NATIONAL TRANSPORTATION SAFETY BOARD
Public Meeting of October 26, 2004
(Information subject to editing)

Report of Aviation Accident
In-Flight Separation of Vertical Stabilizer
American Airlines Flight 587, Airbus Industrie A300-605R, N14053
Belle Harbor, New York
November 12, 2001
NTSB/AAR-04/04

This is a synopsis from the Safety Board's report and does not include the Board's rationale for the conclusions, probable cause, and safety recommendations. Safety Board staff is currently making final revisions to the report from which the attached conclusions and safety recommendations have been extracted. The final report and pertinent safety recommendation letters will be distributed to recommendation recipients as soon as possible. The attached information is subject to further review and editing.

EXECUTIVE SUMMARY

On November 12, 2001, about 0916:15 eastern standard time, American Airlines flight 587, an Airbus Industrie A300-605R, 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. 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 impact forces and a postcrash fire destroyed the airplane. 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.

The safety issues discussed in this report focus on characteristics of the A300-600 rudder control system design, A300-600 rudder pedal inputs at high airspeeds, aircraft-pilot coupling, flight operations at or below an airplane's design maneuvering speed, and upset recovery training programs. Safety recommendations concerning these issues are addressed to the Federal Aviation Administration and the Direction Général de l'Aviation Civile.

CONCLUSIONS

1. The captain and the first officer (the flying pilot) were properly certificated and qualified under Federal regulations. No evidence indicates any preexisting medical conditions that may have adversely affected the flight crew's performance during the flight. Flight crew fatigue was not a factor in this accident.

2. The accident airplane was properly maintained and dispatched in accordance with Federal regulations.

3. The air traffic controllers who handled American Airlines flight 587 were properly trained and qualified. The local controller complied with Federal Aviation Administration wake turbulence spacing requirements when handling flight 587 and Japan Air Lines flight 47, which departed immediately before flight 587.

4. The witnesses who reported observing the airplane on fire were most likely observing a fire from the initial release of fuel or the effects of engine compressor surges.

5. Flight 587's cyclic rudder motions after the second wake turbulence encounter were the result of the first officer's rudder pedal inputs.

6. Flight 587's vertical stabilizer performed in a manner that was consistent with its design and certification. The vertical stabilizer fractured from the fuselage in overstress, starting with the right rear lug while the vertical stabilizer was exposed to aerodynamic loads that were about twice the certified limit load design envelope and were more than the certified ultimate load design envelope.

7. The first officer had a tendency to overreact to wake turbulence by taking unnecessary actions, including making excessive control inputs.

8. The American Airlines Advanced Aircraft Maneuvering Program ground school training encouraged pilots to use rudder to assist with roll control during recovery from upsets, including wake turbulence.

9. The American Airlines Advanced Aircraft Maneuvering Program excessive bank angle simulator exercise could have caused the first officer to have an unrealistic and exaggerated view of the effects of wake turbulence, erroneously associate wake turbulence encounters with the need for aggressive roll upset recovery techniques, and develop control strategies that would produce a much different, and potentially surprising and confusing, response if performed during flight.

10. Before the flight 587 accident, pilots were not being adequately trained on what effect rudder pedal inputs have on the A300-600 at high airspeeds and how the airplane's rudder travel limiter system operates.

11. The A300-600 rudder control system couples a rudder travel limiter system that increases in sensitivity with airspeed, which is characteristic of variable stop designs, with the lightest pedal forces of all the transport-category aircraft evaluated by the National Transportation Safety Board during this investigation.

12. The first officer's initial control wheel input in response to the second wake turbulence encounter was too aggressive, and his initial rudder pedal input response was unnecessary to control the airplane.

13. Certification standards are needed to ensure that future airplane designs minimize the potential for aircraft-pilot coupling susceptibility and to better protect against high loads in the event of large rudder inputs.

14. Because of its high sensitivity (that is, light pedal forces and small pedal displacements), the A300-600 rudder control system is susceptible to potentially hazardous rudder pedal inputs at higher airspeeds.

15. To minimize the potential for aircraft-pilot coupling events, transport-category pilots would benefit from training about the role that alternating full control inputs can play in such events and training that

emphasizes that alternating full rudder inputs are not necessary to control a transport-category airplane.

16. There is a widespread misunderstanding among pilots about the degree of structural protection that exists when full or abrupt flight control inputs are made at airspeeds below the maneuvering speed.

17. Federal Aviation Administration standards for unusual attitude training programs that take into account industry best practices and are designed to avoid inaccurate or negative training wouldlead to improvement and standardization of industry training programs.

18. The use of lower levels of automation, such as simulators without motion or simple computer screen displays, may be more appropriate to provide the necessary awareness training with less danger of introducing incorrect information.

PROBABLE CAUSE

The National Transportation Safety Board determines 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 to these rudder pedal inputs were characteristics of the A300-600 rudder system design and elements of the American Airlines Advanced Aircraft Maneuvering Program.

SAFETY RECOMMENDATIONS

NEW RECOMMENDATIONS

As a result of the investigation of this accident, the National Transportation Safety Board makes the following recommendations:

To the Federal Aviation Administration:

1. Modify 14 *Code of Federal* Regulations Part 25 standards to include a certification standard that will ensure safe handling qualities in the yaw axis throughout the flight envelope, including limits for rudder pedal sensitivity. (A-04-XX)

2. After the yaw axis certification standard recommended in safety recommendation number 1 has been established, review the designs of existing airplanes to determine if they meet the standard. For existing airplanes designs that do not meet the standard, the FAA should determine if the airplanes would be adequately protected from the adverse effects of a potential aircraft-pilot coupling (APC) after rudder inputs at all airspeeds. If adequate protection does not exist, the FAA should require modifications, as necessary, to provide the airplanes with increased protection from the adverse effects of a potential APC after rudder inputs at high airspeeds. (A-04-XX)

3. Review the options for modifying the A300-600 and the A310 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. (A-04-XX)

4. Develop and disseminate guidance to transport-category pilots that emphasizes that multiple full deflection, alternating flight control inputs should not be necessary to control a transport-category

airplane and that such inputs might be indicative of an adverse aircraft-pilot coupling event and thus should be avoided. (A-04-XX)

5. Amend all relevant regulatory and advisory materials to clarify that operating at or below maneuvering speed does not provide structural protection against multiple full control inputs in one axis or full control inputs in more than one axis at the same time. (A-04-XX)
6. Adopt and disseminate written guidance for use in developing and accepting upset recovery programs; such guidance could take the form of an advisory circular and should reflect the industry's best practices and be designed to avoid inaccurate or negative training. (A-04-XX)

7. Along with developing the guidance recommended in safety recommendation number 6, evaluate issues concerning the level of automation appropriate to teaching upset training, and develop and disseminate guidance that will promote standardization and minimize the danger of inappropriate simulator training. (A-04-XX)

To the Direction Général de l'Aviation Civile :

8. Review the options for modifying the A300-600 and the A310 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. (A-04-XX)

Previously Issued Recommendations Resulting From This Accident Investigation:

To the Federal Aviation Administration:

1. Require the manufacturers and operators of transport-category airplanes to establish and implement pilot training programs that: (1) explain the structural certification requirements for the rudder and vertical stabilizer on transport-category airplanes; (2) explain that a full or nearly full rudder deflection in one direction followed by a full or nearly full rudder deflection in the opposite direction, or certain combinations of sideslip angle and opposite rudder deflection can result in potentially dangerous loads on the vertical stabilizer, even at speeds below the design maneuvering speed; and (3) explain that, on some aircraft, as speed increases, the maximum available rudder deflection can be obtained with comparatively light pedal forces and small pedal deflections. The FAA should also require revisions to airplane and pilot operating manuals that reflect and reinforce this information. In addition, the FAA should ensure that this training does not compromise the substance or effectiveness of existing training regarding proper rudder use, such as during engine failure shortly after takeoff or during strong or gusty crosswind takeoffs or landings. (A-02-01)

2. Carefully review all existing and proposed guidance and training provided to pilots of transport-category airplanes concerning special maneuvers intended to address unusual or emergency situations and, if necessary, require modifications to ensure that flight crews are not trained to use the rudder in a way that could result in dangerous combinations of sideslip angle and rudder position or other flight parameters. (A-02-02)

3. Require all manufacturers of transport-category airplanes to review and, if necessary, revise their maintenance manual inspection criteria for severe turbulence and extreme in-flight maneuvers to ensure that loads resulting from positive and negative vertical accelerations, as well as lateral accelerations, are adequately addressed. (A-03-41)

4. Require all manufacturers of transport-category airplanes to establish and validate maximum threshold

values for positive and negative vertical and lateral G accelerations beyond which direct manufacturer oversight and intervention is required as a condition for returning the airplane to service. (A-03-42)

5. Require all operators of airplanes that have experienced accelerations exceeding the threshold values established as a result of Safety Recommendation A-03-42 (or that the operator has reason to believe might have exceeded those thresholds), as determined from FDR and other available data, to notify the FAA immediately of such high loading events and provide all related loads assessment and inspection results. (A-03-43)

6. Require manufacturers of transport-category airplanes to immediately notify the appropriate certification authority of any event involving accelerations exceeding the threshold values (or that the manufacturer has reason to believe might have exceeded those thresholds) necessitating the intervention of the manufacturer, and provide all related loads assessment and inspection results. (A-03-44)

7. Require that within 2 years, all Airbus A300-600/A310 and Boeing 747-400 airplanes and any other aircraft that may be identified as recording filtered data be retrofitted with a flight data recorder system capable of recording values that meet the accuracy requirements through the full dynamic range of each parameter at a frequency sufficient to determine a complete, accurate, and unambiguous time history of parameter activity, with emphasis on capturing each parameter's dynamic motion at the maximum rate possible, including reversals of direction at the maximum rate possible. (A-03-50)

Previously Issued Recommendations Classified in This Report:

1. Safety Recommendation A-96-120 (previously classified "Open—Acceptable Response") is classified "Open—Unacceptable Response."