Log 2529

National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: November 7, 1994

In reply refer to: A-94-181 through -185

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

On October 31, 1994, about 1600 central standard time, a Simmons Airlines Avions de Transport Regional ATR-72-210, operating as American Eagle flight 4184, crashed into a soybean field 3 miles south of Roselawn, Indiana. The flight was on an instrument flight rules flight plan from Indianapolis, Indiana, to O'Hare International Airport, Chicago, Illinois, and had been placed in a holding pattern over Roselawn because of weather delays being experienced at O'Hare. The airplane's primary and secondary radar returns disappeared from the air traffic control radar shortly after the flight was cleared to continue the holding pattern and to descend from 10,000 to 8,000 feet. Witnesses observed the airplane descend out of a low overcast and strike the ground in a steep nose-down attitude. All 64 passengers and 4 crewmembers were killed in the accident.

The investigation of the accident is continuing, and probable causes have not been determined. However, based upon evidence uncovered in the investigation, the National Transportation Safety Board believes that the Federal Aviation Administration (FAA) should take immediate action pertaining to ATR-42 and ATR-72 aircraft. Evidence from air traffic control (ATC) sources and the airplane's flight recorders have prompted the Safety Board's concern that the loss of control leading to the steep dive might be attributed to the weather conditions encountered by the flight and the characteristics of the aerodynamic design and flight control systems of the airplane.

The investigation has determined that flight 4184 was delayed by an ATC ground hold at Indianapolis for 38 minutes before it was released for flight. At the time of release, there was no anticipation of a need for en route airborne holding. However, the dynamic weather conditions resulted in additional delays in the O'Hare arrivals. Consequently, flight 4184 had been in the holding pattern near Roselawn for about 32 minutes before the accident. The weather conditions during the period of holding were characterized by a temperature near freezing and visible moisture--probably a supercooled cloud. There was no evidence of convective activity or significantly high values of water content.

The flight data recorder (FDR) and cockpit voice recorder (CVR) data show that the airplane was configured with flaps extended to 15° at airspeeds varying between 160 knots and 175 knots while maintaining level flight at 10,000 feet in the holding pattern. The airplane's deice system was operating. Shortly after the flight was cleared by ATC to descend to 8,000 feet and told to expect an additional 10 minutes in the holding pattern, the airplane began to descend, airspeed increased to between 180 and 185 knots, and the audible flap configuration overspeed warning sound activated. The FDR data show that when descending through about 9,400 feet, the wing flaps began to retract and concurrently the airplane's angle of attack began to increase. Within 8 seconds, about 1 second after the flaps were fully retracted, the vane angle of attack (VAOA) increased to about 6°. The data show that at that point, the autopilot disengaged and within an additional 1/4 second, the ailerons deflected to near maximum travel in the right-wing-down direction. The airplane responded to the aileron movement with a rapid roll to the right. The FDR data also show that the right rolling moment was momentarily reversed when the VAOA was reduced to below 6° and the ailerons deflected in the left-wing-down direction. The right rolling moment reoccurred as the VAOA again increased to 6° and the aileron deflected in the right-wing-down direction. The final roll to the right was not corrected, and the airplane entered a steep nose-down, inverted attitude.

The Safety Board is aware that similar uncommanded autopilot disengagements and uncommanded lateral excursions have occurred on ATR-42 airplanes during the past 6 years, although none have resulted in a nonrecoverable loss of control. The Safety Board investigated one such event that occurred on December 22, 1988, at Mosinee, Wisconsin. A review of the FDR data for that airplane showed similarities with the data from flight 4184. That is, as the angle of attack increased, an autopilot disengagement and rapid roll command was evident. In the 1988 occurrence, the flightcrew regained control after losing 600 feet of altitude, and the subsequent landing was uneventful.

Following the 1988 event, the FAA issued Airworthiness Directive (AD) 89-09-05, revised May 3, 1992, which required that the following statement be incorporated into the ATR 42 Airplane Flight Manual (AFM):

> When operating in icing conditions, as defined in the AFM, or when freezing rain is forecast or reported, use of the autopilot is prohibited.
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> Warning
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> Prolonged operation in freezing rain should be avoided. Ice accretion due to freezing rain may result in asymmetric wing lift and associated increased aileron forces necessary to maintain coordinated flight. Whenever the aircraft exhibits buffet onset, uncommanded roll, or unusual control wheel forces, immediately reduce angle-of-attack and avoid excessive maneuvering.

On June 28, 1989, ATR issued Service Bulletin ATR-42-57-0018, Revision 1, which described the installation of vortex generators on the upper surface of the wing forward of the ailerons. The FAA subsequently issued an amendment to AD 89-09-05 which accepted the compliance with the ATR Service Bulletin as terminating action for the AFM limitation regarding use of the autopilot when operating in icing conditions. The ATR-72 incorporated the installation of vortex generators in the original design. Thus, there was no prohibition against use of the autopilot when operating an ATR-72 in icing conditions.

Although the Safety Board was not involved in the aerodynamic performance analysis or flight test activities that led to the ATR Service Bulletin or FAA AD, the Board believes that the vortex generators were intended to: (1) Prevent premature boundary layer separation on the aileron control surface(s) as a result of an in-flight accumulation of ice on the upper wing surface aft of the deicing boot; and (2) to assist in the recovery from a roll departure. Nevertheless, the Safety Board is aware of another occurrence wherein the flightcrew of an ATR-42 experienced roll control difficulties while operating in icing conditions, although the vortex generators had been installed.

Therefore, the Safety Board is concerned that an amount of ice that can be accumulated under some flight conditions encountered during winter line operations may be more critical to the flying quality of ATR-42 and ATR-72 airplanes than to other airplanes. The Safety Board believes that a slight amount of ice accumulated under some conditions may produce boundary layer separation on

one or both ailerons that can result in abrupt changes to the aileron hinge moment. The Safety Board believes that the control wheel force-versus-airplane rolling moment characteristic may be unstable depending upon the angle of attack and the magnitude of aileron deflection. The circumstances of this accident and the previous incidents involving ATR-42 airplanes indicate that the use of the autopilot can mask the onset of the lateral control instability. The Safety Board believes that the autopilot, operating in a lateral navigation or attitude hold mode, will provide commands to the lateral control system that compensate for aileron hinge moment changes until a given force or position error threshold is reached. The autopilot will then disengage, and the lateral control system will react to the abnormal aileron forces. Because the FDR does not record control wheel force, the Safety Board could not determine the amount of pilot force needed to counter the uncommanded aileron deflection. However, the Safety Board believes that it is likely that both pilots were attempting to exert the force necessary to level the wings and were unable to do so, except for those instances in which the angle of attack was lowered sufficiently.

On November 4, 1994, the FAA issued a Flight Standard Information Bulletin (FSIB) to the operators of ATR-42 and ATR-72 airplanes based upon the preliminary findings of the ATR-72 accident. The FSIB solicited compliance with operating procedures to minimize exposure to potentially adverse environmental conditions. The policy states:

1. Holding Procedures in icing conditions must be accomplished with flaps zero degrees and at an airspeed not less than VMHBO Icing and preferably at a speed equal to or greater than conservative maneuvering speed for the ATR-42 or 175 knots for the ATR-72.

2. For all operations in icing conditions, the propeller RPM must be at or above 86 percent, as stated in the Airplane Operating Manual.

3. Use of the autopilot in icing conditions is prohibited.

4. Pilots should be advised that prolonged operations in temperatures near freezing with visible moisture, should be avoided. Operations in these conditions, or with visible ice on the aircraft, may result in asymmetric wing lift and associated increased aileron forces necessary to maintain coordinated flight. Whenever the aircraft exhibits buffet onset, uncommanded roll, or unusual control wheel

forces, immediately reduce the angle-of-attack and avoid excessive maneuvering.

While the Safety Board concurs that the issuance of the FSIB was prudent and justified as an immediate measure to reduce the possibility of accidents involving the ATR-42 and ATR-72 airplanes in icing conditions, the Safety Board is concerned that these measures may not be adequate. The prohibition of the use of the autopilot may be the most beneficial guidance, since pilots manually controlling the airplane may note changes of the aileron control forces in time to take corrective actions. However, the Board believes that the onset of the problem may be rapid and the Board is not certain that the pilot would be able to recover from a full deflection aileron maneuver.

The Safety Board also believes that increasing the wing angle of attack, in the presence of upper surface ice, is the primary initiating event for the loss of control. Increases in AOA may result from such events as raising the flaps, slowing down, turning, initiating climbs, or arresting descents. The Safety Board does not yet understand the effect that flap position may have on the nature and position of the accumulation of ice and the subsequent effect on aileron hinge moments. Further, the Safety Board believes that pilots should be given more guidance regarding the recovery procedure; that is, lowering the angle of attack might be counter to a pilot's natural reaction to a steep roll and pitch maneuver.

Although the findings of this investigation are preliminary, the Safety Board believes that the flying qualities of ATR-42 and ATR-72 airplanes, when operating in icing conditions, should be reexamined. The Safety Board believes that, until further information is available, stronger precautionary measures should be taken by the FAA to prevent a recurrence of icing-related accidents involving the ATR airplanes. The Safety Board recommends that the Federal Aviation Administration:

Conduct a special certification review of the ATR-42 and ATR-72 airplanes, including flight tests and/or wind tunnel tests, to determine the aileron hinge moment characteristics of the airplanes operating with different airspeeds and configurations during ice accumulation and with varying angles of attack following ice accretion. As a result of the review, require modifications as necessary to assure satisfactory flying qualities and control system stability in icing conditions. (Class II Priority Action) (A-94-181)

Prohibit the intentional operation of ATR-42 and ATR-72 airplanes in known or reported icing conditions until the effect of upper wing surface ice on the flying qualities and aileron hinge moment characteristics are examined further as recommended in A-94-181 and it is determined that the airplanes exhibit satisfactory flight characteristics. (Class I, Urgent Action) (A-94-182).

Issue a general notice to ATC personnel to provide expedited service to ATR-42 and ATR-72 pilots who request route, altitude, or airspeed deviations to avoid icing conditions. Waive the 175 knot holding air speed restriction for ATR-42 and ATR-72 airplanes pending acceptable outcome of the special certification effort. (Class I, Urgent Action) (A -94-183)

Provide guidance and direction to pilots of ATR-42 and ATR-72 airplanes in the event of inadvertent encounter with icing conditions by the following actions: (1) define optimum airplane configuration and speed information; (2) prohibit the use of autopilot; (3) require the monitoring of lateral control forces; (4) and define a positive procedure for reducing angle of attack. (Class I, Urgent Action) (A-94-184)

Caution pilots of ATR-42 an ATR-72 airplanes that rapid descents at low altitude or during landing approaches or other deviations from prescribed operating procedures are not an acceptable means of minimizing exposure to icing conditions. (Class I, Urgent Action) (A-94-185)

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

By: Jim Hall
Chairman