National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: November 10, 2004

In reply refer to: A-04-63

Honorable Michel Wachenheim
Director Général
Direction Général de l'Aviation Civile
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On November 12, 2001, about 0916:15 eastern standard time, American Airlines flight 587, an Airbus Industrie A300-605R,[1] N14053, crashed into a residential area of Belle Harbor, New York, shortly after takeoff from John F. Kennedy International Airport, Jamaica, New York. Flight 587 was a regularly scheduled passenger flight to Las Americas International Airport, Santo Domingo, Dominican Republic, with 2 flight crewmembers, 7 flight attendants, and 251 passengers aboard the airplane. The airplane's vertical stabilizer and rudder separated in flight and were found in Jamaica Bay, about 1 mile north of the main wreckage site.[2] The airplane's engines subsequently separated in flight and were found several blocks north and east of the main wreckage site. All 260 people aboard the airplane and 5 people on the ground were killed, and the airplane was destroyed by impact forces and a postcrash fire. Flight 587 was operating under the provisions of 14 *Code of Federal Regulations* Part 121 on an instrument flight rules flight plan. Visual meteorological conditions prevailed at the time of the accident.[3]

The National Transportation Safety Board determined that the probable cause of this accident was the in-flight separation of the vertical stabilizer as a result of the loads beyond ultimate design that were created by the first officer's unnecessary and excessive rudder pedal inputs. Contributing[4] to these rudder pedal inputs were characteristics of the Airbus A300-600 rudder system design and elements of the American Airlines Advanced Aircraft Maneuvering Program (AAMP).[5]

[1] The A300-605R is one of several variants of the A300-600 series airplane. The "5" refers to the type of engine installed on the airplane, and the "R" refers to the airplane's ability to carry fuel in the horizontal stabilizer.

[2] The vertical stabilizer is attached to the airplane's aft fuselage. The vertical stabilizer provides supporting structure for the rudder, which is an aerodynamic control surface that is used to make the airplane yaw, or rotate, about its vertical axis. An airplane cannot be flown without its vertical stabilizer.

[3] For more information, see *In-Flight Separation of Vertical Stabilizer, American Airlines Flight 587, Airbus Industrie A300-605R, N14053, Belle Harbor, New York, November 12, 2001*, Aircraft Accident Report NTSB/AAR-04/04 (Washington, DC: NTSB, 2004).

[4] Members Carmody and Healing voted against the Vice Chairman's revision, which reversed the order of the two contributing factors shown in the staff draft report.

[5] According to American Airlines, AAMP is "advanced training for experienced aviators involving upsets in aircraft attitude." AAMP consists of ground school and simulator flight training.

Rudder Pedal Inputs at High Airspeeds

The Safety Board notes that some rudder control system designs incorporate features (such as hinge moment capacity limits or yaw damper characteristics) that can help attenuate the hazardous buildup of sideslip[6] and/or vertical stabilizer loads resulting from alternating rudder pedal inputs at high airspeed, even though these features may not have been designed for this purpose. However, because alternating pedal inputs are not considered in the airplane certification standards, the absence of rudder system features that, in addition to their primary function, mitigate the hazards posed by such inputs does not necessarily constitute a design deficiency.

Some airplanes have hinge moment restrictions to limit the hydraulic force that the rudder actuator can apply.[7] With this design feature (also called a blowdown limit), the hydraulic power available to move the rudder is limited and cannot overcome high vertical stabilizer aerodynamic loads regardless of the pilot's commands. This feature adds an extra level of safety to prevent high vertical stabilizer aerodynamic loads.

In addition, the yaw damper can provide an additional level of protection against inappropriate alternating full rudder inputs commanded by the pilot. Most transport-category airplanes have yaw damper systems that automatically input a small amount of rudder deflection to dampen lateral-directional oscillations. These yaw damper systems, including the one on the A300-600, typically act independently of pedal commands, so the yaw damper may add to or subtract from the rudder commanded by the pilot.

The yaw damper is not intended to correct for or contain inappropriate oscillatory rudder pedal inputs commanded by the pilot. However, because the yaw damper can suppress all lateral-directional oscillations, it will tend to have such an effect and will consequently delay the buildup of the sideslip angle that can result from such pedal commands.

The Safety Board notes that the A300-600 yaw damper system allows a pilot input to override a yaw damper command when the rudder is at the full deflection limit permitted by the rudder travel limiter system for a particular airspeed. Under these conditions, a pilot input can override a yaw damper command in the opposite direction and keep the rudder at the full deflection limit by providing increasing pressure on the rudder pedals. Simulation and flight data recorder data indicated that the first officer's rudder pedal inputs during the flight 587 accident sequence were consistent with a suppression of yaw damper inputs at the rudder deflection limits. The simulations indicated that, if the yaw damper inputs had not been suppressed, the yaw damper would have moved the rudder partially back toward neutral, thereby lessening (but not preventing) the buildup of the sideslip angle and aerodynamic loads on the vertical stabilizer. Such a delay could have provided an additional level of safety because the initial response of the

[6] Sideslip is the angle between the longitudinal stability axis of the airplane and the direction of motion that produces an airspeed component along the airplane's lateral axis; simply stated, sideslip is a measure of the "sideways" motion of the airplane through the air.

[7] The A300-600 does not have this design feature.

airplane to a sustained rudder pedal input would not have been as severe and could have reduced the chance of pilot surprise or confusion.

The Safety Board concludes that, because of its high sensitivity (that is, light pedal forces and small pedal displacements), the Airbus A300-600 rudder control system is susceptible to potentially hazardous rudder pedal inputs at higher airspeeds.

Therefore, the National Transportation Safety Board recommends that the Direction Général de l'Aviation Civile:

> Review the options for modifying the Airbus A300-600 and the Airbus A310[8] to provide increased protection from potentially hazardous rudder pedal inputs at high airspeeds and, on the basis of this review, require modifications to the A300-600 and A310 to provide increased protection from potentially hazardous rudder pedal inputs at high airspeeds.[9] (A-04-63)

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any actions taken as a result of its safety recommendations and would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendation A-04-63 in your reply.

Chairman ENGLEMAN CONNERS, Vice Chairman ROSENKER, and Members CARMODY, HEALING, and HERSMAN concurred in this recommendation.

Original Signed

By: Ellen Engleman Conners
Chairman

[8] The A310 vertical stabilizer is structurally identical to that of the A300-600.

[9] This safety recommendation was also made to the Federal Aviation Administration (A-04-58).