SUBMISSION OF THE

AIR LINE PILOTS ASSOCIATION

TO THE

NATIONAL TRANSPORTATION SAFETY BOARD

REGARDING AN INCIDENT INVOLVING

AMERICAN EAGLE AIRLINES FLIGHT 3008

Santa Maria, CA

January 2, 2006

1 Summary

On January 2, 2006 a Saab 340 aircraft operated by American Eagle Airlines as flight 3008 encountered icing conditions during an enroute climb over Santa Maria, California. At 11,700 feet mean sea level, (msl) the airplane departed controlled flight and descended to 6,500 feet msl before the crew was able to regain full control. The crew having declared an emergency elected to continue to their scheduled destination at Los Angeles International Airport (LAX) where they landed without further incident. The airplane did not sustain any damage and there were no injuries reported by the 2 flight crew members, 1 flight attendant, or 25 passengers onboard. The flight had originated from San Luis County Regional Airport (SBP), San Luis Obispo, California.

As party to this investigation, The Air Line Pilots Association, International (ALPA) is providing this submission to present our analysis of the factual records and provide recommendations to reduce the risk for future incidents or accidents that could occur under similar circumstances.

2 History of flight

The incident flight was the fifth trip of the day for the flight crew, and their second trip in the incident airplane. On the trip prior to the incident flight, the captain was the pilot flying and had observed light rime ice accumulating on the wing surface and windshield wipers during their descent from 9,000 to 5,000 feet msl into SBP. The de-ice boot system was operated manually because the de-ice timer control system was logged as inoperative from a previous flight. The crew had an uneventful landing at SBP and arrived at the gate about 15 minutes late with an anticipated turnaround time of 20 minutes.

While at the gate the captain took time to review the dispatch weather information which included two AIRMET (airmen's meteorological information) reports that indicated a possibility of icing in clouds. Based upon the information he had, the captain concluded that the anticipated weather conditions fell within operational criteria defined by the American Eagle S340 Airplane Operating Manual (AOM) as "*Ice Protection Level 2*". The airplane was equipped with the icing protection systems required by the AOM for these conditions which included Left & Right Engine anti-ice operational and the Wing/Stab boots operational either in the continuous mode or activated manually. Because the de-ice timer control system was reported to be inoperative the crew anticipated having to activate the Wing/Stab boots manually if needed. And as an extra precaution due to the short runway and gusty wind conditions anticipated at takeoff, it was decided that the captain would fly the initial departure and then transfer control authority to the first officer (FO) at the airplane's acceleration altitude.

The flight departed from SBP in instrument meteorological conditions (IMC) with the captain flying the takeoff and initial climb as planned. At 2,500 feet msl the FO assumed the pilot-flying duties with the autopilot engaged in the medium (M) Climb mode which according to the AOM provides pitch commands to maintain approximately 160 knots indicated airspeed (KIAS), depending on the aircraft's pressure altitude. Shortly after taking control the FO then selected the Vertical Speed (VS) mode of the autopilot which maintains the rate of climb present at the time of VS mode selection. While in the VS

mode the autopilot will allow the airspeed to vary in order to hold constant the selected rate of climb. According to the Digital Flight Data Recorder (DFDR) at the time the autopilot transitioned to VS mode the airspeed briefly decreased from 160 to about 135 KIAS then accelerated up to 180 KIAS as the airplane continued in the climb.

According to the AOM, "*VS mode may be used for enroute climbs, but the crew shall pay particular attention to IAS (indicated airspeed).*" The AOM further states, "*If climbing during ice accretion or with residual ice on the airframe, IAS is the **only** FD/AP mode authorized. However, other vertical modes may be used temporarily to transition to an appropriate climb speed.*" The captain, according to his statements, diligently looked for possible ice accumulation on the wings, propellers and windshield wipers through out the climb because they had encountered icing conditions on their inbound trip. Up to this point when the crew initially transitioned the autopilot from Climb to VS they had not yet encountered ice accretion and was operating in accordance with their AOM procedures. Their AOM minimum climb speed was 126 KIAS for a clean wing and 141 KIAS if in icing conditions (Vcln+15).

The flight was cleared to continue directly to the San Marcus VOR and the crew intended to climb to an altitude of about 13,000 feet msl. The autopilot remained selected in VS mode and according to the DFDR, at 9,200 feet msl the airspeed which had been holding steady at 180 KIAS during the climb began a gradual decrease along with a simultaneous increase in pitch angle. According to the NTSB Performance study the airplane's aerodynamic lift and drag characteristics exhibited during the deceleration were consistent with the accumulation of ice forming on the airframe. At 11,000 feet msl when according to the DFDR the airspeed had decayed to 140 KIAS, the captain first noticed light rime ice on the windshield wipers and then on the leading edge span of the left wing. At about 11,500 feet msl, with the airspeed continuing to decay the captain began to initiate the manual de-ice boot sequence which requires a crew member to depress the de-ice controls in a certain order, as described in the AOM. This manual operation requires the focused attention of a flight crew member and therefore degrades overall attention for monitoring the status of other items such as airspeed. Within seconds after the captain had directed his attention to the manual de-icing sequence, the cockpit windows became opaque due to a layer of ice. The captain reported that while he was reaching up to engage the de-ice system, the clacker and stick-shaker activated, indicating an imminent stall. According to the DFDR the airspeed had decayed to 118 KIAS as the airplane entered into an aerodynamic stall at about 11,700 feet msl. Moments later the autopilot, which was still selected in the VS mode, disengaged. The captain, who had been focused on the manual de-icing sequence, immediately declared that he was taking control of the aircraft. The airplane began a rapid decent with the wings oscillating.

After several oscillations the captain was able to control the decent and stabilize the airplane as it passed through 6,500 feet msl. According to his statement, an immediate concern was to exit IMC and get the airplane below the freezing level. The captain maintained a rate of decent of 500 feet per minute (fpm), declared an emergency to the air traffic controller, and requested a block altitude. He flew the airplane in a controlled descent to about 5,000 feet msl heading in a westerly direction toward the ocean and over Santa Maria, California. During the decent he said that he could hear "large ice masses" impact the sides of the fuselage. The captain opted to continue the flight to LAX,

recognizing that the runways were longer and more emergency facilities were available than the surrounding airports. He made several cabin calls to inform the passengers of the situation and explain that he was now in control of the airplane. The airplane was landed at LAX without further incident.

3 Weather

3.1 Weather Radar

According to the weather radar, neither SBP nor the event location was situated in an area of significantly bad weather. All radar pictures show that the upset location was on the outside edge of the system and the depicted intensities were not significantly high.

3.2 AIRMETS

There were several AIRMET's issued for the region and AIRMET Zulu update 4 noted occasional moderate rime/mixed icing in clouds and in precipitation between freezing level (6,000ft to 8,000ft for central California; 7,000ft to11,000ft for southern California) and FL 220. AIRMET Tango did not mention any icing conditions but did make mention of moderate turbulence.

The Los Angeles Center Weather Advisory reported isolated severe turbulences and low level wind shear with strong up and down drafts

3.3 Conclusion

The flight crew had encountered rime ice on the inbound flight into SBP and was therefore aware of potential icing conditions in the vicinity. With the additional weather information received before departing, they reasonably concluded that the anticipated icing conditions on the outbound flight were within the company's AOM flight operational criteria.

4 Operations

4.1 Deferred De-Ice Timer Control System

The de-ice timer control system was reported to be inoperative on a previous flight and deferred on this flight in accordance with the airplane's Minimum Equipment List (MEL) procedure. The deferral procedure required a placard to be placed adjacent to the deicer timer switch and the auto cycling switch to remain in the "off" position. Therefore the de-ice boot system had to be operated manually. The automatic de-ice boot will inflate boot sections for six seconds each in the following order: tail (horizontal and vertical stabilizer), outboard wing, inboard wing, and tail. There are two settings, "One-Cycle" which will go through this sequence just once and "Continuous" which will repeat this sequence every 3 minutes.

Since the timer control system was deferred the flight crew had to operate the de-ice boots manually. The crew is instructed to depress and hold each "MAN" button for six seconds in a certain order. The buttons are oriented from left to right and are labeled as: "STAB", "W INBD" and "W OUTB". In order to check the proper function of the boots,

there are no warning lights so the crew is instructed to monitor green lights that indicate the sufficient inflation of each boot section. Manual operation of the de-ice boot system requires focused attention by a crew member and as a result could significantly increase the overall crew workload during a critical phase of flight.

4.2 Stall Warning System

The SaaB 340 has a Stall warning system that gets input from two AOA Sensors which are transmitted to two independent warning computers. These computers then trigger 5 warning categories. Stall warning is provided by an Aural Warning ("clacker") and a Stick Shaker that activates at a predefined AOA which should be reached approximately 6 to 8 knots before the stall occurs assuming a "clean" or "ice free" uncontaminated wing. Also if the autopilot happens to be in an engaged mode, it will disengage when the stall warning systems are activated.

At a higher predefined AOA (stall threshold) a stick pusher is activated which will impart 80 pounds of pressure on the left control column to decrease the AOA by approximately 4 degrees; the stick pusher also activates the PUSH 1 and PUSH 2 Amber lights.

The safety margin of 6 to 8 knots for stall warning activation is only valid assuming uncontaminated wings. This margin would be smaller during icing conditions and would therefore reduce the time the crew has to react. As in this case, the stick shaker did not activate prior to achieving the predefined clean wing AOA. If the crew would have had a more timely warning, the upset might have been avoidable. ALPA is aware of provisions provided in Saab 340B aircraft operated by other airlines such that the predefined AOA warning settings is adjusted by the crew for weather conditions such as icing.

4.3 Stall Recovery Training

Flight conditions and recovery techniques for *approach to stalls* are trained at American Eagle, however full aerodynamic stalls and in particular stalls in simulated icing conditions are not practiced. Both pilots stated that they did not receive any simulator training in unusual attitudes in icing conditions. Further they described the only ground training they received with regards to severe icing was to review the severe icing portion on the AOM. The FO also saw a Saab video on icing.

Saab emphasizes that recovery technique for stalls in an iced-up condition should be "prompt and well trained." They recommend that the techniques be taught and practiced during recurrent simulator training. However, they also mention that "Simulators might not necessarily represent a real aircraft since limited aero data is available at excessive attitudes." Consequently, methods are needed to improve the aerodynamic fidelity of training simulators in unusual attitude conditions. ALPA is aware that both NASA and the FAA had been pursuing new technologies and methods to improve flight simulation to enable training at unusual attitude and off nominal conditions.

4.4 Autopilot usage

According to the American Eagle S340 AOM, "*If climbing during ice accretion or with residual ice on the airframe, IAS is the **only** FD/AP mode authorized. However, other vertical modes may be used temporarily to transition to an appropriate climb speed.*" The

AOM further states, "*Since the autopilot may mask tactile cues that indicate adverse changes in handling characteristics, use of the autopilot is* ***prohibited*** *when the visual cues (for severe icing conditions) exist*". At the beginning of the climb when the FO took control of the aircraft and selected the autopilot VS mode, the crew had not encountered nor were they expecting to encounter severe or prohibited icing conditions. When the FO engaged the autopilot he lost the potential situation awareness from tactile cues that would have warned him of an impending stall. At the time of autopilot mode transition the crew was operating to the best of their knowledge in accordance with their American Eagle S340 AOM procedures. However as stated in the AOM they should have remained in VS mode only temporarily and paid particular attention to the airspeed as they continued in the climb. When the captain noticed that ice was accumulating on the airplane he directed his attention to the manual activation of the de-ice boot sequence. This was a highly focused procedure that further contributed to over all degraded situation awareness for the crew. Apparently, the crew never realized in a timely manner that they had encountered an icing condition that was causing the airspeed to decay towards a stall situation. According to the captain's statement, within seconds after he transitioned his gaze from outside to inside, the airplane began a heavy vibration leading up to the stall.

Since this event the FAA has issued Airworthiness Directive 2008-06-11 that required amendments to the Saab Airplane Flight Manual (AFM) intended to address minimum speed requirements for operating in icing conditions. In addition the American Eagle S340 AOM was modified from stating "If climbing *during ice accretion or with residual ice on the airframe*, IAS is the only FD mode authorized" to state "If climbing *in icing conditions*, IAS is the only FD Mode authorized".

5 Findings

- Both the captain and FO were certified to fly the Saab S340 airplane in accordance with existing Federal Aviation Regulations.
- Based upon the weather information the crew had at the time, they had no reason to believe they were to encounter severe icing conditions along their route of flight that would be hazardous to the routine operation of the aircraft
- With the autopilot engaged in the Vertical Speed mode, the crew needed to pay particular attention to the indicated airspeed.
- The de-ice boot auto timer had to be operated manually, which significantly increased the crew workload during the enroute climb in icing conditions.
- The aircraft slowed to an airspeed below minimum icing speed per American Eagle AOM presumably during an extended encounter with light to moderate rime icing conditions
- The aircraft encountered an area of unexpected and unforecasted severe icing that quickly iced up the airframe resulting in an aerodynamic stall

6 Recommendations

- Develop and implement weather forecasting technologies that will provide timely notification and better definition of the areas, altitude levels, and types of icing conditions (moderate, severe, etc..) that crews may encounter along their planned route of flight.

- For aircraft that are certificated under FAR part 25, require that the AOA used for stall warning system activation take into account the ice protection system status. Essentially when in icing conditions that have a potential for wing contamination, the AOA level at which the stall warning activates should be reduced in order to provide the same safety margins as when in clean wing conditions. This requirement should be retroactive to cover all aircraft engaged in air carrier operations.

- Require all air carrier pilots receive simulator training in both full stall recovery and ice induced roll upsets. Simulators should include contaminated airfoil handling qualities characteristics (e.g. ice induced roll upsets).

- Aural annunciation to the crew when flight critical aircraft parameters (e.g. airspeed, pitch, angle of attack, angle of bank, etc…) are reaching a level where autopilot disconnect is imminent.

- The FAA must continue its flight icing research on all aircraft with intent of providing flight crews improved methods to identify the environment they are operating in and in particular to be made aware of any effects that icing is having on the flight characteristics of the aircraft.

- For all aircraft with pneumatic de-icing systems and automatic de-icing timer controls, revise Operating Procedures to require that when in icing conditions of moderate or greater flight crews should disengage the autopilot, and the automatic de-icing timer control system must be operational.