log #2494

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 25, 1994

In reply refer to: A-94-98

Honorable David R. Hinson
Administrator
Federal Aviation Administration
Washington, DC. 20591

On July 31, 1993, at 1349 Pacific daylight time, a Robinson Model R44 helicopter, N445RH, was involved in a fatal accident at the El Monte Airport, El Monte, California. The helicopter (Serial No. 0005), operating in visual meteorological conditions under Title 14 Code of Federal Regulations (CFR) Part 91, had been cleared for takeoff and was departing from a hover from the approach end of runway 19. According to witnesses, the pilot maintained an aircraft heading over the center of the runway, and the takeoff and initial climb appeared normal. However, about 50 to 100 feet above the ground, and at a speed of approximately 50 knots, the helicopter suddenly pitched down, rolled to the right, and crashed onto the runway, 1,900 feet from the departure end. Examination of the wreckage disclosed the pitch and roll impact angles to be approximately 35° and 30°, respectively. The helicopter was destroyed, an intense postcrash fire erupted, and the pilot and the two passengers aboard the aircraft were killed.

The four-passenger Robinson Model R44 helicopter was certificated by the Federal Aviation Administration in December 1992. The helicopter had been purchased by the operator, Uni West Aviation, Inc., on May 27, 1993, at an aircraft hour meter reading of 106 flight hours and, reportedly, had accumulated a total time in service of 174 flight hours at the time of the accident. The official weather observation station at the El Monte Airport reported scattered clouds at 18,000 feet; visibility, 7 miles; and wind, 180° at 8 knots.

The National Transportation Safety Board conducted metallurgical examinations of the helicopter's main rotor swashplate in September 1993, and of the cyclic control stick assembly in February 1994. The examinations disclosed that all of the fractures were typical overstress separations except for the fracture at the bottom of the cyclic control stick. This fracture occurred below the pivot point where the cyclic stick transitions from a steel tube to a welded steel box structure (comprised of side plates and cap plates) and exhibited characteristics consistent with a brittle fracture mechanism such as fatigue cracking. For example, the fracture

plane on some of the broken members was flat and intersected the surface at a 90° angle. Moreover, little or no plastic deformation was noted in the fracture area. A river pattern,[1] visible on the fracture surface of one of the side plates, was consistent with fatigue crack initiation at the forward edges of the side plates. The fatigue had progressed through about two thirds of one plate and entirely through the other plate before the cyclic stick box structure separated.

Robinson Model R44 helicopters have been involved in two other recent fatal accidents. The first, involving Serial No. 0043, occurred on March 21, 1994, on the Yangtze River in a remote location in China; the wreckage has not been recovered. The second, involving Serial No. 0013, occurred on April 2, 1994, about 8 miles east of the Hanover Airport in Germany. Preliminary information concerning this accident indicates that the main rotor blades departed the aircraft in flight as a result of rotor mast bumping.

The Robinson Helicopter Company (RHC) commenced a redesign effort of several R44 control system components following the accident involving N445RH. Because many components were destroyed or obliterated by crash-impact forces and/or the intense postcrash fire, no conclusions could be drawn as to when or precisely how they might have failed. Therefore, according to Robinson, five control system components were strengthened immediately and fatigue testing of other control system components similar to those installed in N445RH was initiated. After the Safety Board's metallurgical findings concerning the cyclic control system fatigue cracks were released on February 16, 1994, an inquiry was sent to the RHC concerning the status of the redesign efforts and possible cracks in other R44 cyclic control assemblies. The following are excerpts from the RHC letter responding to these questions:

> In response to your letter of 22 February, the R44 has not had <u>any</u> history of cracking in the cyclic control assembly. All of the cyclic controls removed from the three prototype R44's and from the R44's in service were removed and inspected. No cracks were found in any of these cyclic components.
>
> The cyclic stick from S/N 0004 had some chips and scratches in the paint but examination with a 10X magnifying glass did not reveal any cracks. S/N 0004 was a prototype which had experienced a hard landing during the H-V (dead man's curve) demonstration requiring replacement of the cabin shell during rebuild. It was then flown for 100 hours, most of which was at max continuous or take-off power, to satisfy the FAA Drive System and Control System endurance test requirements. After that it was flown as the lead-the-fleet ship in a service test until it had accumulated 800 flight hours at which point it was torn down and inspected. Due to this extraordinary severe exposure, the cyclic control system from S/N 0004 was not considered representative of the system in the accident aircraft, S/N 0005, and therefore was not used in the subsequent fatigue tests. Its components were destroyed along with the obsolete parts from the other R44's to prevent their inadvertent installation in other aircraft.

[1] A river pattern is a series of small steps in a fracture that indicate the local direction of crack propagation.

The cyclic stick assemblies used in the fatigue tests were from the first production run of the revision H assemblies. They were new parts, not parts removed from the aircraft, but they were of the same structural design as the stick assembly in S/N 0005 except as noted on the MRR's.

Concerning the design changes made after the accident, we ended up redesigning more than a dozen different parts in the cyclic control system. Once we changed the parts that were damaged or destroyed in the fire, they were then considerably stronger than the rest of the system. So we continued fatigue testing and redesigning parts until we brought the entire cyclic system up to that higher strength level.

The Safety Board determined the probable cause of the accident involving N445RH to be a fatigue failure of the cyclic control stick assembly, which resulted in an in-flight loss of control and collision with the ground. The RHC's fatigue testing and redesign of the R44 cyclic control system, which commenced immediately following the accident, is commendable. However, fatigue failure of a critical control system component in a relatively new, recently certificated aircraft and the more recent fatal accidents overseas prompt the Safety Board to believe that the lack of oversight of the R44 design certification process may have contributed to one or more of these occurrences.

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

Conduct a Special Certification Review (SCR) of the Robinson Model R44 helicopter to ascertain that the manufacturer is complying with all applicable certification requirements concerning structural and systems design engineering, quality control assurance, and manufacturing processes and procedures. The review should specifically determine the design adequacy (durability and reliability) of the aircraft's cyclic control system. (Class I, Urgent Action)(A-94-98)

Chairman VOGT and Members LAUBER, HAMMERSCHMIDT, and HALL concurred in this recommendation.

By: Carl W. Vogt
Chairman