National Transportation Safety Board
Aviation Accident Final Report

Location:	Beverly, MA	**Accident Number:**	NYC07LA081
Date & Time:	03/17/2007, 1430 EDT	**Registration:**	N511AT
Aircraft:	Cessna 500	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	6 None
Flight Conducted Under:	Part 135: Air Taxi & Commuter - Non-scheduled - Air Medical (Discretionary)		

Analysis

During the landing descent in instrument meteorological conditions , the copilot of the Cessna 500 noticed that the windscreen was picking up a trace amount of rime ice. Neither crewmember saw any ice on the wings, and the crew did not activate the deicing boots. The approach seemed normal until reaching approximately 100 feet above ground level, when the crew experienced what the copilot described as a "burble," and the airplane rolled "steeply" to the right. The pilot stated that there was "no buffet and no warning." The crew attempted to recover, but were unsuccessful, and the right wingtip struck the runway overrun area. Postflight inspection revealed "light rime ice" on the wings, horizontal stabilizer, and radome. The airplane was certificated for flight into known icing conditions, but no ice detector, or stall warning system was installed. The Citation 500 was certificated with full span deicing boots on the wing leading edge, but this airplane had been modified with electrically heated anti-ice panels on the inboard wing leading edge. The deicing boots had no automatic or continuous mode. Both pilots had taken Federal Aviation Administration (FAA) approved systems training for the Cessna 500. The pilot stated that he had heard about "ice bridging," at the training provider and his company. The copilot stated that "unless you have 1/4 to 1/2 inch of ice" the boots should not be activated. A review of the Cessna model 560 airplane flight manual (AFM) revealed that like the Cessna 500 operating manual, it advised pilots to wait for ice to build before inflating the pneumatic de-icing boots. Both the study guide and the AFM stated that, "Early activation of the boots may result in ice bridging on the wing." In 1996, the FAA conducted icing evaluations of the Cessna 560. These evaluations resulted in modifications to the stall warning system to increase stick shaker speed in icing conditions, but did not change the procedures for pneumatic de-ice boot operation. In 1997, the Safety Board recommended that, "leading edge deicing boots should be activated as soon as the airplane enters icing conditions because ice bridging is not a concern." A 1997 industry workshop reported that there was no substantiation for the phenomenon of ice bridging. In 1999, the FAA proposed several airworthiness directives (ADs) on 17 airplane models (including Cessna 500, 501, 550, 551, and 560) that would have required manufacturers to change the AFMs so that pilots would be required to inflate de-ice boots as soon as ice accumulation began. Cessna Aircraft Company succeeded in convincing the FAA to withdraw the proposed ADs. In December 2002, the FAA issued advisory circular AC 91-74, which stated that there were few, if

any, documented cases of ice bridging on modern boot designs. In February 2005, the Safety Board investigated an icing accident involving a Cessna 560, and review of the AFM again revealed guidance that stated that the pneumatic de-icing boots should be activated when ice is 1/4 to 1/2 inch thick. In December 2006, the FAA released a report stating that test results supported "the activation of lifting surfaces" deicers at the first detection of ice formation on the aircraft's lifting surfaces and for the operation of pneumatic deicers in an automatic cycling mode." Although more than 10 years have passed since it was established that ice bridging does not occur, the FAA has not taken any regulatory action, and Cessna Aircraft Company has only removed the references to ice bridging in it's AFMs but, still advises to wait until the ice thickness is 1/4 to 1/2 inch before activating the surface de-ice. Since 1982, the Safety Board has investigated 43 icing occurrences involving turbine-powered airplanes. These events have resulted in 201 deaths and 16 serious injuries. In the past 4 years, the Safety Board has issued 18 recommendations and one Safety Alert related to icing. As of June 2008, actions to reduce dangers to aircraft flying in icing conditions remain on the Safety Board's 10 Most Wanted List. The Safety Board has classified the FAA response to this issue as "Unacceptable."

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The inadequate guidance and procedures provided by the airplane manufacturer regarding operation of the pneumatic de-icing boots. Also causal was the Federal Aviation Administration's inadequate directives which failed to require manufacturers to direct flightcrews to immediately operate pneumatic deicing boots upon entering icing conditions.

Findings

Occurrence #1: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: APPROACH

Findings
1. WEATHER CONDITION - ICING CONDITIONS
2. ANTI-ICE/DEICE SYSTEM - NOT USED - FLIGHTCREW
3. (C) PROCEDURES/DIRECTIVES - INADEQUATE - MANUFACTURER
4. (C) PROCEDURES/DIRECTIVES - INADEQUATE - FAA(OTHER/ORGANIZATION)

Occurrence #2: IN FLIGHT COLLISION WITH TERRAIN/WATER
Phase of Operation: APPROACH

Findings
5. TERRAIN CONDITION - GROUND

Factual Information

HISTORY OF FLIGHT

On March 17, 2007, about 1430 eastern daylight time, a Cessna 500, N511AT, operated by Air Trek, Inc., was substantially damaged during landing at Beverly Municipal Airport (BVY), Beverly, Massachusetts. None of the four crewmembers or two passengers were injured. Instrument meteorological conditions prevailed and an instrument flight rules flight plan had been filed for the flight, which originated at Charlotte County Airport (PGD), Punta Gorda, Florida at approximately 1100. The air ambulance flight was conducted under 14 Code of Federal Regulations (CFR) Part 135.

During the descent into BVY, the flight crew was given, information 'Hotel' by air traffic control (ATC); with wind at 310 degrees at 8 knots, visibility 1 statute mile, a 500 foot overcast sky with mist, and good ground braking action. The given approach at BVY was the RNAV 16, circle-to-land Runway 34.

According to the flight crew, they advised ATC that their general operations manual (GOM) prohibited circling approaches with ceilings less then 1500 feet, and requested the GPS RUNWAY 16 approach at BVY. Reference speed was set to 97 knots. After passing the initial approach fix they entered the clouds at 3,500 feet mean sea level (msl), turned on the anti-ice system, and noticed that there was "quite a bit of wind" which they had to compensate for. Moments later, the copilot noticed that they were picking up a trace amount of rime ice on the windscreen; however, since neither pilot saw any ice on the wings, the deicing boots were never activated.

As they neared the final approach fix (FAF), they "added a notch" of approach flaps, and then added full flaps when they crossed the FAF. At 600 feet msl, they acquired the field and the precision approach path indicator (PAPI). Once established on the PAPI, speed was V-ref +10 (107 knots), and the approach to landing seemed normal until reaching approximately 100 feet above ground level. At this point, the flight crew experienced what the copilot described as a "burble," and the airplane rolled "steeply" to the right. The pilot stated that there was "no buffet and no warning." They attempted to roll wings level, and added power to arrest the sink, but were unsuccessful and the right wingtip struck the surface of the runway-overrun area.

After landing and taxiing to the ramp, the flight crew conducted a post flight inspection of the airplane. They noted that the right wing was bent upward about 10 degrees, and "Light rime ice" was present on the leading edges of the wings, horizontal stabilizer, and radome.

According to a customer service agent, after the airplane came to a stop on the airport ramp area, he also observed an accumulation of ice on the leading edges and nose of the airplane. He described it as a rime ice strip, about two inches top to bottom, covering the entire leading edge from wing tip to wing root. The white of the ice was "highly visible," although, he could see the wing's rubber boot through the ice in some areas, and estimated that approximately 90 to 95% of the wing boot was covered by the two-inch strip. On the nose of the aircraft he also witnessed a solid coverage of ice approximately 10-15 inches in diameter that was about 1/16 to 1/8 of an inch thick. Upon exiting the aircraft, he also observed the flight crew immediately go the right wing to inspect it and asked them, "What happened?" They replied, that they believed they had encountered "wind shear," when they came across the tree line on the approach to runway 16, and, "it was like the bottom just fell out on us."

The ATC tower controller also witnessed the event and stated that the airplane appeared to touchdown hard and on its right wing. When he asked the pilot if everything was all right, the pilot replied, "I believe so," and stated that they had experienced a wind shear on final. The ATC controller said he queried the crew of a Canadair Challenger that landed on runway 16 just after the mishap, if they had experienced any wind shear and they said they had not.

PERSONNEL INFORMATION

The pilot held an airline transport pilot certificate with multiple ratings including airplane multi-engine land, and a CE-500 type rating. According to records provided by Air Trek, the pilot had a total flight experience of 4,950 hours, with 3,200 hours in the accident airplane make and model. His most recent FAA first-class medical certificate was issued on October 25, 2006.

The copilot held an airline transport pilot certificate with multiple ratings including airplane multi-engine land and a B-737 type rating. According to records provided by Air Trek, he had a total flight experience of 25,982 hours, with 24.8 hours in the accident airplane make and model. His most recent FAA first-class medical certificate was issued on August 22, 2006.

AIRCRAFT INFORMATION

The airplane was manufactured in 1974, and had been modified with a Sierra Industries Incorporated, Citation Eagle (wing) modification. This modification had been originally developed by Advanced Systems Technology Incorporated (ASTEC) and was originally marketed as the "ASTEC EAGLE." The owner purchased the airplane on October 2, 1997. The most recent continuous airworthiness inspection was completed on February 28, 2007. At the time of the accident, the airplane had accumulated 22,015 total hours of operation. No recorders were installed.

METEOROLOGICAL INFORMATION

A weather observation taken about 11 minutes after the accident, included; wind at 300 degrees at 7 knots, visibility 10 miles, ceiling overcast at 500 feet, temperature 30 degrees Fahrenheit, dew point 28 degrees Fahrenheit, and an altimeter setting of 29.44 inches of mercury.

AIRPORT INFORMATION

BVY had two runways, oriented in a 09/27 and 16/34 configuration. Runway 16 was asphalt, and in good condition. It was equipped with a 4-light PAPI, a medium intensity approach light system, medium intensity runway edge lights, and non-precision markings. The total length of the runway was 5,001 feet, and its width was 100 feet.

WRECKAGE AND IMPACT INFORMATION

Post accident examination of the accident site and airplane by a Federal Aviation Administration (FAA) inspector revealed that, ground scars and impact signatures, which corresponded with the right wing striking the paved surface, existed approximately 100 ft before the displaced threshold.

The upper wing skin of the right wing/fuel tank had been breached, exposing the main spar. The spar was broken and the outboard portion of the right wing and aileron had been bent in an upward direction at an approximate 10-degree angle, seven feet inboard of the wingtip. No preimpact mechanical malfunctions were discovered.

TESTS AND RESEARCH

Warning Systems

According to the airplane manufacturer, an AOA system was optional, and no ice detector, or stall warning system was installed.

Stall warning was achieved aerodynamically, aided by stall strips on the inboard section of each wing. The strips would disrupt the airflow over the wing causing that area to stall first and accentuate the pre-stall buffet. This would alert the pilot of the impending stall by aerodynamic buffeting which would occur at "approximately VS1 +12 in the clean (flaps up) configuration, and VSO + 5 in the landing configuration."

Eagle Wing Modification

According to 14 CFR Part 25.1419, if an airplane manufacturer seeks certification for flight in icing conditions, the airplane must be able to safely operate in the continuous maximum and intermittent maximum icing conditions of appendix C.

As part of the supplemental type certificate for the ASTEC Eagle wing modification (STC SA645NW), additional icing tests and analysis were required by the FAA to demonstrate that the anti-icing performance of the Eagle system met those requirements, and that it's anti-icing performance was equivalent to, or higher than, the level of anti-icing performance of the Cessna 500.

Modifications to meet these requirements included a revised wing leading edge for the inboard portion of the wing. As the engines were mounted aft of this area, that portion of the wing leading edge directly ahead of the engine inlet was anti-iced to prevent possible damage to the engines by ingestion of ice shed from the wing leading edge and upper surfaces. The areas outboard of this area remained unmodified and continued to utilize pneumatic boots for de-icing. Anti-icing for both the Eagle and the Cessna 500 inboard wing was accomplished with electrical heaters. The heaters were identical in construction, installation and wattage distribution. The heaters only differed in that the chordwise heated length for the Eagle installation, was greater than for the Citation 500 installation, due to a larger impingement limit for the Eagle inboard wing.

According to ASTEC documentation, in flight measurements of the engine anti-ice panel temperatures were made on both the ASTEC EAGLE and a basic Cessna 500 airplane. Results of these tests indicated that the surface temperature distributions were similar for both airplanes. During testing the EAGLE anti-ice system also demonstrated greater energy capability. Based upon the measured temperatures and the energy comparisons, the FAA considered that, the EAGLE anti-ice panel provided engine ice protection equivalent to that of the basic Cessna 500 with reduced risk of runback problems in the wing-body intersection region, and a higher degree of ice protection than the basic airplane.

Anti-Ice and De-Ice Systems

According to the Cessna Citation (Cessna 500) operating manual, the anti-ice systems were designed to prevent ice formation on the pitot tubes, static ports, windshields, angle of attack probe (if installed), and to protect against engine ice damage. The various anti-icing functions used electrical power or engine bleed air and were actuated by switches on the left switch panel and control knobs on the co-pilot's panel. Cessna Aircraft Company advised that, "the Anti-ice systems should be turned on when operating in visible moisture with an indicated OAT

between +4°C and -30°C (+40°F and -22°F)."

The airframe de-ice system provided for removal of ice formed on the leading edge of the wing (outboard of the heated area) and tail aerodynamic surfaces by the pneumatically expanded boots. The airframe de-ice boots were controlled by a three-position SURFACE DE-ICE switch which was spring-loaded to OFF and provided two six-second cycles following momentary actuation. There was no automatic or continuous mode.

Boot cycling, was controlled by three control valves. On the first six second cycle, one valve opened the inflate line to the vertical stabilizer and the left horizontal stabilizer. Two control valves then actuated on the second cycle to direct air to both wings and the right horizontal stabilizer. The time circuit would elapse twelve seconds after initiation and de-energize the control valves. The boots then deflated by bleeding the air back through the control valve and dumping it overboard. The boots were held deflated by vacuum.

In the event the boots remained inflated or it was desirable to stop boot inflation and terminate the cycle, the pilot could place the surface de-ice switch to the RESET position. This would override the timer circuit and immediately deactivate the control valves. It was not necessary to go to the reset position after every boot cycle, and returning the switch to the OFF position would prepare the system for the next actuation.

Satisfactory operation of the deice boot cycle was verified by illumination of the surface de-ice annunciator light and "visual inspection of the wing leading edges." Illumination of the surface de-ice light indicated there was bleed air pressure to the boots for inflation. The light would momentarily blink off, between each cycle.

The operating manual stated that, the operation of the boots should be functionally checked, "prior to icing encounters while on the ground, or in flight with the OAT above -40° C (-40°F)" and that, "Surface de-ice should be used when ice buildup is estimated between 1/4 and 1/2 inch thickness." The manual also stated that, "Early activation of the boots may result in ice bridging on the wing," and added that, "If accumulation is in excess of 1/2 inch, boot cycling may not clear it." A wing inspection light was also provided to illuminate the left wing to "observe ice buildup during night flight." No abnormal or emergency procedures were listed in the event of a system failure.

Post Accident Interviews

Both pilots had taken FAA approved training for the Cessna 500. During post accident interviews of the pilots by National Transportation Safety Board investigators, the pilots advised that they both had received systems training for the Cessna 500.

The copilot advised that during their "checks in the air," they never saw ice on the wings and that their was no requirement to increase the reference speeds in icing conditions or in conditions conducive to icing. He also stated that "boots have some adverse features," and "unless you have 1/4 to 1/2 inch of ice" you should not operate them, and that the information was contained in the study guide provided to him by the company as well as in Section II of the airplane operating manual.

The pilot advised that, he looked at the wing but saw no ice. He also stated that you do not want to "blow" the boots too soon as you can get a "hollowed area." He had also seen multiple on-line training videos, which included information on "tail plane icing." He had been informed about "hinge moment reversals" by another pilot, had just completed "icing training,"

and had heard of "ice bridging," at both Simuflight and Air Trek.

ADDITIONAL INFORMATION

Cessna Model 560

A Review of the Cessna 560 airplane flight manual (AFM) by Safety Board investigators revealed that like the Cessna 500 operating manual, the AFM for the Cessna 560 advised pilots to wait for ice to build before inflating the pneumatic de-icing boots, stating that, "The surface de-ice system should be used when ice buildup is estimated to be between one-quarter-inch and one-half-inch thickness. Early activation of the boots may result in ice bridging on the wing. If ice is allowed to accumulate in excess of one inch, boot cycling may not clear it." Unlike the Cessna 500 (which has a different wing design), in the section titled Operating Procedures Model 560 Normal Procedures, Approaches, it advised pilots not to wait for ice to build first. "When reconfiguring for approach and landing, and any ice accretion is visible on the wing leading edge, regardless of thickness, activate the surface de-ice system. Continue to monitor the wing leading edge for any reaccumulation."

In 1996, the FAA conducted evaluations of the Cessna 560. Evaluations of stall speeds and characteristics when operating in icing conditions were conducted. The evaluations were conducted partially as the result of two icing-related Cessna 550 and 560 accidents.

One accident had occurred on December 30, 1995, when a Cessna 560 crashed while circling to land in icing conditions in Eagle River, Wisconsin, fatally injuring the 2 occupants. The investigation revealed that about 1/8 inch of rime ice had accumulated on the left wing and horizontal stabilizer leading edges. The other accident occurred on January 2, 1996, when a Cessna 560 crashed while on final approach in icing conditions in Augsburg, Germany. The pilots reported that the airplane started to buffet, entered a stall, and rolled right. No stall warnings were activated during the flight. The investigation by the German Flight Investigations Bureau (FUS) revealed that about 2 mm (0.078 inch) of ice had accumulated along the leading edges of the wing. These evaluations resulted in modifications to the stall warning system to increase stick shaker speed in icing conditions, but did not change the procedures for pneumatic de-ice boot operation.

Comair Flight 3272

On January 9, 1997, the Safety Board investigated the accident involving Comair Flight 3272 in which 29 people were fatally injured. The Safety Board concluded that a small amount of rough ice had built up on the wing as the airplane slowed to configure for approach, but this small amount was sufficient to cause the aircraft to stall without warning as speed decreased. As a result, the Safety Board recommended that: "leading edge deicing boots should be activated as soon as the airplane enters icing conditions because ice bridging is not a concern in such airplanes and thin amounts of rough ice can be extremely hazardous."

The Safety Board noted that pilots operating airplanes with pneumatic de-icing boots were cautioned against the dangers of "ice bridging" and were being advised against activation of the pneumatic de-icing boots before sufficient ice built up on the leading edge (generally between 1/4 and 1 inch). This was done out of concern that the ice could form the shape of the inflated boot, resulting in the boot inflating and deflating under a shell of ice, making de-icing impossible. The Safety Board also found that despite widespread belief in this phenomenon, and its coverage in numerous technical publications, its existence could not be substantiated, either technically or anecdotally.

Ice Bridging Workshop

On November 19, 1997, the FAA and the National Aeronautics and Space Administration held the Deicing Boot Ice Bridging Workshop at the Ohio Aerospace Institute in Cleveland, Ohio.

During the workshop, information regarding icing tunnel and flight test research into the ice-bridging phenomenon was disseminated and discussed among industry personnel. The research revealed that modern turbine-powered airplanes, with their high-pressure, segmented pneumatic deicing boots, were not at risk for ice bridging. Additionally, at that meeting the major manufacturers of pneumatic de-icing boots reported that they had been unable to reproduce ice bridging under any laboratory or wind tunnel conditions, and that any operational report of ice bridging investigated by them had been determined to be a report of residual or intercycle ice, which is the ice remaining on a pneumatic de-icing boot surface after an inflation cycle.

As a result of this workshop, the FAA in 1999 proposed a series of airworthiness directives (ADs) regarding ice bridging on 17 turbine-powered airplanes (including Cessna's 500, 501, 550, 551, and 560 models). The ADs would have required manufacturers to change their AFMs so pilots would be required to inflate de-ice boots as soon as they begin accumulating ice.

In response to comments about the proposed AD, the FAA stated that, "The FAA has reviewed the icing-related incident history of certain airplanes and has determined that icing incidents may have occurred because pneumatic de-icing boots were not activated at the first evidence of ice accretion. As a result, the handling qualities or the controllability of the airplane may have been reduced due to the accumulated ice."

Cessna Aircraft Company asked however, that the FAA withdraw the proposed AD, and advised the Safety Board that the 560 had no problem flying in tests that they conducted in 1996, with 1/2 inch ice shapes on the airframe. They did not however, indicate that they had tested for ice bridging or had ever been able to replicate it.

Advisory Circular AC 91-74A

On December 12, 2002, the FAA issued AC 91-74, Pilot Guide: Flight in Icing Conditions, and revised it on December 31, 2007 as AC 91-74A. In the AC, the FAA discussed ice bridging stating that, "A traditional concern in the operation of pneumatic boots has been "ice bridging." This is attributed to the formation of a thin layer of ice, which is sufficiently plastic to deform to the shape of an expanded deicing boot without being fractured or shed during the ensuing tube deflation. As the deformed ice hardens and accretes additional ice, the boot may be ineffective in shedding the "bridge" of ice. Traditional advice on avoiding this problem has been to wait for a layer of ice of a predetermined thickness to form before cycling the boot. This thickness has been variously prescribed as one-quarter inch, one half inch, and even an inch."

It went on to state that, studies done in the late 1990's established that there were few, if any, documented cases of ice bridging on modern boot designs. In addition, several icing tunnel tests sponsored by the FAA since 1999 showed no ice bridging on modern boot designs. Known cases were confined to boots of designs dating back a quarter century or more. Furthermore, it was recognized that a layer of ice a 1/2 inch thick, especially if rough, could have a significant effect on aircraft performance, stability, and control and advised that some

manufacturers "now advise that the boots be cycled as soon as icing is encountered, rather than waiting for a prescribed thickness to accrete." It went on to say that, studies in 2005 also showed that at airspeeds typical of general aviation airplanes with modern boot designs, ice would not shed, at every boot inflation.

Additionally, it advised that depending on the icing conditions and airspeed, it could take anywhere from 4 to 25 minutes to shed ice (perhaps longer at the extremely cold temperature of -30 degrees Celsius (-22 degrees Fahrenheit), even when boots were activated at the first sign of icing, and cycled every minute thereafter. Cycling early and often provided a small improvement over waiting until 1/4 or 1/2 inch of ice had accreted before activating the boots. Also, residual and intercycle ice is inherent in the use of any available deicing system, including pneumatic boots. Proper operation of the boots is necessary to minimize the effect of this ice. It also went on to advise that it is essential that the pilot consult the airplane flight manual (AFM) or pilot operating handbook (POH) and that the POH must be consistent with the operating limitations section of the AFM for guidance on proper use of the system. The 2005 testing also showed that proper application of ice adhesion inhibitors improved ice shedding at colder temperatures and the FAA strongly encouraged the use of the manufacturer's recommended ice adhesion inhibitors.

Circuit City Cessna 560

On February 16, 2005, the Safety Board investigated another icing accident. This time involving a Cessna 560 where the pneumatic de-icing boots were not operated as the airplane entered the second of two icing layers and an estimated 1/6 of an inch of ice accumulated which caused the airplane to stall prior to stick shaker activation. The airplane entered a rapid left roll, impacted terrain, and all 8 occupants were fatally injured. Review of the company and manufacturer's guidance by Safety Board investigators again revealed guidance that stated that the pneumatic de-icing boots should be activated when ice is 1/4 to 1/2 inch thick.

In the Board's final report (NTSB Accident Report NTSB/AAR-07/02) of the Circuit City Cessna 560 accident investigation, the Board stated:

The Safety Board concludes that ice bridging does not occur on modern airplanes; therefore, it is not a reason for pilots to delay activation of the deice boots.

Additionally, the report stated:

The Safety Board concludes that activating the deice boots as soon as an airplane enters icing conditions provides the greatest safety measure. On the basis of this accident and the Board's continued concerns in this area, the Board believes that the FAA should require manufacturers and operators of pneumatic deice boot-equipped airplanes to revise the guidance contained in their manuals and training programs to emphasize that leading edge deice boots should be activated as soon as the airplane enters icing conditions. The new recommendation will supersede Safety Recommendation A-98-91 and will be classified "Open-Unacceptable Response."

The new recommendation was issued as A-07-14.

DOT/FAA/AR-06/48

In December of 2006, the FAA's Office of Aviation Research and Development released a report titled: "Investigations of Performance of Pneumatic Deicing Boots, Surface Ice Detectors, and Scaling of Intercycle Ice (DOT/FAA/AR-06/48)." A review of the report by

Safety Board investigators revealed that, the test results supported "the activation of lifting surfaces' deicers at the first detection of ice formation on the aircraft's lifting surfaces and for the operation of pneumatic deicers in an automatic cycling mode."

Previous Recommendations

Pilots of airplanes fitted with pneumatic de-icing boots have been provided direction on operational use of the boots in their AFMs. In most cases though, AFMs still direct pilots to delay operation of the pneumatic de-icing boots, either in the manual mode or automatic mode (if fitted), until 1/4 to 1 inch of ice has built up on the leading edge. As was pointed out above, this guidance was included to prevent the occurrence of ice bridging, though the FAA and manufacturers have been unable to substantiate, its existence.

In 2007, the FAA issued an NPRM regarding ice protection system activation for newly manufactured airplanes that wish to receive approval for flight in icing conditions. The new rule would require methods to detect icing and activate the ice protections system, and prescribes activation of the ice protections system at the first sign of ice accretion.

The final rule however, has not yet been issued.

Post Accident Actions

Post accident, Cessna Aircraft Company advised the Safety Board that they no longer believed that ice bridging was a concern for modern de-icing boot designs.

On February 4, 2008, they issued Temporary FAA Approved Airplane Flight Manual Change 500FM TC-R57-19. This removed the reference of ice bridging from the Model 500 AFM. It also contained a warning that "Waiting until ice accumulates to greater than 1/2 inch prior to system activation may result in such excessive ice build-up on the empennage surfaces that ice shedding is not adequate."

The temporary change however, did not remove the requirement to wait until the ice thickness was estimated to be 1/4 to 1/2 inch.

Since 1982 the Safety Board has investigated 43 loss of control occurrences in turbine-powered airplanes, where icing was a factor. These accidents and incidents have resulted in 201 deaths and 16 serious injuries.

The safety Board however, has never investigated an accident were the probable cause has been associated with ice bridging.

In the last 4 years, the Safety Board has issued 18 recommendations and a Safety Alert related to icing.

At the time of this report, actions to reduce dangers to aircraft flying in icing conditions, still remain on the Safety Board's 10 Most Wanted List. The issues are classified as: Unacceptable Response.

Pilot Information

Certificate:	Airline Transport; Flight Instructor; Commercial	**Age:**	45, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land; Single-engine Sea	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Gyroplane; Helicopter	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane Single-engine	**Toxicology Performed:**	No
Medical Certification:	Class 1 With Waivers/Limitations	**Last Medical Exam:**	10/01/2006
Occupational Pilot:		**Last Flight Review or Equivalent:**	01/01/2007
Flight Time:	4950 hours (Total, all aircraft), 3200 hours (Total, this make and model), 4500 hours (Pilot In Command, all aircraft), 370 hours (Last 90 days, all aircraft), 100 hours (Last 30 days, all aircraft), 10 hours (Last 24 hours, all aircraft)		

Co-Pilot Information

Certificate:	Airline Transport; Commercial	**Age:**	60, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 With Waivers/Limitations	**Last Medical Exam:**	08/01/2006
Occupational Pilot:		**Last Flight Review or Equivalent:**	01/01/2007
Flight Time:	25982 hours (Total, all aircraft), 25 hours (Total, this make and model), 22238 hours (Pilot In Command, all aircraft), 105 hours (Last 90 days, all aircraft), 46 hours (Last 30 days, all aircraft), 4 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	Cessna	**Registration:**	N511AT
Model/Series:	500	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	500 0166
Landing Gear Type:	Retractable - Tricycle	**Seats:**	7
Date/Type of Last Inspection:	02/01/2007, Continuous Airworthiness	**Certified Max Gross Wt.:**	12500 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo Jet
Airframe Total Time:	22015 Hours	**Engine Manufacturer:**	Pratt & Whitney
ELT:	Installed, not activated	**Engine Model/Series:**	JT15D-1A
Registered Owner:	Air Ambulance by Air Trek Inc.	**Rated Power:**	2200 lbs
Operator:	Air Trek Inc.	**Air Carrier Operating Certificate:**	On-demand Air Taxi (135)
Operator Does Business As:		**Operator Designator Code:**	FDIA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Instrument Conditions	**Condition of Light:**	Day
Observation Facility, Elevation:	BVY, 107 ft msl	**Observation Time:**	1441 EDT
Distance from Accident Site:		**Direction from Accident Site:**	
Lowest Cloud Condition:	Unknown	**Temperature/Dew Point:**	-1°C / -2°C
Lowest Ceiling:	Overcast / 500 ft agl	**Visibility**	10 Miles
Wind Speed/Gusts, Direction:	7 knots, 300°	**Visibility (RVR):**	
Altimeter Setting:	29.44 inches Hg	**Visibility (RVV):**	
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Punta Gorda, FL (PGD)	**Type of Flight Plan Filed:**	IFR
Destination:	Beverly, MA (BVY)	**Type of Clearance:**	IFR
Departure Time:	1100 EDT	**Type of Airspace:**	

Airport Information

Airport:	Beverly Municipal Airport (BVY)	**Runway Surface Type:**	Asphalt
Airport Elevation:	107 ft	**Runway Surface Condition:**	Wet
Runway Used:	16	**IFR Approach:**	Global Positioning System
Runway Length/Width:	5001 ft / 100 ft	**VFR Approach/Landing:**	None

Wreckage and Impact Information

Crew Injuries:	4 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	2 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	6 None	**Latitude, Longitude:**	42.584167, -70.916389

Administrative Information

Investigator In Charge (IIC):	Todd G Gunther	**Adopted Date:**	08/28/2008
Additional Participating Persons:	Ron Williams; FAA/FSDO; Boston, MA Seth D Buttner; Cessna Aircraft Company; Wichita, KS		
Publish Date:			
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		