

4. RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board makes the following additional recommendations:

--to the Federal Aviation Administration:

Intensify research in the nondestructive inspection field to identify emerging technologies that can serve to simplify automate, or otherwise improve the reliability of the inspection process. Such research should encourage the development and implementation of redundant ("second set of eyes") inspection oversight for critical part inspections, such as for engine rotating components. (Class II, Priority Action) (A-90-167)

Encourage research and development of backup flight control systems for newly certificated wide-body airplanes that utilize an alternative source of motive power separate from that source used for the conventional control system. (Class II, Priority Action) (A-90-168)

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Conduct system safety reviews of currently certificated aircraft as a result of the lessons learned from the July 19, 1989, Sioux City, Iowa, DC-10 accident to give all possible consideration to the redundancy of, and protection for, power sources for flight and engine controls. (Class II, Priority Action) (A-90-169)

Analyze the dispersion pattern, fragment size and energy level of released engine rotating parts from the July 19, 1989, Sioux City, Iowa, DC-10 accident and include the results of this analysis, and any other peripheral data available, in a revision of AC 20-128 for future aircraft certification. (Class II, Priority Action) (A-90-170)

Conduct a comprehensive evaluation of aircraft and engine manufacturers' recordkeeping and internal audit procedures to evaluate the need to keep long-term records and to ensure that quality assurance verification and traceability of critical airplane parts can be accomplished when necessary at all manufacturing facilities. (Class II, Priority Action) (A-90-171)

Create the mechanism to support a historical data base of worldwide engine rotary part failures to facilitate design assessments and comparative safety analysis during certification reviews and other FAA research. (Class II, Priority Action) (A-90-172)

Issue an Air Carrier Operations Bulletin for all air carrier flightcrew training departments to review this accident scenario and reiterate the importance of time management in the preparation of the cabin for an impending emergency landing. (Class II, Priority Action) (A-90-173)

Issue an Airworthiness Directive to mandate service life limits or recurrent inspection requirements on GEAE CF6-6 engine stage 1 fan disks inspected in accordance with AD-89-20-01. (Class II, Priority Action) (A-90-174)

Issue an Airworthiness Directive based on the GEAE CF6-6 Engine Service Bulletin 72-962, pertaining to 119 stage 1 fan disks made from ALCOA forgings, to mandate compliance with the intent of the service bulletin by all operators. (Class II, Priority Action) (A-90-175)

--to the Air Transport Association:

Encourage member operators to incorporate specific maintenance inspection techniques in their maintenance manuals and maintenance contracts that simplify, automate, and provide redundant ("second set of eyes") inspection oversight for critical part inspection, such as for rotating engine parts. (Class II, Priority Action) (A-90-176)

--to the Aerospace Industries Association of America, Inc.

Encourage members to incorporate specific maintenance inspection techniques and inspection equipment in their service manuals that simplify, automate, and provide redundant ("second set of eyes") inspection oversight for critical part inspection, such as for rotating engine parts. (Class II, Priority Action) (A-90-177)

Also, during the course of this investigation, the National Transportation Safety Board issued the following safety recommendations to the Federal Aviation Administration:

On August 17, 1989

Conduct a directed safety investigation (DSI) of the General Electric CF6-6 turbine engine to establish a cyclic threshold at which the fan shaft and the fan disks should be separated and inspected for defects in the components. The DSI should include a review and analysis of:

- (a) the certification, testing and stress analysis data that were used to establish the life limits of the fan disks and fan shaft components and the recommended inspection frequencies for these components;*
- (b) the manufacturing processes associated with the production of the fan assembly and fan forward shaft;*
- (c) metallurgical analysis of the front flange of the fan forward shaft in which cracks were recently discovered;*
- (d) the maintenance practices involved in the assembly and disassembly of the fan disks and the fan forward shaft for the potential to damage the components during these processes;*

- (e) *nondestructive inspection of spare fan disks and fan forward shafts beginning with those components with the highest number of cycles in service; and*
- (f) *nondestructive inspections of fan disks on installed engines that may be performed by an approved inspection procedure. (Class I, Urgent Action) (A-89-95)*

Following completion of the directed safety investigation of the General Electric CF6-6 turbine engine discussed in A-89-95, issue an airworthiness directive to require appropriate inspections of the fan disks and the fan forward shaft at appropriate cyclic intervals. (Class I, Urgent Action) (A-89-96)

Evaluate, because of similarities in design, manufacture, and maintenance, the need for a directed safety investigation of all General Electric CF6-series turbine engines with the objectives of verifying the established life limits for rotating parts of the fan modules and establishing appropriate cyclic inspection requirements for these parts. (Class II, Priority Action) (A-89-97)

These recommendations were classified as "Closed-Superseded" by other recommendations issued on June 18, 1990.

On May 30, 1990

Revise 14 CFR 91,121 and 135 to require that all occupants be restrained during takeoff, landing, and turbulent conditions, and that all infants and small children below the weight of 40 pounds and under the height of 40 inches to be restrained in an approved child restraint system appropriate to their height and weight. (Class II, Priority Action) (A-90-78)

Conduct research to determine the adequacy of aircraft seatbelts to restrain children too large to use child safety seats and to develop some suitable means of providing adequate restraint for such children. (Class II, Priority Action) A-90-79)

The FAA Administrator responded to Safety Recommendations A-90-78 and -79 on August 6, 1990. Regarding A-90-78, the FAA issued a Notice of Proposed Rulemaking (NPRM) on February 22, 1990, for child restraint system provisions. The Safety Board is evaluating the response.

On June 18, 1990

- 1) *Develop, with the assistance of General Electric Aircraft Engines, an alternate method of inspecting the bore area of the CF6-6 engine fan Stage 1 rotor disks for the presence of surface cracks; issue an Airworthiness Directive to require that these disks be inspected with this method on an expedited basis, that disks found to have cracks be removed from service, and that the inspection be repeated at a cyclic interval based upon the crack size detectable by the inspection method, the stress level in the applicable area of the disk, and the crack propagation characteristics of the disk material. (Class I, Urgent Action) (A-90-88)*
- 2) *Evaluate currently certificated turbine engines to identify those engine components that, if they fracture and separate, could pose a significant threat to the structure or systems of the airplanes on which the engines are installed; and perform a damage tolerance evaluation of these engine components. Based on this evaluation, issue an Airworthiness Directive to require inspections of the critical components at intervals based upon the crack size detectable by the approved inspection method used, the stress level at various locations in the component, and the crack propagation characteristic of the component material. (Class III, Longer Term Action) (A-90-89)*
- 3) *Amend 14 CFR part 33 to require that turbine engines certificated under this rule be evaluated to identify those engine components that, if they should fracture and separate, could pose a significant threat to the structure or systems of an airplane; and require that a damage tolerance evaluation of these components be performed. Based on this evaluation, require that the maintenance programs for these engines include inspection of the critical components at intervals based upon the crack size detectable by the inspection method used, the stress level at various locations in the component, and the crack propagation characteristics of the component material. (Class III, Longer Term Action) (A-90-90)*
- 4) *Require turbine engine manufacturers to perform a surface macroetch inspection of the final part shape of critical titanium alloy rotating components during the manufacturing process. (Class II, Priority) (A-90-91)*