National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: July 10, 2006

In reply refer to: A-06-48 (Urgent) through -51
Reiterate A-03-53 and -54

Honorable Marion C. Blakey
Administrator
Federal Aviation Administration
Washington, D.C. 20591

Based on preliminary findings from the National Transportation Safety Board's ongoing investigation of an incident involving the loss of control of a Saab SF340 and findings following previous icing accidents/incidents investigated by the Australian Transport Safety Bureau (ATSB), the Safety Board has become concerned about deficiencies in the cold weather operational procedures used by Saab SF340 pilots, as well as the performance of the airplane in icing conditions. This letter proposes recommendations that, the Board believes, require immediate attention to mitigate the existing risk to the Saab SF340 fleet when operating in icing conditions.

Background

On January 2, 2006, about 1439 Pacific standard time, American Eagle flight 3008, a Saab-Scania AB SF340B+, N390AE, departed from San Luis County Regional Airport (SBP), San Luis Obispo, California, destined for Los Angeles International Airport (LAX), Los Angeles, California. The airplane encountered icing conditions during the en route climb and departed controlled flight at an altitude of about 11,500 feet mean sea level (msl) and descended to an altitude of about 6,500 feet msl. The pilots recovered control of the airplane and continued to their scheduled destination, where they landed about 1540 without further incident. American Eagle Airlines, Inc., operated the scheduled domestic passenger flight under the provisions of 14 *Code of Federal Regulations* (CFR) Part 121. The 2 flight crewmembers, 1 flight attendant, and 25 passengers were not injured, and the airplane did not sustain any damage. Instrument meteorological conditions (IMC) prevailed, and the flight was operating on an instrument flight rules flight plan.

The flight crewmembers stated in postincident interviews that before the incident flight, they had encountered light rime icing and moderate turbulence on the inbound leg to SBP as they were descending from 9,000 to 5,000 feet msl. The pilots stated that, while preparing for the return flight to LAX from SBP, they reviewed the weather conditions for the intended route of flight. They indicated that the operator's dispatch package noted two AIRMET (airmen's meteorological information) reports for icing in clouds and two PIREPs (pilot weather reports) for turbulence. The pilots discussed the conditions that they had encountered on the way in, as well as the conditions for the intended route of flight outbound. They indicated that, because of the gusty wind conditions and the short runway at SBP, the captain would perform the departure and turn control of the airplane over to the first officer after completing the climb checklist at the acceleration altitude.

In accordance with American Eagle's minimum equipment list (MEL),[1] the incident airplane was dispatched with the continuous mode of the boot deice system inoperable[2] for the previous inbound flight and subsequent incident flight. The flight crewmembers reported that they performed the manual test[3] of the deicer boots as called for in the MEL and observed the operation of the inboard and outboard wing boot segments; however, they could not see the stabilizer segments and did not have qualified ground personnel available to observe the test as required by the MEL. The pilots reported that they did confirm illumination of the green boot inflation lights on the overhead panel when they pressed the manual buttons.

In accordance with company procedures that require flight crews to activate the deice system at the first sign of ice accretion and operate the deice boots continually, the crew stated that they were prepared to operate the deice boots in manual mode as needed during the flight. They departed in level 2 weather conditions (defined as 10° Celsius or colder with visible moisture) and with the engine anti-ice on.[4] The captain reported that he turned control of the airplane over to the first officer as they climbed through 2,500 feet with the autopilot engaged in

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[1] American Eagle's MEL permitted the dispatching of an airplane into known or forecast icing conditions with an inoperable automatic deice control system if specified tasks are completed. These tasks included a ground test of the deicer boots using the manual mode and a visual confirmation of their inflation and deflation by qualified ground personnel.

[2] The continuous mode was inoperable because of a deicer timer light failure.

[3]The stabilizer and wing deice panel is on an overhead panel just above the captain's right shoulder. Operating the deice boots in manual mode requires the crew to press three buttons in the following sequence each time a deice boot inflation is desired: STAB, which operates the horizontal and vertical stabilizer boots simultaneously; WING OUTBOARD; WING INBOARD; then STAB again. A green light above each button illuminates as long as the selected boot is inflated, and the selected boot will stay inflated as long as the crewmember presses the button. Crews are recommended to press each button for 6 seconds. In automatic operation, the deicing system operates the deice boots in the following 3-minute cycle: the horizontal and vertical stabilizer boots are inflated for 6 seconds, the wing outboard boots are inflated for 6 seconds, the wing inboard boots are inflated for 6 seconds, the horizontal and vertical stabilizer boots are inflated again for 6 seconds, then the system rests for 156 seconds.

[4] The Saab SF340 Airplane Operating Manual (AOM) specifies that, in level 2 conditions, the crew should use left and right engine anti-ice. Level 2 conditions also require operating wing and stabilizer deice in the continuous mode or manually on a continuous basis as needed at the first sign of ice accumulation anywhere on the airplane. The AOM also states that if ice accumulation is more than 5 mm (1/4 inch), the crew will need to operate the system manually between the automatic cycles.

the medium climb[5] mode and at an airspeed of 165 knots. The pilots stated that the weather radar was on and that they did not observe any activity on it. The first officer reported that, once he assumed control of the airplane, he switched the autopilot to the vertical speed (VS) mode, which gives pitch attitude commands to maintain the vertical speed existing at the time of mode engagement.[6]

The flight crewmembers reported that they initially observed no ice accretion during the climb but continued to scan for it. The captain reported that as they were climbing through 11,000 feet at 165 knots and were approaching their cruise altitude, he observed some light rime ice on the windshield wipers,[7] as well as a narrow strip of ice about 1/2 inch wide on the left-wing leading edge.[8] The captain further stated that he looked up at the switch panel and prepared to press the manual stabilizer deice buttons. He reported that as he transitioned his gaze from outside to inside, the windshield went opaque in a matter of seconds. He then felt a heavy vibration in the airframe. He stated that immediately thereafter, the airplane's nose dropped, the left wing dropped, and the autopilot disconnected. He stated that he grabbed the control yoke after the autopilot disconnected to take control of the airplane and that the clacker sounded (indicating an imminent stall), the stickshaker activated, and the ground proximity warning system emitted a "bank angle" aural warning.

Information from the digital flight data recorder (DFDR) showed that the upset began at 130 knots indicated airspeed (KIAS) and before the stall warning activated. The airplane initially rolled to 86º left wing down after the autopilot disconnected. The airplane then rolled right to a maximum of 140º right wing down while the airplane pitched to 48º nose down. The airplane then rolled back to the left then back to the right. The pilots reported that the airplane vibrated again but less violently than the first episode. The captain leveled the wings and began pulling up on the control yoke. At this point, he instructed the first officer to manually operate the deice boots. The captain stated that he pushed the condition levers to the maximum position and brought the power levers to idle. The captain reported that the airplane stabilized in roll and that he could hear chunks of ice shedding off and hitting the fuselage. DFDR data indicate that the loss of control lasted about 50 seconds. The captain stated that he kept the airplane in a nose-down attitude, maintaining a 500 feet per minute rate of descent.

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[5] When using the flight director/autopilot, available vertical modes include the following: VS (vertical speed), IAS (indicated airspeed), and CLIMB (high, medium, and low). The climb mode setting is determined by the flight control computer, which computes and updates a climb IAS as a function of altitude with medium airplane weight. A high climb setting provides a high airspeed and low rate of climb, medium provides a medium airspeed and a medium rate of climb, and low provides a low airspeed and a high rate of climb.

[6] In certain situations when the autopilot is in VS mode, sufficient power is not available to sustain the climb, and the autopilot will allow the airspeed to bleed off to a stall while it is commanding the airplane to maintain a constant vertical speed.

[7] The captain reported that the windshield wipers are usually the first place that he notices ice. The AOM also notes in its discussion of ice detection that ice will likely first be seen on windshield wipers. The AOM states that "crew vigilance in observing ice formation is the primary means of determining that the airplane has entered ice accretion conditions. Visual indication can usually be detected on such surfaces as windshield wipers, prop spinners, wing leading edges, and engine inlets."

[8] The captain only determined the spanwise width of the ice and did not estimate its chordwise thickness.

Simultaneous Upward Movement of Both Ailerons

DFDR data from the incident airplane also indicated that the left and right ailerons simultaneously moved upward during the initial upset event.[9] Typically, the upward movement of one aileron may be counteracted by control forces applied by the pilot and by the opposing forces generated by the opposite, downward-moving aileron. However, as is believed to have occurred in the October 31, 1994, accident involving American Eagle flight 4184 (an ATR-72), which crashed in Roselawn, Indiana,[10] following a loss of control in-flight, control wheel forces can be so high that a flight crew cannot counteract the problem. In the case of flight 3008, the flow separation over both wings likely caused upward forces at both ailerons sufficient to activate the mechanical breakout mechanism that is in place between the captain's and first officer's control wheels. This anomalous aileron movement effectively prohibits roll control of the airplane. The Safety Board's investigation into this aspect of the incident is ongoing.

Previous Saab 340 Icing Events

The ATSB has investigated three Saab SF340 icing incidents in the past 8 years in which airspeed decayed with ice accumulation; two of these incidents resulted in an aerodynamic stall and departure from controlled flight. The first incident occurred on November 11, 1998, in Eildon Weir, Victoria.[11] After being slowed to enter a holding pattern, the airplane experienced an aerodynamic stall at 137 KIAS. Its airspeed decreased 4 knots in the 4 seconds before the upset occurred. During the stall event and recovery, the airplane rolled left approximately 126º, pitched down approximately 35º, and descended 2,300 feet. The crew received no stall warning or stickpusher before the stall. The second incident occurred on June 28, 2002, during descent into icing conditions near Bathurst, New South Wales.[12] The airplane stalled at 109 KIAS, reached a maximum negative pitch of 27º, and rolled to the left to a maximum of 109º. Its airspeed decreased 20 knots during the 8 seconds before the upset occurred. During recovery, the airplane rolled to the right and descended to 112 feet above ground level. The crew received no stall warning or stickpusher before the stall. The third incident occurred June 18, 2004, 83 kilometers southwest of Albury, Victoria.[13] The airplane experienced a rapid loss of 8 to 13 knots in airspeed while in icing conditions. The stickshaker activated for 2 seconds when the autopilot disconnected after holding level flight (by providing nose-up elevator movement and

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[9] Uncommanded upward movement of an aileron can be caused by airflow separation over the wing in front of the aileron.

[10] The Roselawn, Indiana, ATR-72 accident occurred following loss of control due to a sudden, uncommanded upward movement of one aileron caused by airflow separation over the wing in front of that aileron. The airplane had been operating in freezing rain, and a ridge of ice developed aft of the deice boots, which induced the airflow separation over the aileron. For more information, see National Transportation Safety Board *In-flight Icing Encounter and Loss of Control Simmons Airlines, d.b.a. American Eagle Flight 4184 Avions de Transport Regional (ATR) Model 72-212, N401AM, Roselawn, Indiana, October 31, 1994; Volume 1: Safety Board Report (Revision 9/13/02),* Aircraft Accident Report NTSB/AAR-96/01 (Washington, DC: NTSB, 1996).

[11] ATSB Report 199805068, Saab-SF340A, VH-LPI Eildon Weir, Victoria, 11 November 1998.

[12] ATSB Report BO/200203074, *Inflight Loss of Control to Airframe Icing,* Saab-340B, VH-OLM, 28 June 2002.

[13] ATSB Report 200402415, Saab-SF340A, VH-KEQ, 18 June 2004.

automatically re-trimming) as airspeed decreased. The indicated airspeed decreased and the angle of attack (AOA) increased during the incident.

Discussion

Minimum Airspeeds for Flight in Icing Conditions

American Eagle's 340B+ AOM calls for flight crews to compute a final clean airplane climb speed, or Vcln,[14] and to add 15 knots to that value to determine the minimum speed with ice accretion (Vcln+15). For the incident flight, Vcln was computed to be 126 KIAS, and the minimum speed with ice accretion was 141 KIAS. Saab recommends adding 13 knots to Vcln to determine the minimum speed with ice accretion. Using Saab's recommended value, the minimum speed with ice accretion for the incident flight would have been 139 KIAS.

DFDR data for the incident airplane showed that it experienced a decay of airspeed while climbing and that the rate of this decay accelerated in the final 10 seconds before the autopilot disconnected and the airplane departed controlled flight at an airspeed of 130 KIAS. The DFDR data also revealed that about 26 seconds before the stall roll departure, while the airplane was at a speed of 144 KIAS, the airplane began to experience a slight rolling anomaly that was counter to the direction of the aileron input. Further aileron input from the autopilot arrested this slight rolling motion. However, previous Safety Board accident investigations[15] have shown that the introduction of a rolling motion in the direction opposite to that expected from an aileron deflection is an indication of a localized airflow separation, particularly in the area of the wing near one or both of the ailerons. Further, movement of the ailerons in the trailing-edge-down direction can induce an expansion of the area of separated airflow and result in an abrupt roll control reversal. Additionally, the onset of a localized airflow separation at an airspeed much higher than normally expected for an aerodynamically clean airplane is indicative of airplane performance degradation due to ice accretion. Thus, the incident airplane was exhibiting significant climb performance and control degradations at 144 KIAS, or 5 knots faster than Saab's recommended minimum safe speed in icing conditions.

Because the data from the four incidents discussed in this letter suggest that the onset of performance degradations in icing conditions can occur at airspeeds above current published minimum safe speeds in icing conditions, the Safety Board is concerned that the recommended speeds do not provide an adequate margin of safety when operating in icing conditions. The Safety Board considers the minimum safe speed in icing conditions to be the speed that provides a substantial margin above the speed at which loss of control occurs. The minimum safe speed should also provide pilots adequate time to successfully exit icing conditions with consideration

[14] Vcln is defined as 1.2xVs1g, where Vs1g is the 1G stall speed for the given weight and flaps-up configuration.

[15] For more information see a) National Transportation Safety Board *In-Flight Icing Encounter and Uncontrolled Collision with Terrain, Comair Flight 3272, Embraer EMB-120RT, N265CA, Monroe, Michigan, January 9, 1997*, Aircraft Accident Report NTSB/AAR-98/04 (Washington, DC: NTSB, 1998) and b) incident DCA98SA029, which is discussed in the Comair flight 3272 report.

that airplane performance is likely to degrade further while the airplane is leaving icing conditions.

In the case of American Eagle flight 3008, a minimum speed in icing conditions of 150 KIAS may have provided a safer margin above the speed at which flow separation initiated and would have provided additional time for the pilots to notice deteriorating conditions. For the weight of the airplane, 150 KIAS would be 1.45xVs1g. Because the loss of control due to icing encounters can be extremely dangerous and such icing encounters can occur during any season and in any part of the United States, mitigating actions should be taken immediately. Therefore, the Safety Board believes that the FAA should immediately require all operators of Saab SF340 series airplanes to instruct pilots to maintain a minimum operating airspeed of 1.45xVs during icing encounters and before entering known or forecast icing conditions and to exit icing conditions as soon as performance degradations prevent the airplane from maintaining 1.45xVs.

Revised Stall Protection for Flight in Icing

The Safety Board is aware that during Transport Canada's examination of the Saab SF340 before its 1994 introduction into Canadian operations, Transport Canada became concerned that the airplane could stall during flight into icing conditions with no warning to the crew. To comply with Canadian requirements, the manufacturer added stall protection logic to Canadian SF340s and an "ice speed" switch that was to be activated during flight into icing. When activated, it provides a lower trigger AOA in the stall warning system and a greater level of stall protection than SF340s not certified for operations in Canada. According to a Saab representative, a review of the Saab SF340 fleet revealed that there are no Saab 340 series airplanes operating outside of Canada that have the "ice speed" switch modification installed.

In its report on the 1998 Saab SF340 icing incident in Eildon Weir, Victoria, the ATSB concluded that if the airplane had been equipped with the Canadian "ice speed" stall protection system, the system would have activated 9 seconds before the prestall buffet that was encountered before the stall departure.[16] The ATSB further stated that, "This evidence reinforces [National Transportation Safety Board Recommendation A-98-96[17] to the FAA]: Require the manufacturers and operators of all airplanes that are certified to operate in icing conditions to install stall warning/protection systems that provide a cockpit warning (aural warning and/or stickshaker) before the onset of stall when the airplane is operating in icing conditions." In the report's "Safety Action" section, the ATSB reiterated its interim recommendation to require that "Saab modify the stall warning system of the worldwide fleet of Saab 340 airplanes to include the ice speed modification, as a matter of priority."[18]

Examination of the DFDR AOA parameters for the American Eagle flight 3008 incident indicated that the stall system should have activated at a vane[19] AOA of 12.5º, which was 3 seconds after the roll departure. If the "ice speed" modification to the stall warning system had

[16] ATSB Report 199805068, Saab-SF340A, VH-LPI Eildon Weir, Victoria, 11 November 1998 p. 40.

[17] Safety Recommendation A-98-96 is currently classified "Open—Unacceptable Response."

[18] ATSB Report 199805068, Saab-SF340A, VH-LPI Eildon Weir, Victoria, 11 November 1998 p. 47.

[19] The AOA sensor for the stall protection system is called a vane.

been installed and operating during the incident flight, the system would have activated 4 seconds earlier at a vane AOA of 5.9º, or 1 second before the roll departure. Although, in this case, the ice speed modification would have provided only an additional 4 seconds of warning, the ATSB's findings in its investigations further demonstrate the additional safety margin provided by the "ice speed" modification. Based on the evidence that American Eagle flight 3008 departed controlled flight at 130 KIAS and that the stall warning system did not activate before the departure from controlled flight, the Safety Board is concerned that the current fleet of Saab SF340 series airplanes operating in the United States does not provide adequate warning to flight crews of an approaching aerodynamic stall in icing conditions. Therefore, the Safety Board believes that the FAA should require the installation of modified stall protection logic in Saab SF340 series airplanes certified for flight into known icing conditions.

Ice Detection System

American Eagle flight 3008 was not equipped with an ice detection system. Without an ice detection system, pilots are dependent on visual inspection (which may be impaired by workload, the airplane's geometry, and visibility) or their awareness of performance degradation. The Safety Board is concerned that a hazardous performance degradation could develop if the deice boots are not activated in a timely fashion either due to an unexpected icing encounter or lack of pilot awareness of ice accretion in times of higher workload. If American Eagle flight 3008 had been equipped with an ice detection system, the crew would have been alerted to the ice buildup sooner and would have been able to take steps to avoid the stall departure. The Board is aware of other turbopropeller airplanes (for example, the EMB-120, ATR -42, and -72) that are equipped with ice detectors and that ice detectors are an option for the Raytheon King Air, Falcon 50 business jet, and Lear 60 business jet, to name a few. Because an ice detection system will assist pilots of Saab SF340 series airplanes in taking appropriate action when entering icing conditions before the controllability of the airplane is adversely affected, the Safety Board believes that the FAA should require the installation of an ice detection system on Saab SF340 series airplanes.

Use of Autopilot in Icing Conditions

The limitations section of the American Eagle 340B+ AOM stipulates that IAS mode is the only authorized flight director/autopilot mode if an airplane is climbing during ice accretion or with residual ice on the airframe. In IAS mode, the flight control computer gives pitch attitude commands to maintain the indicated airspeed existing at the time of mode engagement. (Minimum climb speed with ice accretion is Vcln+15 per the AOM; note that the Safety Board is recommending a new speed with ice accretion in any configuration of 1.45xVs).

DFDR data from American Eagle flight 3008 indicated that the autopilot was in the VS hold mode for the climb out from SBP. When ice accretion disturbed the airflow over the wings, the autopilot slowly increased pitch in an attempt to maintain the selected vertical speed. Because power was not sufficient to maintain the vertical speed at the desired airspeed, the airspeed decreased. Although the slow pitch-up movement commanded by the autopilot probably was not detectable by the flight crew's kinesthetic or vestibular senses, the pilots could have detected the change in pitch and the slowly decreasing airspeed by visually inspecting the airplane's primary flight instruments. However, use of the autopilot likely reduced the flight crew's visual sampling of this information.

If the flight crew had been flying the airplane manually, the airplane's performance degradation would have been more readily apparent. The flying pilot would have maintained a continuous scan of the primary flight instruments and would have been required to increase backpressure on the yoke or continuously manually trim the airplane to maintain the desired climb rate. The pilot also likely would have been aware of the resulting changes in pitch and any tendency for the airplane to roll. It is also more likely that he would have noticed the associated decrease in airspeed and reduced the airplane's pitch angle and climb rate to avoid further airspeed reductions.

The Safety Board notes that numerous previous icing accidents and incidents have occurred while the airplane was operating in icing conditions with the autopilot engaged. Information provided by the ATSB indicates that the three loss-of-control incidents involving SF340s occurred with the autopilot engaged. In addition, a March 19, 2001, accident in which an EMB-120, operating as Comair flight 5054, lost control while flying in icing conditions at 17,000 feet msl also involved autopilot usage.[20] The final report on the Safety Board's investigation of the ATR-72 accident in Roselawn, Indiana, also documented five previous ATR-42 incidents in which the upset occurred while the airplane was being operated with the autopilot engaged in icing conditions. The Board also addressed the use of autopilot in icing conditions in its final report for the EMB-120 accident in Monroe, Michigan; the report documented four incidents (including the subject accident) in which the autopilot was engaged at the time of the event. As a result of its investigation of the Monroe, Michigan, accident, the Safety Board issued Safety Recommendation A-98-97, which asked the FAA to require all operators of turbopropeller-driven air carrier airplanes to require pilots to disengage the autopilot and fly the airplane manually when they activate the anti-ice systems. The FAA disagreed with the recommended action, and the recommendation was classified "Closed—Unacceptable Action" on January 12, 2001.

The Safety Board recognizes that, during its evaluation of this recommendation, the FAA considered concerns from the commercial aviation industry regarding the desirability of judiciously using autopilot during periods of high workload. Although the Board considers intermittent use of the autopilot during periods of high workload to be acceptable, the Board is concerned that prolonged use of autopilot during high workload periods especially while operating in icing conditions can mask important changes in performance and handling quality that can occur. Disengaging the autopilot when operating in icing conditions will allow pilots to sense tactile cues associated with the aerodynamic effects of airplane icing and enhance their ability to control the airplane. Because the circumstances of the American Eagle Saab SF340 incident further demonstrate this principle, the Safety Board believes that the FAA should require all operators of turbopropeller-driven airplanes to instruct pilots, except during

[20] The description for this accident, DCA01MA031, can be found on the Safety Board's Web site at <http://www.ntsb.gov>.

intermittent periods of high workload, to disengage the autopilot and fly the airplane manually when operating in icing conditions.

Low-Speed Warning

The loss of airspeed in the American Eagle flight 3008 and the Australian incidents cited previously demonstrate that if the flight crews had been alerted to the rapid airspeed decrease in a timely fashion, they may have been able to take corrective action and perhaps avoid the stall. The lack of low-airspeed alerting was also found to be an issue during the Safety Board's investigation of the October 25, 2002, accident involving a Raytheon (Beechcraft) King Air A100, which crashed at Eveleth-Virginia Municipal Airport, Eveleth, Minnesota.[21] The flight crew involved in this accident allowed airspeed to decrease to dangerously low levels while attempting to execute a nonprecision instrument approach in IMC, and the airplane entered an aerodynamic stall from which the flight crew did not recover before the airplane impacted terrain. The two pilots and six passengers were killed, and the airplane was destroyed by impact forces and a postcrash fire.

The Safety Board concluded that the circumstances of the Eveleth accident and a history of accidents involving flight crew's lack of low-airspeed awareness indicate that reliance on flight crew vigilance and on existing stall warnings does not provide adequate protection against hazardous low-airspeed situations. As a result, the Safety Board issued Safety Recommendations A-03-53 and -54 to the FAA, which asked the FAA to do the following:

> Convene a panel of airplane design, aviation operations, and aviation human factors specialists, including representatives from the National Aeronautics and Space Administration, to determine whether a requirement for the installation of low-airspeed alert systems in airplanes engaged in commercial operations under 14 *Code of Federal Regulations* Parts 121 and 135 would be feasible, and submit a report of the panel's findings. (A-03-53)
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> If the panel requested in Safety Recommendation A-03-53 determines that a requirement for the installation of low-airspeed alert systems in airplanes engaged in commercial operations under 14 *Code of Federal Regulations* Part 121 and 135 is feasible, establish requirements for low-airspeed alert systems, based on the findings of the panel. (A-03-54)

In a January 12, 2005, response letter, the FAA reported that it shares the Safety Board's concern regarding flight crew awareness of low-airspeed situations but provided no information regarding planned actions. Pending a more detailed response, Safety Recommendations A-03-53 and A-03-54 were classified "Open—Await Response."

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[21] See National Transportation Safety Board, *Loss of Control and Impact With Terrain Aviation Charter, Inc., Raytheon (Beechcraft) King Air A100, N41BE, Eveleth, Minnesota, October 25, 2002*, Aircraft Accident Report NTSB/AAR-03/03 (Washington, DC: NTSB, 2003).

Although Safety Recommendations A-03-53 and A-03-54 resulted from a stall accident that did not involve icing conditions, these recommendations are particularly pertinent to the Saab SF340 icing upsets. Specifically, airframe ice will cause an airplane to slow down much faster than normal and stall at a much higher airspeed than normal. Both conditions result in the pilot having much less time to recognize and react to the performance degradations. In fact, many of the SF340 crews indicated in postincident statements that the resulting upsets came as a complete surprise.

The Safety Board notes that, following the March 19, 2001, incident involving Comair flight 5054, a low-airspeed alert system was developed for Embraer EMB-120 airplanes. FAA Airworthiness Directive 2001-20-17, effective October 22, 2001, mandated installation of the alert system on the EMB-120. The system is designed to alert flight crews to low airspeed in certain airplane configurations and in icing conditions through the use of an amber-colored indicator light installed in the control panel and an audible alert. The development of this system for EMB-120s demonstrates that it may be feasible to develop low-airspeed alert systems for most airplane types. The Safety Board concludes that if a low-airspeed alerting system had been installed on American Eagle flight 3008, the flight crew would have been alerted sooner to the degraded airplane performance that resulted from airframe icing and may have been able to take timely corrective action to avoid a stall. Therefore, the Safety Board reiterates Safety Recommendations A-03-53 and A-03-54.

Flight With an Inoperative Automatic Boot Deice System

As was stated previously, American Eagle flight 3008 departed SBP with the automatic boot inflation system inoperative. The Safety Board anticipates that specific operational changes regarding the permitted dispatching of SF340s with an inoperative automatic boot deice system may not be necessary if the recommendations discussed in this letter are incorporated. However, the Safety Board is concerned that the manual operation of the deicing boots in a correct and effective fashion may be neglected when flying in icing conditions during periods of high workload situations, such as departure and approach/landing. Thus, the Safety Board will evaluate the success in accomplishing the intent of these safety recommendations and may consider the need for more stringent operational restrictions when the automatic deicing system is inoperative.

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

> Require all operators of Saab SF340 series airplanes to instruct pilots to maintain a minimum operating airspeed of 1.45xVs during icing encounters and before entering known or forecast icing conditions and to exit icing conditions as soon as performance degradations prevent the airplane from maintaining 1.45xVs. (A-06-48) Urgent
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> Require the installation of modified stall protection logic in Saab SF340 series airplanes certified for flight into known icing conditions. (A-06-49)

Require the installation of an icing detection system on Saab SF340 series airplanes. (A-06-50)

Require all operators of turbopropeller-driven airplanes to instruct pilots, except during intermittent periods of high workload, to disengage the autopilot and fly the airplane manually when operating in icing conditions. (A-06-51)

In addition, the National Transportation Safety Board reiterates the following recommendations to the Federal Aviation Administration:

Convene a panel of airplane design, aviation operations, and aviation human factors specialists, including representatives from the National Aeronautics and Space Administration, to determine whether a requirement for the installation of low-airspeed alert systems in airplanes engaged in commercial operations under 14 *Code of Federal Regulations* Parts 121 and 135 would be feasible, and submit a report of the panel's findings. (A-03-53)

If the panel requested in Safety Recommendation A-03-53 determines that a requirement for the installation of low-airspeed alert systems in airplanes engaged in commercial operations under 14 *Code of Federal Regulations* Part 121 and 135 is feasible, establish requirements for low-airspeed alert systems, based on the findings of the panel. (A-03-54)

Acting Chairman ROSENKER and Members HERSMAN and HIGGINS concurred with these recommendations.

[Original Signed]

By: Mark V. Rosenker
Acting Chairman