



National Transportation Safety Board

Washington, D.C. 20594
Safety Recommendation

Date: November 10, 1993

In reply refer to: A-93-143 through -152

Honorable David R. Hinson
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On April 6, 1993, at 0110 Hawaiian Standard Time (HST), China Eastern Airlines flight 583 (CES583), a McDonnell Douglas MD-11, Chinese registration B-2171, a scheduled international passenger flight from Beijing, China, to Los Angeles, California, with an intermediate stop in Shanghai, China, had an inadvertent deployment of the leading edge wing slats while in cruise flight, approximately 950 nautical miles south of Shemya, Alaska. The autopilot disconnected, and the captain was manually controlling the airplane when it progressed through several violent pitch oscillations and lost 5,000 feet of altitude. The captain regained stabilized flight, declared an emergency because of passenger injuries, and diverted to the U.S. Air Force Base, Shemya, Alaska. Of the 235 passengers and 20 crewmembers aboard the airplane, 2 passengers were fatally injured, and 149 passengers and 7 crewmembers received various injuries. The airplane received no external structural damage, but the passenger cabin interior was extensively damaged.¹

The National Transportation Safety Board determined that the probable cause of this accident was the inadequate design of the flap/slat actuation handle by the Douglas Aircraft Company (DAC) that allowed the handle to be easily and

¹For more detailed information, read Aircraft Accident Report--"Inadvertent In-Flight Slat Deployment, China Eastern Airlines Flight 583, McDonnell Douglas MD-11, B-2171, 950 Nautical Miles South of Shemya, Alaska, April 6, 1993" (NTSB/AAR-93/07)

inadvertently dislodged from the UP/RET position, thereby causing extension of the leading edge slats during cruise flight. The captain's attempt to recover from the slat extension, given the reduced longitudinal stability and the associated light control force characteristics of the MD-11 in cruise flight, led to several violent pitch oscillations.

Contributing to the violence of the pitch oscillations was the lack of specific MD-11 pilot training in recovery from high altitude upsets, and the influence of the stall warning system on the captain's control responses. Contributing to the severity of the injuries was the lack of seat restraint usage by the occupants.

The investigation revealed that the captain had recently completed recurrent training and was aware of all available information regarding the inadvertent slat extensions. Consequently, when the leading edge slats extended inadvertently, the airplane pitched up while the autopilot was engaged. The captain's initial corrective action was to verify that the flap/slat handle was in the UP/RET position. In addition, his initial reaction to counter the pitchup was to exert forward control column force to reduce the pitch attitude. The control force input when the autopilot disconnected resulted in an abrupt aircraft nose-down elevator command. The captain subsequently commanded elevator movements to correct the pitch attitude; however, these inputs were greater than desirable because of the airplane's light control force characteristics and were in response to the observed pitch attitude and the activation/deactivation of the airplane's stall warning system. This resulted in several violent pitch oscillations that resulted in the passengers and flightcrew members experiencing severe positive and negative G-forces.

The Safety Board is aware of five MD-11 incidents in which inadvertent leading edge slat extension resulted in significant overcontrol-related PIOs [pilot-induced oscillations] during recovery. In all of the cases, the autopilot was engaged at the beginning of the upset, and the stall warning system activated repeatedly through the PIO. Analysis of the cases suggests that the PIOs during recovery from the pitch attitude upsets are, in part, due to excessive and prolonged control movements by the pilot in reaction to the stall warning system activations.

The Safety Board is concerned that MD-11 pilots did not receive specific training related to high altitude upsets and stall warnings. The MD-11 is designed to fly with minimal longitudinal stability margin to improve the economic performance of the airplane. The control column forces needed for manually controlling the airplane during normal maneuvers in cruise flight are lighter than those that pilots might have encountered in their past experiences in other model airplanes, and they are considerably lighter than the control forces normally used at lower speeds and altitudes. DAC warns against excessive control inputs at high altitude and recommends that a target pitch attitude be used to minimize control commands during a high altitude upsets. However, in the event of a stall warning, this corrective action may conflict with the pilot's trained response to react to the stall warning. In addition, pilots are not provided information defining the "overshoots" and possible overcontrol-related PIOs that may be encountered when they delay pitch recovery while trying to silence the stall warning.

DAC recommends that the airplane be operated at lower altitudes if high altitude turbulence is encountered in order to increase the stall margin to 1.4G to 1.5 G. According to DAC, the Federal Aviation Administration (FAA) has no certification requirement for high altitude stall margins while the European Joint Airworthiness Authority requires that airplanes be operated with at least a 1.3-G margin. The Safety Board believes that a greater stall margin would provide the MD-11 with enhanced protection from unsafe pitch oscillations following turbulence and slat deployment-induced pitch upsets. In addition, the number and length of stall warning activations would be limited by the greater margin, thereby limiting the influence of the stall warning on the pilot during recovery.

The Safety Board is concerned that the margin between the MD-11's normal operating angle-of-attack (AOA) and that at which the stall warning system activates may be insufficient to allow for pilot recovery from unanticipated pitch attitude upsets without activation of the stall warning system. As evidenced by the incidents to date, the MD-11 stall warning system activations may result in or contribute to overcontrol-related PIOs during recovery from unanticipated pitch upsets.

The Safety Board believes that throughout the recovery sequence, the captain of the accident flight used more control than desirable or needed (approximately 50 percent of full authority), as a result of the airplane's low stick

force characteristics, and that he delayed elevator control responses until the stall warning deactivated. While the captain responded rapidly to the stall warnings with corrective elevator control, earlier response and lesser control inputs would have been more effective in stabilizing the pitch oscillations.

Once the stall warning activated, it stayed on until the AOA had decreased about 3 degrees below the initiation AOA and the normal G-load was about 0.2 G to 0.3 G. Each time the stall warning system deactivated, the pilot made nose-up control inputs in an attempt to restore a nose-up pitch attitude. However, the "overshoot" resulted in AOAs that were 5 to 10 degrees below the AOAs at stall warning activation and the vertical G reached -0.2 G and -0.8 G.

Contributing to the "overshoot" problem is the fact that the MD-11 stall warning system deactivates 1 second after the AOA decreases to the initiation threshold AOA, as a result of a system time delay. DAC has indicated that this 1-second time delay was intentionally designed into the stall warning system to prevent secondary stall warnings that might otherwise be induced by pilots if the stall warning stops exactly at the point where the stall warning conditions numerically cease. This delay appears to have caused the pilot to maintain nose-down elevator commands that much longer, which tended to push the pitch oscillations that much further into the nose-down regime.

Thus, the Safety Board believes that the MD-11's longitudinal stability, stall warning margin, stall buffet damage susceptibility, and pilot training must undergo a thorough review to ensure that routine pitch attitude upsets do not result in stall warning system activations, overcontrol-induced oscillations, structural damage, or any other condition that could lead to unsafe flight.

The investigation also revealed that the fire-blocking material under the dress covers of the passenger seat cushions had deteriorated to an extent that the material no longer provided fire protection of the seat cushions. Samples of fire-blocking material removed from the accident airplane, an ATR-42 that is currently being flown by a U.S. air carrier, as well as a new sample of the fire-blocking material, supplied by the manufacturer, failed to meet the standards set forth in 14 Code of Federal Regulations (CFR), Part 25.853. Additionally, the material degraded under both normal usage (in 2 years on the accident airplane) and simulated wear and tear conditions that equated to 2 years in service.

Based on the findings of the postaccident testing of this fire-blocking material, the Safety Board believes that all transport-category aircraft manufactured or operating in the United States that have seat cushions covered with Testori-manufactured fire-blocking material may not meet the airworthiness requirements of 14 CFR 121.312 and 14 CFR 25. Consequently, the Safety Board believes that 14 CFR 25.853 should, in addition to current burn tests of fire-blocking materials, require burn tests of like materials that have been subject to wear that simulates in-service wear. This later test would serve to establish a service life of the material in an effort to verify and maintain the integrity of the material. If the material is found to be defective, it should be removed from service.

Therefore, as a result of its investigation of this accident, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Require Douglas Aircraft Company to provide data needed to upgrade MD-11 training simulators to accurately represent the aircraft's longitudinal stability and control characteristics for high altitude cruise flight; and to develop specific guidance and simulator scenarios to train pilots in optimum techniques for the recovery from high altitude upsets, including those accompanied by stall warning. (Class II, Priority Action) (A-93-143)

Require operators to provide specific training for the recovery from high altitude upsets, including those accompanied by stall warning. (Class II, Priority Action) (A-93-144)

Establish high altitude stall margins for MD-11 airplanes in order to limit the effects of high altitude pitch upsets. (Class II, Priority Action) (A-93-145)

Evaluate the dynamics of the MD-11 stall warning system to ensure that the "on" and "off" logic are consistent with providing the pilot timely information. (Class II, Priority Action) (A-93-146)

Conduct a thorough review of the MD-11 high altitude cruise longitudinal stability and control characteristics, stall warning margins, and stall buffet susceptibility to ensure that pilot responses to routine pitch attitude upsets do not result in hazardous pitch oscillations, structural damage, or any other condition that could lead to unsafe flight. (Class II, Priority Action) (A-93-147)

Require that fire-blocking materials identified as Testori 0200-316 and 0206-100 be replaced with new materials that meet the fire retardant requirements of 14 CFR 25.853. (Class II, Priority Action) (A-93-148)


Amend 14 CFR 25.853 to include a requirement to test the fire-retardant properties of fire blocking materials after they have been subjected to in-service wear. (Class II, Priority Action) (A-93-149)

Conduct research upon the effects of actual in-service wear on the continued airworthiness of fire-blocking materials. Based on the findings, require periodic actual in-service tests of fire-blocking materials to verify compliance with the requirements of 14 CFR 25.853. (Class II, Priority Action) (A-93-150)

Inform other certification authorities of the findings regarding the deterioration of the fire-blocking materials noted in this accident investigation with the view toward replacing them, as required. (Class II, Priority Action) (A-93-151)

Direct principal maintenance inspectors to inform operators of the need to periodically inspect fire-blocking materials for wear and damage and to replace defective materials. (Class II, Priority Action) (A-93-152)

Chairman VOGT, Vice Chairman COUGHLIN, and Members LAUBER, HAMMERSCHMIDT, and HALL concurred in these recommendations.


By: Carl W. Vogt
Chairman