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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: JAN 22 1997

In reply refer to: A-97-2

Honorable Linda Hall Daschle
Acting Administrator
Federal Aviation Administration
Washington, DC 20591

On December 28, 1995, during the departure climbout from Toulouse, France, a Boeing 737-232 airplane, F-GSCL, equipped with Pratt & Whitney (P&W) model JT8D-7B engines and operated by Euralair on a flight from Toulouse to London, England, experienced an uncontained failure of the number 1 (No. 1) engine, 9th stage high pressure compressor (HPC) disk, and lost hydraulic system "A" pressure. The flight returned to Toulouse, and landed without further incident. Examination showed that a 9th stage disk rim segment had separated from the disk and ruptured the HPC case. Secondary airplane damage was confined to the left wing leading edge just forward of the main wing spar. Engine debris had penetrated the leading edge skin and punctured an "A" system hydraulic line that runs parallel to the spar. There were no injuries to passengers or crew.

The National Transportation Safety Board, under the provisions of Annex 13 to the International Convention on Civil Aviation, participated in the French Bureau Enquetes-Accidents (BEA) investigation of the accident.

Engine records indicated that the 9th stage HPC disk, part number (P/N) 701509G, serial number (S/N) G42945, was manufactured in 1977 and delivered to United Airlines. It was installed on the accident engine, S/N 653341, on April 26, 1978. The disk was removed from this engine only once. This occurred during an engine overhaul performed by Israel Aircraft Industries (IAI) on January 15, 1988. At the time of the IAI shop visit, the disk had accumulated 16,641 hours and 11,241 cycles since new. IAI records show that the disk was then found to be corrosion pitted; it was repaired and replated with nickel-cadmium coating using the P&W JT8D Engine Manual.

The life limit on the 9th stage HPC disk is 30,000 hours or 20,000 cycles. The age of the disk at failure was 18 years and 6 months, and it had accumulated 27,336 hours and 18,547 cycles since new. This equates to 91 percent of the life limit for time and 93 percent of the life limit for cycles, respectively. At failure, the elapsed time, hours, and cycles since the replating of the disk were 8 years, 10,695 hours, and 7,306 cycles.

Metallurgical examination of the fractured compressor disk, both at the Center d'Essais des Propulseurs (CEPR) in Saclay, France, and at the Safety Board's materials laboratory, revealed that a fatigue crack emanating from the rim of the disk had moved radially inward and circumferentially until a critical length was reached. The rim segment then separated in static overload. The examination confirmed the presence of extensive corrosion pitting in multiple sites

that were concentrated in the outer web and rim areas of the disk. This, coupled with evidence of fatigue striations moving from the rim inboard, suggested that the failure had initiated in a dovetail slot on the disk rim. While an actual pitting initiation site was not found due to postfracture damage, the large number of pits present suggests that corrosion pitting was the most probable initiation mechanism.

Corrosion pitting has been a factor in other uncontained failures of JT8D HPC disks. One of these occurred on May 3, 1991, on a Ryan International Airlines Boeing 727-100QC airplane. The crew rejected their takeoff at Bradley International Airport, Windsor Locks, Connecticut, when, at approximately 80 knots during the takeoff roll, they heard a loud "bang," felt the airplane "shudder," observed the No. 3 engine fire warning light, and noted that the instrument indications for the No. 3 engine were erratic. The airplane was subsequently destroyed by fire. Investigation revealed that the 9th stage HPC disk had ruptured from a fatigue crack on the disk rim that initiated at a corrosion pit .010 inch deep. The forward rim fillet radius of the disk exhibited heavy surface corrosion and numerous corrosion pits, some of which were measured to be as deep as 0.020 inch. Shrapnel generated by the disk failure severed fuel, oil, and hydraulic lines and penetrated the fuselage. The failed disk had been operated 24,625 hours and 15,523 cycles since new at the time of the failure. It had been operated 4,553 hours and 4,564 cycles since its installation on October 19, 1985, on the Ryan airplane. The calendar time between the installation and the failure was 5 years and 7 months. The failure mechanism was a corrosive attack that occurs most rapidly in engines that are not operated a minimum number of hours/cycles per year (low utilization disks).[1] The pits penetrate into the material until, in combination with operational stresses, a fatigue crack develops.

Following the Ryan accident, the Safety Board issued Safety Recommendations A-91-42 through -44 on June 11, 1991. The recommendations asked the FAA to immediately conduct a directed safety investigation, in conjunction with P&W, to determine the magnitude and cause of the corrosion pitting on the HPC rotating disks of JT8D model engines, to identify those engines that are most susceptible to corrosion, and to develop corrective action. The Safety Board further asked the FAA to issue an airworthiness directive (AD) to require timely corrective actions that are developed as a result of the directed safety investigation. In response to the Safety Board's recommendation, the FAA issued AD 94-20-01, effective November 28, 1994, which required additional tracking and inspections of disks that were determined by a special P&W study to be vulnerable to corrosion pitting. The detailed instructions for compliance with the AD are contained in P&W Alert Service Bulletin (ASB) 6038, Revision 5. Based upon the FAA and P&W action, Safety Recommendation A-91-44 was classified "Closed--Acceptable Action" on May 8, 1995.

The Safety Board and the French BEA found no evidence to suggest that the failed Euralair 9th stage disk had been improperly inspected or replated 8 years before the accident. However, based on accumulated hours and cycles, according to the P&W ASB the separated Euralair disk was a low utilization disk. Also, as noted previously, the Euralair disk was found to have corrosion pitting during its January 1988 overhaul.

ASB 6038 does not specify reinspection of such HPC disks until 10 years after their nickel-cadmium replating. Based on the investigation of the failure of the Euralair 9th stage HPC

[1] Pratt & Whitney Alert Service Bulletin 6038, Rev. 5, August 17,1994, defines a "low utilization" disk as one that accrues less than 1,300 hours or 900 cycles per year. Once a disk is classified as low utilization, it remains in that classification until it is replated or recoated.

disk, the Safety Board concludes that 10 years is too long an inspection interval for low-utilization 7th through 10th stage HPC disks in P&W JT8D model engines. The Safety Board believes that the FAA should issue an AD that reduces the initial and recurring inspection intervals for overhauled nickel-cadmium plated HPC disks of P&W JT8D-1 through -17 engines that are categorized "low-utilization" by the calculations of P&W ASB 6038 Revision 5, dated August 17, 1994. The inspection interval should be reduced to significantly less than 8 calendar years and should be consistent with further corrosion rate studies by P&W.

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

> Issue an airworthiness directive that reduces the initial and recurring inspection intervals for overhauled nickel-cadmium plated high pressure compressor disks of Pratt & Whitney (P&W) JT8D-1 through -17 engines that are categorized "low utilization" by the calculations of P&W Alert Service Bulletin 6038 Revision 5, dated August 17, 1994. The inspection interval should be reduced to significantly less than 8 calendar years and should be consistent with further corrosion rate studies by P&W. (A-97-2)

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

By: Jim Hall
Chairman