



National Transportation Safety Board

Washington, D.C. 20594
Safety Recommendation

Date: January 26, 1990
In reply refer to: A-90-7 and -8

Honorable James B. Busey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On August 13, 1989, a DC-10-40, operating as Northwest Airlines flight 308, was flying from Los Angeles, California, to Minneapolis, Minnesota. While climbing through 38,000 feet, the flight crew heard a loud bang that was immediately followed by heavy vibration of the airframe. After noting indications of a malfunction in the No. 2 engine, the flight crew shut down the engine. The heavy vibration continued until the flight crew made an unscheduled landing without further incident in Denver, Colorado.

Inspection of the Pratt & Whitney (P&W) JT9D-20 engine after the incident revealed that one of the first-stage compressor fan blades (S/N EB2506) had separated about 8 inches above the blade platform. Fragments from that fan blade (No. 8) had exited through the left fan cowl in three places and had partially penetrated the vertical stabilizer. The uncontained fan blade separation had also damaged the engine fan module, the low pressure turbine module, the high and low pressure turbine shaft, and other internal engine parts.

The remaining portion of the No. 8 fan blade was removed from the engine for examination under the supervision of a Safety Board metallurgist. The metallurgical examination revealed that the blade separation had stemmed from a 0.34-inch-long fatigue crack that began in a weld adjacent to a patch at the trailing edge of the fan blade. The half moon shaped patch had been welded to the trailing edge of the fan blade by electron beam as part of a repair procedure to restore the chord length of the blade. The examination indicated that the fatigue crack had originated from a small (about 0.03-inch deep), discolored crack region introduced during the repair process. Records revealed that separation of the first-stage compressor fan blade occurred at 107 engine service hours and 32 cycles after it had been patch-repaired. The investigation into this incident is continuing.

The S/N EB2506 fan blade had been patch-repaired by the Coating Division facility of Union Carbide Corporation in Kansas City, Missouri. The fan blade had been subjected to four nondestructive tests at the facility after the repair: X-ray, fluorescent penetrant, ultrasonic, and eddy current inspection. The tests, performed in their proper sequence, had not indicated any cracks or anomalies. The preexisting discolored portion of the crack was of such a magnitude that it should have been detected by an eddy current inspection during the repair process. The Safety Board has not determined why this processing crack was not detected at that time.

Union Carbide has patch-repaired more than 1,000 fan blades of various sizes and shapes. Not all of the repaired blades receive the same number of inspections and in the same sequence. Patch-repaired fan blades are identified on the surface of the blade platform by a DC number (for example, DC-4321).

Shortly after the incident, P&W issued Special Instruction No. 80F-89, dated September 5, 1989, requesting that their customers perform a one-time eddy current inspection for possible cracks in the fan blades that had been welded by electronic beam at a specific repair facility (believed to be Union Carbide).

The Safety Board recently became aware that on September 22, 1989, during an eddy current inspection according to Special Instructions 80F-89, Northwest Airlines personnel found a crack on a patch-repaired fan blade on the No. 4 P&W JT90-7F engine of a Boeing 747 freight airplane (N6716). The crack was on the leading edge of the fan blade adjacent to a weld for the repaired patch at a position about 4 inches from the blade platform. The fan blade (P/N 771421, S/N BB4533) was removed from the airplane and sent to the P&W facility in East Hartford, Connecticut, for further analysis.

Fan blade S/N BB4533 had been patch-repaired at the Union Carbide facility and had thereafter accumulated 3,937.27 engine service hours and 1,218 cycles. The last 808 of these engine service hours had been accumulated on N6716.

When P&W received fan blade, S/N BB 4533, for analysis, the exterior surface area adjacent to the crack had already been etched. The etched surface revealed that the crack originated at the weld on the leading edge of the blade adjacent to the patch. The crack in the fan blade was forced open mechanically and the exposed fracture surfaces were examined. The examination revealed the presence of a 0.025-inch-deep, blue-colored fracture surface at the leading edge of the blade, indicative of a processing crack introduced during patch repair. On December 14, 1989 the Safety Board obtained one half of the exposed fracture surface of the crack. Examination of this half by Safety Board metallurgists disclosed evidence of an approximately 0.01-inch-deep fatigue crack region stemming from the discolored fracture surface that was attributed to processing.

Airworthiness Directive (AD) 76-24-03 issued by the Federal Aviation Administration requires airline operators to visually examine P&W fan blades for foreign object damage at intervals of 600 engine service hours. The Safety Board believes visual inspection is suitable for detecting damage such as nicks, dents, pits, gouges, scratches, and other surface anomalies, but is impractical and inadequate for detecting cracks 0.025 inch or smaller.

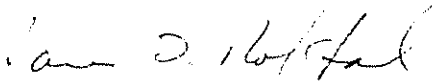
The Safety Board is concerned that other P&W fan blades patch-repaired by Union Carbide may have similar or even smaller cracks that were introduced during patch repair and that these cracks have remained undetected during the inspections at Union Carbide. Such cracks could grow by fatigue in service, producing blade separation and resulting in personal injury, loss of life, and substantial damage to the airplane and engine components.

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

Issue an Airworthiness Directive requiring a one-time eddy current inspection of all patch-repaired first-stage compressor rotor blades (fan blades) in Pratt & Whitney JT9D Model engines according to Pratt & Whitney Special Instruction No. 80F-90. (Class I, Urgent Action) (A-90-7)

Determine the minimum size of patch repair processing cracks that could initiate fatigue cracks in Pratt & Whitney JT9D model engine fan blades and determine the limits of the eddy current inspection or other inspection techniques to detect such cracks. If the minimum size of the patch repair processing cracks is smaller than the detectability limit of the inspection, issue an Airworthiness Directive to require on all blades that have been patch repaired, recurring inspections capable of detecting a propagating fatigue crack before it reaches a critical length. (Class II, Priority Action) (A-90-8)

KOLSTAD, Acting Chairman, BURNETT, LAUBER, and DICKINSON, Members, concurred in these recommendations.


By: James L. Kolstad
Acting Chairman