommendations

The Safety Board believes that adhesive bond joints are likely to degrade with time[11] when subjected to harsh environments, such as the high humidity and high temperatures typically found at or near the sea, and that tap testing of the main rotor blades is not adequate for consistently detecting debond at the skin-to-spar and skin-to-tip cap bond areas. Consequently, separation at bond joints could remain undetected and lead to in-flight separation of the main rotor blade skin and possible loss of control.

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

> Revise Advisory Circular (AC)-27, "Certification of Normal Category Rotorcraft," and AC-29, "Certification of Transport Category Rotorcraft," to include long-term durability testing of adhesive bond joints for helicopter blades to ensure safe operation throughout their design life in all environments and operating load spectrums that the blades will experience and to set service life limits accordingly. (A-08-25)
>
> Require Robinson Helicopter Corporation to develop a nondestructive inspection technique or combination of techniques capable of consistently detecting bonding defects, such as voids, debonds, and weak (kissing) bonds, in bond areas between

[11] Degradation can occur as a result of flight time and/or calendar time depending on the severity of operating/storage conditions. For example, blades that are washed before storage may not be as susceptible to bond degradation as blades that are not washed before storage.

the skin and spar at the tip of the blade and between the skin and tip cap for R22 and R44 model helicopters. (A-08-26)

Require that all Robinson Helicopter Corporation main rotor blades be inspected using the effective and reliable nondestructive inspection method(s) developed in response to Safety Recommendation A-08-26 at intervals appropriately less than 596 hours time in service (TIS), which investigations have shown to be the earliest known TIS at which debonding occurs, to evaluate the bond joints between the skin and spar at the tip of the main rotor blade and between the skin and tip cap to find bonding defects. (A-08-27)

Amend Airworthiness Directive 2007-26-12 and add requirements that the main rotor blades are to be inspected for crack(s) in the paint layer at the skin-to-spar bondline. Main rotor blades that contain a crack in the paint layer at the skin-to-spar bondline should be removed from service. (A-08-28)

Review the manufacturing processes and continued airworthiness requirements for blades manufactured by companies other than Robinson Helicopter Corporation, and, for those using adhesive bonding, determine if sufficient durability testing and inspections of adhesive bonds are in place to ensure the safe operation of the blades without failure throughout their designed life expectancy in all environmental and operating load spectrums that the blades will experience. (A-08-29)

In response to the recommendation(s) in this letter, please refer to Safety Recommendation(s) A-08-25 through -29. 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 at the same address for instructions on how to use our Tumbleweed secure mailbox procedures. 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 ROSENKER, Vice Chairman SUMWALT, and Members HERSMAN, HIGGINS, and CHEALANDER concurred in these recommendations.

[Original Signed]

By: Mark V. Rosenker
Chairman