



National Transportation Safety Board

Washington, D. C. 20594

Safety Recommendation

Date: July 11, 1988

In reply refer to : A-88-73 through A-88-7

Honorable T. Allan McArtor
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On May 21, 1988, the captain of an American Airlines McDonnell Douglas DC-10-30 airplane executed a rejected takeoff (RTO) from runway 35L at the Dallas-Fort Worth Regional Airport, Texas, following a takeoff warning almost simultaneous with the "V₁" call and an illumination of a "Flap/Slat Disagree" light. In response to the RTO procedures, the airplane decelerated normally for 5 to 6 seconds, slowing from 178 knots, the maximum ground speed, to about 130 knots. At that point, the deceleration decayed rapidly, resulting in the airplane departing the end of the runway at a ground speed of about 97 knots. The nose gear collapsed in soft ground and the plowing action of the nose slowed the airplane to a stop about 1,000 feet beyond the end of the runway. The first officer and the flight engineer received serious injuries; the captain and 5 of the 240 passengers suffered minor injuries. Damage to the airplane was so extensive that repair may not be economically practical.

Although the National Transportation Safety Board's investigation is continuing, the postaccident investigation disclosed that the leading edge slats and trailing edge flaps were symmetrical and properly configured for the takeoff. The "disagree" warning was attributed to a slight out-of-tolerance condition of the left outboard leading edge slat and its position monitoring switch. Since a takeoff warning indication during the high-speed portion of a takeoff roll, irrespective of its occurrence with relation to V₁, can prompt a pilot to reject a takeoff with potentially critical results, the Safety Board believes that the flap/slat disagree logic of the DC-10 airplane takeoff warning system should be redesigned as necessary to eliminate the probability of a nuisance warning.

Of greater concern to the Safety Board, however, is the fact that the airplane failed to decelerate during the RTO according to test and certification data. It was clearly evident from the longitudinal acceleration data recorded on the airplane's digital flight data recorder (DFDR) that the airplane's brakes failed during the RTO. Preliminary examination of the airplane wheel brake systems revealed safety-related deficiencies in the "maximum brake wear" standards established for the DC-10-30 airplanes. Two of the 10 brakes on the airplane were almost new, and one appeared to have operated throughout the attempted RTO. All of the remaining

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eight wheel brakes were near the maximum wear limits before the RTO. The examination revealed that the additional wear of the brake material during the RTO permitted the brake pistons to extend beyond the normal limits and allow the piston O-ring seals to escape from the brake cylinders. With the displaced seals, the hydraulic fluid escaped from the brake cylinders, which disabled the brakes. The longitudinal acceleration data indicated that the majority of the eight worn brakes probably failed about 5 to 6 seconds after the initiation of the RTO and that the remainder failed in the next several seconds.

Maintenance inspection records indicate that the day before the accident the brake wear for each brake was within acceptable limits for operation in accordance with current American Airlines standards approved by the McDonnell Douglas Corporation. Other maintenance records showed that the eight brakes had incurred between 762 and 1,043 landings since the last brake overhaul. American Airlines indicated that an average of 1,000 landings can be obtained between overhauls.

At the time of the RTO, the airplane was operating at a gross weight of about 557,900 pounds and a maximum ground speed of about 178 knots. The kinetic energy was about 87 percent of the kinetic energy the brake system was designed to absorb. The Safety Board believes that the brake wear during the first 5 or 6 seconds of the RTO greatly exceeded the wear previously expected during a maximum gross weight/maximum speed RTO that normally lasts about 31 seconds. Since the eight brakes that were near the maximum brake wear limits failed because of extreme wear during the early part of the RTO, the Safety Board believes that the current maximum brake wear limits are not adequate. Although the cause of the greater-than-expected wear is still being investigated, the Safety Board believes that the worn brakes have too little mass to absorb or dissipate the heat built up during the RTO.

Although additional testing is scheduled to more accurately define the nature of braking performance with worn brakes under the conditions that existed, the Safety Board is concerned that many DC-10-30 and -40 airplanes are operating with brakes near the current wear limits and that the brakes will most likely fail if a high gross weight/high-speed RTO is attempted. Further, this problem may not be limited to the DC-10-30 and -40 airplanes, but it also may exist for other transport category airplanes because the Federal Aviation Administration has no requirements to ensure that the brake kinetic energy capacity ratings for wheel brake assemblies that are at the allowable "maximum brake wear" limit are greater than the kinetic energy absorption requirements that result from the critical combination of weight, true airspeed, altitude, temperature, runway slope and tail wind component for which the airplane is certified. The Civil Aviation Authority of Great Britain has long required dynamometer testing of worn brakes to establish kinetic energy absorption capacities and to establish brake wear limits that are more conservative than current U.S. industry practice. In contrast, U.S. aircraft certification procedures permit the use of new wheel brakes to establish conformance to stopping distance requirements and to define maximum brake wear limits.

Therefore, considering the potential for serious accidents in DC-10-30 and -40 airplanes and other turbojet transport category airplanes should a RTO be attempted at or near the maximum gross takeoff weights, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Require the McDonnell Douglas Aircraft Corporation to immediately redefine the "maximum brake wear" limits for the DC-10-30 and -40 airplanes to ensure that the brake kinetic energy capacity ratings for wheel brake assemblies that are at the allowable "maximum brake wear" limit are not less than the kinetic energy absorption requirements that result from the critical combination of weight, true airspeed, altitude, temperature, runway slope and tail wind component for which the airplane is certified. (Class I, Urgent Action) (A-88-73)

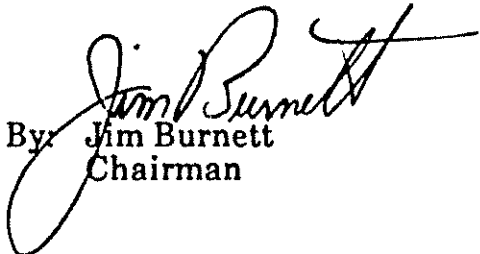
Issue a telegraphic airworthiness directive for DC-10-30 and -40 airplanes to require that operators comply with redefined brake wear limits. (Class I, Urgent Action) (A-88-74)

Revise 14 CFR 25.735(f) to require that the brake kinetic energy capacity ratings for wheel brake assemblies that are at the allowable "maximum brake wear" limit may not be less than the kinetic energy absorption requirements that result from the critical combination of weight, true airspeed, altitude, temperature, runway slope and tail wind component for which the airplane is certified. (Class I, Urgent Action) (A-88-75)

Verify, by conducting tests and data analysis as necessary, that all turbojet transport category airplanes meet the requirement of 14 CFR 25.735(f) for wheel brake assemblies at the "maximum brake wear" limits. (Class II, Priority Action) (A-88-76)

Require that McDonnell Douglas Corporation redesign the flap/slat disagree logic of the DC-10 airplane (all models) takeoff warning system as necessary to eliminate the probability of a nuisance warning. (Class II, Priority Action) (A-88-77)

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

By: 
Jim Burnett
Chairman