



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: May 25 1999

In reply refer to: A-99-39 through -44

Honorable Jane F. Garvey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

On July 13, 1996, at 2040 eastern daylight time, a McDonnell Douglas¹ MD-11, N1768D, operated by American Airlines as flight 107, experienced an in-flight upset near Westerly, Rhode Island.² One passenger received serious injuries, and one passenger and two flight attendants received minor injuries. The airplane was not damaged. Flight 107 was being conducted under the provisions of 14 Code of Federal Regulations (CFR) Part 121 as an international scheduled passenger service flight from London, England, to John F. Kennedy International Airport in Jamaica, New York.

On June 8, 1997, at 1948 Japan standard time, another MD-11, JA8580, operated by Japan Airlines as flight 706, experienced an in-flight upset near Nagoya, Japan. One flight attendant³ and three passengers received serious injuries, and four flight attendants and five passengers received minor injuries. The airplane was not damaged. Flight 706 was being conducted as a scheduled passenger flight from Hong Kong to Nagoya, Japan. The National Transportation Safety Board is participating in the Japanese Aircraft Accident Investigation Committee's (AAIC) investigation of the accident.

Investigations into these accidents revealed that both upsets occurred when flight crewmembers made manual flight control inputs while the autopilot system was engaged. The accidents raise concerns about the warning information and training provided to MD-11 pilots regarding proper use of the autopilot system that the Federal Aviation Administration should address.

¹ McDonnell Douglas is now known as Boeing, Douglas Products Division (DPD).

² For more information, see Brief of Accident NYC96LA148 (enclosed).

³ The seriously injured flight attendant died from her injuries in February 1999. However, the International Civil Aviation Organization states that an injury must result in death within 30 days of an accident to be classified as fatal.

The MD-11 is equipped with an automatic flight system that includes two flight control computers with integrated autopilots. Each autopilot is capable of automatically controlling the airplane in various vertical and lateral modes. Autopilot controls, located on the flight control panel, include the AUTO FLIGHT switch, which is used to engage the autopilot, and the pitch wheel, which can be used to adjust the airplane's rate of descent. The autopilot can be disconnected by pressing the autopilot disconnect switch on the flight control yoke.

According to Boeing DPD, the MD-11 autopilot cannot respond correctly when manual flight control inputs are made; therefore, pilots should never make control inputs when the autopilot is engaged. If control inputs are made when the autopilot is engaged, there will be a sudden and abrupt movement of some flight control surfaces and an associated but unpredictable aircraft response when the autopilot disengages.

When American Airlines flight 107 was cleared to descend to 24,000 feet, the first officer initiated a descent via the autopilot. With approximately 1,000 feet left in the descent, the captain became concerned that the airplane might not level off at the assigned altitude and instructed the first officer to slow the rate of descent. The first officer adjusted the pitch thumbwheel on the autopilot control panel; however, this maneuver proved ineffective. The captain then took manual control of the airplane, began applying back pressure to the control column, then disconnected the autopilot. Flight data recorder (FDR) data show that the airplane experienced an immediate 2.3 G pitch upset followed by additional oscillations, resulting in the injuries.

Although the Japanese AAIC's final report of the investigation into the Japan Airlines flight 706 in-flight upset has not yet been published, the Safety Board understands that when the airplane was cleared to descend from cruise altitude, the captain initiated a descent via the autopilot. During the descent, the captain stated that he believed the airplane was going to accelerate beyond the maximum operating airspeed. The captain took manual control of the airplane and began applying back pressure to the control column while the autopilot system was still engaged. As the captain's input force increased to about 50 pounds, the autopilot disconnected,⁴ and FDR data show that the airplane responded abruptly to the captain's accumulated input force. The airplane experienced a series of pitch oscillations, ranging from +2.78 to -0.5 G, resulting in the injuries.

After the American Airlines upset, the Safety Board researched the information provided to MD-11 pilots about disengaging the autopilot before making manual control inputs. A reference was found in the McDonnell Douglas MD-11 Flight Crew Operating Manual (FCOM) under the heading "Severe Turbulence and/or Heavy Rain Ingestion," which stated

⁴ The autopilot disconnected because of the activation of a feature known as the Autopilot Elevator Command Response Monitor. This monitor will disconnect the autopilot automatically when the position of the elevator differs from the autopilot commanded position. According to Boeing DPD, this can occur when a crewmember applies enough force to the control column to cause the elevator to deflect away from its autopilot commanded position.

Do not attempt to overpower the autopilot with control forces. This can cause the autopilot to disengage with too much control input, which could result in over control during recovery. Every attempt should be made not to over control.

Safety Board staff questioned Boeing DPD about whether this warning should apply to all flight conditions in which the autopilot may be used, not just conditions of severe turbulence and/or heavy rain ingestion. Following these discussions, the company issued MD-11 FCOM Temporary Revision 2-826, dated December 2, 1997, which contained the following warning in the “Automatic Flight System, General Overview” section:

Applying force to the control wheel or column while the autopilot is still engaged has resulted in autopilot disconnects and subsequent abrupt aircraft maneuvers. The pilot should never apply force to the control wheel or column while the autopilot is engaged. If the pilot is not satisfied with the autopilot performance, or is unsure that it is operating correctly, it should be immediately disconnected by using one of the autopilot disconnect switches.

The wording of this warning is appropriate; however, the Safety Board is concerned that, because many MD-11 operators use their own company flight manuals (CFM), which may not reflect the information in the McDonnell Douglas MD-11 FCOM, some pilots may not be aware of this warning. Placing the warning in the FAA-approved MD-11 Airplane Flight Manual (AFM), which is required for each airplane delivered, and requiring operators to include the warning in their CFMs will ensure that all pilots are made aware of this safety hazard. Therefore, the Safety Board believes that the FAA should require Boeing to revise the MD-11 AFM and all MD-11 operators to revise their CFMs to ensure that pilots are warned about the hazards of applying force to the control wheel or column while the autopilot is engaged.

Pitch upsets may be more severe in the MD-11 than in other airplanes because the control column forces needed for manual control of the MD-11 in cruise flight can be much lighter than those that pilots might have previously encountered in other airplane models and considerably lighter than those normally used at lower speeds and altitudes.⁵ As a result, pilots may overcontrol the MD-11 in manual flight after autopilot disengagement. To minimize this hazard, flight crew training should emphasize the proper procedures for autopilot disconnect and subsequent manual control of the airplane. Therefore, because of the potential for light stick forces in cruise flight, the Safety Board believes that the FAA should issue a flight standards information bulletin that directs principal operations inspectors to ensure that MD-11 training programs provide simulator instruction in the proper procedure for autopilot disengagement and the subsequent manual control of the airplane.

The certification requirements for transport-category autopilot systems are addressed in 14 CFR Part 25.1329, “Automatic Pilot System.” Compliance with this regulation is addressed in Advisory Circular 25.1329-1A, “Automatic Pilot Systems Approval.” However, neither of these

⁵ National Transportation Safety Board. 1997. *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.* Aircraft Accident Report NTSB/AAR-97-07. Washington, DC.

references includes information about how an airplane should respond when a manual flight control input is made while the autopilot is engaged. The Safety Board is aware that some transport-category airplane autopilot systems are designed to disconnect whenever pilots apply force⁶ to the flight controls. A similar design feature would have prevented the pitch upsets that occurred in these two accidents, and the Safety Board is aware that there may be other viable means to prevent such upsets. The Safety Board concludes that the current MD-11 autopilot design, which allows for upsets to occur when pilots apply force to the flight controls, is not acceptable. Therefore, the Safety Board believes that the FAA should require that the MD-11 autopilot system be modified to prevent upsets from occurring when manual inputs to the flight controls are made. In addition, the Safety Board believes that the FAA should review the design of all transport-category airplane autopilot systems and require modifications to those determined to be capable of creating upsets when manual inputs to the flight controls are made. Finally, the FAA should require all new transport-category airplane autopilot systems to be designed to prevent upsets when manual inputs to the flight controls are made.

In the American Airlines flight 107 upset, the first officer adjusted the pitch thumbwheel seven times as the autopilot was attempting to level the airplane after descending. Boeing DPD engineers informed the Safety Board that, when the autopilot is engaged, movement of the pitch thumbwheel interrupts the autopilot's altitude capture mode. Once the pitch thumbwheel is released, there is a 2-second delay before the autopilot can resume the level-off. Therefore, the American Airlines flight crewmember's repeated use of the pitch thumbwheel during the level-off process prevented the autopilot from capturing the assigned altitude. The Safety Board learned that American Airlines operations and training personnel were not aware of this 2-second delay and that it was not addressed in the manufacturer's operations or training material.

After the accident, Boeing DPD issued MD-11 FCOM Temporary Revision 3-101, dated June 18, 1997, which stated the following:

When the pitch wheel is moved, the AP [autopilot] will cancel the altitude capture mode (if engaged) and will not re-engage in altitude capture until the pitch wheel has come to rest for 2 seconds. Altitude capture will not engage if the pitch wheel is repeatedly adjusted.

Although this information adequately describes the effect of pitch thumbwheel adjustment during altitude capture, the Safety Board is again concerned that, because many MD-11 operators use their own CFMs rather than the McDonnell Douglas MD-11 FCOM, some pilots may not be aware of this warning. Placing the warning in the FAA-approved MD-11 AFM, which is required for each airplane delivered, and requiring operators to include the warning in their CFMs will ensure that all pilots are made aware of this potential safety hazard. Therefore, the Safety Board believes that the FAA should require Boeing to revise the MD-11 AFM and all MD-11 operators to revise their CFMs to ensure that pilots are warned about the hazards of adjusting the pitch thumbwheel during a level off with the autopilot system engaged.

⁶ To prevent nuisance disconnects caused by incidental pressure on the controls, the force required to disconnect the autopilot must exceed a threshold value.

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

Require Boeing to revise the MD-11 Airplane Flight Manual and all MD-11 operators to revise their company flight manuals to ensure that pilots are warned about the hazards of applying force to the control wheel or column while the autopilot is engaged. (A-99-39)

Issue a flight standards information bulletin that directs principal operations inspectors to ensure that MD-11 training programs provide simulator instruction in the proper procedure for autopilot disengagement and the subsequent manual control of the airplane. (A-99-40)

Require that the MD-11 autopilot system be modified to prevent upsets from occurring when manual inputs to the flight controls are made. (A-99-41)

Review the design of all transport-category airplane autopilot systems and require modifications to those determined to be capable of creating upsets when manual inputs to the flight controls are made. (A-99-42)

Require all new transport-category airplane autopilot systems to be designed to prevent upsets when manual inputs to the flight controls are made. (A-99-43)

Require Boeing to revise the MD-11 Airplane Flight Manual and all MD-11 operators to revise their company flight manuals to ensure that pilots are warned about the hazards of adjusting the pitch thumbwheel during a level off with the autopilot system engaged. (A-99-44)

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman

Enclosure