

LOG 2399



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 3, 1993

In reply refer to: A-93-2

Honorable Joseph Del Balzo
Acting Administrator
Federal Aviation Administration
Washington, D.C. 20591

On August 27, 1992, a Sikorsky S-58T helicopter, N58EN, operating under contract to the U.S. Department of Agriculture, Forest Service, sustained substantial damage during a hard landing following a separation of the engine drive shaft, P/N 58350-10030-045. This shaft (a thin walled tube with a diameter of about 4.5 inches) transmits torque from the combining gearbox to the angle gearbox. The pilot and two passengers aboard the helicopter were not injured. The accident occurred just after takeoff from Lee Bird Field, North Platte, Nebraska.

Examination of the shaft at the National Transportation Safety Board's materials laboratory revealed that the shaft separation was caused by fatigue cracking that initiated from a balance weight rivet hole near the forward end of the shaft. To reduce vibrations, the shaft contains up to four balance weights that are riveted to the shaft in appropriate locations. On the separated shaft, light wear from contact with the balance weight rivet shank was noted on the bore surface of the hole. In addition, the bore surface of the hole adjacent to the inside diameter of the shaft contained a wear ring from contact with the formed end of the rivet.

Sikorsky Aircraft has investigated several other previous cases of cracking that initiated from or near balance weight rivet holes in the engine drive shaft. In all of these cases, looseness of the balance weight and fretting damage were found at the fatigue initiation site. Fretting damage can greatly reduce the number of cycles of stress necessary for initiation of fatigue cracking. The wear found in the rivet hole at the initiation site of the subject shaft could have been fretting damage that preceded the fatigue cracking or it could have occurred as a result of the cracking. However, based on Sikorsky's experience with cracked shafts, the Safety Board believes that the wear or fretting of the subject shaft most likely preceded the cracking and was a factor in crack initiation.

As a result of the previous instances of cracking in the engine drive shaft, Sikorsky issued Alert Service Bulletin (ASB) 58B35-30 on May 17, 1989. This ASB recommends that all P/N 58350-10030-045 shafts receive certain inspections "as soon as possible but not later than the next 100 flight hours." Initially, the shaft is inspected for loose balance weights. Any shaft that has a gap between a balance weight and the shaft that is greater than 0.002 inch is to be removed from service. Shafts with a

gap of 0.002 inch or less are to be subjected to a fluorescent penetrant inspection (FPI). The ASB requires that the paint be stripped from the shaft in the areas of the balance weights before performing the FPI and that two layers of "Amlguard" (a clear lacquer) be applied over the stripped area after FPI. Performance of the inspections in ASB 58B35-30 was made mandatory by Airworthiness Directive (AD) 90-10-02, effective June 1, 1991. The AD allowed 50 hours time in service to accomplish the inspections. The AD and ASB contained no provisions that required or suggested periodic inspections of the shaft.

Based on the operator's records from June through August 1992, the helicopter involved in the North Platte accident was accumulating about 40 hours of service per month and had accumulated far more than 50 hours of service in the 15 months between the effective date of the AD and the accident. Thus, if the helicopter had not been a public use aircraft, inspections of the shaft as required by the AD would have been required long before the accident. However, examination of the separated shaft revealed no evidence that paint had been stripped from or that "Amlguard" had been applied to the balance weight areas on the shaft, indicating that the inspections required by AD 90-10-02 were not performed. A review of the operator's "Airworthiness Directives Worksheet" indicated that the operator was aware of AD 90-10-02, but believed that the AD was not applicable to the accident helicopter. The worksheet listed the shaft's part number as P/N 58350-10030-046 instead of P/N 58350-10030-045, the shaft part number to be inspected. Representatives of Sikorsky indicated that the -046 part number is a subassembly within the -045 shaft assembly, and that the -045 part number is the proper identification for the installed shaft. Both the -045 and -046 part numbers are printed in the same general area on the shaft, which may have contributed to the operator's apparent confusion regarding the correct part number to use to identify the shaft.

If the operator had properly inspected the shaft per AD 90-10-02, loose balance weights or cracking may have been discovered and the shaft may have been removed from service, thereby preventing the accident. For this reason, the Safety Board believes that Airworthiness Directive 90-10-02 needs to be revised to state clearly that it is applicable to the P/N 58350-10030-046 shaft subassembly as well as to the P/N 58350-10030-045 shaft assembly.

As a result of this accident, Sikorsky issued ASB 58B35-31 on December 4, 1992, which replaces ASB 58B35-30. The new ASB incorporates the loose rivet inspection and FPI from ASB 58B35-30 and includes suggestions for (a) a 25-hour periodic visual inspection of the P/N 58350-10030-045 shaft, (b) a 250-hour periodic FPI of the P/N 58350-10030-045 shaft, and (c) a 2,500-hour periodic FPI of a replacement P/N 58350-10030-047 shaft or a P/N 58350-10030-045 shaft that has been reworked per Overhaul and Repair Instruction (ORI) No. 58350-001. The reworked -045 shaft and the replacement -047 shaft have bonded balance weights and oversized balance weight rivets, features that are intended to reduce the possibility that fretting will develop. Representatives of Sikorsky have also indicated that ASB 58B35-31 will be revised to indicate that P/N 58350-10030-046 shafts are properly referred to as -045 shafts and should be included in the inspections.

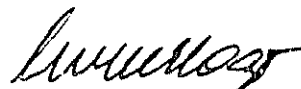
The Safety Board believes that the periodic visual and FPI inspections suggested in Sikorsky ASB 58B35-31 are necessary to ensure that shafts are airworthy, and is concerned that there are no AD requirements to perform such inspections. Therefore, the Safety Board believes that AD 90-10-02 should either be revised or replaced so that such periodic inspections become mandatory.

The Safety Board also believes that it would be prudent for operators to either rework P/N 58350-10030-045 shafts per Sikorsky ORI No. 58350-001 or replace them with P/N 58350-10030-047 shafts within an appropriate time period. The rework procedure appears relatively uncomplicated, and reworking or replacing the shaft would increase the inspection interval from every 250 hours to every 2,500 hours. This would decrease the reliance on inspections for maintaining airworthiness and would reduce the exposure of the shafts to the possibility of unintended damage during the inspection process.

The Safety Board is concerned that a separation of another engine drive shaft on a Sikorsky S-58T helicopter could result in a serious or fatal accident. To reduce the possibility of such a separation, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Revise or replace Airworthiness Directive 90-10-02 to require that the P/N 58350-10030-045 engine drive shaft assemblies on Sikorsky S-58T helicopters: (a) be subjected to periodic visual and fluorescent penetrant inspections per Sikorsky Alert Service Bulletin 58B35-31; and (b) be either reworked per Sikorsky Overhaul and Repair Instruction No. 58350-001 or replaced with a P/N 58350-10030-047 shaft within an appropriate time period. The revised or replacement airworthiness directive should also make clear that the P/N 58350-10030-046 shaft subassembly is part of the P/N 58350-10030-045 shaft assembly and is subject to the inspection, rework, and replacement provisions of the airworthiness directive. (Class II, Priority Action) (A-93-2)

Chairman VOGT, Vice Chairman COUGHLIN, and Members LAUBER, HART, and HAMMERSCHMIDT concurred in this recommendation.



By: Carl W. Vogt
Chairman