



National Transportation Safety Board

Washington, D.C. 20594
Safety Recommendation

Date: March 17, 1994

In reply refer to: A-94-37 through -
39

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

On December 7, 1992, about 1036 Coordinated Universal Time, a McDonnell Douglas MD-11, Taiwan registration B-150, China Airlines, flight CI-012, encountered moderate turbulence at flight level 330.¹ The airplane subsequently departed controlled flight and sustained damage to the left and right outboard elevator skin assemblies, portions of which separated from the airplane. The airplane was operating under the provisions of Title 14, Code of Federal Regulations, Part 129, as a scheduled passenger flight from Taipei, Taiwan, to Anchorage, Alaska. There were 246 passengers, 3 flightcrew members, 2 additional crewmembers, and 14 cabincrew members on board, none of whom reported any injuries. The airplane continued on and landed uneventfully at Anchorage, Alaska.²

The National Transportation Safety Board has determined that the probable cause of this incident was the light control force characteristics of the MD-11 airplane in high altitude cruise flight. The upset was induced by a moderate lateral gust and was exacerbated by excessive control deflections. Contributing to the incident was a lack of pilot training specific to the recovery from high altitude, high speed upsets in the MD-11.

¹The flight level is a pressure altitude of 33,000 feet.

²For more detailed information, read Aircraft Incident Report--"In-Flight Turbulence Encounter and Loss of Portions of the Elevators, China Airlines Flight CI-012, McDonnell Douglas MD-11-P, Taiwan Registration B-150, About 20 Miles East of Japan, December 7, 1992" (NTSB/AAR-94/02)

The captain reported that during cruise, at 33,000 feet, 290 knots, with the autopilot on, the airplane began a series of abrupt pitch and roll changes that lasted about 10 seconds. The autopilot and autothrottles automatically deactivated during the upset. The captain reportedly fought to keep control of the airplane and made several manual throttle changes to avoid stalling the airplane. The flight data recorder (FDR) information showed that the airplane pitched up and that the airspeed decreased, ultimately leading to stall buffet. The significant pitch and airspeed deviations that produced stall buffet imparted a dynamic load on the outboard elevators that resulted in structural overload and failure of portions of the outboard elevators.

The MD-11 airplane is designed with minimal static longitudinal stability, and, as a consequence, uses a Longitudinal Stability Augmentation System (LSAS). In addition to damping externally induced pitch disturbances, LSAS provides aerodynamic stall recovery assistance by commanding a 5-degree nose-down elevator deflection when the airplane is approaching a stall. To manually override this LSAS command, the pilot must apply about 50 pounds of force to the control column. FDR data indicated that the airplane stalled at least four times during the recovery, activating the LSAS stall recovery input. The captain overrode the 50-pound control column force and thereby maintained the airplane in a stalled condition for about 2 minutes and 45 seconds.

The Safety Board believes that the flightcrew's initial reaction to the lateral gust by using excessive control deflections worsened the situation. The pilot believed that he was experiencing severe turbulence and apparently recognized the motion cues as turbulence rather than stall buffet.

In an accident involving another MD-11, China Eastern Airlines flight 583, the Safety Board determined that the pilot also used excessive and delayed flight control deflections in response to stall warnings.³ In the China Eastern Airlines accident, two passengers were fatally injured, and many others were seriously injured.

The investigations of the China Eastern Airlines accident and the China Airlines incident revealed that neither flightcrews had received training to aid in recovering from high altitude, high speed upsets in the MD-11 or hands-on training

³See Aircraft Accident Report--"China Eastern Airlines Flight 583, 950 Nautical Miles

that would demonstrate the light control force characteristics when flying the airplane manually at high altitudes and at high speeds. Although the events leading to the China Eastern Airlines accident and the China Airlines incident were different, the Safety Board believes that both cases clearly indicate that specific training is needed to demonstrate the light control forces required of the MD-11 in high altitude, high speed flight. The training should ensure that pilots can properly recover from high altitude, high speed upsets without inducing severe acceleration loads or multiple stalls. That training should also include severe turbulence and stall buffet recognition.

In its report on the China Eastern Airlines accident, the Safety Board made the following safety recommendations to the Federal Aviation Administration (FAA) that it believes are relevant to the CI-012 incident:

A-93-143

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.

A-93-144

Require operators to provide specific training for the recovery from high altitude upsets, including those accompanied by stall warning.

A-93-145

Establish high altitude stall margins for MD-11 airplanes in order to limit the effects of high altitude pitch upsets.

A-93-146

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.

A-93-147

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.

On February 7, 1994, the FAA replied to the Safety Board concerning these safety recommendations, and the Safety Board is in the process of reviewing the FAA's response. The Safety Board notes that the FAA agreed with several of its recommendations and that it is currently conducting a special certification review of the MD-11's handling characteristics at high altitude.

The investigation of the incident involving CI-012 revealed that the MD-11 elevator skin ruptures that have occurred to date during in-flight upsets have been benign failures. That is, the skin rupture "decouples" the balance weight, which prevents high loads from the balance weight being transferred to the structure. In each incident, the airplane continued to its planned destination, and no control handling or performance problems were noted. Douglas has stated that the balances are required for aerodynamic purposes only in the event that hydraulic power to the elevators is lost. Further, Douglas has stated that the airplane can safely fly if two of the four elevators separate from the airplane. Nonetheless, because the elevator skin separation probably resulted from overstress produced during the stall buffet, the Safety Board believes that inspection, using nondestructive ultrasound "A" scan techniques, should be required for composite elevators on MD-11 airplanes that are known to have been operated outside the design buffet boundary.

The MD-11 airplane operates at lower longitudinal stability margins because of the aft center-of-gravity position that the airplane is designed for in high-altitude cruise flight. Control forces are lighter than for most conventional transport airplanes, while performing comparable maneuvers, because there are no compensatory changes in the airplane's pitch control system. Consequently, a pilot is more likely to overcontrol the MD-11 airplane during recovery from a turbulence upset. This overcontrol can lead to excessive positive load factors that can cause the airplane to enter stall buffet, and/or to excessive negative load factors that can lead to severe injuries to unrestrained passengers.

The Safety Board's investigation also revealed that Douglas had neither demonstrated by flight tests MD-11 stall recovery from abrupt high altitude, high speed upsets, nor was Douglas required to do so as part of the certification process. Further, the Safety Board is concerned that there are no specific certification requirements or flight test standards that address the issue of recovery from abrupt, high altitude, high speed upsets. The Board believes that the FAA should establish certification requirements for appropriate flight control handling characteristics, and require flight demonstrations to ensure that pilots can safely recover from abrupt, high altitude, high speed upsets.


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

Require Douglas Aircraft Company to advise MD-11 operators of the potential for damage to the composite elevators if the airplane is operated beyond the limits of the design buffet boundary, and to inform these operators that pilots might perceive the stall buffet (and subsequent loss of control) encountered during high altitude, high speed upsets as severe turbulence. (Class II, Priority Action) (A-94-37)

Require inspection, using nondestructive ultrasound "A" scan inspection techniques, of composite elevators on MD-11 airplanes that are known to have been operated outside the design buffet boundary. (Class II, Priority Action) (A-94-38)

Establish certification requirements for flight control handling characteristics, such as stick force per G limits, and require flight demonstrations to ensure that pilots can safely recover from abrupt high altitude, high speed upsets in transport-category airplanes. (Class II, Priority Action) (A-94-39)

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


By: Carl W. Vogt
Chairman