



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 14, 1994
In reply refer to: A-94-92

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

On March 1, 1994, the right wing-mounted Rolls-Royce RB211-22B engine on a Rich International Airlines Lockheed L-1011, N303EA, incurred an uncontained rotor burst during the takeoff roll at Fairbanks, Alaska. The airplane was being ferried to Miami, Florida, and the three flightcrew members were the only occupants. A fragment from the failed rotor of the right engine struck and substantially damaged the left wing-mounted engine. The airplane was stopped safely and the flightcrew was not injured.

Early in the takeoff roll, as full power was reached, the sixth stage disk of the intermediate compressor stage 6-7 rotor shaft assembly in the right wing-mounted engine ruptured. Several large segments and numerous smaller fragments of the disk were liberated from the engine. The main fuel inlet line to the engine was severed, and the fuel was ignited. The fire damaged the inboard reverser translating cowl before it was extinguished by airport fire department personnel after the airplane had been stopped. One disk segment penetrated the left wing-mounted engine high pressure turbine case and destroyed the first stage turbine vanes and blades, thus causing a loss of thrust in that engine. Small fragments also punctured the fuselage in several places.

About 80 percent of the disk was recovered and taken to the Safety Board's Materials Laboratory for metallurgical examination. Although the metallurgical examination has not been completed and the primary failure has not yet been identified, a condition has been identified that the Safety Board believes must be corrected to preclude further uncontained rotor failures of certain Rolls-Royce RB211 engines. The metallurgical examination showed that at least six fractures occurred radially through the bolt holes used for securing the stage 6-7 rotor shaft assembly to the stage 5 disk. In most of these fractures, there was evidence of preexisting fatigue cracks originating from corrosion pitting. At the time of failure, the rotor assembly had accumulated 16,327 cycles. It was installed in this engine in June 1989, at 14,713 cycles.

In January 1992, inspection by Rolls-Royce of another stage 6-7 compressor rotor assembly that had reached its life limit of 18,000 cycles revealed cracks in the bolt holes used for attachment of the rotor assembly to the stage 5 disk. The cracks were parallel to the disk radii and originated from corrosion pitting in the bolt holes. The manufacturer's analysis determined that the cracks were due to low cycle fatigue that had initiated early in the disk life. Detailed stress analysis by Rolls-Royce showed that no structural problems were likely at rotor

lives up to 16,000 flight cycles but, at higher lives or in the event of rotor overspeed, rotor failure was possible.

In January 1992, Rolls-Royce issued Service Bulletins RB.211-72-9569, applicable to RB211-22B engines, and RB 211-72-9571, applicable to RB211-524 engines. These service bulletins defined schedules for removing rotors from service based on accumulated cycles. In RB211-22B engines, rotors exceeding 16,000 cycles were to be removed from service by July 31, 1992, and rotors exceeding 14,000 cycles by April 30, 1993. In RB211-524 engines, rotors exceeding 13,000 cycles were to be removed before the next flight, those exceeding 12,500 cycles were to be removed by February 7, 1992, and those exceeding 10,500 cycles by July 31, 1993. It was also proposed that the Time Limits Manual be revised to limit the life of unmodified RB211-22 engine stage 6-7 rotors to 11,000 cycles effective July 31, 1994, and to limit the life of RB211-524 rotors to 7,500 or 8,500 cycles, contingent upon prior incorporation of a particular modification. The United Kingdom Civil Aviation Authority declared these service bulletins "mandatory," which, for British operators or British registered aircraft, is equivalent to an airworthiness directive (AD) in the United States. Rolls-Royce also developed a rework procedure, described in Service Bulletin RB 211-72-9594, that allows the rotors to be operated to their original life limit.

United Kingdom Mandatory Service Bulletins are not mandatory for U.S.-certificated operators or U.S.-registered airplanes unless separately mandated by Federal Aviation Administration (FAA) ADs. In this case, the FAA has not issued ADs to require U.S. operators to comply with the provisions of Rolls-Royce Service Bulletins RB.211-72-9569 and RB 211-72-9571. Although most operators of RB211-22 and -524 engines have reportedly complied with the service bulletins, it is apparent from this event that not all affected rotors have been removed from service. The Safety Board believes that it is imperative that the FAA mandate such action by issuing an AD to reduce the potential for other uncontained rotor disk failures and consequential airframe damage.

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

Issue an airworthiness directive to require that all operators of RB211-22 and -524 engines comply with the provisions of Rolls-Royce Service Bulletins RB.211-72-9569 and RB.211-72-9571. (Class I, Urgent Action)(A-94-92).

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


By: Carl W. Vogt
Chairman