106 1117

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C.

ISSUED: December 21, 1979

Forwarded to:

Honorable Langhorne M. Bond
Administrator
Federal Aviation Administration
Washington, D.C. 20591

SAFETY RECOMMENDATION(S)

A-79-98 through -105

The National Transportation Safety Board has completed its determination of probable cause and final report on the American Airlines DC-10 accident in Chicago on May 25, 1979. The Safety Board's analysis of the evidence, and recommendations submitted to the Board by the other parties who participated in the investigation and public hearing, have identified several areas which we believe require the Federal Aviation Administration's (FAA) early attention. We recognize that the independent studies conducted by FAA following the accident also have identified needed specific actions, and the Safety Board is aware that several actions have already been taken or are anticipated as a direct result of those studies. While the Secretary of Transportation's current overview of the FAA's safety processes and the FAA's institution of a National Resource Specialist Program should generally enhance aviation safety, the Safety Board believes that further attention must be directed specifically toward fairly immediate solutions of some of the apparent deficiencies which led to this accident.

The Safety Board views the DC-10 accident with particular concern because the identified deficiencies touch almost every phase of aviation. First, the deficiencies raise concerns about aircraft design and certification. Putting aside any issue of whether or not the design of the DC-10 engine pylon assembly satisfied all of the structural requirements of the applicable regulations, its vulnerability to critical damage during maintenance apparently was not considered by either the manufacturer's design personnel or the FAA's certification review team. Additionally, the design of the aircraft's systems apparently failed to account for the possibility that a single event could simultaneously render critical portions of the flight control, hydraulic, and electrical systems inoperative. Although singularly, any one of these failures would probably have had little effect on the pilot's ability to fly the aircraft safely, in combination, they presented all but insuperable problems.

2662F

Secondly, the Safety Board is concerned that discrepancies in fabrication unrelated to the Chicago accident found in a number of engine pylons on other DC-10 aircraft can be attributed to deficiencies in the manufacturing and quality control processes of a major airframe manufacturer. That the deficiencies were not detected by the manufacturer shows weaknesses in their quality assurance program and FAA's surveillance of that program. Furthermore, the DC-10 maintenance program established by the Maintenance Review Board permitted these discrepancies to escape detection even after the aircraft had been in commercial service for many years.

Another key problem uncovered in the investigation of this accident is the method through which operators could establish and introduce procedures to conduct major maintenance. Two major U.S. air carriers with extensive maintenance and engineering capabilities were able to introduce the maintenance procedure which led to damage of critical structural elements of DC-10 aircraft. Even though the procedure deviated from that recommended by the airframe manufacturer, apparently neither carrier performed or was required to perform a sufficiently comprehensive review of the procedure to allow it to foresee that the procedure could lead to hazardous damage. Furthermore, the FAA's maintenance inspection program contains no mechanism requiring review and analysis of the operator's maintenance procedures to assure that optimum safety levels are maintained.

It is of special concern that one of the air carriers persisted in using the variant maintenance procedure despite the fact that, on two separate occasions before the Chicago accident, it had discovered damage to the pylon assembly which had been introduced during maintenance. Had more comprehensive communication taken place between the carrier, the manufacturer, and the FAA regarding the damage and how it was being inflicted, action might have been taken which could have prevented the Chicago accident; however, neither incident was brought to the attention of the FAA (nor was it clearly required to be). The manufacturer was notified of the problem because a structural repair was required for which the carrier requested engineering assistance from the manufacturer. While the manufacturer, in a report to other DC-10 operators, included information concerning these incidents, the report which was distributed failed to place any emphasis on the significance of the event. As a result the information was treated routinely by carriers and none sufficiently analyzed the variant maintenance practice to ascertain its potential for causing damage which would affect the structural integrity of the aircraft.

Finally, the Safety Board believes that the operational aspects of this accident involved limitations in the prescribed engine failure procedure. Flight simulation conducted as part of the accident investigation disclosed that the aircraft could have continued to fly if

sufficient airspeed had been maintained, notwithstanding the extensive damage caused by the structural failure of the engine pylon assembly. Successfully flying the aircraft was, however, contingent upon immediate recognition of the need to maintain an airspeed above the procedurally prescribed airspeed schedule--recognition which was inhibited in this accident by the damage itself because it rendered the asymetric slat and stall warning systems inoperable. The Safety Board questions whether the prescribed procedures were optimal for all conditions and whether they could not have provided for a safer speed margin to cope with unforeseen emergencies without producing intolerable effects on other aspects of the aircraft's performance.

In this accident, the flightcrew was adhering to the prescribed engine failure procedure and corresponding flight director logic which required a climb at the takeoff safety speed (V_2). This speed was approximately 6 knots below the stall speed of the wing on which the leading edge slats had retracted. The aircraft had attained a speed more than 10 knots higher than V_2 when it first became airborne; however, as it decelerated to the target V_2 speed, the left wing stalled without warning resulting in a roll and impact. The Safety Board notes that approved flight manuals for some other aircraft prescribe an engine failure procedure wherein the speed attained in excess of V_2, up to V_2 + 10 knots, is maintained during the climb. The Safety Board believes that the FAA should evaluate and determine the acceptability of the latter procedure as a standard for the industry.

While the overall safety record of the current generation of jet aircraft clearly indicates a basically sound foundation for the regulatory oversight of U.S. commercial aviation and the commitment of the industry to safety, the Safety Board is concerned that this accident may be indicative of a climate of complacency. Although the accident in Chicago on May 25 involved only one manufacturer and one airline, the Safety Board is concerned that the nature of the identified deficiencies in design, manufacturing, quality control, and maintenance and operational procedures may reflect an environment which could involve the safe operation of other aircraft by other carriers.

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

Incorporate in type certification procedures full consideration of:

(a) Factors which affect maintainability, such as accessibility for inspection, positive or redundant retention of connecting hardware and the clearances of interconnecting parts in the design of critical structural elements; and

(b) Possible failure combinations which can result from primary structural damage in areas through which essential systems are routed. (Class II--Priority Action) (A-79-98)

Insure that the design of transport category aircraft provides positive protection against asymmetry of lift devices during critical phases of flight; or, if certification is based upon demonstrated controllability of the aircraft under condition of asymmetry, insure that asymmetric warning systems, stall warning systems, or other critical systems needed to provide the pilot with information essential to safe flight are completely redundant. (Class II--Priority Action) (A-79-99)

Initiate and continue strict and comprehensive surveillance efforts in the following areas:

(a) Manufacturer's quality control programs to assure full compliance with approved manufacturing and process specifications; and

(b) Manufacturer's service difficulty and service information collection and dissemination systems to assure that all reported service problems are properly analyzed and disseminated to users of the equipment, and that appropriate and timely corrective actions are effected. This program should include full review and specific FAA approval of service bulletins which may affect safety of flight. (Class II--Priority Action) (A-79-100)

Assure that the Maintenance Review Board fully considers the following elements when it approves an Airline/Manufacturer Maintenance Program:

(a) Hazard analysis of maintenance procedures which involve removal, installation, or work in the vicinity of structurally significant 1/ components in order to identify and eliminate the risk of damage to those components;

(b) Special inspections of structurally significant components following maintenance affecting these components; and

1/ Structural significant items as defined in Appendix 1 of Advisory Circular 120-17A - "Maintenance Control by Reliability Methods."

(c) The appropriateness of permitting "on condition" maintenance and, in particular, the validity of sampling inspection as it relates to the detection of damage which could result from undetected flaws or damage to structurally significant elements during manufacture or maintenance. (Class II--Priority Action) (A-79-101)

Require that air carrier maintenance facilities and other designated repair stations:

(a) Make a hazard analysis evaluation of proposed maintenance procedures which deviate from those in the manufacturer's maintenance manual and which involve removal, installation, or work in the vicinity of structurally significant components; and

(b) Submit proposed procedures and analysis to the appropriate representative of the Administrator, FAA, for approval. (Class II--Priority Action) A-79-102)

Revise 14 CFR 121.707 to more clearly define "major" and "minor" repair categories to insure that the reporting requirement will include any repair of damage to a component identified as "structurally significant." (Class II--Priority Action) (A-79-103)

Expand the scope of surveillance of air carrier maintenance by:

(a) Revising 14 CFR 121 to require that operators investigate and report to a representative of the Administrator the circumstances of any incident wherein damage is inflicted upon a component identified as "structurally significant" regardless of the phase of flight, ground operation, or maintenance in which the incident occurred; and

(b) Requiring that damage reports be evaluated by appropriate FAA personnel to determine whether the damage cause is indicative of an unsafe practice and assuring that proper actions are taken to disseminate relevant safety information to other operators and maintenance facilities. (Class II--Priority Action) A-79104)

Revise operational procedures and instrumentation to increase stall margin during secondary emergencies by:

(a) Evaluating the takeoff-climb airspeed schedules prescribed for an engine failure to determine whether a continued climb at speeds attained in excess of V_2, up to V_2 + 10 knots, is an acceptable means of increasing stall margin without significantly degrading obstacle clearance.

(b) Amending applicable regulations and approved flight manuals to prescribe optimum takeoff-climb airspeed schedules; and

(c) Evaluating and modifying as necessary the logic of flight director systems to insure that pitch commands in the takeoff and go-around modes correspond to optimum airspeed schedules as determined by (a) and (b) above. (Class II--Priority Action) (A-79-105)

KING, Chairman, DRIVER, Vice Chairman, McADAMS, GOLDMAN, and BURSLEY, Members, concurred in the recommendations.

By: James B. King
Chairman