LOG 2523

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: August 30, 1994
In reply refer to: A-94-167 through -169

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

On July 14, 1994, at 1536 Hawaiian standard time, an Aerospatiale AS-350D AStar helicopter, N151BH, operating as a sightseeing flight under the provisions of Title 14 Code of Federal Regulations Part 135, sustained a total loss of power near Hanalei, Kauai, Hawaii. The pilot reported he lost engine power. He then autorotated to the Pacific Ocean near a rocky shore line and successfully evacuated the helicopter along with six passengers. However, he and two passengers drowned attempting to reach shore. The helicopter sank in 25 feet of water approximately 15 feet from shore. The helicopter was equipped with a Textron-Lycoming LTS-101 turboshaft engine and a Chandler Evans Company (CECO) MFP-261 engine-driven fuel pump.

Inspection of the airframe and drive train revealed no evidence of power being applied to the drive train. Surviving passengers said there was no engine noise during descent and landing, and they described motions of the helicopter consistent with an autorotative landing. Bench testing and complete disassembly of the fuel control, overspeed governor, and overspeed limiter revealed no anomalies other than salt water intrusion consistent with immersion. No internal mechanical damage or abnormalities were identified that would have caused a power loss.

Disassembly of the CECO fuel pump revealed an internal failure that would result in immediate and total loss of fuel supply to the engine. The fuel pump had been operated 2,370 hours since its previous overhaul. The primary rotating components of this fuel pump consist of the fuel pump main driveshaft, the fuel pump driver gear, the fuel pump driven gear, and the fuel control driveshaft. One end of the fuel pump driveshaft has external splines[1] that extend out of the pump mount face. Internal splines on the other end of the driveshaft mesh with external splines on one end of the driver gear, which is totally encased in the pump. The fuel control driveshaft is concentric to the fuel pump driver gear and contains external splines that also mesh with the internal splines on one end of the fuel pump driveshaft.

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[1]The term "splines" in this letter refers to the teeth of a splined shaft.

Examination of the disassembled pump at the Safety Board's materials laboratory revealed that the internal splines on the fuel pump main driveshaft had worn to the point that the external splines of the fuel pump driver gear could be rotated freely within the internal splines. The portion of the driveshaft internal splines that engages the fuel control driveshaft external splines was not worn. The drive faces of the external splines of the fuel pump driver gear had lost a small thickness of material due to wear. The greater amount of wear on the internal splines of the driveshaft is consistent with the lower hardness of this component, when compared to the relatively high hardness of the nitrided case on the external splines of the fuel pump driver gear. Despite the loss of a relatively small amount of material, the drive faces of the external splines on the driver gear were rough where they had contacted the driveshaft splines, and each external spline contained what appeared to be a gaping crack along the length of the spline, about midway between the spline root and crown. The location of these cracks corresponded to the crowns of the internal splines on the driveshaft.

CECO Service Bulletin (SB) MFP-261-73-9 applies to the fuel pump from the accident helicopter. This SB was issued on June 30, 1985, and recommends adding grease to the spline area and installing an internal O-ring seal to prevent fuel from flushing the grease out. This SB was issued after CECO determined that inadequate lubrication was a contributing factor in a similar pump failure that occurred in 1983. The failed pump from N151BH contained the O-ring seal specified in the SB. However, only traces of the lubricating grease were found when the pump was disassembled.

The Safety Board's investigation has revealed six additional similar failures of CECO MFP-261 and -265[2] model pumps since 1984. All of these failures occurred on pumps that had been modified in accordance with SB MFP-261-73-9. One of the failures resulted in a 1991 accident when another Aerospatiale AS-350 had a total power loss. On July 27, 1994, the failure of a CECO fuel pump in a twin-engine Bell 222 helicopter resulted in a safe single-engine landing. This fuel pump was also examined in the Safety Board's materials laboratory. The wear and damage found on the fuel pump components were very similar to the wear and damage found on the pump from N151BH, and only traces of lubricating grease were found in the wear area. Details of the accident results of the other pump failures are not available. The time since overhaul (TSO) for the these seven failed pumps (the pump from N151BH and six additional failures) ranged from 1,000 hours to 2,370 hours. An additional two pumps failed in a similar manner in September 1993 and May 1994. These two pumps each failed at approximately 200 hours TSO, and both were installed on the same accessory gearbox and engine. CECO has reported that these two low-time failures were a result of severe misalignment of the internal fuel pump components.

The engine maintenance manual recommends that the pump be removed from the accessory gearbox at 300-hour intervals and inspected for wear of the external splines on the portion of the driveshaft that extends out of the pump (the end of the shaft opposite from the

[2]The MFP-261 and -265 model pumps have the same driveshaft and driver gear configuration.

failure location). However, to examine the internal splines of the fuel pump driveshaft, the drive portion of the pump must be disassembled. Disassembly and internal inspection of the pump are not authorized except by CECO or CECO-approved repair stations. Therefore, an operator would not be able to detect spline wear where it was found in N151BH during normal maintenance.

CECO recommends that the pumps be overhauled every 2,400 hours and has indicated that approximately 80 percent of the fuel pump main driveshafts are replaced during overhaul, primarily because of wear on the fuel pump drive external splines on the input side of the shaft (on the opposite end of the shaft from the failure location). CECO has indicated that the fuel pump driver gear is also frequently replaced at overhaul.

It is likely that the drive surfaces on the external splines of the driver gear would be degraded as wear occurs between the driveshaft and driver gear splines. However, the only inspection of the internal and external splines consists of physical measurement during the 2,400-hour overhaul. Because of the small size of the splines (19 teeth on a diameter of less than 0.5 inches), it may be difficult to visually detect a degraded condition of the drive face of these splines. Therefore, the Safety Board believes that a magnified visual inspection of the splines on the fuel pump driver gear is necessary to eliminate the possibility that undetected damage of this type could cause premature wear of the driveshaft splines.

CECO has advised the Safety Board that many fuel pump driveshafts reach overhaul with little or no wear to the internal splines and are subsequently reinstalled for another 2,400 hours of service. However, the service history indicates that failures have occurred in much less than 2,400 hours. The Safety Board believes that there are several possibilities that could contribute to premature failure of the fuel pump: inadequate sealing of O-rings, allowing fuel seepage to remove the lubricating grease; improper alignment of the pump components; and degraded fuel pump driver shaft splines remaining in service.

The MFP-261 and -265 fuel pumps are installed only on Textron-Lycoming LT-101 series engines. The estimated population of engines affected is 2,000 worldwide, with over 800 in the United States. These engines are installed on single- and twin-engine helicopters and in fixed-wing airplanes. It is estimated that between 200 and 300 single-engine AS-350 helicopters are affected.

The Safety Board believes that the driveshafts and driver gears from the fuel pumps on affected engines should be subjected to inspections for spline wear or degraded condition to reduce the possibility of fuel pump failure and the risk of serious accidents. The frequency of the inspections should be determined by considering the failure history of the pump (1,000 to 2,730 hours since overhaul, except for the two pumps that failed due to severe misalignment of the pump internal components) and the existing requirement to inspect the pump driveshaft at 300-hour intervals.

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

Issue an emergency airworthiness directive requiring that the internal splines of the fuel pump driveshaft and the external splines of the fuel pump driver gear on all Chandler Evans Company MFP-261 and -265 fuel pumps used in single-engine applications for more than a specified number of hours since overhaul be inspected for wear and replaced if the wear exceeds a specified amount. The specified time for inspection should be based upon the failure history of the pump. The wear inspection should include a magnified visual examination of the driver gear splines for a degraded condition. (Class I, Urgent Action) (A-94-167)

Issue an airworthiness directive requiring that the internal splines of the fuel pump drive shaft and the external splines of the fuel pump driver gear on all Chandler Evans Company MFP-261 and -265 fuel pumps be periodically inspected for wear and replaced if the wear exceeds a specified amount. The wear inspection should include a magnified visual examination of the driver gear splines for a degraded condition. The interval for the inspection should be established based on the failure history of the pumps. (Class II, Priority Action) (A-94-168)

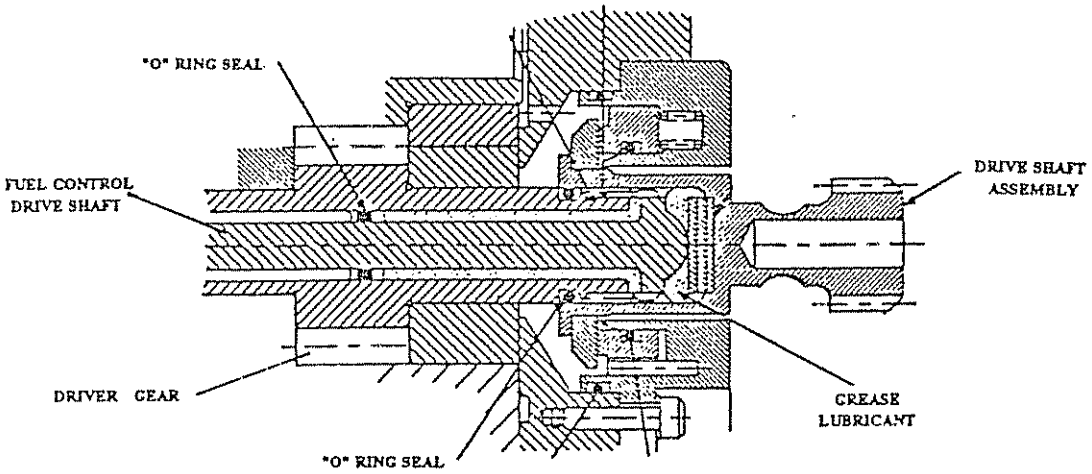
In conjunction with the manufacturer of the Chandler Evans Company MFP-261 and -265 fuel pumps, evaluate the pump design and the modification specified in Service Bulletin MFP-261-73-9 to ensure proper lubrication and alignment of the fuel pump driveshaft components during reassembly. (Class II, Priority Action) (A-94-169)

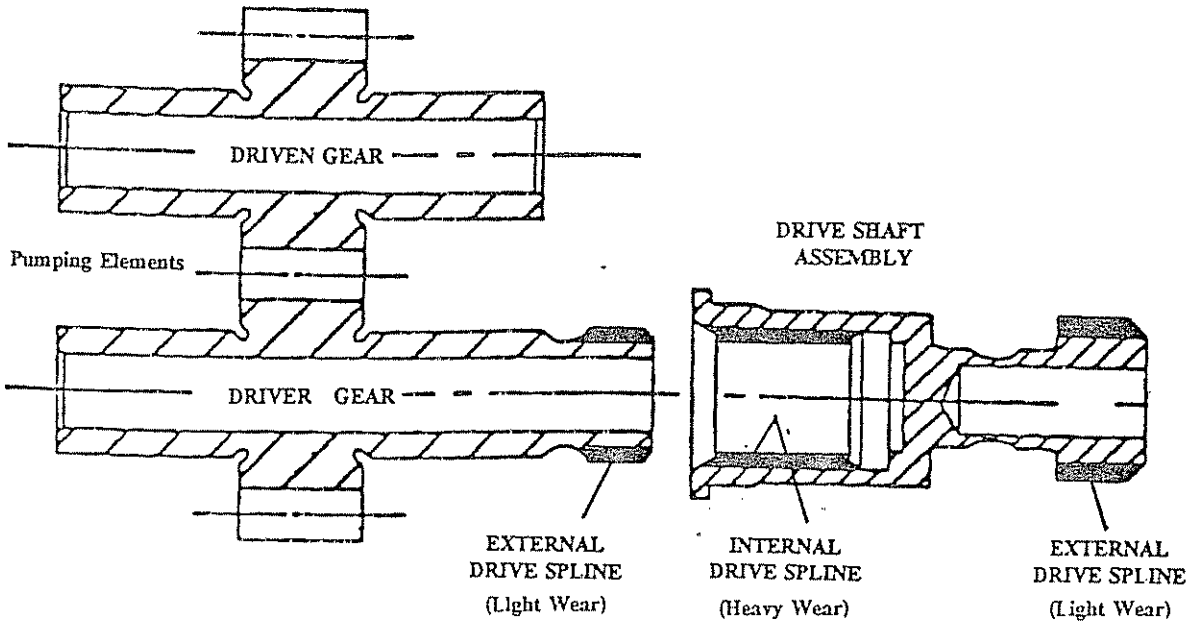
Acting Chairman HALL and Members LAUBER, HAMMERSCHMIDT, and VOGT concurred in these recommendations.

By: Jim Hall
Acting Chairman

Chandler Evans (CECO)
Model MFP261
MAIN FUEL PUMP

FUEL PUMP DRIVE
(CROSS SECTION)





Note: Spline areas are enhanced for clarity and identification.