

# AIRCRAFT ICING

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HEARING  
BEFORE THE  
SUBCOMMITTEE ON  
AVIATION  
OF THE  
COMMITTEE ON  
TRANSPORTATION AND  
INFRASTRUCTURE  
HOUSE OF REPRESENTATIVES  
ONE HUNDRED ELEVENTH CONGRESS  
SECOND SESSION

February 24, 2010

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**U.S. House of Representatives**  
**Committee on Transportation and Infrastructure**  
Washington, DC 20515

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February 23, 2010

**SUMMARY OF SUBJECT MATTER**

**TO:** Members of the Subcommittee on Aviation  
**FROM:** Subcommittee on Aviation Staff  
**SUBJECT:** Hearing on “Aircraft Icing”

**PURPOSE OF HEARING**

The Subcommittee on Aviation will meet on Wednesday, February 24, 2010, at 2:00 p.m., in room 2167 of the Rayburn House Office Building to receive testimony regarding aircraft icing.

**BACKGROUND**

After the 1994 crash of a regional airliner in Roselawn, Indiana, which took 68 lives, the National Transportation Safety Board (NTSB) added in-flight icing to its Most Wanted List of transportation safety improvements. According to the NTSB, the Roselawn crash was caused by in-flight icing conditions and subsequent loss of control of the aircraft. NTSB further states that ice accumulation on an aircraft affects performance and handling by adding weight to the aircraft and by disrupting the normal airflow over the surfaces of the aircraft. In-flight icing can occur during winter weather at low altitudes or at high altitudes year-round, while ground icing occurs only in cold weather.

During the NTSB’s investigation into the Roselawn crash, the Board examined how icing conditions affected the airframe structure and concluded that the aircraft encountered icing conditions outside of its certification envelope<sup>1</sup> (i.e., outside the condition parameters in which the aircraft was certified to fly). This led the NTSB to conclude that the Federal Aviation Administration’s (FAA) aircraft icing certification process was inadequate because it did not require manufacturers to demonstrate an aircraft’s flight handling capabilities under a realistic range of

<sup>1</sup> Part 25 of the FAA’s regulations govern the design and airworthiness standards for transport category aircraft. These include all aircraft operated by major airlines, as well as most business jet aircraft. 14 C.F.R. part 25, Appx. C (2007).

adverse ice conditions, including supercooled large droplet (SLD)<sup>2</sup> conditions and freezing drizzle/freezing rain and mixed water/ice crystal conditions. In addition, the NTSB determined, after the 1997 crash of Comair flight 3272 in Monroe, Michigan, which was also caused by in-flight icing, that the FAA should perform additional research into the effects of in-flight icing and apply revised icing requirements to currently certificated aircraft. See Appendix A: U.S. Accidents Due to Icing in the Past Ten Years.

According to the FAA, since the Roselawn accident, it has reviewed aircraft in-flight icing safety and developed a comprehensive aircraft icing program, which includes almost 200 airworthiness directives (ADs)<sup>3</sup> to improve designs of over 50 aircraft types. The ADs cover safety issues ranging from crew operating procedures in the icing environment to direct aircraft design changes. The FAA has also required changes to flight manuals, pilot training, and other operating documents to address icing safety and issued bulletins and alerts to operators emphasizing icing safety issues.<sup>4</sup>

Nevertheless, according to the NTSB, “the pace of the FAA’s activities in response to all of these recommendations remains unacceptably slow, despite some encouraging action in 2007.”<sup>5</sup> The FAA cites the actions it has taken since 1994 as the reason there has not been a commercial airline accident due to icing since 1997.<sup>6</sup> The FAA also asserts that additional research was required on some of the icing conditions to better understand how to mitigate the effect of icing on aircraft before rulemaking could occur. According to the Government Accountability Office (GAO), though many efforts have been taken to mitigate the effect of icing on aircraft in-flight, between 1998 and 2007, there were 523 icing-related aviation accidents, which resulted in 221 fatalities,<sup>7</sup> in parts 135 and 91 operations.<sup>8</sup>

## **I. FAA ICING PROGRAMS**

### **A. AIRFRAME CERTIFICATION**

Aircraft surfaces, especially wings, are designed to produce “lift,” which is the aerodynamic force that makes them fly. Even the smallest disruption to these surfaces (e.g., the accumulation of ice) can make it more challenging for a pilot to control the aircraft. In addition to the added weight hazard posed by in-flight icing, ice also changes the shape of the wing, which may alter the

<sup>2</sup> SLDs are typically found in freezing drizzle and rain where water droplets stay in liquid form even though the water temperature of the droplets is below freezing. Droplets greater than about one fourth the thickness of human hair are considered SLDs. They freeze on contact with aerodynamic surfaces.

<sup>3</sup> ADs are legally enforceable rules issued by the FAA in accordance with 14 C.F.R. part 39 to correct an unsafe condition in an aircraft, aircraft engine, propeller, or appliance.

<sup>4</sup> FAA, Fact Sheet: Flying in Icing Conditions, Feb. 13, 2009.

<sup>5</sup> NTSB, Aviation: Reduce Dangers to Aircraft Flying Icing Conditions, Most Wanted Transportation Safety Improvements, Nov. 2009.

<sup>6</sup> John Hickey, FAA, Briefing to Aviation Subcommittee Staff, Oct. 8, 2009.

<sup>7</sup> Dr. Gerald Dillingham, GAO, Aviation Subcommittee Roundtable on Aircraft Icing, Oct. 15, 2009. Part 121 operators had four accidents with zero fatalities, part 135 operators had 48 accidents with 27 fatalities, and part 91 operators had 471 accidents with 194 fatalities.

<sup>8</sup> Part 135 include commercial operations designed for commuter and on-demand air transportation with 9 passenger seats or less, and a payload capacity of 7,500 pounds or less. Part 91 operations are generally non-commercial, privately operated aircraft usually referred to as general aviation.

aerodynamics of the wing, decreasing the aircraft's ability to fly.<sup>9</sup> Ice shedding off the aircraft may also cause damage to another part of the aircraft (e.g., hitting the tail or by being sucked into the engine). In winter weather and at higher altitudes, ice can accumulate on the wing, tail, and other areas that threaten the pilot's ability to control the aircraft. For instance, an aircraft may stall at a faster speed in icing conditions than under normal conditions.

Current FAA certification standards for transport-category aircraft (commercial aircraft) require an aircraft to be able to fly in icing conditions defined in Appendix C of title 14, Code of Federal Regulations (C.F.R.) part 25.<sup>10</sup> According to FAA, Appendix C defines the scope of atmospheric conditions in which an aircraft may encounter icing, such as temperature and humidity. These parameters set the "envelope" of conditions within which aircraft must be able operate to be certified for flight in icing. Icing certification involves rigorous assessment, including flight tests, icing wind tunnel tests, and numerical analyses. Relatively few small aircraft receive this certification. Aircraft that do not have all of the required ice protection equipment installed and functional are prohibited by law from flying in areas where icing conditions are known.

## B. CURRENT REGULATIONS

To be in compliance with FAA operating regulations, an aircraft must have a "clean wing," meaning that there is no discernible ice present.<sup>11</sup> On the ground, aircraft certificate holders must have, and use, an FAA-approved anti-ice<sup>12</sup>/deice<sup>13</sup> plan<sup>14</sup> that provides detailed methods for keeping the aircraft free of ice before takeoff is allowed. A pilot is responsible for implementing the plan by determining if the aircraft needs to be deiced following the approved plan, taking into consideration precipitation and temperature. Once a determination is made that the aircraft must be deiced, the aircraft is sprayed with deicing fluid, such as propylene glycol. Deicing fluid keeps the plane free of ice for approximately 30 to 45 minutes, depending on the weather.<sup>15</sup>

In instances where an aircraft is certified to fly in icing conditions, the pilot is responsible for deploying the aircraft's ice protection system at the first sign of icing. Deicing may involve a device called a boot<sup>16</sup> that inflates and deflates to break off the crust of ice that forms on a wing, fluid deice systems (on smaller aircraft), or heated systems throughout the critical areas of the aircraft.

If an aircraft is not certified for flight in icing conditions and inadvertently encounters icing, it is required to exit the area as soon as possible. This is usually done by flying either at a higher or lower altitude or mapping a path around the precipitation. According to the FAA, if an aircraft is

<sup>9</sup> According to the FAA, smaller aircraft are more adversely affected by icing because small amounts can dramatically change the shape of the wing and weight of the aircraft.

<sup>10</sup> 14 C.F.R. § 25.21(g)(1) requires the airplane to meet certain performance and handling qualities requirements of part 25 subpart B while operating in the atmospheric icing environment defined in Appx. C to part 25 (2007).

<sup>11</sup> 14 C.F.R. § 121.629 (1996), § 125.221 (1993), and § 135.227 (1996).

<sup>12</sup> Anti-icing consists of applying a protective layer of heat (e.g. an electric blanket) or using a thick fluid called anti-icing fluid on the aircraft to protect against the formation of frozen contaminant, snow, ice, or slush.

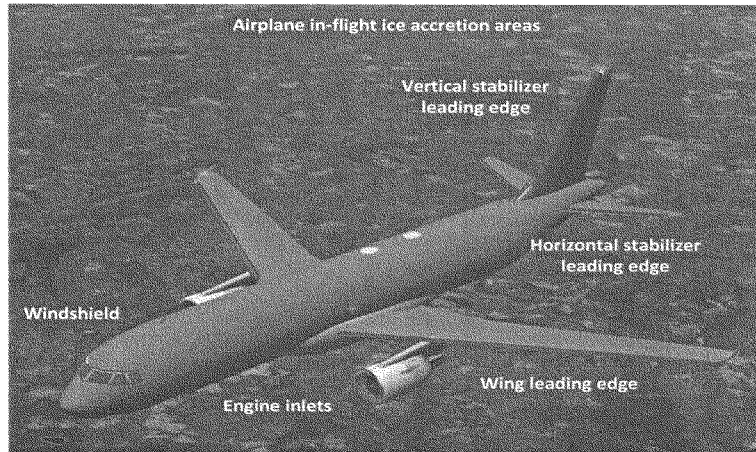
<sup>13</sup> Deicing on the ground is usually done by spraying the aircraft with deicing fluid.

<sup>14</sup> 14 C.F.R. § 121.629 (1996).

<sup>15</sup> The FAA maintains charts for pilots to use to determine when an aircraft needs to be deiced on the ground based on the current airport weather.

<sup>16</sup> Pneumatic deicing boots are elastic membranes on the leading edge of airfoils, which can be inflated using pressurized air. When they are inflated, ice which has accumulated on the boot is fractured and carried away by the airflow.

not certified for icing conditions it is the pilot's responsibility to know current weather forecasts and have alternative plans should the weather change.



Source: NTSB

### C. IN-FLIGHT AIRCRAFT ICING PLAN

In 1996, the FAA sponsored the International Conference on Aircraft In-flight Icing, where icing experts recommended improvements to boost the level of safety of aircraft operating in icing conditions. Based on the results of the conference, the FAA developed a comprehensive, multi-year In-flight Aircraft Icing Plan in 1997. Since 1997, the FAA has issued nearly 200 ADs for over 50 aircraft types and updated numerous Advisory Circulars (ACs) to provide operational guidance.

In accordance with the FAA In-flight Aircraft Icing Plan, the FAA tasked an Aviation Rulemaking Advisory Committee (ARAC)<sup>17</sup> to develop certification criteria for the operation of aircraft in SLD conditions and ice crystal/mixed phase conditions. The work was carried out by ARAC's Ice Protection Harmonization Working Group (IPHWG). The IPHWG was originally tasked with providing advice and recommendations for SLD in 1997 for part 23<sup>18</sup> (small airplane regulations) and part 25 regulations. During this same time period, the FAA also began a joint research effort with the National Aeronautics and Space Administration to gather additional SLD data. In 2002, the FAA removed part 23 from the assignment<sup>19</sup> and in 2005 added

<sup>17</sup> The ARAC was established in 1989 to allow the FAA to consult with interested parties on rulemakings.

<sup>18</sup> Part 23 of the FAA's regulations govern the design and airworthiness standards for small normal, utility, acrobatic, and commuter category aircraft.

<sup>19</sup> This was done because it was determined that the recommendations for part 25 aircraft were likely to be inappropriate for part 23 aircraft. Letter from John Hickey, Deputy Assoc. Administrator for Aviation Safety, FAA, to Jerry Costello, Chairman, H. Comm. on Trans. & Infra. Subcomm. on Aviation (Nov. 16, 2009) (on file with Aviation Subcommittee).

recommendations for part 33 (aircraft engines) in SLD conditions. According to the FAA, the third report of the IPHWG in 2007 included “sufficiently detailed recommendations to proceed to develop a Notice of Proposed Rulemaking (NPRM).”<sup>20</sup>

In 2008, the FAA Rulemaking Management Council approved the project as high priority, and assigned a rulemaking team to draft the NPRM and complete a full regulatory evaluation. At an October 15, 2009, Subcommittee on Aviation roundtable on aircraft icing, Mr. John Hickey, Deputy Associate Administrator for Aviation Safety at the FAA, indicated that he believed the NPRM would be published no later than Spring 2010. Also, in March 2009, the FAA formed an Aviation Rulemaking Committee to provide recommendations on how part 23 should be modified to address SLD.

#### **D. AIRPORTS -- DEICING AND RUNWAY ICING**

Airport pavement deicing is conducted by airports to delay the formation of physical bonding between runway surfaces and new snowfall, to break up ice and snow, and to groom and clear remnants of snow and ice from runways, taxiways, and ramp areas. Although these practices are not mandated by FAA regulation, according to the Airports Council International, airfield pavement deicing has become critical for airports over the past 15 years to ensure safe aircraft operations during winter conditions.

Airlines, or their handling agents,<sup>21</sup> apply deicing and anti-icing fluids to aircraft to assure safe operation in winter precipitation in accordance with requirements of the FAA. Although airports play a role in assisting and facilitating airlines’ performance of aircraft deicing, the primary responsibility lies with individual airlines.

Airport stormwater runoff is regulated by the U.S. Environmental Protection Agency (EPA). Individual permits are issued for each airport to ensure that deicing fluid runoff is properly treated to prevent adverse impacts to the environment. Airports maintain the permits of the facilities used by airlines and general aviation, allowing regulated discharges of deicing stormwater, while meeting the requirements of the Clean Water Act (P.L. 92-500, enacted in 1972, amended by P.L. 95-217 in 1977, P.L. 97-117 in 1981, and P.L. 100-4 in 1987).

On August 28, 2009, the EPA published an NPRM entitled “Effluent Limitation Guidelines and New Source Performance Standards for the Airport Deicing Category.” This rule would be incorporated into airport stormwater permits. The proposal consists of collection and treatment requirements for aircraft deicing fluid, along with a ban on the use of urea<sup>22</sup> for pavement deicing. Final comments on the proposed rule are due on February 26, 2010. Airports are currently assessing the impact of the proposed rule on the industry. The airline industry has indicated concern that the proposed rule would require a diversion of significant Airport Improvement Program funds for construction of centralized deicing pads at a number of land-constrained airports in the northeast, which may cause ground safety issues and reduce operational throughput at the airports.

<sup>20</sup> *Id.*

<sup>21</sup> According to the FAA, approximately 70 to 80 percent of aircraft ground de/anti-icing is accomplished by third party contract service providers (e.g., airport fixed base operators or another airline).

<sup>22</sup> Urea is also used as a nitrogen-release fertilizer and is known to contribute toxic ammonia in the form of runoff to area waters.

## II. PILOT TRAINING FOR ICING

Commercial pilots receive initial ground and in-flight icing training during the course of attaining a commercial pilot's license. Most training focuses on the collection and interpretation of weather information to recognize critical weather situations and the use of aeronautical weather reports and forecasts. FAA regulations also require commercial pilots to receive recurrent training on weather,<sup>23</sup> but some safety experts have commented that this training is minimal because "there is an assumption that once a pilot reaches the professional ranks that he has already received the weather training he will need in this career."<sup>24</sup> Additional information or training is usually provided to pilots through flight manuals and ADs. It is worth noting that icing training is primarily academic, since it is hard to replicate icing conditions in simulators that may include only a limited range of icing scenarios.<sup>25</sup>

Pilots groups have expressed concern that aircraft operational limits are not always clearly identified. In addition, pilot groups have also raised concerns that aircraft operational limits do not always mirror real world flying conditions. Likewise, the NTSB states that a gap exists between the icing flight conditions in which an aircraft is tested during the certification process versus those that can be experienced in the real operating environment.

To mitigate potential icing situations that are outside the certification parameters of the aircraft, some have suggested that pilots receive additional training for in-flight icing to ensure pilots can handle this condition as well as a failure of automated aircraft ice protection systems. Some have also suggested that clear criteria be developed for pilots and operators to use for go/no-go decisions for flight into known icing conditions. Additional training has also been suggested for region-specific flying rather than general icing briefings, especially for those pilots who fly a geographically wider variety of routes. Some say pilots who fly multiple takeoffs and landings may also benefit from additional icing training, because they are more likely to be exposed to icing more often, while others content that multiple takeoffs and landings improve a pilot's proficiency in icing conditions.

## III. NTSB PENDING RECOMMENDATIONS AND FAA'S RESPONSES

The NTSB recommendations on icing fall into two areas of concern: (1) icing criteria and icing testing requirements necessary for an aircraft to be approved for in-flight icing conditions within the United States; and (2) operational means and limitations to determine icing conditions in which it is permissible to operate an aircraft. The NTSB notes that the FAA currently has rulemaking activities geared towards improving aircraft icing design standards. However, the NTSB is concerned that because these rulemakings are in the preliminary stages, implementation may be years away and will only apply to newly-certificated aircraft. Accordingly, the NTSB still has icing on its Most Wanted List because the FAA has not yet adopted a systematic and proactive approach

<sup>23</sup> 14 C.F.R. parts 121, 125, and 135.

<sup>24</sup> Steve Erickson, *The Need for Operationally Based In-flight Icing Training for Aviators*, SAE International (2003) at 2.

<sup>25</sup> *Id.*

to the certification and operational issues of airplane icing.<sup>36</sup> Set forth below are the NTSB's aviation recommendations.

**NTSB Most Wanted List Recommendations**

<b>Rule</b>	<b>Date</b>	<b>Added</b>	<b>Status</b>
<b>Revise Icing Criteria for Aircraft Certification</b> -- Revise the icing criteria published in 14 C.F.R. parts 23 and 25, in light of both recent research into aircraft ice accretion under varying conditions of liquid water content, drop size distribution, and temperature, and recent developments in both the design and use of aircraft. Also, expand the Appendix C icing certification envelope to include freezing drizzle/freezing rain and mixed water/ice crystal conditions, as necessary.	August 15, 1996	1997	Open— Unacceptable Response
<b>Revise Icing Certification Testing</b> -- Revise the icing certification testing regulation to ensure that airplanes are properly tested for all conditions in which they are authorized to operate, or are otherwise shown to be capable of safe flight into such conditions. If safe operations cannot be demonstrated by the manufacturer, operational limitations should be imposed to prohibit flight in such conditions and flight crews should be provided with the means to positively determine when they are in icing conditions that exceed the limits for aircraft certification.	August 15, 1996	1997	Open— Unacceptable Response
<b>Require revised guidance to activate deice boots upon entering icing conditions</b> -- 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.	February 27, 2007	2008	Open— Acceptable Response
<b>Review deice boot-equipped aircraft in light of revised icing certification standards and criteria</b> -- When the revised icing certification standards and criteria are complete, review the icing certification of pneumatic deice boot-equipped airplanes that are currently certificated for operation in icing conditions and perform additional testing and take action as required to ensure that these airplanes fulfill the requirements of the revised icing certification standards.	February 27, 2007	2007	Open— Unacceptable Response

<sup>36</sup> NTSB, "Most Wanted" List Brochure (Feb. 2010), [http://www.ntsb.gov/Recs/brochures/MostWanted\\_2010.pdf](http://www.ntsb.gov/Recs/brochures/MostWanted_2010.pdf).



## FAA Rulemakings Regarding Icing

RULE	STATUS
<b>Part 25 Performance and Handling in Icing</b> -- FAA revised the 14 C.F.R. part 25 requirements and related advisory material. This change introduced new requirements for evaluating airplane performance and handling characteristics of transport-category airplanes for flight in the icing conditions of 14 C.F.R. part 25, Appendix C.	The final rule went into effect on Oct. 9, 2007, as amendment 25-121 to 14 C.F.R. part 25.  AC 25-25 was published on Sept. 10, 2007, which provides information on ways to comply with the new standards.
<b>Part 25 Expansion of Certification Icing Conditions</b> -- The final ARAC report included recommendations for a new appendix to 14 C.F.R. part 25, defining an SLD environment and a new 14 C.F.R. part 33, Appendix D to address ice crystal/mixed phase conditions. Included in the report are also recommendations addressing 14 C.F.R. part 25 aircraft performance and handling qualities, engine installation effects, ice protection system requirements, and 14 C.F.R. part 33 engine requirements.	The FAA plans to publish the part 25 SLD NPRM in early 2010.  In March 2009, the FAA decided to form an ARC that will be tasked to provide recommendations on whether 14 C.F.R. part 23 should be modified to include the SLD and ice crystal/mixed phase requirements that are planned for part 25. The Order that will establish the ARC has been drafted and once the Order is signed the ARC will be formed.
<b>Ban of Polished Frost on Wings</b>	Final rule went into effect Jan. 30, 2010.
<b>Part 121<sup>27</sup> Exiting Icing</b> -- The ARAC recommended that the FAA issue a part 121 rule to require less subjective means of determining when the flight crew should exit icing conditions.	The FAA stated that it plans to publish the part 121 Exiting Icing NPRM in early 2010.
<b>Part 25 Activation of Ice Protection</b>	The final rule was published on Aug. 3, 2009.
<b>Part 121 Activation of Ice Protection</b>	The FAA published an NPRM on Nov. 23, 2009.

## IV. ENGINE ICING

According to the FAA, since 2003, internal engine ice is responsible for 15 dual-engine and several single-engine shutdowns in-flight, called "flameouts." The FAA has discovered that at high altitudes near intense storms, moisture may turn into tiny ice crystals that can be sucked into an engine. At first the crystals melt, but sometimes the water freezes again on metal surfaces and becomes slush. Eventually, a buildup of ice can either melt and douse the engine's ignition system, or break into chunks that damage engine turbine blades.

Each flameout event was in or near weather with ice-crystal icing; this type of icing does not appear on radar due to its low reflectivity, and neither the airplane ice detector nor visual indications indicate the presence of this type of icing conditions. To date, no accidents have been attributed to flameouts, because pilots have been able to restart the engines on large commercial aircraft using FAA recommended procedures. In August 2008, the FAA issued ADs requiring pilots to turn on

<sup>27</sup> Part 121 of the FAA's regulations govern the operating requirements for air carriers —airlines operating scheduled service in aircraft with 10 seats or more. In addition to rules in part 91, air carriers have to comply with these requirements to meet their responsibility to provide air transportation at the highest level of safety practicable.

engine anti-ice systems more frequently during descents, to reduce the chances of sudden shutdowns and to increase the likelihood that engines that quit will restart.

WITNESSES

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**The Honorable Deborah A.P. Hersman**

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Air Line Pilots Association, International

**Mr. Gregory Principato**

President  
Airport Council International – North America

## APPENDIX A: U.S. ACCIDENTS DUE TO ICING IN THE PAST TEN YEARS

Date	Aircraft Type	Airline/Ops	Incident	Result
Mar. 19, 2001	Empresa Brasileira de Aeronautica, S/A (Embraer) EMB-120	Comair Airlines, Inc. Flight 5054 Part 121	Encountered icing conditions while in cruise flight at 17,000 feet mean sea level and departed controlled flight, descending to an altitude of about 10,000 feet.	No injuries, but the airplane sustained substantial damage to the elevators and horizontal stabilizer.
Oct. 10, 2001	Cessna CE-208 <sup>28</sup> Caravan	Peninsula Airways Flight 350 Part 135	In-flight loss of control resulting from upper surface ice contamination that the pilot-in-command failed to detect during his preflight inspection of the airplane.	The pilot and nine passengers were killed, and the airplane was destroyed.
Nov. 4, 2003	Cessna 208B	Non-scheduled cargo flight Part 135	In-flight ice accumulations cause the aircraft to hit the runway hard, causing the nose landing gear to collapse.	The pilot (the sole occupant) was not injured.
Feb. 16, 2005	Cessna Citation 560	Martinair, Inc., for Circuit City Stores, Inc. Part 91	Crashed four miles from airport while on an instrument landing system approach in icing conditions.	The two pilots and six passengers on board were killed, and the airplane was destroyed by impact forces and post crash fire.
Jan. 2, 2006	Saab-Scania AB SF340B+	American Eagle Flight 3008 Part 121	The flight lost 5,000 feet of altitude after it encountered icing conditions during the en route climb and departed controlled flight at an altitude of about 11,500 feet mean sea level and descended to an altitude of about 6,500 feet.	No injuries or damage to the aircraft was reported.
Mar. 17, 2007	Cessna 500	Air Trek, Inc. Part 135 (air ambulance)	Aircraft was substantially damaged during landing in icing conditions.	No injuries were reported.
Jan. 6, 2010	Beech Model 99	Part 135	On an instrument approach, the pilot reported the airplane picked up light to moderate icing on approach and he cycled the deicing boots once prior to the final approach. Due to ice accumulation, the aircraft experienced a hard landing.	There were no injuries, though the aircraft was substantially damaged.

Source: NTSB

<sup>28</sup> From 1987 to 2003, the NTSB investigated 26 icing-related accidents and incidents involving Cessna 208 series airplanes, resulting in at least 36 fatalities. An NTSB assessment revealed that 15 of the 26 icing-related events resulted from ice that had accumulated while the airplane was in flight. Further, most of these icing related loss-of-control accidents occurred during flight in icing conditions that appeared to be within the parameters of the FAA's icing certification envelopes.



## HEARING ON AIRCRAFT ICING

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Wednesday, February 24, 2010,

HOUSE OF REPRESENTATIVES,  
SUBCOMMITTEE ON AVIATION,  
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE,  
*Washington, DC.*

The Subcommittee met, pursuant to call, at 2:00 p.m., in Room 2167, Rayburn House Office Building, the Honorable Jerry F. Costello [Chairman of the Subcommittee] presiding.

Mr. COSTELLO. The Subcommittee will come to order. The Subcommittee will ask all Members, staff, and everyone to turn electronic devices off or on vibrate.

The Subcommittee is meeting today to receive testimony regarding aircraft icing. I intend to give a short opening statement, then I will call on the Ranking Member, Mr. Petri, for his opening statement or any remarks that he may have.

I welcome everyone to this Subcommittee hearing on aircraft icing.

In winter weather and at higher altitudes, ice can accumulate on an aircraft's wing, tail, and other areas and can threaten a pilot's ability to control the aircraft. Current regulations with the FAA require that an aircraft has no visible ice present on its wings to take off and be certified to fly in icing conditions if icing is present at the time of takeoff.

After the 1994 crash of a regional airliner in Roselawn, Indiana, which took 68 lives, the National Transportation and Safety Board added icing to its safety Most Wanted List in 1997. Since that time, the Board has issued 82 recommendations to the FAA aimed at reducing risks from icing. Thirty-nine were implemented by the FAA and acceptable progress was made on 25 of them.

Last October, Ranking Member Petri and I held a roundtable on icing issues. During the roundtable, we discussed ice protection systems to prevent ice from forming on an aircraft in flight. These systems may not protect in all icing conditions, such as supercooled large droplets. In addition, we discussed the current status of aircraft icing standards and procedures. Because aviation safety is the number one priority of this Subcommittee, we decided to hold a follow-up hearing to fully explore these important issues.

Many challenges exist regarding aircraft icing, such as access to accurate weather information and the need for additional icing-related research. I would like to focus on the issues of pilot training to operate in icing conditions and the FAA'S rulemaking efforts.

First, while the aircraft operator must maintain an FAA-approved de-icing plan, the pilot is ultimately responsible for deter-

mining whether the aircraft needs to be de-iced. In flight, it is also the pilot's responsibility to deploy the aircraft's ice protection system. Currently, icing must be covered in a commercial pilot's initial and recurrent training. It is critical that this training be specific to the airplane the pilot is flying and the conditions the pilot is likely to encounter.

To address these concerns and raise the bar on safety, we included important icing-related requirements in H.R. 3371, the Airline Safety and Improvement Act of 2009, to ensure commercial pilots have the experience and knowledge to fly safely in icing conditions.

I look forward to hearing from the Air Line Pilots Association and the FAA on what needs to be done to provide pilots with better-defined operating procedures for operations in icing and winter weather conditions.

Second, it has been 13 years since a commercial air carrier was involved in a fatal icing-related accident. However, between 1998 and 2007 there were 523 icing-related aviation accidents involving small commerce operators and general aviation aircraft resulting in 221 fatalities.

Since the Roselawn accident in 1994, the FAA has issued over 100 icing-related airworthiness directives on 50 different aircraft models, adopted three final rules, and is conducting additional research on icing in partnership with NASA.

Despite the FAA'S work to date, two critical NTSB recommendations from the 1997 Most Wanted List have not been addressed. Last week, the NTSB adopted its Most Wanted List for 2010, which includes four recommendations to reduce the hazards to aircraft flying in icing conditions. The NTSB said that the FAA'S efforts in this area have been "unacceptably slow," and I agree.

The length of time that it has taken to complete these icing rules is unacceptable. I understand the deliberative nature of the FAA'S rulemaking process, and that even more research may be needed in this area. However, 13 years have passed since the NTSB made these recommendations to change the way aircraft are designed and approved for flight in icing conditions and these recommendations are still open with unacceptable responses. The FAA must adopt a systematic and proactive approach to address the icing criteria for aircraft certification and testing. I look forward to hearing from Mr. Hickey on the steps the agency is taking to finish the icing-related rules as soon as possible.

I am also interested to hear from the GAO on research I requested regarding icing and any recommendations it may have on the topic.

Before I recognize Mr. Petri for his opening statement, I ask unanimous consent to allow two weeks for all Members to revise and extend their remarks and to permit submission of additional statements and materials by Members and witnesses. Without objection, so ordered.

The Chair now recognizes the Ranking Member, Mr. Petri.

Mr. PETRI. Well, thank you, Mr. Chairman, for calling this hearing as a follow-up to the Subcommittee roundtable on in-flight and ground icing issues last fall.

At the roundtable, we learned about the long-awaited revisions to the icing safety regulations, as well as the challenges associated with promulgating these regulations. I am interested in getting an update from the FAA on the status of the regulatory safety improvements.

Roundtable participants also noted that, more often than not, pilots navigate through icy conditions without incident. It is noted, however, that the ability to routinely deal with icing conditions can lead to a sense of complacency about the dangers that icing can pose. I would like to hear from the Air Line Pilots representative what steps unions are taking to instill continued vigilance in the cockpit.

In addition to addressing the in-flight icing hazards, the FAA, airports, and airlines all work hard to ensure that aircraft are ready to fly and that airport runways are maintained in a safe condition.

The Environmental Protection Agency has recently proposed a new rule to regulate runoff of aircraft de-icing fluid and runway de-icing agents. It is a conflict here between environmental concerns and aviation concerns, and we clearly have to be sure that we are not endangering people's lives as they fly.

I am interested to learn what impacts the proposed rule would have on airports and passengers. Obviously, there must be a careful balance between regulating de-icing fluids and ensuring the safety and efficient movement of passengers and commerce. It is this Subcommittee's responsibility to ensure that a balance is maintained.

While airliners are required to be equipped with icing countermeasures, most general aviation and commuter aircraft are not. When these aircraft inadvertently encounter icing conditions, the outcome can be disastrous. For years we have heard testimony about the potential capacity and efficiency benefits of NextGen. The Chairman took the Committee to the research center in New Jersey recently for an update on some of the efforts that are being made in this area. But I am interested to hear how the enhanced weather information touted in NextGen plans might affect the icing safety record.

Thank all of you for your participation in this hearing today, and I look forward to your testimony. Thank you very much.

Mr. COSTELLO. The Chair thanks the Ranking Member and will recognize Members. Does anyone have an opening statement or remarks they would like to add?

[No response.]

Mr. COSTELLO. If not, the Chair will go directly to our witnesses today. Let me introduce our witnesses.

First we have Mr. John Hickey, who is the Deputy Associate Administrator for the FAA for Aviation Safety. He is accompanied by Mr. John Duncan, who is the Air Transportation Division Manager for Flight Standards Division at the FAA. The Honorable Deborah Hersman, who is the Chairman of the National Transportation Safety Board; Dr. Gerald Dillingham, who is Director of Physical Infrastructure Issues with the U.S. Government Accountability Office; Captain Rory Kay, the Executive Air Safety Committee Chairman for the Air Line Pilots Association, International; and Mr.

Gregory Principato, who is the President of the Airports Council International-North America.

Let me welcome all of our witnesses here today. We normally have a five minute rule that we try to ask witnesses to summarize their testimony in a five minute period. We want all of our witnesses to know that their entire statements will be entered into the record. We understand that Chairman Hersman has a PowerPoint that she will be presenting at some point and we, of course, look forward to that.

With that, the Chair would recognize Mr. Hickey.

**TESTIMONY OF JOHN HICKEY, DEPUTY ASSOCIATE ADMINISTRATOR FOR AVIATION SAFETY, FEDERAL AVIATION ADMINISTRATION, ACCOMPANIED BY JOHN DUNCAN, AIR TRANSPORTATION DIVISION MANAGER, FEDERAL AVIATION ADMINISTRATION; THE HONORABLE DEBORAH A.P. HERSMAN, CHAIRMAN, NATIONAL TRANSPORTATION SAFETY BOARD; DR. GERALD DILLINGHAM, DIRECTOR, PHYSICAL INFRASTRUCTURE ISSUES, U.S. GOVERNMENT ACCOUNTABILITY OFFICE; CAPTAIN RORY KAY, EXECUTIVE AIR SAFETY COMMITTEE CHAIRMAN, AIR LINE PILOTS ASSOCIATION, INTERNATIONAL; AND GREGORY PRINCIPATO, PRESIDENT, AIRPORTS COUNCIL INTERNATIONAL-NORTH AMERICA, ACI**

Mr. HICKEY. Thank you, Chairman Costello, Ranking Member Petri, and Members of the Subcommittee.

Thank you for inviting me here today to discuss the challenges icing conditions pose to flight operations, as well as FAA'S efforts to mitigate the safety risks posed by icing. Before I begin my prepared remarks, I want to introduce my colleague, Mr. John Duncan, FAA'S Manager of the FAA Flight Standards Air Transportation Division, who is accompanying me today.

The timing of this hearing is particularly appropriate in light of the recent reminder that a snow storm can have a crippling effect on ground operations. But while the accumulation of more than two feet of snow in the Washington area was uncommon, aircraft operations in icing conditions are not. In fact, the conditions that can result in in-flight aircraft icing are extremely common and can occur at any time of the year.

Because icing conditions are so common, we take the icing threat very seriously, aggressively mitigating newly understood or discovered risks through immediate requirements for specific aircraft and advisory material for operators. Once a potential risk is addressed, we can focus our attention on conducting additional research to understand the science behind complex icing phenomena and developing comprehensive flight-wide solutions without compromising safety in the interim.

While the institutional standards set by our rulemaking are a cornerstone of our safety oversight regime, many appear to measure the safety of the existing fleet solely by our rulemaking process. This measure, however, creates a misperception about the standards we have set and the level of safety we have achieved for the existing fleet.

FAA has a myriad of tools available to intercede when safety risks are identified. For example, we address immediate icing safe-



ty concerns through the use of airworthiness directives, or ADs, which carry the same force as a regulation. We have the authority to issue an AD if we determine that some aspect of flying in icing conditions on a particular airplane model creates an unsafe condition. We have been extremely aggressive in issuing ADs when needed, issuing over 200 icing-related ADs on over 50 different aircraft models covering safety issues ranging from design changes to crew operating procedures.

We also issue guidance to operators to ensure that even if a design change is not appropriate for their particular aircraft, that they have the information to make optimal decisions about icing operations. In addition, the FAA safety team publishes winter operations guidance and information on an annual basis.

These are just some of the examples of tools that we use to ensure the safety of aircraft operations while our research, development, and general rulemaking take an appropriate, measured and deliberative attack.

I also want to clarify another misperception about our icing program and, in particular, the supercooled large droplet, or SLD, rulemaking, the misperception that somehow we had the answers early on but failed to act. As I attempted to explain at the icing roundtable this Subcommittee invited me to last October, and again in my follow-up correspondence, in order to understand SLD, we first had to gather, then analyze enough data to understand in-flight SLD icing conditions. At the roundtable it was suggested that the FAA completed its SLD research in the year 2000 but failed to undertake timely rulemaking. Unfortunately, I was unable to clarify that mis-impression then, but I would like to do so now.

In February 1999, the FAA had gathered sufficient SLD raw data to move forward. The data was then analyzed by NASA and Environment Canada. This analysis was not complete until October 2001. Using this data, the ARAC's icing group worked to define the range of conditions in which we believe SLD conditions can occur, what we call the SLD icing envelope. Although they completed the majority, but not all, of the work to define the SLD icing envelope in December 2002 and continued to tune their findings on into 2003, we had yet to determine the technical solutions that would allow aircraft to continue safe operations in SLD.

The development of technical solutions included determinations of how aircraft designers and manufacturers could comply with these solutions, as well as test for compliance. The ARAC issued its first report in 2005, but the report was revised three times over the next four years as we continued to learn more about SLD and develop potential solutions. After the ARAC's third report, we had enough detail, advice, and direction to move forward with rulemaking, and we did just that, and today I can tell you that this rulemaking is now in final executive coordination.

I would like to conclude by highlighting the fact that the number of accidents attributed to the icing environment has been declining year after year for the last 13 years. Although our work is ongoing, the reduction in the number of accidents attributed to icing is a strong indicator that our actions have increased the level of safety.

This concludes my prepared remarks, and I would be happy to answer any questions you may have.

Mr. COSTELLO. The Chair thanks you, Mr. Hickey, and now recognizes Chairman Hersman.

Ms. HERSMAN. Good afternoon.

In-flight icing is a serious ongoing safety concern and has been on our Most Wanted List since 1997. The watershed accident that generated many of our recommendations was the 1994 accident of an American Eagle ATR 72 in Roselawn, Indiana, due to in-flight icing. The airplane was equipped with a system of de-ice boots designed to remove accumulated ice from the leading edge of the wing; however, the accident flight flew through clouds that contained supercooled large droplets for which the ice protection system was not designed. Large water droplets caused ice to accumulate behind the de-ice boots which could not be removed. The ice accumulation disrupted the airflow in front of the ailerons, causing loss of roll control in the airplane.

This animation shows the aircraft motion and control surfaces and the pilot's control wheel based on information obtained from the flight data recorder. When the flaps, highlighted in yellow, were retracted, the loss of control was initiated. Soon afterwards, the ailerons, highlighted in red, moved uncommanded to their maximum position as a result of the airflow disruption. The airplane lost roll control and entered a steep dive from which it did not recover, despite control inputs from the crew. Although this animation is rather old, the issues identified in the investigation are still open.

Supercooled large droplets, or SLD, is not a typical icing encounter, but it needs to be considered in certification. NTSB investigations and industry research have demonstrated that SLD can cause serious aerodynamic problems. It can accrete aft of the protected surfaces and can cause stall or control problems at a much higher airspeed than expected. In addition, flight crews may not recognize an unsafe condition and take appropriate and timely action.

Since the Roselawn accident, there have been other fatal accidents involving in-flight icing which have generated additional recommendations. The 1997 Comair accident in Monroe, Michigan, was a Part 121 fatal icing accident. Other accidents involving Part 135 or 91 operators have experienced in-flight icing and resulted in fatal accidents. This photo is of a 2005 Circuit City Part 91 corporate flight that encountered SLD and resulted in eight fatalities.

The Safety Board has issued broad recommendations about icing, but we have also issued type-specific recommendations when we identify a unique safety issue. For example, we have issued seven recommendations regarding Cessna 208 Caravans following numerous in-flight accidents and incidents.

The Safety Board is also concerned about serious incidents that have occurred in icing conditions but have not resulted in fatalities or injuries. These precursor events include ones like the loss of control event involving Comair aircraft near West Palm Beach that resulted in a 7,500 foot altitude loss and structural damage.

Some incidents have involved encounters with SLDs, such as the event where an aircraft lost 5,000 feet and was nearly inverted, but the crew managed to recover the aircraft without injuries and substantial damage.

This photo shows an example of an Air Ambulance flight that experienced a loss of control due to ice on the wings during landing and resulted in structural damage to the aircraft wing.

Currently, the NTSB has 15 open recommendations regarding in-flight icing. Of these, four comprise the icing issue on our Most Wanted List. The Safety Board is concerned about the slow pace of the FAA'S response to these recommendations.

The FAA has already made several regulatory and advisory changes that respond to some of our open recommendations. These consist of airworthiness directives addressing operational procedures to detect and exit severe icing and de-ice boot operation in icing conditions. Recently, the FAA has issued final rules regarding aircraft certification for flight in icing conditions and ice protection operation for Part 25 airplanes. Additionally, an NPRM for in-service airplane de-ice boot operation was issued in 2009. These are all positive safety improvements that address the intent of our safety recommendations.

However, the FAA has not yet adequately addressed three key safety areas more than a decade after the recommendations were issued, including consideration of SLD in certification, applying these revised standards to all airplanes currently certificated for flight in icing conditions, and requiring de-ice boot equipped airplanes to operate de-ice boots as soon as the airplane enters icing conditions.

This concludes my presentation and I would be pleased to answer questions.

Mr. COSTELLO. The Chair thanks you, Chairman Hersman, and now recognizes Dr. Dillingham.

Mr. DILLINGHAM. Thank you, Mr. Chairman, Congressman Petri, Members of the Subcommittee. Today I will present preliminary information from a study that we have underway for this Subcommittee, the full T&I Committee, and the Senate Commerce Science and Transportation Committee.

GAO was asked to provide the Committees with information in three areas: first, the extent to which aircraft have been involved in accidents and incidents related to icing and winter weather operations; second, the nature and extent of FAA and other aviation stakeholders' efforts to improve safety; and, third, the issues that should be the focus of future efforts to improve safety in icing and winter operating conditions.

Regarding the scope of the problem. Overall, during the last 12 years, there have been only six icing-related accidents involving large commercial aircraft in the United States. None of these were fatal. During that same period there were slightly more than 500 icing-and winter-related accidents involving small commercial aircraft and general aviation. These accidents resulted in slightly more than 200 fatalities, the overwhelming majority of which involved privately operated and GA-type aircraft.

As accident data for the last several years clearly shows, very few large commercial aircraft are involved in icing-related accidents. Yet, incident data shows that aircraft icing and winter weather operations remain a significant safety risk. According to some aviation experts, aviation incidents are potential indicators or precursors of aviation accidents.

FAA'S incident database contains about 200 reports of icing-related incidents involving large commercial carriers between 1998 and 2007. In addition, the anonymous aviation reporting system that is managed by NASA includes over 600 icing-related incident reports for large commercial carriers for that same time period. This database includes reports by pilots, controllers, ground personnel, and others. These reports cite a variety of safety issues, including problems related to runways contaminated by snow or ice, ground de-icing problems, and in-flight icing encounters.

This brings us to our second issue, namely, the nature and the extent of efforts by aviation stakeholders to improve safety in icing and other winter operating conditions. In our written statement we identify a wide range of activities and initiatives that aviation stakeholders have undertaken. FAA has developed standards, rules and regulations, and monitored airlines' compliance with them.

In addition, FAA has supported research and development, much of it in partnership with NASA and with the private sector. FAA has also provided over \$200 million in airport improvement program funding for airport de-icing facilities and equipment.

Aircraft manufacturers continue to increase the sophistication of their aircraft and their operation capabilities in icing and winter weather through automation and redundancies in safety systems. Airlines, pilots, and ground personnel continue to meet various types of initial and recurrent training requirements. These training requirements are increasingly being met through the use of simulators which incorporate sophisticated technologies that can represent a wide range of conditions.

Despite these efforts and progress, the focus going forward needs to be on continuous improvement to further mitigate the safety risks associated with icing and winter weather operations. Our work has identified five areas in which continued efforts could reduce risk and improve safety.

First, FAA needs to continue its current efforts to improve the timeliness and efficiency of the rulemaking process, including the completion of longstanding icing-related rulemakings; second, adequate resources are needed to support rulemaking and form the basis of technological improvements; third, FAA and airlines must ensure that the training pilots receive is thorough, relevant, and realistic. For example, pilots who are assigned to fly missions in different geographic areas may face unfamiliar winter area conditions and may need region-specific training beyond initial and recurring training to cover their missions and prepare them for those conditions.

Fourth, more timely and accurate weather information is critical to reducing safety risks associated with winter weather operations. Finally, FAA recognizes that icing and winter weather operations is a multidimensional issue and is working to develop an integrated oversight approach. This initiative could be expedited.

Mr. Chairman, if further issues arise from this hearing or otherwise, GAO stands ready to further assist the Subcommittee with its work in this area. Thank you, Mr. Chairman.

Mr. COSTELLO. Thank you, Dr. Dillingham.

The Chair now recognizes Captain Kay.

Mr. KAY. Good afternoon and thank you for inviting ALPA to testify before this Committee.

Over the span of 79 years, ALPA has been a part of nearly every significant safety and security improvement in the airline industry. Today we run the largest non-governmental aviation safety organization in the world.

Professional airline pilots fly a vast range of aircraft types in all sorts of weather conditions, including icing. ALPA has long been an advocate for improving aircraft operations in icing conditions, both in the air and on the ground, primarily because of the guesswork still inherent in these procedures. Allow me to explain.

When pilots fly into icing conditions, all they truly know is that they are in a situation that may be hazardous. With little more than experience as a guide, pilots must attempt to determine exactly the conditions in which they are flying, evaluate if their aircraft is designed to handle those conditions, and to determine what actions to take to safely continue the flight.

Making such critical decisions is not unusual for an airline pilot, but in this environment pilots still face the dilemma of making that decision without defined parameters for operating in icing conditions or without the information they need to properly determine the risk. The bottom line is that our pilots need to know, in real-time and with certainty, what type of icing conditions they are entering, what effects the icing is having on the specific aircraft they are flying, and how to avoid areas of severe icing altogether.

While the airline industry has made some progress in this area, the variable nature of icing makes establishing norms and limits for standard operations difficult but, nevertheless, critical. Icing guidance to pilots is frequently general in nature and inconsistent from airline to airline. I have included examples of this in my written testimony.

Manufacturers' flight testing evaluate specific sets of conditions, but cannot duplicate every possible situation that may be encountered in actual operations. In daily service, pilots must fill in the information divide between icing, flight conditions tested during development, and the actual conditions that they encounter. ALPA continues its call for more comprehensive certification methods that require either additional testing or better simulations of icing conditions that set clear limitations on icing operations. The evaluation of these conditions should occur in the design and certification process, not on a revenue flight.

In reality, a pilot's own training and flight experience in icing may be the primary or even the only means of determining how a specific aircraft's flight handling characteristics might deteriorate in icing. Therefore, ALPA strongly believes that airliners should be equipped with the means to provide pilots with specific information about the type of icing and the rate of accumulation. These systems would not only alert the flight crew, but, when supported with robust procedural guidance, would clearly define the actions needed to maintain a safe level of operation.

While consistent standards and technology upgrades would improve safety in icing tremendously, we must also consider the need for technologies that allow pilots to avoid entering hazardous icing conditions in the first place. Similar to avoiding thunderstorms, pi-

lots need a combination of onboard equipment, training, judgment, and weather forecasting technologies to navigate around severe icing areas.

There is limited use, largely experimental, of these technologies, and manufacturers are developing updated products that deliver real-time weather information to pilots in the cockpit. ALPA strongly supports the adoption of these tools and urges the FAA to encourage broader use of new weather forecasting technologies to improve the safety of airliner operations.

Arming pilots with the hard data they need to make critical informed decisions will dramatically improve operations in icing conditions. With proper standards and procedures in place, we can take the guesswork out and help to keep this industry safe.

Thank you.

Mr. COSTELLO. The Chair thanks you, Captain Kay, and now recognizes Mr. Principato.

Mr. PRINCIPATO. Chairman Costello, Congressman Petri, Members of the Subcommittee, on behalf of all the members of Airports Council International-North America, thank you for allowing me to testify this afternoon.

First, let me discuss the difference between airplane de-icing and airfield de-icing. Airplane de-icing, of course, is conducted to ensure that critical aerodynamic surfaces are free of contaminant that can compromise flight performance, while airfield de-icing is conducted to improve the quality of runway surface conditions and ensure adequate airplane braking performance on snow and ice-contaminated surfaces. Airplane de-icing is performed by airlines or their handling agents to ensure compliance with FAA regulations. Although airports play a role in assisting airlines, the primary responsibility for this de-icing lies with the individual airlines.

Maintaining runway and airfield pavement surfaces in safe conditions and reporting on the conditions is the responsibility of airport operators under FAA requirements. Airfield pavement de-icing has become a critically important tool for safe airplane operations during winter storms. If this was not done, snow and ice removal would be significantly slower, potentially resulting in more delayed and diverted flights.

Snow removal procedures at airports require significant coordination between airport operations personnel, airlines, fixed-based operators, FAA air traffic control, and other concerned parties, which is why airport snow removal plans are developed far in advance of the winter storm season. To give some sense of the level of effort involved, during a typical snowstorm, one large northeastern airport uses a crew of 30 people, 11 multi-function units costing \$800,000 a piece, two large runway brooms, five 27-foot pusher plows, four rollover plows, 10 4500 tons per hour snow blowers—which could have been used on my street a couple of weeks ago—and various front-end loaders and miscellaneous equipment to clear 4.6 million square feet of runway and 5.7 million square feet of non-tenant apron. That is just at one northeastern airport.

Even though the airlines are responsible for airplane de-icing, airport operators are often the permit holders for stormwater discharge, meaning that airports are responsible for the collection and recycling of stormwater runoff. Airplane de-icing operations and

the collection of runoff vary from airport to airport. Some airports use centralized de-icing pads, which are like car washes, for all de-icing efforts. At other airports, de-icing takes place at the gate; at others on taxiways or cargo aprons. Regardless, airports have runoff collection procedures and are required to comply with local, State, and Federal requirements.

In August, the EPA issued a proposed rule for de-icing discharges. ACI-North America has great concerns with the proposal, including the negative impact it will have on airfield ground operations and efficiency, without any real safety benefit.

Members of the Subcommittee, I want to make it clear that airports follow all Clean Water Act requirements with regard to the collection of stormwater runoff. We are committed to high environmental standards, even though we may disagree with the particulars of EPA'S current proposal. On Friday we expect to submit substantial comments to the EPA that will address our concerns, as well as offer possible alternatives that should be considered. I will send a copy of our comments to the Committee and work with the staff on this issue.

On a final note, allow me once again to thank you for your efforts to get an FAA Reauthorization bill passed and signed into law. We can all agree that eight is enough; eight extensions are enough. We estimate that if the EPA, for example, were to finalize this rule, it would cost the airport industry alone hundreds of millions of dollars. Without an increase in the Passenger Facility Charge limit, like the one you proposed in H.R. 915, I really don't know how we will finally comply with that regulation.

Again, thank you, and I look forward to your questions and to working with you on this important issue.

Mr. COSTELLO. The Chair thanks you and I am told early this afternoon that Senator Reid has said that they intend to take up the reauthorization bill sometime during the month of March. So I hope that is true. We have heard that before and it didn't hold, but we are hopeful.

Let me begin by asking Chairman Hersman just a few questions about the icing recommendations on the 2010 Most Wanted Safety List. One, what qualifies a recommendation to be included on the list? In other words, why did you choose to put the specific items on the Most Wanted List this year, as opposed to some other items that could have been included?

Ms. HERSMAN. Chairman Costello, are you asking about all of the items or just the icing ones?

Mr. COSTELLO. The icing ones.

Ms. HERSMAN. Just the icing ones? On our Most Wanted List there is an icing issue area that contains four recommendations. Those are the recommendations that we think are proceeding too slowly, or are most important, or may deserve some special attention; by putting them on our Most Wanted List we could push for action on those issues. So we use our Most Wanted List to highlight the things that we think have the widest safety benefit. Clearly, there are many issues that could be on the Most Wanted List, including many icing recommendations, but these are the four that we think are the most important.

Mr. COSTELLO. Second question. I take it from your testimony that you believe that the FAA currently has the necessary research to revise the way aircraft are designed and approved for flight in icing conditions. Do you believe that they have the necessary research available?

Ms. HERSMAN. Yes, we do. We understand when we first issued these recommendations that some research may have needed to be conducted. We think the research that FAA and NASA conducted is good, sound research. I think the challenge here is there is always more that could be learned or more that could be done, but at some point they have to pull the trigger and make the decision to move ahead with these rulemaking activities.

We haven't even gotten to the point where we have seen a Notice of Proposed Rulemaking. It has been 13 years since we issued the recommendations. We know that the rulemaking process will take many more years before it is completed, so we believe that it is proceeding too slowly and they need to move forward.

Mr. COSTELLO. Dr. Dillingham, the same question for you. Do you believe that the FAA has the necessary research at this point?

Mr. DILLINGHAM. Chairman, it is hard for us to say whether they have the necessary research. We certainly, in the course of doing our work, have talked to NASA and to FAA, and they indicate that the research that was needed, at least early on, has been completed. And we followed up to try and understand what was taking so long at this point in time, and we are still trying to get clarity on that once they said they have the research they need.

Mr. COSTELLO. You would agree with Chairman Hersman, though, that you can continue to research forever; at some point in time you have to pull the trigger. Are you comfortable at this point with the research that has been done by the FAA and NASA that they need to move forward and do rulemaking?

Mr. DILLINGHAM. Yes, sir, I agree with the Chairman that you can always learn more, and at a certain point it is necessary to go forward.

Mr. COSTELLO. Mr. Hickey, would you respond to Chairman Hersman's comments about the research that is available, and Dr. Dillingham's comments as well?

Mr. HICKEY. Yes, Mr. Chairman. First of all, let me say I empathize and actually agree with all the comments made regarding the length of time on rulemaking. For those of us in the FAA and any other agency that are involved in rulemaking, we understand the frustration all of us have on the length of time. In the case of SLD, we have pulled the trigger on rulemaking. We have initiated rulemaking; we are in the process of doing that.

I perhaps may respectfully disagree with Chairman Hersman about when we were ready to pull the trigger on the research data. While we had some of the raw data early on, it is not sufficient with that data to turn it into a regulation such that designers can comply with the proper envelope, like the long-established Appendix C. So I think we have taken the time to get that.

But what is very important to understand is if you reflect back on my opening remarks, what gives us or affords us the opportunity to get it right on the rule is the actions we have taken as part of the 200 airworthiness directives. General rulemaking is



largely an institutionalizing of actions already taken by the agency, and I think we are not accurately gaging the actual level of safety even without the SLD rule. I think we have to account for all the ADs that we have issued, and it provides for a very safe environment for airplanes to avoid SLD conditions.

Mr. COSTELLO. When do you expect to issue a final rule or set of rules addressing the hazards of SLDs?

Mr. HICKEY. As I mentioned earlier, Mr. Chairman, our Notice of Proposed Rulemaking is going through final executive coordination. We are anticipating that to be published this spring, and I think the normal congressional mandate is to have it 16 months after the close of comment period, so I would be looking at late 2011.

Mr. COSTELLO. Mr. Hickey, as you will recall, you sent me a letter on November the 16th of 2009 and you indicated, to that same question, that it would be done in January of 2010, and you are saying now that it is late this year?

Mr. HICKEY. Mr. Chairman, if I could respectfully disagree. I believe my comments in that roundtable were the spring of 2010.

Mr. COSTELLO. When?

Mr. HICKEY. The spring of 2010, sir.

Mr. COSTELLO. We will find the exact date. It says January 2010 on your time chart here. It says January 2010 anticipate publication of the SLD rule.

Mr. HICKEY. I will go back and make sure we supply it for the record, sir.

Mr. COSTELLO. And you are saying that now, instead of January 2010, you are talking late this year, 2010?

Mr. HICKEY. No, I am not, sir. I am suggesting the spring of 2010. It has left the agency; it is in executive coordination right now.

Mr. COSTELLO. So in April or May of this year we should anticipate that.

Mr. HICKEY. Or partly June.

[Information follows:]

**FAA insert for the record at p. 35, line 745:**

During the hearing, there was a misunderstanding that I wish to clarify, regarding my estimations for the publication date for the supercooled large drop (SLD) notice of proposed rulemaking (NPRM). The chairman was led to believe that in my November 16, 2009, letter to him I stated that the SLD NPRM would be published in January 2010. However, as I discussed with committee staff immediately following the hearing, in my prior correspondence with the chairman, in the chart that the chairman referenced during the hearing, and at the icing round table, I indicated that the estimated times for publication of the SLD NPRM were dependent on OMB action. Because OMB has determined that the SLD rulemaking is significant, the necessary review prior to publication has taken additional time. The entire correspondence package and the chart are attached for the record.<sup>1</sup>

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<sup>1</sup> The estimated dates of publication for the SLD NPRM can be found in the first correspondence enclosure in response to question 13 and on the last page of the chart titled, "Timeline of SLD Activities".



U.S. Department  
of Transportation  
**Federal Aviation  
Administration**

800 Independence Avenue SW  
Washington, DC 20591

NOV 16 2009

The Honorable Jerry F. Costello  
Chairman, Aviation Subcommittee  
House of Representatives  
Washington, DC 20515

Dear Mr. Chairman:

Thank you for your letter dated October 15 asking questions related to our supercooled large drop (SLD) icing rulemaking. The response to your specific questions is attached as Enclosure 1. I would like to take this opportunity to put the SLD rulemaking in the context of Federal Aviation Administration's (FAA) overall icing program which I believe is comprehensive and effective. Mitigating the safety risks posed by icing is challenging; but FAA has been successful in improving the safety of flying in those conditions. The FAA program was developed shortly after a 1994 accident of an ATR-72 airplane in icing conditions near Roselawn, Indiana. This program consists of a number of both short and long term significant actions to address the icing threat. To date, our efforts have included:

- Issuing nearly 200 airworthiness directives (AD) on 50 different aircraft models,
- Adopting two final rules and working on several others,
- Conducting targeted research into specific icing risk areas,
- Issuing numerous safety bulletins to pilots and operators highlighting how to minimize specific safety risks associated with flying in icing conditions,
- Working with the National Aeronautics and Space Administration, airplane manufacturers, and aviation industry associations to develop and make available improved training for flight in icing conditions, and
- Updating existing Advisory Circular guidance information.

Throughout this ongoing effort, we have been guided by the recommendations of the National Transportation Safety Board (NTSB). Although we are not always able to take the exact action the Board recommends, we value the intent of their recommendations and benefit from their investigations of icing-related accidents and significant incidents.

#### **Immediate Safety Actions**

The FAA's icing program addressed the immediate icing safety concerns for the current fleet of airplanes through the use of ADs. The FAA has the authority to issue an AD if we determine that some aspect of flying in icing conditions on a particular airplane model is unsafe. ADs are legally enforceable rules that must be complied with in order to continue to operate the airplane. As noted above, FAA has been aggressive in issuing ADs when we determine they are needed. The nearly 200 ADs issued have addressed icing threats by

requiring actions ranging from airplane design changes to changes in crew operating procedures. These ADs significantly reduced the icing risk to the current fleet.

#### **Longer Term Actions**

The FAA's icing program includes a number of longer term actions to further improve the safety of flying in icing conditions both for the current fleet and for future airplane designs. These actions include issuing safety bulletins, developing improved training material, updating existing Advisory Circular guidance material, rulemaking, and further research. We recognize that fast action is an important goal for implementing any safety improvement, yet we also recognize and take into account the fact that some actions take longer than others.

For example, rulemaking is a deliberative process that must involve those affected by the rules (including both the affected industry and the general public). In general, the more controversial or significant the rulemaking, the longer it takes. In some cases, including the SLD rulemaking, developing and implementing rules depends on completing further research in order to better understand and address particular phenomena and their effect on safety.

There are seven separate rulemaking efforts in our icing program:

1. Performance and Handling Qualities in Icing Conditions for Transport Category Airplanes
2. Activation of Airframe Ice Protection Systems for Transport Category Airplanes
3. Removal of Airplane Operating Regulations Allowing Polishing of Frost on Wings of Airplanes
4. Activation of Airframe Ice Protection Systems for Certain Airplanes Used in Domestic, Flag, or Supplemental Operations
5. Airplane and Engine Certification Requirements in Supercooled Large Drop, Mixed Phase, and Ice Crystal Icing Conditions (not including small airplanes)
6. Small Airplane Certification Requirements in Supercooled Large Drop, Mixed Phase, and Ice Crystal Icing Conditions
7. Requirements for Exiting Icing Conditions for Certain Airplanes Used in Domestic, Flag, or Supplemental Operations

We have completed action by issuing final rules for the first two of these rulemakings. Release of the final rule for the third rulemaking and the proposal for the fourth rule are imminent. In addition, we anticipate publication of proposal for the fifth rulemakings by the spring of 2010 and we are tasking an Aviation Rulemaking Committee to provide us with recommendations for the sixth rulemaking. At this time, we do not have a schedule for the seventh of these rulemakings, but I think you will agree that FAA has been far from complacent with respect to our work on icing.


In summary, I believe we have a robust, comprehensive and effective program for improving the safety of airplanes flying in icing conditions. Additional FAA significant

actions that substantially reduced the risks of another icing accident are provided in Enclosure 2. It has been nearly 13 years since a United States commercial air carrier was involved in a fatal icing accident. The FAA is proud of this achievement and is committed to continuing to address icing safety risks.

During our roundtable discussion, you asked me for a list of the ADs we have issued for icing. Enclosure 3 is the listing as well as copies of the 191 ADs.

If I can be of further help, please contact Mr. Roderick D. Hall, Assistant Administrator for Government and Industry Affairs, at (202) 267-3277.

Sincerely,



John J. Hickey  
Deputy Associate Administrator  
for Aviation Safety

Enclosures:

- 1- FAA Response to Specific Questions from Chairman Costello
- 2- Additional FAA Significant Activities
- 3- Icing AD Listing

Enclosure 1 to Letter to Chairman Costello

1. *What is the date the rulemaking process started?*

**Response:** The Supercooled Large Drop (SLD) rulemaking was formally initiated in January 2008, when the FAA's Rulemaking Management Council approved both the drafting plan and a schedule. As is sometimes the case, when the NTSB issued recommendations on addressing SLD icing, there was inadequate data to support a rulemaking. In order to understand the condition sufficiently to identify an appropriate solution and require airplane manufacturers to implement that solution, a significant amount of research had to be done. In 1996, the FAA began tasked the Aviation Rulemaking Advisory Committee (ARAC) to develop certification criteria for the safe operation of airplanes in SLD icing conditions. At the same time (winter of 1996-1997), FAA began supporting research efforts by NASA and Environment Canada to gather additional SLD data. As detailed in response to question seven, the ARAC working group charged with working on SLD has issued four reports, one as recently as June of this year. It was only after the third report was issued in April of 2007 that the FAA received sufficiently detailed recommendations to proceed to develop a Notice of Proposed Rulemaking (NPRM).

2. *When was the Aviation Rulemaking Committee (ARAC) chartered?*

**Response:** The ARAC is a standing advisory committee which was originally chartered by the FAA on February 15, 1991 in accordance with the Federal Advisory Committee Act. ARAC is comprised of an Executive Committee with 10 technical issue areas (subordinate groups), one of which is the Transport Airplane and Engine Issues Group (TAEIG). The TAEIG conducts its work through 29 lower level working groups. The Ice Protection Harmonization Work Group (IPHWG) was assigned most of the SLD work. The IPHWG was originally tasked on December 8, 1997, to provide advice and recommendations for SLD. The notice issued pertained to part 23 (small airplane regulations) and part 25 (transport category airplane regulations) aircraft and contained one short term and six long term tasks. The FAA modified the scope of the work assignment twice. In February 2002, the FAA removed the assignment that IPHWG make recommendations for part 23 aircraft because the recommendations for part 25 aircraft were likely to be inappropriate for part 23 aircraft. In January 2005, IPHWG was charged with providing advice and recommendations for aircraft engines in SLD conditions.

3. *How often did the ARAC meet?*

**Response:** As noted in response to question two, the ARAC is an extremely broad entity. Its Executive Board meets twice a year. The actual work on the SLD recommendations was performed by the IPHWG. The IPHWG met 37 times between February 1998 and February 2009. The meetings were consistently attended by 20-25 members who represented governmental bodies, industry, and aviation associations from the United States, Canada, Europe and South America.

4. *Who was on the ARAC?*

**Response:** The ARAC itself consists of 55 member organizations selected by the FAA as most representative of the various viewpoints of entities impacted by FAA regulations. At the working level, the IPHWG membership consisted of representatives from government bodies (FAA, NASA, Transport Canada, Environment Canada, Joint Aviation Authorities), industry (Aerospatiale, Airbus Industrie, British Aerospace-Airbus, Boeing, Canadair, Cessna, Embraer, SAAB Aircraft AB), and aviation associations (Airline Pilots Association, General Aviation Manufacturers Association, Regional Airline Association).

5. *How were the ARAC members selected?*

**Response:** The IPHWG members were selected using established ARAC operating procedures. The non-FAA individuals sought membership by writing to the Assistant Chair and Assistant Executive Director of ARAC TAEIG and the Chair of IPHWG. The selected representatives were found to have an interest in the tasks assigned to the IPHWG. The FAA representatives were selected based on their technical expertise.

6. *When did the ARAC first approve a concept to revise certified standards due to SLD?*

**Response:** The ARAC Executive Committee approved the "SLD rule concept" in March 2002. The rule concept serves as the outline for the working group's report on recommended rulemaking. Concept approval is done to ensure that the ARAC agrees that the working group is proceeding in a direction consistent with the work assignment before further resources are dedicated. After the rule concept is approved, the working group develops a recommended rulemaking report to support FAA drafting of the rule. After receiving approval of the SLD rule concept, the IPHWG continued to work for five years to complete the rulemaking recommendations. As noted in the response to question two above, during that period of time, in January 2005, the FAA and the ARAC expanded the task scope to require the IPHWG to address part 33 (aircraft engine) SLD issues.

7. *When did the ARAC submit its report to the Federal Aviation Administration?*

**Response:** The ARAC has submitted four separate reports to the FAA in support of the SLD rulemaking. The first was issued in November 2005, the second in March of 2006, the third in April of 2007 and the most recent in June of this year.

8. *What did the ARAC's report recommend?*

**Response:** As noted above, the ARAC issued four reports due in part to the number of assigned tasks and expanded information requests. As provided in greater detail in the attached timeline, the IPHWG did not define the SLD icing envelope until December 2002. The part 33 requirement was added in January 2005. The initial report (November 2005) recommended parts 25 and 33 SLD rulemaking. It also recommended that the IPHWG complete a review of the available means of compliance with such a rulemaking. The report is 350 pages of technical information. For your reference, we have included a copy of the letter submitting the report and

the table of contents which identifies specific recommendations. The second report (March 2006) contained slight revisions to the initial report. The third report (April 2007) recommended specific airspeed indicating systems and angle of attack sensors, and advisory material for part 25 aircraft. It was at this point, that FAA had enough detail, advice and direction to move forward with a rulemaking. The final report was received in June of this year and contains revised advisory material regarding acceptable means of compliance to meet the ARAC rulemaking recommendations.

**9. *Is there a legal obligation for the FAA to follow the recommendations of the ARAC?***

**Response:** No. The purpose of the ARAC is to provide rulemaking advice and recommendations to the FAA. The exchange of ideas that occurs through the ARAC process affords the FAA additional opportunities to obtain information and insight from those parties who are most affected by existing and proposed regulations before rulemaking is officially initiated. In the end, after analyzing and evaluating the information provided, it is the sole responsibility of FAA to determine how to move forward in the best interest of aviation safety.

**10. *It is my understanding that the FAA is currently performing an economic analysis of the ARAC's report. When will this be completed?***

**Response:** The economic analysis of the draft NPRM was completed in July 2009.

**11. *Is the economic analysis for title 14 Code of Federal Regulation part 25 aircraft or does it also include part 23 aircraft?***

**Response:** As noted in response to question two, part 23 aircraft were removed from the ARAC SLD task in February 2002. This was done because it was determined that the recommendations for part 25 aircraft were likely to be inappropriate for part 23 aircraft. In March 2009, the FAA formed an Aviation Rulemaking Committee (ARC) that was tasked to provide recommendations to determine how part 23 should be modified to address SLD.

**12. *Since the ARAC report was submitted to the FAA, what has been done with the information?***

**Response:** As noted in previous responses, the ARAC submitted four separate reports to the FAA. While FAA conducted some preliminary economic analysis of the rulemaking recommendations received in the first two reports, it was not until FAA received the April 2007 report that all of the rulemaking recommendations were completed. Upon receipt of that report, FAA initiated the process of assigning a priority to the rulemaking project. In January 2008, the FAA Rulemaking Management Council approved the project as a high priority and assigned a rulemaking team to draft the NPRM and complete a full regulatory evaluation. The draft NPRM was completed in May 2008 and the regulatory evaluation was completed in July 2009. Between May 2008 and June 2009, the IPHWG conducted and completed a review of the available means of compliance with the draft NPRM. The rulemaking process is carefully prescribed and internal reviews are required within FAA, the Department of Transportation and throughout the executive branch. The required review is ongoing. The typical time period between when a



rulemaking team receives authority to formally start working on a rulemaking project and the publication of a final rule for a significant rulemaking is approximately three years. If the rulemaking is deemed to be non-significant, it is slightly over two years. The final determination of significance is made by the Office of Management and Budget (OMB).

*13. Does the FAA still plan on issuing its Notice of Proposed Rulemaking in early 2010?*

**Response:** As noted in the response to question 12, part of the timing of the publication of the NPRM is contingent on whether OMB agrees with FAA that this rule should be considered non-significant. If the rule is determined by OMB to be significant, additional reviews would be required. Mr. Hickey stated at the round table that he believed the NPRM would be published no later than the spring of 2010, but it could be earlier depending on OMB action.

Enclosure 2 to Letter to Chairman Costello

**Additional FAA Significant Activities**

1. The FAA conducted an ice contaminated tailplane stall evaluation of existing airplanes with unpowered flight control systems (of which many are equipped with pneumatic deicing boots) operating under the 14 CFR parts 121 or 135 operating rules. The FAA mandated changes to improve tailplane stall margins for airplanes found to be susceptible.
2. In 1995, the FAA initiated a roll control force evaluation that addressed 14 CFR parts 23 and 25 airplanes used in regularly scheduled revenue passenger service in the United States and equipped with pneumatic deicing boots and unpowered ailerons. All airplanes were found to have acceptable roll control forces should a ridge of ice form aft of deicing boots and forward of the ailerons.
3. Between April 1996 and February 1998, the FAA issued over forty severe icing airworthiness directives (ADs) for 14 CFR Parts 23 and 25 airplanes equipped with pneumatic deicing boots and unpowered ailerons. The ADs provide the flightcrew with visual cues to determine when the airplane has encountered severe icing conditions that exceed the capabilities of the airplane's ice protection equipment. The ADs also require the flightcrew to exit the severe icing conditions.
4. On July 19, 1996, the FAA issued revised Advisory Circular (AC) 91-51A, *Effect of Icing on Aircraft Control*. This AC provides information for pilots regarding the hazards of aircraft icing and the use of airplane deice and anti-ice systems.
5. Between November 1999 and May 2000, the FAA issued over twenty-five ADs for Title 14 Code of Federal Regulations (CFR) parts 23 and 25 airplanes requiring:
  - a. Activation of the deicing boots at the first sign of ice accretions anywhere on the aircraft, and
  - b. Cycling the boots in the automatic mode, if available, or manually operating to minimize the ice accretions on the airframe.
6. In 2004, the FAA assisted the Air Safety Foundation of the Aircraft Owners and Pilots Association in publication of a Safety Advisor on the limitations of ice protection equipment on general aviation airplanes.
7. On February 2, 2004, the FAA issued AC 20-147, *Turbojet, Turboprop, and Turbofan Engine Induction System Icing and Ice Ingestion*. This AC provides guidance for demonstrating compliance with the applicable engine induction system icing and engine ice ingestion requirements.
8. On May 7, 2004, the FAA issued revised AC 25.1419-1A, *Certification of Transport Category Airplanes for Flight in Icing Conditions*. This AC provides guidance for certification of airframe ice protection systems on transport category airplanes.
9. On December 20, 2004, the FAA issued revised AC 120-60B, *Ground Deicing and Anti-Icing Program*. This AC provides a standard means for obtaining approval of a ground deicing/anti-icing program as required by 14 CFR part 121, section 121.629.
10. In 2005-2006, the FAA worked with airplane manufacturers to require operators of transport category airplanes without leading edge high lift devices to perform a visual and tactile check of wing leading edges and upper surfaces before taking off in icing conditions.
11. On December 13, 2005, the FAA issued AC 120-89, *Ground Deicing Using Infrared Energy*. This AC provides guidelines and recommendations for pilots, certificate holders,

and operators of deicing facilities regarding the use of infrared (IR) technology for deicing aircraft.

12. On March 29, 2006, the FAA issued a Safety Alert for Operators (SAFO) 06002 on ground deicing practices for turbine airplanes in nonscheduled Part 135 and Part 91 service.
13. On August 6, 2006, the FAA issued revised AC 20-73A, *Aircraft Ice Protection*. This AC provides detailed guidance on how to comply with the ice protection requirements of 14 CFR 23, 25, 27, 29, 33, and 35.
14. On October 6, 2006, the FAA issued SAFO 06014 to warn against the hazards posed by polished frost.
15. On November 11, 2006, the FAA issued SAFO 06016 to increase awareness of in-flight icing dangers for pilots flying turbo-propeller powered airplanes.
16. On September 9, 2007, the FAA issued AC 25-25, *Performance and Handling Characteristics in the Icing Conditions Specified in Part 25, Appendix C* to provide guidance on how to comply with the icing requirements introduced by amendment 121 to 14 CFR part 25.
17. On November 30, 2007, the FAA issued SAFO 07009 to inform owners, operators, and FAA entities of training requirements for pilots of CE-208 (Cessna Caravan 1) and CE-208B (Cessna Grand Caravan) airplanes for flight into icing conditions.
18. On December 31, 2007, the FAA issued updated AC 91-74A, *Pilot Guide: Flight in Icing Conditions*, incorporating information on the effect of ice crystals on turbine engines and to educate pilots on icing certification and to help them understand the limitations of their airplane in icing conditions. This AC was originally published in December 2002 and included information on potential hazards of flight (including takeoff and landing) in SLD conditions.
19. On May 20, 2008, the FAA issued SAFO 08012 on aircraft taxi operations during snow and ice conditions.
20. On February 11, 2009, the FAA issued SAFO 09004 to emphasize preflight and in-flight planning for winter airport operations for taxi, takeoff, and landing. It also elaborates on SAFO 0812.
21. On October 27, 2009, the FAA issued AC 25.1419-2, *Compliance With the Ice Protection Requirements of § 25.1419(e), (f), (g), and (h)*. This AC provides guidance for installing a primary ice detection system, developing visual cues and installing an advisory ice detection system to alert the flightcrew that the airframe ice protection system (IPS) must be activated, identifying conditions conducive to airframe icing through the use of temperature and visible moisture cues, and including in the airplane flight manual procedures for activating and deactivating the airframe IPS.
22. The FAA conducted research projects from 1999 to 2007 to better define critical ice accretions to be used for icing certification.
23. The FAA revised Advisory Circular 23.1419-2 in 2004, and again in 2007, so that the icing certification of new part 23 airplanes, which include light jets, incorporate the results of recent icing research and lessons learned from icing accident investigations.
24. To promote safety of small airplanes operating in icing, the FAA published articles on part 23 icing certification on the 2008 FAA Safety Team (FAAST) website and in the November/December 2009 issue of the FAA Aviation News.
25. The FAA worked with NASA Glenn to produce numerous icing training products for pilots.

Enclosure 3 to Letter to Chairman Costello			
Number	AD Number	Aircraft Model	Action Required Summary
1.	2008-26-11	Piper PA-46 series	Modifies stall warning heat wiring to allow heat with gear down.
2.	2008-16-02	Hawker Beech 390 series	Requires post-flight check of AOA probes and replace or modify the stall warning AOA transmitters. Correct potentially inadequate stall warning with loss of stick pusher function.
3.	2007-10-15	Cessna 208 series	Supersedes AD 2006-06-06. Revise the AFM which mandates annual icing training and installation of a Low Airspeed Awareness System, adds icing climb performance data.
4.	2007-05-05	Socata M.S. 760 series	Revise the Airplane Flight Manual (AFM) to mandate no ice, snow, frost or slush on critical surfaces for takeoff.
5.	2006-06-06	Cessna 208 series	Supersedes AD 2005-07-01. Revise the AFM Limitations and Procedures in icing conditions. Prohibits flight in moderate icing or greater, adds icing exit criteria, prohibits autopilot use in icing.
6.	2006-01-11	Cessna 208 series	Mandates installation of cargo pod/landing gear deicing boots and a pilot assist handle.
7.	2005-18-20	Goodrich FASTProp Deicers	Requires inspection, repair, or replacement of those "FASTprop" propeller de-icers that fail daily visual checks.
8.	2005-07-01	Cessna 208 series	Revise the AFM Limitations and Procedures in icing conditions. Mandates pre-takeoff tactile wing check for contamination, adds minimum airspeeds, adds warning on stall warning.
9.	2003-22-07	Mitsubishi MU-2B series	Supersedes AD 97-20-14. Mandates viewing an updated icing training video every two years prior to flight in known or forecast icing.
10.	2002-11-02	Hawker Beech 390 series	Revise AFM by prohibiting flight in icing and adding exit procedures due to possible manufacturing obstruction in wing leading edge ice protection system.
11.	2002-01-16	Fairchild Aircraft 226,227 series	Supersedes ADs 86-24-11 and 86-25-04. Mandates modification of engine ignition systems to prevent flameout in icing conditions.
12.	2000-26-17	Pilatus PC-12, PC-12/45	Requires modification of windshield ice protection system.
13.	2000-14-08	Piper PA-42 Series	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated continuously.
14.	2000-11-14	Pilatus PC-12 and PC-12/45	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated

			continuously.
15.	2000-09-15	Mitsubishi MU-2B series	Mandates installation of trim-in-motion system, automatic autopilot disconnect system, engine auto-ignition, and empennage deice monitor system.
16.	2000-06-06	Piper PA-31 Series	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated continuously.
17.	2000-06-04	Fairchild Aircraft SA226 and SA227 Series	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated continuously.
18.	2000-06-3	Bombardier Inc., DHC-6 Series	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated continuously.
19.	2000-06-02	Dornier 228 Series	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated continuously.
20.	2000-03-18	Partenavia Costruzioni Aeronauticas, S.p.A., Models AP68TP series	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated continuously.
21.	2000-02-30	Twin Commander 600 Series	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated continuously.
22.	2000-02-29	SOCATA TBM 700	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated continuously.
23.	2000-02-28	AeroSpace Technologies Of Australia Pty Ltd., Models N22B and N24A.	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated continuously.
24.	2000-02-27	Embraer EMB-110P1 and EMB-110P2	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated continuously.
25.	2000-02-26	Harbin Model Y12 IV	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated continuously.
26.	2000-02-25	Mitsubishi MU-2B Series Airplanes.	Wing and Tail Deicing Boot must be activated at the first sign of ice formation, or upon annunciation from an ice detector system; and the system must be operated

			continuously.
27.	99-14-01	Piper PA-23, PA-30, PA-31, PA-34, PA-39, PA-40, and PA-42 Series	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures. Supersedes AD 98-04-27
28.	98-21-28	British Aerospace Jetstream 3101	Requires modification of propeller deice system to assure system performance at low ambient temperature.
29.	98-20-38	Hawker Beech 200 Series	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
30.	98-20-33	Cessna Model T210R	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
31.	98-20-28	Pilatus Models PC-12 and PC-12/45	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
32.	98-11-01	Pilatus PC-12, PC-12/45	Modifies fuel tank vents to prevent freezing of moisture
33.	98-07-18	Pilatus PC-12, PC-12/45	Mandates modification of propeller deicing system to prevent loss of operation due to EMI.
34.	98-05-14 R1	Cessna Models T210, P210, P210R	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
35.	98-04-28	Cessna Models T303, 310R, T310R, 335, 340A, 402B, 402C, 404, F406, 414, 414A, 421B, 421C, 425, and 441	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
36.	98-04-26	Piper Models PA-46 series	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
37.	98-04-25	Hawker Beech Model 2000 Airplanes	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
38.	98-04-24	Hawker Beech Models E55, E55A, 58, 58A, 58P, 58PA, 58TC, 58TCA Airplanes, and 60, 65-B80, 65-B90, 90, F90, 100, 300, and B300 Series	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
39.	98-04-23	Aerostar Models PA-60-600, PA-60-601, PA-60-601P, PA-60-602P, and PA-60-700P	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
40.	98-04-21	Britten-Norman Ltd., Models BN-2 series	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
41.	98-04-20	Partenavia Costruzioni Aeronauticas, S.p.A. P68 series	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
42.	98-04-19	Harbin Aircraft Model Y12 IV	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
43.	98-04-18	AeroSpace Technologies Of Australia Pty Ltd., Models N22B and N24A.	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.

44.	97-20-14	Mitsubishi MU-2B Series	Mandates viewing an icing training video every two years prior to flight in known or forecast icing.
45.	97-15-10	Allied Signal TPE331 engine	Mandates engine modifications to prevent icing of engine PT2 sensor from causing loss of thrust.
46.	96-25-02	Mitsubishi MU-2B Series	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures. Also defines minimum airspeed, limits flap use.
47.	96-11-01	Jetstream Aircraft Limited Models 3101 and 3201 Airplanes	Modifies timing of wing and tail deicing boots,
48.	96-09-17	Jetstream Aircraft Limited Models 3101 and 3201 Airplanes	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
49.	96-09-16	Fairchild Aircraft 227 series	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
50.	96-09-15	Cessna 208 Series	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
51.	96-09-14	Dornier 228 Series Airplanes	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
52.	96-09-12	Embraer EMB-110P1 and EMB-110P2	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
53.	96-09-13	Hawker Beech Models 99, 99A, A99A, B99, C99, B200, B200C, 1900, 1900C, and 1900D	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
54.	96-09-11	De Havilland, Inc., DHC-6 Series	Adds AFM Limitation to exit severe icing conditions and adds severe icing cues and exit procedures.
55.	95-22-03	Hawker Beech Model 60, A60	Revise AFM by mandating minimum airspeeds in icing.
56.	95-15-12	British Aerospace Jetstream HP137 Mk1 and Series 200	Revise the AFM flap operating limitations in icing conditions.
57.	95-02-06	British Aerospace Jetstream 3101	Revise the AFM flap operating limitations in icing conditions.
58.	93-01-02	British Aerospace HP 137 Mk1, Jetstream Models 200, 3101, and 3201	Requires modification of the tailplane deicing system to prevent its failure.
59.	90-14-01	Fairchild Aircraft 226 and 227 series	Reinforce cockpit window due to ice shed from the propeller.
60.	87-16-11	Hawker Beech Model 58	Modify the stall warning heat circuit.
61.	86-26-02	Mitsubishi MU-2 series	Modify the engine ignition system to prevent flameout in icing conditions.
62.	86-25-04	Fairchild Aircraft 227 series	Revise AFM to modify engine ignition operating procedures to prevent engine flameout in icing conditions.
63.	86-24-13	Cessna Model 441	Revise AFM to modify engine ignition operating procedures to prevent engine flameout in icing

			conditions.
64.	86-24-11	Fairchild Aircraft 226 series	Revise AFM to modify engine ignition operating procedures to prevent engine flameout in icing conditions.
65.	86-24-10	British Aerospace Jetstream 3101	Revise AFM to modify engine ignition operating procedures to prevent engine flameout in icing conditions.
66.	86-24-09	Hawker Beech Model 100	Revise AFM to modify engine ignition operating procedures to prevent engine flameout in icing conditions.
67.	86-20-01	Mitsubishi MU-2B series	Modify the pitot to assure anti-ice capability of pitot system.
68.	86-01-01	Cessna T303	Revise AFM procedures and modify ice protection system for ice accretion at juncture of vertical and horizontal tail.
69.	85-11-05	Cessna T303	Prohibit flight into known icing due to flutter of vertical stabilizer.
70.	84-12-04	Mitsubishi MU-2B series	Requires modification of the engine inlet ice protection system prior to flight into known icing.
71.	83-22-07	British Aerospace Jetstream 3101	Prohibits flight into known icing until airplane modifications are incorporated and aft center of gravity limit moved forward due to pitch oscillations.
72.	82-26-06	De Havilland, Inc., DHC-6 Series	Install an electrically heated windshield
73.	82-20-02	Embraer Model 110	Supersedes AD 82-15-06. Required modification of the empennage ice protection system.
74.	82-06-10	Cessna 210 series	Modifies pneumatic system
75.	82-05-05	Fairchild Aircraft 227 series	Prohibits flight into known icing or incorporation of a Service Bulletin to address propeller ice accretion.
76.	81-24-04	Fairchild Aircraft 226 series	Requires installation of an engine auto-ignition system for flight into known icing
77.	81-01-01	Piper PA-31T series	Requires modification of propeller and engine inlet ice protection systems.
78.	80-19-10	Model 335 and 340A	Requires inspection and possible modification to ice protection systems.
79.	76-12-10	Hawker Beech Model 200	Requires inspection and possible replacement of pneumatic lines to prevent wing deice failure.
80.	71-05-03	Hawker Beech Model A60, 99	Requires modification of ice protection systems prior to flight into known icing.
81.	68-21-04	Hawker Beech Model 65-90 series	Requires modification to engine inlet inertial vane and installation of an engine automatic ignition system.
82.	99-15-06	Honeywell ALF502	Requires incorporation of an improved fan core inlet anti-ice system, to prevent ice accretion on the fan core inlet stator vane surfaces, which can result in engine rollback and loss of thrust control in icing conditions.
83.	00-05-25	BAE146 / ALF502	Revises AD 96-14-09. This AD requires replacement of



			new placards. This amendment also provides for a terminating modification for the AFM revision and replacement of placards.
84.	2007-17-01	General Electric CF6-80E1 series	Requires new engine software that increases margin to flameout in icing conditions. Exposure to ice crystals during flight is associated with the engine flameouts.
85.	2007-22-07	General Electric CF6-80C2D1F	Requires new engine software that increases margin to flameout in icing conditions. Exposure to ice crystals during flight is associated with the engine flameouts.
86.	2007-12-07	General Electric CF6-80C2B series	Requires new engine software that increases margin to flameout in icing conditions. Exposure to ice crystals during flight is associated with the engine flameouts.
87.	2007-21-06	General Electric CF6-80C2A5F	Requires new engine software that increases margin to flameout in icing conditions. Exposure to ice crystals during flight is associated with the engine flameouts.
88.	2007-26-19	Rolls Royce Deutschland Tay 611-8, -8C, 620-15, 650-15, 651-54	This AD supersedes an earlier AD and requires initial & repetitive inspections of the ice impact panels and replace as needed. It also requires the installation of new panels as terminating action. Release of panels due to ice and can result in loss of thrust.
89.	2008-24-10	Pratt & Whitney Canada JT15D-5, -5B, -5F, -5R	This AD requires design changes to the P3 engine control line to prevent freezing. Certain icing conditions can result in excessive moisture and freezing in the P3 control line.
90.	2006-21-02	Hawker Beech Beechjet 400A	Requires revising the airplane flight manual to modify the Operating Limitations, Abnormal Procedures, and Normal Procedures, as applicable, for flight in icing conditions.
91.	86-25-52 R1	Aerospatiale ATR42	Prohibits flight into known or forecast icing conditions
92.	89-09-05	Aerospatiale ATR42	Prohibits use of the autopilot when operating in icing conditions; AFM change.
93.	89-24-07	Aerospatiale ATR42	Install anti-icing advisory system
94.	96-09-28	Aerospatiale ATR42, ATR72	Modify the wing leading edge de-icing boots.
95.	99-09-19	Aerospatiale ATR42, ATR72	Omnibus AD. Revise AFM to reinforce severe icing detection and increase the speed during exit maneuver.
96.	99-19-10	Aerospatiale ATR42, ATR72	Revise the AFM to require de-ice boot activation at the first sign of icing.
97.	2003-18-07	Aerospatiale ATR42-200, -300, -320, -500. ATR72	Supersedes AD 2001-16-10. Revise the AFM for takeoff performances with use of Type II or IV de-icing fluids. See 2000-NM-379-AD.
98.	85-15-03	Aerospatiale NORD 262A	Modification to correct unsafe conditions in windshield and engine anti-icing control circuits
99.	2001-13-17	Airbus A300, A300-600, A310	Revise AFM to incorporate procedures for airspeed fluctuations in icing conditions.
100.	2001-13-13	Airbus A330, A340	Revise AFM for airspeed fluctuations in icing

			conditions.
101.	89-23-10	Boeing 737-300, 737-400	AFM revision: Avoid prolonged flight in icing conditions
102.	2003-03-03	Boeing 777-200, -300	Revise AFM icing conditions. Engine anti-ice system must be on for all ground and flight operations when icing conditions exist.
103.	09-06-05	Bombardier CL-600-1A11 (CL-600), CL-600-2A12 (CL-601), and CL-600-2B16 (CL-601-3A, CL-601-3R, and CL-604)	Inspect and replace anti-ice piccolo ducts as appropriate.
104.	2008-08-06	Bombardier CL-600-1A11, -2A12, -2B16, -2B19	Supersedes AD 2005-04-07. Revise the AFM for inspection/takeoff/flight in icing conditions. See 2005-NM-023-AD.
105.	2008-21-09	Bombardier CL-600-2B19, -1A11, -2A12, -2B16	Supersedes AD 2008-08-06. Adds new requirements. Revise the Limitations and Procedures sections of the AFM for inspection/takeoff/flight in icing conditions. See 2008-NM-068-AD.
106.	2003-24-03	Bombardier CL-600-2C10	Supersedes AD 2003-12-06. Revise the AFM to prohibit flight into known icing conditions. Inspect/replace the wing anti-ice ducts system. See 2003-NM-98-AD.
107.	99-19-18	Bombardier DHC-7, DHC-8	Revise the AFM to require de-ice boot activation at the first sign of icing.
108.	2004-20-03	Bombardier DHC-8-100, -200, -300	Inspect/Replace wing leading edge de-icing boot.
109.	2001-03-05	Bombardier Lear 45	Replace the anti-ice manifold assembly and revise the airplane flight manual for flight in icing conditions.
110.	93-22-08	British Aerospace 4101	Inspect/replace earth post and propeller cables of the dc generator and propeller de-icing system
111.	96-09-19	British Aerospace 4101	AFM revisions to prohibit flight into freezing rain/drizzle conditions; limit/prohibit use of various flight control devices; and provide crew with recognition cues and exit procedures from icing conditions.
112.	92-02-02	British Aerospace ATP	Adds additional optional terminating modification which entails the application of autoglym 12 as an alternative to icex icing inhibitor
113.	96-09-18	British Aerospace ATP	AFM revision to prohibit flight into freezing rain/drizzle conditions; limit/prohibit use of various flight control devices; and provide crew with recognition cues and exit procedures from icing conditions.
114.	99-19-11	British Aerospace ATP	Revise the AFM to require de-ice boot activation at the first sign of icing.
115.	99-26-17	British Aerospace ATP	Modify the intake ducts with new cable routes and improved contamination protection of connectors on the engine intake de-icing system.
116.	96-09-20	British Aerospace HS 748	AFM revisions to prohibit flight into freezing

			rain/drizzle conditions; limit/prohibit use of various flight control devices; and provide crew with recognition cues and exit procedures from icing conditions.
117.	99-19-13	British Aerospace HS 748	Revise the AFM to require de-ice boot activation at the first sign of icing.
118.	96-09-22	CASA C-212, CN-235	AFM revisions to prohibit flight into freezing rain/drizzle conditions; limit/prohibit use of various flight control devices; and provide crew with recognition cues and exit procedures from icing conditions.
119.	99-19-15	CASA C-212, CN-235	Revise the AFM to require de-ice boot activation at the first sign of icing.
120.	2009-18-06	CASA CN-235	Modify the de-icing boots control system.
121.	2000-03-09	Cessna 560	Supersedes AD 96-24-06. Revise the AFM to incorporate increased landing speeds during icing conditions and additional limitations for de-ice boot system use. See 96-NM-267-AD
122.	98-04-38	Cessna 500, 501, 550, 551, 560	Revise the AFM to specify procedures that would prohibit flight in severe icing conditions (as determined by certain visual cues), limit or prohibit the use of various flight control devices while in severe icing conditions, and provide the flight crew with recognition cues for, and procedures for exiting from, severe icing conditions.
123.	2007-01-12	Dassault FALCON 50, 900, 900EX, 2000, 2000EX	Inspect/repair/replace the outboard slat anti-icing manifold. Revise the AFM to increase N1 mini with anti-ice on. **MARPA comments.**
124.	2004-02-04	Dassault Falcon 900 EX	Revise AFM to advise crew of operating limitations during flight icing conditions.
125.	2000-04-19	Dassault MYSTERE-FALCON 50	Supersedes AD 97-21-16. Revise the AFM to incorporate operation in icing conditions procedures. See 97-NM-275-AD.
126.	84-24-51-R1	de Havilland DHC-7	Clarify/revise afm instructions for operations
127.	96-09-25	de Havilland DHC-7, DHC-8	AFM revisions to prohibit flight into freezing rain/drizzle conditions; limit/prohibit use of various flight control devices; and provide crew with recognition cues and exit procedures from icing conditions.
128.	95-04-51	Dornier 328-100	TELEGRAPHIC AD. Inspect/replace de-icing boots; revise AFM
129.	96-09-23	Dornier 328-100	AFM Revisions to prohibit flight into freezing rain/drizzle conditions; limit/prohibit use of various flight control devices; and provide crew with recognition cues and exit procedures from icing conditions.
130.	98-21-18	Dornier 328-100	Replace the de-icing timer.
131.	99-19-16	Dornier 328-100	Revise the AFM to require de-ice boot activation at the first sign of icing.
132.	2004-20-15	Dornier 328-100	Supersedes AD 95-04-51 to mandate mod, add SB

			revisions, add requirements, remove requirements, and revise part numbers. Inspect/repair engine air intake de icing system, powerplant exchange of air intake, and modification of by-pass duct outlet. Revise limitations and abnormal procedures section of the AFM.
133.	2005-10-02	Dornier 328-300	Install a mounting angle for the de-icing pipe in the wing leading edges.
134.	96-09-24	EMBRAER EMB-120	Revise AFM to prohibit flight into known freezing rain or drizzle See 95-NM-225-AD
135.	97-26-06	EMBRAER EMB-120	Revise AFM to incorporate limitations for flight in icing conditions.
136.	2001-02-06	EMBRAER EMB-120	Supersedes AD 97-26-06. Adds requirements. Revise the AFM for flight in icing conditions; and install an ice detector system. X-Ref: 97-NM-46-AD.
137.	2001-06-18	EMBRAER EMB-120	Supersedes AD 2001-02-06. Adds requirements. Revise the AFM for flight in icing conditions; and install an ice detector system. X-Ref: 2000-NM-125-AD.
138.	2001-13-14	EMBRAER EMB-120	Revise the AFM for autopilot procedures in icing conditions; install placard; and remove de-ice boots inflation cycle control 'light-heavy' switch.
139.	2001-20-17	EMBRAER EMB-120	Supersedes AD 2001-13-14. Adds new requirements. Revise the AFM to impose additional low airspeed alert and allow use of autopilot in icing conditions. X-Ref: 2001-NM-190-AD.
140.	98-13-16	EMBRAER EMB-145	Replace anti-icing valve and improve the insulation over the anti-icing ducts of the horizontal stabilizer in the thermal anti-icing system.
141.	98-24-19	Embraer EMB-145	Revise the AFM to incorporate anti-icing system changes.
142.	98-04-31	Fairchild F-27, FH-227	Revise the AFM to specify procedures that would prohibit flight in severe icing conditions (as determined by certain visual cues), limit or prohibit the use of various flight control devices while in severe icing conditions, and provide the flight crew with recognition cues for, and procedures for exiting from, severe icing conditions.
143.	99-19-09	Fairchild F-27, FH-227	Revise AFM to require de-ice boot activation at the first sign of icing.
144.	2004-03-03	Fokker F.28 Mark 0070, 0100	Revise AFM to incorporate changes in operations in icing conditions.
145.	96-09-26	Fokker F27	AFM revisions to prohibit flight into freezing rain/drizzle conditions; limit/prohibit use of various flight control devices; and provide crew with recognition cues and exit procedures from icing conditions.
146.	99-19-19	Fokker F27	Revise the AFM to require de-ice boot activation at the first sign of icing.

147.	2000-05-02	Fokker F27 MARK 050, 200, 500, 600	Install a flight deck monitor system for the horizontal and vertical stabilizer de-icing system.
148.	94-25-03	Fokker F28	SUPERSEDED. Revise AFM to include alternate takeoff procedure when icing conditions exist
149.	2006-15-17	Fokker F28 MARK 0070, 0100	Modify the wiring of the AC bus transfer power system and the windshield anti-icing system.
150.	96-03-04	General Dynamics CONVAIR 240, 340, 440	Revise AFM to limit flap selection in icing conditions.
151.	98-04-36	Gulfstream G-159	Revise AFM to specify procedures that would prohibit flight in severe icing conditions (as determined by certain visual cues), limit or prohibit the use of various flight control devices while in severe icing conditions, and provide the flight crew with recognition cues for, and procedures for exiting from, severe icing conditions.
152.	88-20-04	Gulfstream G-IV	Prohibits flight into icing conditions, until modification of crew alerting system and anti-ice system accomplished
153.	2000-10-11	Gulfstream American (Frakes) DC-3	Revise the AFM to require de-ice boot activation at the first sign of icing.
154.	98-04-33	Gulfstream American (Frakes) G-73, G-73T	Revise AFM to specify procedures that would prohibit flight in severe icing conditions (as determined by certain visual cues), limit or prohibit the use of various flight control devices while in severe icing conditions, and provide the flight crew with recognition cues for, and procedures for exiting from, severe icing conditions.
155.	99-19-07	Gulfstream American (Frakes) G-73, G-73T	Revise the AFM to require de-ice boot activation at the first sign of icing.
156.	2000-10-19	Israel 1125 Westwind Astra, Astra SPX	Replace the pneumatic de-icing boot pressure indicator switch.
157.	99-16-03	Learjet 23, 24, 25, 28, 29, 31, 55, 60	Inspect and correct the wiring of the horizontal stabilizer anti-icing system, install a warning placard, and install a wire ID strap or color coded sleeving.
158.	99-19-17	Lockheed 1329-23, 1329-25	Revise the AFM to require de-ice boot activation at the first sign of icing.
159.	98-04-32	Lockheed L-14, L-18	Revise AFM to specify procedures that would prohibit flight in severe icing conditions (as determined by certain visual cues), limit or prohibit the use of various flight control devices while in severe icing conditions, and provide the flight crew with recognition cues for, and procedures for exiting from, severe icing conditions.
160.	99-19-08	Lockheed L-14, L-18	Revise the AFM to require de-ice boot activation at the first sign of icing.
161.	98-24-25	Lockheed L-188A, L-188C	Revise the AFM to provide the flight crew with modified procedures and limitations for operating in icing conditions.
162.	98-04-35	McDonnell Douglas DC-3,	Revise AFM to specify procedures that would prohibit

		DC-4	flight in severe icing conditions (as determined by certain visual cues), limit or prohibit the use of various flight control devices while in severe icing conditions, and provide the flight crew with recognition cues for, and procedures for exiting from, severe icing conditions.
163.	2000-04-03	McDonnell Douglas DC-3, DC-4	Revise the AFM to require de-ice boot activation at the first sign of icing.
164.	92-03-01	McDonnell Douglas DC-9-10	AFM revision to require flight crewmember to perform visual and tactile inspection of wing for ice/frost prior to takeoff
165.	93-11-01	McDonnell Douglas DC-9-10	Supersedes AD 92-03-01. Modify the wing leading edge bleed air anti-ice system. X:REF: 92-NM-01-AD.
166.	82-24-04	McDonnell Douglas DC-9-30, DC-9-50, DC-9-81, -82, -83, -87, MD-88, C-9	Inspection of the horizontal stabilizer de-icing spray tube for proper installation
167.	92-03-02	McDonnell Douglas DC-9-81, -82, -83, -87, MD-88	AFM revision to require flight crewmember to perform visual and tactile inspection of wings for ice/frost prior to takeoff; installation of tufts and decals on wing as visual aids in detecting clear ice
168.	2001-06-16	McDonnell Douglas DC-9-81, DC-9-82, DC-9-83, DC-9-87, MD-88	Supersedes AD 92-03-02. Adds installation of an over wing heater blanket system -- Revise the AFM to specify restrictions on operations during icing conditions and installation of decals. See 92-NM-02-AD.
169.	2002-06-11	McDonnell Douglas MD-90-30	Inspect/replace the strake feed-thru and internal wire connectors of the strake anti-icing and control.
170.	99-21-30	Mitsubishi MU-300	Install ice detector; revise AFM to include limitations in icing conditions.
171.	99-19-06	Mitsubishi YS-11, YS-11A	Revise the AFM to require de-ice boot activation at the first sign of icing.
172.	91-06-04	Mitsubishi YS-11, YS-11A	Revise AFM to limit flap positions in icing conditions on final approach to landing
173.	91-16-01	Mitsubishi YS-11, YS-11A	AFM revision to limit flaps in icing conditions during landing. adds references to MHI transmittal letters.
174.	98-04-34	Mitsubishi YS-11, YS-11A	Revise AFM to specify procedures that would prohibit flight in severe icing conditions (as determined by certain visual cues), limit or prohibit the use of various flight control devices while in severe icing conditions, and provide the flight crew with recognition cues for, and procedures for exiting from, severe icing conditions.
175.	2006-21-02	Raytheon BEECH 400, 400A, 400T; MITSUBISHI MU-300	Revise the limitations, normal, and abnormal sections of the AFM to revise procedures for flight in icing conditions.
176.	96-19-08	Saab 2000	Inspect/modify stabilizer boot de-icing system.
177.	98-19-19	Saab 2000	Inspect electrical harness of the propeller de-icing system and of the hydraulic pressure pipe from the engine driven pump (EDP)

178.	96-01-04 R1	Saab 340B	Revises: ad 96-01-04. AFM revisions for operation in icing conditions -- clarification. x-ref. docket: 95-nm-260-ad.
179.	2008-06-11	Saab SAAB/SF340A, SAAB 340B	Revise the Limitations section of the AFM to include procedures to address icing conditions. Terminates certain paragraphs of ADs 96-01-04R1 and 99-19-14.
180.	85-26-51	Saab SF340A	Modify restrictions for flight in icing conditions
181.	85-26-51 R2	Saab SF340A	Use of continuous ignition during icing; provides optional automatic ignition system (MOD #1414)
182.	96-09-21	Saab SF340A, 340B, 2000	AFM Revisions to prohibit flight into freezing rain/drizzle conditions; limit/prohibit use of various flight control devices; and provide crew with recognition cues and exit procedures from icing conditions.
183.	99-19-14	Saab SF340A, 340B, 2000	Revise the AFM to require de-ice boot activation at the first sign of icing.
184.	96-01-04	Saab SF340A, SF340B	Revised by: AD 96-01-04 R1. Revise AFM to include procedures for operation in icing conditions. x-ref docket: 96-NM-74-AD.
185.	99-19-03	Sabreliner 40, 60, 70, 80	Revise the AFM to require de-ice boot activation at the first sign of icing.
186.	98-04-37	Sabreliner NA-265-40, NA-265-60, NA-265-70, NA-265-80	Revise AFM to specify procedures that would prohibit flight in severe icing conditions (as determined by certain visual cues), limit or prohibit the use of various flight control devices while in severe icing conditions, and provide the flight crew with recognition cues for, and procedures for exiting from, severe icing conditions.
187.	99-19-20	Short Brothers SD3-30, SD3-60, SD3-SHERPA	Revise the AFM to require de-ice boot activation at the first sign of icing.
188.	96-09-27	Short Brothers SD3-30, SD3-60, SHERPA	AFM revisions to prohibit flight into freezing rain/drizzle conditions; limit/prohibit use of various flight control devices; and provide crew with recognition cues and exit procedures from icing conditions.
189.	88-18-05	Short Brothers SD3-60	Replace copper pitot tubes; icing problems
190.	96-21-10	Short Brothers SD3-60 SHERPA	AFM revision to prohibit flight into freezing rain/drizzle conditions. limit/prohibit use of various flight control devices; provide crew with recognition cues and exit procedures from icing conditions.
191.	2001-02-08	Short Brothers SD3-30, SD3-60, SD3-30 SHERPA, SD3-60 SHERPA	Replace the pneumatic de-icing boot pressure indicator switch.

Timeline of SLD Activities		
Date	SLD related Actions	Additional Information
Nov 16, 1994 through Feb 13, 1995	FAA issued a series of 4 icing related Airworthiness Directives against the ATR-42/72 model airplanes	
November 1995 through September 1995	The FAA conducted a special certification review (SCR) of the ATR 42/72 series airplane as recommended by the NTSB.	The SCR team found the airplane was properly certificated to the requirements of the FARs. The SCR team found that the icing conditions of the Roselawn accident were well outside the 14 CFR part 25, appendix C icing envelope.
March 1995	FAA initiated investigation of airplanes certified under 14 CFR parts 23 and 25 that are used in regularly scheduled passenger service in the United States and equipped with pneumatic deicing boots and unpowered ailerons.	All of these airplanes were found to have acceptable roll control forces should a ridge of ice form aft of the deicing boots and forward of the ailerons.
April 24, 1996 and February 6, 1998	FAA issued over 40 severe icing airworthiness directives to part 23 and 25 airplanes equipped with pneumatic deicing boots and unpowered ailerons.	The ADs provide the flight crew with visual cues to determine when the airplane has encountered severe icing conditions that exceed the capabilities of the airplane's ice protection equipment. The ADs also require the flight crew to exit the severe icing conditions.
August 15, 1996	The NTSB issues safety recommendations related to the Roselawn accident.	NTSB Safety Recommendation A-96-54 states in part, "expand the Appendix C icing certification envelope to include freezing drizzle/freezing rain and mixed water/ice crystal conditions, as necessary."
July 23, 1997	FAA issued policy to all Aircraft Certification Offices requiring an evaluation of newly designed or derivative part 23 and 25 aircraft with unpowered ailerons and pneumatic deicing boots.	The evaluation addressed roll control anomalies in certain supercooled liquid droplet conditions. The policy documents the known unsafe condition addressed by the ADs issued in 1996 and 1998. The evaluation consists of requirements similar to those used during the roll control evaluation initiated in March 1995. The flightcrew information is similar to that contained in the ADs issued in 1996 and 1998.
December 1997	ARAC Ice Protection Harmonization Working Group (IPHWG) was assigned 7 tasks.	Task 2 is related to SLD rulemaking: Review NTSB safety recommendations A-96-54, A-96-56, and A-96-58 and define an icing environment that includes supercooled large drops (SLD) and devise requirements to assess the ability of aircraft to safely operate either for the period of time to exit or operate without restriction in SLD.



Date	SLD related Actions	Additional Information
February 1998	First ARAC IPHWG Meeting	The IPHWG held 37 meetings (approximately 3 times a year) between Feb 1998 and Feb 2009 to complete all assigned tasks.
1996-1998	Gathered SLD data in the Great Lakes region.	There was insufficient cloud physics data to characterize SLD icing conditions for rulemaking. NASA and Environment Canada, along with FAA sponsorship, conducted research efforts during the winters of 1996-1998 to gather additional SLD data.
Feb 1999	<ul style="list-style-type: none"> <li>• Consolidation of existing SLD data given to IPHWG.</li> <li>• IPHWG determines they had adequate SLD data and no additional research flights were needed.</li> </ul>	The FAA led an effort to collect, consolidate, and analyze existing SLD data
Sept 2000	TAEIG requests references to part 23 category airplanes be deleted from the tasks.	Request for task revision is in TAEIG letter dated Sept. 6, 2000. TAEIG felt that the recommendations for part 25 aircraft are likely to be inappropriate for art 23 category aircraft. FAA responds to the request in a letter dated Feb 12, 2002.
Oct 2001	NASA and Environment Canada complete analysis of SLD data obtained during the 1996-1998 winters.	This analysis is labor intensive because there are no automated methods to prepare the data.
Feb 2002	IPHWG completes draft SLD icing envelope that is sufficient to develop the SLD rule concept.	
Feb 2002	FAA modifies tasking to only address part 25 airplanes.	Task revision is in FAA letter dated Feb. 12, 2002. This is in response to the Sept 2000 request from TAEIG to remove part 23 from the tasking.
March 2002	ARAC approves SLD rule concept.	
Dec 2002	IPHWG completes the majority of the work defining the SLD icing envelope.	Tuning of the SLD icing envelope continued during 2003.
July 2004	Incorporated the July 23, 1997 SLD policy memo into Advisory Circular 23.1419-2C, but expanded applicability to part 23 airplanes without fully evaporative wing anti-ice systems.	
Jan 2005	FAA revises task 2 (SLD) to add part 33 engine icing requirements.	Task revision is in FAA letter dated January 13, 2005. This results in Task 2 (SLD) covering part 25 and 33. Part 23 was removed from the tasking in Feb 2002

Mr. COSTELLO. I have a few other questions, but at this time I have taken a lot of time. I will recognize the Ranking Member for any questions he might have.

Mr. PETRI. Thank you very much, Mr. Chairman. I do have a couple of questions, one of Dr. Dillingham.

One of the factors that we have heard as a key contributing element involving accidents and incidents related to icing with GA, but also larger carriers, has to do with the availability and quality of weather information, and it might be general, but very specifically in different areas. To your knowledge, can we expect any improvements in the situation so far as operable information about air conditions through the implementation of NextGen?

Mr. DILLINGHAM. Mr. Petri, it is our understanding, based on the work that we are doing for this Subcommittee, as well as others, focusing on NextGen, that, indeed, weather and providing better, more accurate, more timely weather information is a critical component of NextGen. As you know, for flights in general, or schedules in general, up to 70 percent of sort of delays and cancellations and diversions are associated with weather, so it is our understanding that better weather information is a key part of the development of NextGen.

Mr. PETRI. Thank you. We were up at the research center and it was my impression that there may be technology already, but that each plane may be a little reporting station on the conditions of the space that it is going through, and that could be fed into the system. While that technology may already exist, if it is a separate deployment, it is more expensive than if it is part of a NextGen system, and that clearly could give people an extra margin of safety because they could avoid particular—they already do that, but this would be that many more streams of information that each pilot would have and the system would have available to it.

Mr. DILLINGHAM. Yes, sir.

Mr. PETRI. I do wonder if Mr. Principato could expand a little bit for us here. You indicated there is this EPA rulemaking process going forward and it is of great concern and it is important to get it right. If it is not done right, the airport operators' hands can be tied and it could have a lot of implications for costs and for—they just have to be safe—so for the flights that can go forward, because you might not be able to de-ice.

Could you expand on that and what your solutions are? I know you said you have a written statement for us, but just to highlight how you can solve this problem, if you can, or what we need to do to deal with the balance between the environment and the need to de-ice these things?

Mr. PRINCIPATO. Sure. Well, let me begin by saying again that certainly airports comply with all local, Federal, and State requirements, including the Clean Water Act, so we are doing that, and we are always looking for ways of doing a better job of mitigating environmental impacts. So we certainly share the EPA'S goals of improving the environmental performance.

The concerns we really have—and the comments are being finalized; they are due on Friday. We will work with the staff here and share them with the staff and the Members of the Subcommittee.

But the main concerns we have I guess are in a couple of areas. Number one, if you look at Denver and you look at LaGuardia, Denver is an airport with a footprint of 54 square miles; LaGuardia is an airport with a footprint of about a footprint, it is not much more than that. We are concerned that the rule would treat those two airports in too much of an identical manner, that it doesn't fully take into account the differences in airports, whether the size differences or some of the other things.

And I have used Denver and LaGuardia, I keep coming back to that. If you look at those two airports and see the differences in those places, we believe the rule does not adequately take some of those differences into account with regard to how aircraft would have to be de-iced and what would have to be done with the runoff and so forth. So we are going to bring some suggestions on dealing with that.

Our second concern is we don't believe that the cost estimates and the rule adequately take into account the operational costs of the rule, whether it is the operation of the airport, whether it is the operation of the aircraft out there on the airfield. We think it will lead to a lot of inefficiencies and so forth and add to the cost without the environmental benefit that you might add, may or may not add could be added for a much lower cost.

So those two things: it doesn't adequately take into account the differences in the airport—and keep thinking Denver and LaGuardia in your mind as two large hub airports that are very different—and the need to take fully into account the operational costs and efficiencies when implementing a rule that maybe doesn't take into account the differences in airports.

Mr. COSTELLO. The Chair thanks Mr. Petri and now recognizes the gentleman from Iowa, Mr. Boswell.

Mr. BOSWELL. Thank you, Mr. Chairman, for having this hearing.

This has been a tough winter. Captain Kay and maybe Mr. Principato would say something about it. But are there de-icing operations in general? Obviously, there are various intensities, the bigger airports you mentioned, but do we have enough equipment out there to do what we need to do?

Mr. KAY. I would answer that in the affirmative. On a personal note, I tend to operate at larger airports around the Country. I have been very impressed with the way the airports have managed the runway clearance and the aircraft de-icing, and from members of my association who are operating at the smaller ones, they concur with that as well. There has been a large improvement in the way that winter hazards and operations have been dealt with by the airports and by the airlines and the subcontractors.

Mr. BOSWELL. Just a curiosity. How long does that de-icing last? You get de-iced at the gate and you can go to taxi and wait in line. What is your time element? I realize there are variables, but what is kind of the ballpark you are looking at?

Mr. KAY. That is very much size-dependent on the aircraft. A small regional aircraft might be de-iced in four or five minutes, perhaps; and a large wide-body airline could be 15 to 20 minutes. So, obviously, the shorter the gap between completing the de-icing and the aircraft being at the end of the runway is optimal, so it

is preferable in many cases not to do the de-icing at the gate, but to do it at a remote pad near the operating runway.

Mr. BOSWELL. That is what I was leading up to. Those pads sometimes are right at the gate or they come to the airplane before you push back, and so on. I am just wondering what your thoughts were on that.

Thank you, Mr. Chairman. I yield back.

Mr. COSTELLO. The Chair thanks the gentleman and now recognizes Mr. Coble.

Mr. COBLE. Thank you, Mr. Chairman. I apologize to you and Mr. Petri and the panel for my belated arrival; I had another meeting. I am sorry I came in late.

Mr. Hickey, I am going to amplify my ignorance with this question. Define supercooled large droplets for me. And comment on them, if you will.

Mr. HICKEY. Well, supercooled large droplets are in some ways what the word large means, they are very, very large droplets, larger size than we have previously assumed was very typical in icing conditions; and when they form they sometimes form on the airplane and freeze and create ice shapes beyond what most airplanes or a number of airplanes are certified to handle. So they ultimately create a shape on the wing which changes the fundamental ability of the wing to provide lift and speed.

Mr. COBLE. And no doubt present a greater hazard or threat?

Mr. HICKEY. Yes, sir, it is a greater hazard and threat than our current certification standards. But I would like to advise that it is a very rare event. Our information is it happens or occurs less than one percent of the time.

Mr. COBLE. Thank you, sir.

Ms. Hersman, is the NTSB satisfied with the FAA'S progress in addressing aircraft icing issues?

Ms. HERSMAN. No, Congressman Coble, and that is one of the reasons why we placed it on our Most Wanted List of Transportation Safety Improvements. We have an icing issue area, and we believe that the FAA needs to take action on three specific recommendations. One is to expand the certification envelope to include SLD.

And, Reshan, if you could pull that slide up for us to show the SLD conditions.

The second recommendation is to make sure the certification standards apply to all aircraft in service. The third recommendation is to make sure whenever aircraft enter icing conditions, if they have pneumatic de-ice boots, that they activate them and operate them continuously.

A tool that airmen can use to look at icing conditions; is a SIP. You will see the areas in red indicate—and I have also provided a little handout. This is current, this is real-time and this is live. This is the SLD threat, the areas shaded in red. So you will see, yes, there are some in the northeast, but there are also some off the coast of Florida.

So while SLD is considered to be a rare event--99 times out of 100 an icing event, may not be SLD--but, if you are on the aircraft that is that one out of 100 that is getting into SLD, you want to

make sure the aircraft is certified for those conditions and that the pilots know what to do.

Mr. COBLE. Thank you.

Dr. Dillingham, how might emerging EPA regulations on the use of icing countermeasures at airports affect airline operations?

Mr. DILLINGHAM. Mr. Coble, as was just discussed, this is a pending regulation for handling runoff from de-icing so that it could have all kinds of effects depending on how the rule is finally implemented and what the regulations are. It could cost airports additional funds to develop the proper facilities to do this and to take care of the runoff; it could in fact slow down and also increase delays with regard to traffic moving, as well.

So until we know what the final rule is, it is hard to tell what all the implications are, but certainly those airports that don't currently have the facilities to handle runoff will have to find a way to do that.

Mr. COBLE. Thank you, sir.

Mr. Chairman, could I have one more question? I see the red light is on. Thank you.

Captain Kay, you may have touched on this with the gentleman from Iowa, but let me put this to you. It was noted at this fall's roundtable on aircraft icing that the ability to routinely deal with icing conditions could lead to a sense of complacency about the dangers that icing can pose. A, do you agree with that analysis? And, B, what steps are the unions or anybody taking to instill continued and continuous vigilance in the cockpit?

Mr. KAY. Thank you for the question. I cannot agree that the word complacency can be used in the same sentence as icing; it is surely one of the greatest hazards we face airborne. Three basic levels of icing, whether it is light, moderate, or severe; and, obviously, the second and third modes are ones that we do not want to be dealing with.

So we want to know where that icing is; we want to know its severity and its rate of accumulation. I don't think anybody involved in winter operations really has any business getting complacent at all. Meteorology is a very inexact science, so you are dealing with variables all day and nightlong.

With the association, my association takes this issue very, very seriously. We are looking forward to a rule coming out on icing, but our biggest concern is training of the pilots. Right now, we want to have the best possible training available. I have spoken about this on other areas in aviation. I am deeply concerned about the reduced training footprints that airlines are now applying to their pilots, whether it is as ab initio, when they first join an airline or go to a new plane, or whether it is recurrent training.

I am deeply concerned about how much we have chipped away at what gets discussed when a pilot shows up in a training center. So this would be very much high on my list for pushing better and great training and having a greater awareness of what it is we are dealing with when we are getting airborne.

Also, I work also as a check airman. I give simulated checks to pilots, and I am very pleased with just how much we can get a synthetic simulator sitting in a hot, dry room to replicate poor weather conditions. We can simulate many things for a pilot to deal with,

but nothing beats good training and good fundamental understanding in the first place of what the hazard is.

Mr. COBLE. I thank you, sir, and I thank you all for being with us.

Thank you, Mr. Chairman. I yield back.

Mr. COSTELLO. The Chair thanks the gentleman and now recognizes the gentleman from Michigan, Mr. Schauer.

Mr. SCHAUER. Thank you, Mr. Chairman.

Thank you all for your testimony.

Captain Kay, I am glad you just spoke about training. I am from Battle Creek, Michigan. Western Michigan University's College of Aviation is located there in my district at Kellogg Airport. It sounds like, from your comments, there is a certain amount of art, as well as science, and maybe what that really means is experience, and experience and training really matter.

So I was going to ask you to talk a little bit more about the tools that pilots need to make those critical decisions. You comment that those tools haven't yet been fully developed. Can you talk about that and what we need to do to develop those tools and how those can be incorporated into training?

Mr. KAY. Very much so. I have quite a long shopping list, so I will try and keep it short. I would like to have that picture that was up on the wall there just now in my cockpit as a starting point. I don't have access to—that one right there. What we have access to in our cockpits is very limited. We have pictures like this available to us in a preflight planning scenario, but once we are airborne, we are relying on fairly sparse amounts of information coming our way.

Taking a turbo prop airliner, for example, onboard equipment consists of an icing detector on many of these aircraft and it gives me one simple message: ice. I mean, it is on or it is off; it doesn't give me any idea about how it is accreting on the aircraft, whether it is icing that is just forming along the leading edge of the wing, which is undesirable, but not horrible, or whether it is supercooled water droplets that are flowing back across the airframe, and those are a huge problem for us. Those are the ones that really start to impact us flying.

So I want information. I want training in the first place, as we have talked about, especially at that ab initio stage, but in the plane, in the operation, I want all the technologies available to me to allow me to make the best possible decisions. I don't want to wait until I am in that weather and I am becoming a test pilot and my passengers behind me are becoming passengers along for that ride.

So information is what we need. We need the basic education in the first place, how to apply procedures that are laid out for us through the FAA and through the companies and the manufacturers. But once we are actually in the operation, we need to keep that information flow coming.

Curiously enough, a lot of time the best information I get is from an airplane ahead of me, a pilot report. That means he is in it and he doesn't like it because he is making a pilot report, but he is concerned enough that it needs to be passed back. That is what I want to stop. I don't want to see us having to get into this moderate or

severe icing to the point where we are concerned enough we need to pass it back. I would like to find a day where we can avoid that altogether.

Mr. SCHAUER. Thank you. It sounds like technology is a major area of exploration and research. I don't know if the technology exists to do what you are suggesting or whether it just needs to be incorporated on the aircraft.

Mr. KAY. The technology is evolving, but it would give me some better onboard information without having to rely on other aircraft making pilot reports. But I am very big on the basic education. When a pilot decides to be a pilot, that there is a level playing field of information that is being required for a pilot to participate and learn on and take that on and help build his or her experience that way.

Mr. SCHAUER. I am going to ask a final question. I am running out of time, but given that this aviation college in my district is in a northern climate, there may be training opportunities there. They are flying year-round, probably 360 days a year or so in all conditions, so there may be some opportunities, and they are training pilots for commercial aviation.

Are there limits to communications to folks on the ground to talk about weather conditions, to provide that information to pilots?

Mr. KAY. Once you are airborne, there are essentially two groups of people that you are dealing with in an aircraft, one is your dispatcher back on the ground, your company dispatcher, part of whose job it is—it is a shared responsibility to the safe conduct of that flight; and once they are aware of hazardous weather conditions, they obviously have to pass that along to us. And then, of course, is the air traffic controller and the information they have in front of them.

When they are trying to get a bottleneck set of aircraft out of Florida in a very tight amount of airspace, they have very little room to deal with. So there are competing interests there about dealing with hazardous and the routing around it. But I would certainly like to see better coordination with our air traffic controllers so they have a better understanding of aircraft performance limitations as well.

Your district in the northern climes of this Country are particularly well suited to good all-weather flying education. I think that is a huge bonus, to be able to go up and get actual experience in guarded conditions.

Mr. SCHAUER. Thank you.

I yield back.

Mr. COSTELLO. The Chair thanks the gentleman.

Mr. Hickey, to follow up on Captain Kay's point, you also stress in your testimony the importance of ensuring that pilots understand the procedures they should follow when they encounter in-flight icing, and you go on to expand. I guess my question is what has the FAA done to, number one, ensure that commercial pilots receive proper training especially regarding SLDs and, number two, to provide pilots with updated icing information?

Mr. HICKEY. Mr. Chairman, I am going to ask my colleague, Mr. Duncan, to answer that.

Mr. DUNCAN. Mr. Chairman, let me start by saying that training is a cumulative thing for pilots; it starts at the private pilot level, particularly in regard to dealing with the meteorological conditions, including icing, and it progresses through the commercial pilot certificate, through an instrument rating, through an airline transport pilot certificate.

By the time they get to an air carrier, they are dealing with specific meteorological conditions that deal with the environment that they are going to be operating in, as well as the specifics of requirements and procedures of the carrier that they are working with, as well as the specifics related to the type of aircraft that they are flying.

In terms of tools available to them, the chart that you just saw is one of the tools that has been developed over time, and we are still working on additional tools. I will say also that in some GA aircraft that SIP chart is available in flight, along with a lot of other weather information like that.

We also agree that this is a continuous improvement process, and we are fully engaged in continuing to improve the tools that are available. We talked about NextGen and what is planned in NextGen a few minutes ago.

Mr. COSTELLO. Anyone on the panel like to make a comment to follow up on FAA requirements? Captain Kay?

Mr. KAY. When the NextGen evolves to the point where it is fully implemented, I am looking forward to a time where we know precisely what conditions we are dealing with before we ever leave the ground, bearing in mind that a lot of that weather is moving at 80 to 100 miles an hour eastbound, so it is quite a trick to be able to come up with a good routing on that.

I talked about the ice light in a turbo prop earlier on, and I probably should have gone on to point out what a large jet such as I fly has in the way of ice detection, and that is essentially nothing. I can't see behind my arms when I am sitting in the cockpit of a plane; I can't even see my wings. I can't just take a walk back and look at my wings and see if they are icing up.

So we have procedures. If we fly into cloud, we look at what the total air temperature is and we switch on our engine anti-icing and our wing anti-icing. But if we are trying to determine how much ice we are getting, we very scientifically lean forward and look at the windshield wiper blade, and there is a big bolt that holds that onto the rest of the airplane, and that is my very scientific device for the moment for telling me how much I am getting and how fast it is accreting. So we spend a lot of time studying that windshield wiper bolt, so I think we can do better than that.

Mr. COSTELLO. The Chair now recognizes the gentlelady from California, Ms. Richardson.

Ms. RICHARDSON. Thank you, Mr. Chairman.

Ms. Hersman, first of all, I think you got the lucky draw, from what I can tell, of coming to our Committee versus the one down the hall, so we are glad that you are here. I thought it was interesting, when Captain Kay was talking about his not having this type of information readily available during flight, you kind of looked over.



I am a little surprised. Why would you say that they would not have access? I could see that preflight, as a person is preparing information, but clearly if a flight is five hours, four hours, a lot can change from when you are doing your preflight operation to when you are actually flying. So why would we not have this information available for our pilots real-time? It is my understanding many of them have laptops, different means to be able to collect this information.

Ms. HERSMAN. I would say that it is probably limited by whatever technology is available in the aircraft. The Safety Board has made many recommendations to the FAA over the years about having better, more current information. In fact, we just made recommendations in the Colgan investigation, even though that was not considered an icing accident.

We found that the crew in that accident did not have current information about icing that was provided to them by their dispatch. We think it is important for airmen to have information before they get into the cockpit, to make sure that information is understandable, and that it is not part of a 40-page packet that is confusing and hard to find important information.

As far as having in-flight information, we think that is very important, too. This information comes from other pilot reports, but, as Captain Kay pointed out, if you are the first pilot to go into that area, you may not get that information. How helpful that information is to you is also dependent on the size of your aircraft. If Captain Kay is going in and he is flying a 747 through the same cloud that I am going to be going through with a small turbo prop, he might have light to moderate icing, while my experience might be moderate to severe icing just because of the size of my aircraft. So it is a challenge. Our recommendations focus on making sure that the aircraft is certified to operate in all icing conditions and that the pilots know how to handle it or exit when they encounter it.

Ms. RICHARDSON. But didn't Mr. Kay just testify that he may not always know at what point, the soonest point that he would need to do that?

Ms. HERSMAN. And we agree. We think it is very challenging.

Ms. RICHARDSON. So then if he agrees, then doesn't the question go back to you that if he may not necessarily know at what point to activate it and someone else has the information, why aren't you ensuring that the FAA is in fact putting the systems in place to ensure that they know?

Ms. HERSMAN. Maybe you want to ask the FAA that question.

Ms. RICHARDSON. Well, but with you being the Safety Board, if there is one thing that I think we are learning through the process is, isn't your role that, from a basic of safety, to ensure that if things are not safe—and in this instance of what we are referring, it actually costs lives—don't you also have a responsibility to urge more than just the recommendations? Or to say something to this Committee or—

Ms. HERSMAN. The Congress has charged us with investigating accidents and making recommendations. We have issued recommendations. That is one of the reasons why our Most Wanted List has icing on it, because we believe this issue does need to be addressed.

Ms. RICHARDSON. Okay, so what happens in—if you could just sum up, and then I am going to ask Mr. Hickey. But at what point, if it is not being addressed, do you step forward in a more aggressive fashion to ensure that whatever means, if it is the FAA is not implementing it, do you come to Congress for oversight? At some point maybe you have to do a little bit more, and I think in this instance it was probably—it would have been more helpful.

Ms. HERSMAN. You have our reauthorization in front of you right now. If you think there are things that we need to do—I know that people get frustrated because our recommendations don't require change. We make the recommendations; it is up to others to implement them. Using our Most Wanted List to highlight issues and certainly testifying before this Committee are ways to advance those issues. You all have in fact been the ones to require our recommendations to be implemented when we have not met with success.

Ms. RICHARDSON. Okay.

So, Mr. Hickey—and I am now down to 26 seconds—do you view that the recommendations from the NTSB is just kind of paper that you have there, or at what point, when we see that this is a serious problem, what gets you guys to the point to actually do something?

Mr. HICKEY. Ma'am, we take NTSB recommendations very seriously.

Ms. RICHARDSON. Right. But in this case there have been recommendations and they were not in fact implemented.

Mr. HICKEY. They may not be implemented yet. I think a lot of what we are talking about now could be enhanced by advanced technology that are really on the cusp; it is coming down the road.

Ms. RICHARDSON. So do you guys have a commitment to implement this technology in light of what has happened?

Mr. HICKEY. I don't know at this point, ma'am. I can get back for the record.

Ms. RICHARDSON. Okay.

Thank you, Mr. Chairman.

Mr. COSTELLO. The Chair thanks the gentlelady and now recognizes the gentleman from Michigan, Mr. Ehlers.

Mr. EHLERS. Thank you, Mr. Chairman. I am sorry I was delayed by other meetings.

I have always been very interested in this subject as a, I hesitate to call myself a pilot even though I learned how to fly at one point, but you can consider me a would-be pilot in that I read most of the aviation magazines. Lots of articles on icing. I have never encountered it because I am a weakling, I don't like to go outdoors when it is that cold, even though I live in Michigan.

But just a few questions just from observing and flying twice weekly, at a minimum, in commercial airliners. I have always thought that the de-icing procedures at the airports are really quite inefficient, and they have improved quite a bit in the last few years in the process, but, Mr. Principato, maybe you can give me some idea.

Would it make sense to just, at the end of the runway, have essentially what looks like a carwash that sprays the de-icing fluid down? You just keep recirculating it until it reaches a point where

it is ineffective. Rather than—and I am asking this in the context of what the EPA is concerned about and the additional expense that could cause. It would be much better.

You recall the horrible accidents that occurred right here in Washington, D.C. some years ago where the plane was de-iced. It took so long to take off that he should have been de-iced again but wasn't, and crashed into the river.

It seems to me the best place to de-ice is right at the end of the runway, before the plane enters the runway. So, is that an impossibility, to have a system like that, or would it be too expensive or what?

Mr. PRINCIPATO. Well, I think, as Captain Kay had said earlier in response to a question, in which he, I think, testified that the current procedures that he and his colleagues go through with their aircraft actually works very well at airports large and small. It obviously is optimal to take off as soon as possible after you are de-iced. There are places where you can put a de-icing pad closer to the runway geographically. There are places where that just doesn't make any sense for geographic reasons or whatever.

Think about—I said earlier to some of your colleagues, if you think about Denver and LaGuardia, both large hub airports, very, very different. Denver has the de-icing pads, you go out and do it and go out and take off; and at LaGuardia you don't have the footprint for that kind of thing, so you have to come up with a different approach. And, obviously, your own State of Michigan, with which I am well familiar, you have Lansing and Grand Rapids and Kalamazoo and Detroit and Flint and all the airports that are up there—Battle Creek—all the airports that are up there are all very different.

So I think the airports working with the airlines and everybody else tries to find the best, most efficient way to get this done in the safest manner possible so that the aircraft can get off the ground as quickly as possible after it is de-iced; and then, of course, back on the ground, the airport operator living up to its environmental commitments and dealing with the runoff and so forth.

But as I said before, there are some places where it makes sense to put it out in the remote area like that on the way to the runway; there are some places where it just doesn't, and you have to find another way. I think airports and airlines have worked pretty well together on that. But, again, think of Denver and LaGuardia in your mind as you are looking at two places where you have to do things differently.

Mr. EHLERS. Okay. I am not quite sure I follow that, but I will take your judgment, since you are the one who pays much of the bill, or your members do.

This note I have here on there that the EPA is badly underestimating the cost of the pre-proposed de-icing. What is the figure you come up with?

Mr. PRINCIPATO. Our comments will be submitted on Friday, and we can work with you and your staff on that. Our concern, again, is that they are looking at—they are assuming what you are able to do in Denver with a lot of area and so forth would be just as cost-efficient to do at a lot of other places where it just wouldn't

be. We also think that they are not really taking fully into account the operational costs of some of these new requirements.

So we want to work with them to try to find a way to, at the end of the day, improve the environmental performance. We are not just going to go in and say no; we are going to have some suggestions and alternatives that we are working up, and we will be sitting down with them on. But we are concerned that they are badly underestimating the cost. I don't think they are really counting the operational costs at all in what they are looking at doing, and I think they are making assumptions based on what has happened at places like Denver, where you have a lot more options; and then, as I said before, you look at other airports where you don't have so many options and it is more costly to do some of these things.

Mr. EHLERS. Quick question for Captain Kay. You mentioned the difficulty determining whether ice is building up on the plane. What about when the plane is sitting on the ground? Is there any way to detect how much of a problem there is on the wings at that point?

Mr. KAY. That is a good question. I will try to keep the answer short. When I am sitting at the gate, obviously, before any procedure has begun on the aircraft, you can see what you are dealing with and the operator will plan accordingly as to what level of de-icing, followed by anti-icing fluid, is applied. On a sunny morning, when there has been frost all night long, it is pretty straightforward at the gate; you can just spray de-icing fluid just as you would on your car windshield, and then you are good to go. There is no precipitation falling; we are not worrying about anything reforming there.

The big issue becomes when you are dealing with continuous snow or other freezing precipitation falling, and that is when you have to apply what is referred to as an anti-icing fluid; it is called Type 1 for the de-icing and Type 4 for the anti-icing. And that is when it gets a little bit more problematic because you now are looking at an equation as to how hard the snow is falling and possibly re-accumulating.

Once what is called the holdover time is finished, you buy some time when you put this anti-icing fluid on, this Type 4 anti-icing fluid, and it depends on the temperature and the precipitation that is falling, and we go into a little what is called a holdover chart to determine, once they are finished the de-icing, how long we have before we need to be airborne.

We have to determine, before we get airborne, if that fluid has failed, failed to do its job, so we will do a visual inspection prior to takeoff. It is not very scientific. It is not very scientific at all. You look at the wing and try to determine that you still have a clean wing surface, and I would like that there be better science of trying to determine if that fluid is really still doing its job. That is a concern, yes.

Mr. EHLERS. Thank you very much.

Mr. COSTELLO. The Chair thanks the gentleman and would advise Members that we have votes pending on the Floor and only just a few minutes left. I thank the gentleman from Michigan.

The gentlelady from California had a very quick question and a brief answer from our witness.

Ms. RICHARDSON. Thank you, Mr. Chairman.

Mr. Kay, in your testimony you stated that the captain's authority to fly or not fly in icing conditions is supported fully by some airlines and less so by others.

Mr. Hickey, I wanted to get your opinion. Whose authority is it to determine?

Mr. HICKEY. The pilot in command, ma'am.

Ms. RICHARDSON. Okay. And do you get the impression that all the pilots feel that way or understand that?

Mr. HICKEY. I will ask Mr. Duncan, who has previous experience.

Mr. DUNCAN. Ultimately, it is the responsibility of the pilot in command. There are a number of—every air carrier has different procedures for dealing with that question, and—

Ms. RICHARDSON. So since votes have been called and since you have a pilot here who says in his testimony that is not necessarily consistent, are you willing to commit to this Committee that you will reevaluate how the pilots are communicated that that is ultimately their authority and what they can do in this case?

Mr. DUNCAN. We in fact are constantly looking at those kinds of questions in the oversight that we do.

Ms. RICHARDSON. Thank you.

Mr. COSTELLO. The Chair thanks the gentlelady and thanks all of our witnesses. I think it is worth noting that the FAA, on their Fact Sheet concerning the issue of flying in icing conditions from February 13th of last year, just updated their Fact Sheet during this hearing.

Let me thank our witnesses for appearing here today. I think it has been a very informative hearing. I will say to our friends at the FAA, that we will continue to follow up on this issue to make certain that action is in fact taken.

As I said, Mr. Hickey, I would refer you back to the letter that you sent me on November the 16th and the time line, it was January of 2010 and now it is the spring. So I would just ask that you do everything you possibly can internally to move the process along.

Again, I thank all of our witnesses and the Subcommittee stands adjourned. Thank you.

[Whereupon, at 3:27 p.m., the Subcommittee was adjourned.]



OPENING STATEMENT OF  
THE HONORABLE JERRY F. COSTELLO  
AVIATION SUBCOMMITTEE  
HEARING ON AIRCRAFT ICING  
February 24, 2010

- I welcome everyone to this Subcommittee hearing on aircraft icing.
  
- In winter weather and at higher altitudes, ice can accumulate on an aircraft's wing, tail, and other areas and can threaten a pilot's ability to control the aircraft. Current Federal Aviation Administration (FAA) regulations require that an aircraft has no visible ice present on its wing to takeoff and be certified to fly in icing conditions, if icing is present at the time of takeoff.
  
- After the 1994 crash of a regional airliner in Roselawn, Indiana, which took 68 lives, the National Transportation Safety Board (NTSB) added icing to its safety "Most Wanted" List in 1997. Since that time, the Board has issued 82 recommendations to

the FAA aimed at reducing risks from icing. Thirty-nine were implemented by the FAA and acceptable progress was made on 25 of them.

- Last October, Ranking Member Petri and I held a roundtable on icing issues. During the roundtable, we discussed ice protection systems to prevent ice from forming on an aircraft in-flight. These systems may not protect in all icing conditions, such as supercooled large droplets (SLDs). In addition, we discussed the current status of aircraft icing standards and procedures. Because aviation safety is the number one priority of this Subcommittee, we decided to hold a follow-up hearing to fully explore these important issues.
  
- Many challenges exist regarding aircraft icing, such as access to accurate weather information and the need for additional icing-

related research. I would like to focus on the issues of pilot training to operate in icing conditions and the FAA's rulemaking efforts.

- First, while the aircraft operator must maintain an FAA-approved deicing plan, the pilot is ultimately responsible for determining whether the aircraft needs to be deiced. In flight, it is also the pilot's responsibility to deploy the aircraft's ice protection system. Currently, icing must be covered in a commercial pilot's initial and recurrent training. It is critical that this training be specific to the airplane the pilot is flying and the conditions the pilot is likely to encounter.
  
- To address this concern and raise the bar on safety, we included important icing-related requirements in H.R. 3371, the "Airline Safety and Improvement Act of 2009", to ensure every



commercial pilot has the experience and knowledge to fly safely in icing conditions.

- I look forward to hearing from the Air Line Pilots Association (ALPA) and the FAA on what needs to be done to provide pilots with better-defined operating procedures for operations in icing and winter weather conditions.
  
- Second, it has been 13 years since a commercial air carrier was involved in a fatal icing-related accident. However, between 1998 and 2007 there were 523 icing-related aviation accidents involving small commerce operators and general aviation aircraft resulting in 221 fatalities.
  
- Since the Roselawn accident in 1994, the FAA has issued over 100 icing-related airworthiness directives on 50 different aircraft

models, adopted three final rules, and is conducting additional research on icing in partnership with the National Aeronautics and Space Administration (NASA).

- Despite the FAA's work to date, two critical NTSB recommendations from the 1997 Most Wanted List have not been addressed. Last week, the NTSB adopted its Most Wanted list for 2010, which includes four recommendations to reduce the hazards to aircraft flying in icing conditions. The NTSB said the FAA's efforts in this area have been "unacceptably slow"; I agree.
  
- The length of time it has taken to complete these icing rules is unacceptable. I understand the deliberative nature of FAA rulemakings, and that even more research may be needed in this area. However, 13 years have passed since the NTSB made

recommendations to change the way aircraft are designed and approved for flight in icing conditions and these recommendations are still open with unacceptable responses. The FAA must adopt a systematic and proactive approach to address the icing criteria for aircraft certification and testing. I look forward to hearing from Mr. Hickey on the steps the agency is taking to finish the icing-related rules as soon as possible.

- I am also interested to hear from the GAO on research I requested regarding icing and any recommendations it might have on this topic.
  
- Before I recognize Mr. Petri for his opening statement, I ask unanimous consent to allow 2 weeks for all Members to revise and extend their remarks and to permit the submission of

additional statements and materials by Members and witnesses.

Without objection, so ordered.

SENIOR DEMOCRATIC WHIP

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COMMITTEE ON TRANSPORTATION  
AND INFRASTRUCTURE  
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RESOURCES & ENVIRONMENT  
SUBCOMMITTEE ON AVIATION  
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COMMITTEE ON SCIENCE AND TECHNOLOGY  
SUBCOMMITTEE ON RESEARCH AND  
SCIENCE EDUCATION  
SUBCOMMITTEE ON INVESTIGATION AND  
OVERSIGHT

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*Eddie Bernice Johnson*  
Congress of the United States  
30th District, Texas

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STATEMENT OF CONGRESSWOMAN EDDIE  
BERNICE JOHNSON

Subcommittee on Aviation

Hearing on Aircraft Icing

February 23, 2010

**Chairman Costello, thank you for holding this hearing today.**

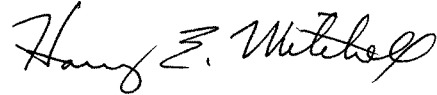
**Aviation safety oversight is one of the core responsibilities  
of this Subcommittee, and I commend you for bringing focus  
to a critical safety issue today, aircraft icing.**

**The National Transportation Safety Board released its 2010 Federal Most Wanted List of Transportation Safety Improvements last week and once again identified aircraft icing on this list.**

**An airliner crash in 1994 prompted the National Transportation Safety Board to examine the issue of airframe structural icing, and the Board concluded that certification standards have been inadequate. At that time it added in-flight icing to its Most Wanted list. Last week the National Transportation Board stated that it continues to believe that the Federal Aviation Administration has failed to make adequate progress in this area and has kept aircraft icing's Most Wanted designation at Red, indicating an unacceptable agency response.**

**I am aware that the Federal Aviation Administration currently has rulemakings underway that are geared towards improving aircraft icing design standards. I am hopeful that through these rulemakings and other actions, enough progress will have been made on the problem of aircraft icing that it will no longer have a place on the Most Wanted Safety Improvements List.**

**Thank you, Mr. Chairman.**



Statement of Rep. Harry Mitchell  
House Transportation and Infrastructure Committee  
Subcommittee on Aviation  
2/24/10

--Thank you Mr. Chairman.

--Icing is a serious safety issue, and I am grateful that we are holding today's hearing.

--While most of us tend to only think about icing during the winter months, it is important to note that in-flight icing can occur at high altitudes year-round.

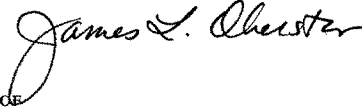
--The National Transportation Safety Board (NTSB) has made a number of recommendations relating to icing. However, in its February 2010 update on the status of its most wanted recommendations, NTSB complained that FAA's rulemaking efforts were "unacceptably slow".

--According to the Government Accountability Office (GAO), improving the timeliness of FAA's winter weather rulemaking efforts is just one of several challenges facing winter weather aviation operations. The GAO is also concerned about the adequacy of resources for icing-related research and development, pilot training, collection and distribution of accurate weather information, as well as the overall integration of winter weather operations.

--I look forward to hearing from today's witnesses about what can be done to improve aviation safety.

--At this time I yield back.





OPENING STATEMENT OF  
THE HONORABLE JAMES L. OBERSTAR  
SUBCOMMITTEE ON AVIATION  
AIRCRAFT ICING  
FEBRUARY 24, 2010

I want to thank Chairman Costello and Ranking Member Petri for holding this hearing on aircraft icing. Twenty years ago, I held hearings on how weather impacts aviation safety. Weather is one factor in aviation that we cannot control, so we must do all that is possible to understand it and manage its hidden dangers. Today, we must again focus on the important weather-related issue of icing and its implications for a safe national airspace system.

After the Colgan 3407 accident near Buffalo last year, it was widely speculated that the aircraft crashed due to icing. While icing was ultimately determined not to have caused the accident, it highlighted the issue of icing. Icing has been on the National Transportation Safety Board's (NTSB) Most Wanted List of transportation safety improvements since 1997 and earlier this month, it was continued on the 2009-2010 List.

The 1994 crash of a regional airliner in Roselawn, Indiana was a safety wake-up call for improved aircraft certification to combat icing. According to the NTSB, the Roselawn crash, in which 68 people were killed, was caused by a loss of control of the

aircraft due to in-flight icing. The NTSB also concluded that the Federal Aviation Administration (FAA) aircraft icing certification process does not adequately test an aircraft's flight handling and stall characteristics under a realistic range of adverse icing conditions, such as those experienced by the aircraft in the Roselawn accident.

According to the FAA and the NTSB, supercooled large droplets (known as SLD) were present in the atmosphere at the time of the Roselawn accident and caused ice accretion of such a character that the aircraft flew beyond the parameters it was certified to fly in. Other icing conditions that, if encountered, may take an aircraft outside the FAA's current certification parameters, include freezing drizzle and rain and mixed water/ice crystal conditions.

As a result of the Roselawn accident, the FAA started a multi-year in-flight aircraft icing plan to address aircraft icing issues. According to the FAA, since the accident, it has issued over 100 Airworthiness Directives (ADs) on 50 different aircraft models. These ADs include changes to procedures pilots must follow in icing conditions, and direct changes in aircraft design. The FAA claims that due to its efforts there has not been a fatal icing accident on a U.S. commercial air carrier in the last 13 years.

Since 1994, the FAA has completed three rulemakings on icing. One rule revised the certification standards for the handling and controllability characteristics of newly-designed part 25 aircraft (such as major airline aircraft and most business jets) in icing conditions; however, the rule did not include revisions to deal with SLD conditions. The second rule pertained to the activation of ice protection systems on newly-designed part 25 aircraft certified for flight in icing conditions. The third rule bans the practice of allowing operators to operate aircraft with “polished frost” (i.e., frost polished to make it smooth) on the wings and other control surfaces.

Though these FAA rulemaking actions show progress on icing issues, the NTSB continues to assert that the “pace of FAA’s activities remains unacceptably slow.” In addition, NTSB states the FAA must use the research it already has on freezing rain and SLD to revise the way aircraft are designed and approved for flight in icing conditions. Further, once FAA has revised its icing requirements, NTSB wants FAA to apply its new requirements to currently certificated aircraft. In addition, the NTSB states that the FAA should require that aircraft with ice protection equipment deploy that equipment as soon as the aircraft enters icing conditions. I look forward to hearing from the FAA on its response to the NTSB’s recommendations.

Meanwhile, I am concerned that pilot training for icing may not be specifically related to the conditions the pilot is likely to encounter and the aircraft that he or she is flying. Aviation would benefit from providing pilots with additional tools, such as better-defined operating procedures for icing and winter weather conditions. Captain Rory Kay from the Air Line Pilots Association is here this afternoon, and I look forward to hearing him testify on this issue.

As the NTSB has indicated, there is a critical need for additional guidance from the FAA on how to deal with in-flight icing. I look forward to hearing from our witnesses on how to neutralize the dangers posed by in-flight icing and what we can do to speed up the icing rulemaking process.

Thank you again, Mr. Chairman, for holding this hearing.



**CONGRESSWOMAN LAURA RICHARDSON (CA-37)**

**COMMITTEE ON TRANSPORTATION  
SUBCOMMITTEE ON AVIATION**

**HEARING:  
"AIRCRAFT ICING"**

**WEDNESDAY, FEBRUARY 24, 2010  
2:00 P.M.  
2167 RAYBURN**

Mr. Chairman, thank you for convening the hearing today on the dangers of aircraft icing. I would also like to thank the witnesses for taking the time to appear before the Committee.

While aircraft icing may not be an issue the 37<sup>th</sup> district of California often confronts, aircraft safety and the handling of problems such as aircraft icing is an issue that every member of this Committee is invested in. Every member has constituents who face delays due to this issue of who could be placed in harm's way. I am pleased that the Subcommittee is reviewing this issue so we can better

understand the actions the Federal Aviation Administration is taking in regard to the aircraft icing and aircraft safety issues in general.

The topic of this hearing is an issue that briefly came up before this Subcommittee during the January 27<sup>th</sup> hearing on the reauthorization of the National Transportation Safety Board. This Subcommittee discussed the fact that 18% of the recommendations by the NTSB have not been adopted by the regulatory and transportation communities, including those regarding aircraft icing.

The NTSB had numerous suggestions for reducing dangers to aircraft flying in icing conditions. These include using current research on freezing rain and large water droplets to revise the way aircraft are designed and approved for flight in icing conditions, applying revised icing requirements to currently certificated aircraft, and requiring

that airplanes with pneumatic deice boots activate the boots as soon as the plane enters icing conditions.

However, NTSB reports that the pace of the FAA's response has been unacceptably slow. Between 1998 and 2007, there were 523 icing-related aviation accidents, which resulted in 221 fatalities. If there is action that the FAA can be taking to prevent these incidents, it is the duty of this Subcommittee to see that it can be taken as soon as possible. I look forward to hearing from our distinguished witnesses, especially from the FAA, as to their thoughts on how we can improve airline safety.

Thank you again, Mr. Chairman, for convening this hearing. I yield back the balance of my time.

United States Government Accountability Office

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**GAO**

Testimony  
Before the Subcommittee on Aviation,  
Committee on Transportation and  
Infrastructure, House of Representatives

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For Release on Delivery  
Expected at 2:00 p.m. EST  
Wednesday, February 24, 2010

## AVIATION SAFETY

### Preliminary Information on Aircraft Icing and Winter Operations

Statement of Gerald L. Dillingham, Ph.D.  
Director, Physical Infrastructure Issues





February 24, 2010

## AVIATION SAFETY

## Preliminary Information on Aircraft Icing and Winter Weather Operations


**GAO**  
 Accountability Integrity Reliability  
**Highlights**

Highlights of GAO-10-441T, a testimony before the Subcommittee on Aviation, Committee on Transportation and Infrastructure, House of Representatives

**Why GAO Did This Study**

Ice formation on aircraft can disrupt the smooth flow of air over the wings and prevent the aircraft from taking off or decrease the pilot's ability to maintain control of the aircraft. Taxi and landing operations can also be risky in winter weather. Despite a variety of technologies designed to prevent ice from forming on planes, as well as persistent efforts by the Federal Aviation Administration (FAA) and other stakeholders to mitigate icing risks, icing remains a serious concern. As part of an ongoing review, this statement provides preliminary information on (1) the extent to which large commercial airplanes have experienced accidents and incidents related to icing and contaminated runways, (2) the efforts of FAA and aviation stakeholders to improve safety in icing and winter weather operating conditions, and (3) the challenges that continue to affect aviation safety in icing and winter weather operating conditions. GAO analyzed data obtained from FAA, the National Transportation Safety Board (NTSB), the National Aeronautics and Space Administration (NASA), and others. GAO conducted data reliability testing and determined that the data used in this report were sufficiently reliable for our purposes. Further, GAO obtained information from senior FAA and NTSB officials, representatives of the Flight Safety Foundation, and representatives of some key aviation industry stakeholder organizations. GAO provided a draft of this statement to FAA, NTSB, and NASA and incorporated their comments where appropriate.

View GAO-10-441T or key components. For more information, contact Gerald L. Dillingham at (202) 512-2834 or [dillinghamg@gao.gov](mailto:dillinghamg@gao.gov).

**What GAO Found**

According to NTSB's aviation accident database, from 1998 to 2009 one large commercial airplane was involved in a nonfatal accident after encountering icing conditions during flight and five large commercial airplanes were involved in nonfatal accidents due to snow or ice on runways. However, FAA and others recognize that *incidents* are potential precursors to accidents and the many reported icing incidents suggest that these airplanes face ongoing risks from icing. For example, FAA and NASA databases contain information on over 600 icing-related incidents involving large commercial airplanes.

FAA and other aviation stakeholders have undertaken many efforts to improve safety in icing conditions. For example, in 1997, FAA issued a multiyear plan for improving the safety of aircraft operating in icing conditions and has since made progress on the objectives specified in its plan by issuing regulations, airworthiness directives, and voluntary guidance, among other initiatives. Other government entities that have taken steps to increase aviation safety in icing conditions include NTSB, which has issued numerous recommendations as a result of its aviation accident investigations, and NASA, which has contributed to icing-related research. The private sector has deployed various technologies on aircraft, such as wing deicers, and operated ground deicing and runway clearing programs at airports.

GAO identified challenges related to winter weather aviation operations that, if addressed by ongoing or planned efforts, could improve safety. These challenges include (1) improving the timeliness of FAA's winter weather rulemaking efforts; (2) ensuring the availability of adequate resources for icing-related research and development; (3) ensuring that pilot training is thorough and realistic; (4) ensuring the collection and distribution of accurate weather information; and (5) developing a more integrated approach to effectively manage winter operations.

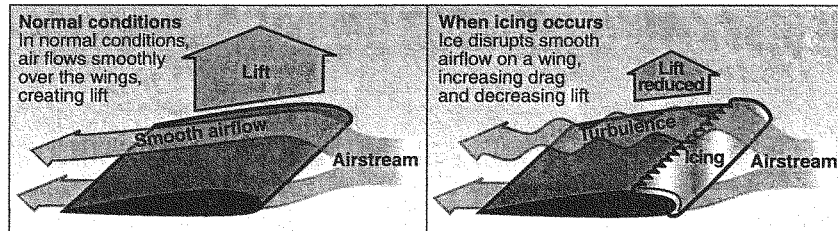
**Example of Ground Deicing to Help Ensure Clean Aircraft**

Source: Gerald R. Ford International Airport.

Mr. Chairman and Members of the Subcommittee:

Thank you for the opportunity to testify today on issues related to aircraft icing and conducting aviation operations on contaminated runways.<sup>1</sup> Icing can be a significant hazard for aviation operations of all types, including commercial flights, no matter the season of the year. As shown in figure 1, when there is ice on an aircraft's wings, it can disrupt the smooth flow of air over the wings and prevent the aircraft from safely taking off or decrease the pilot's ability to control the aircraft in flight. Depending on the location of the ice, the shape of the wing, and the phase of flight, even small, almost imperceptible amounts of ice can have a significant detrimental effect. Despite a variety of technologies designed to prevent ice from forming on planes or to remove ice that has formed, as well as persistent efforts by the Federal Aviation Administration (FAA) and other stakeholders to mitigate icing risks, icing remains a concern. Furthermore, runways that have not been cleared of snow or ice can be hazardedly slick for planes during takeoff and landing.

Figure 1: Effect of Ice Build-up on Aircraft Wings



Sources: GAO and FAA.

<sup>1</sup>In this statement we use the term *icing* to refer to icing of airplane surfaces. We use the term *contaminated runway* to refer to ice, snow, slush, frost, or standing water on the runway. The presence of standing water, snow, slush, or ice on the runway at low temperatures may be defined as icing conditions for the airplane, which may require certain ground icing procedures (e.g., checks or deicing of wings). Runways that are contaminated with snow, slush, or ice are generally associated with operations in winter conditions.

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Based on an ongoing review for this Subcommittee, as well as for the Senate Aviation Subcommittee and Senator Charles Schumer, my testimony today discusses preliminary information on (1) the extent to which large commercial airplanes have experienced accidents and incidents related to icing and contaminated runways, (2) the efforts of FAA and other aviation stakeholders to improve safety in icing and winter weather operating conditions, and (3) the challenges that continue to affect aviation safety in icing and winter weather operating conditions. My statement is based on our analyses of data related to icing obtained from FAA, the National Transportation Safety Board (NTSB), the National Aeronautics and Space Administration (NASA), and others. It also includes updates from FAA of information published in our related reports. It reflects our discussions with senior FAA, NTSB, NASA, and National Oceanic and Atmospheric Administration (NOAA) officials and representatives from the Flight Safety Foundation and several aviation industry organizations.<sup>2</sup> As part of our ongoing review, we performed this work from August 2009 to February 2010 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our review objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. Further, we conducted data reliability testing and determined that the data used in this report were sufficiently reliable for our purposes. We provided a draft of this testimony to FAA, NTSB, and NASA officials to obtain their comments. In response, FAA, NTSB, and NASA provided additional information that we incorporated where appropriate.

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<sup>2</sup>The Flight Safety Foundation is an independent, nonprofit, international organization engaged in research, auditing, education, advocacy, and publishing to improve aviation safety.

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**Although Large Commercial Airplanes Have Experienced Few Icing-Related Accidents since 1998, the Many Reported Icing Incidents Suggest that Icing Is an Ongoing Risk to Aviation Safety**

According to NTSB's aviation accident database, from 1998 to 2009 one large commercial airplane was involved in a nonfatal accident after encountering icing conditions during flight and five large commercial airplanes were involved in nonfatal accidents related to snow or ice on runways.<sup>3</sup> Although there have been few accidents, FAA and others recognize that incidents are potential precursors to accidents.<sup>4</sup> Data on hundreds of incidents that occurred during this period reveal that icing and contaminated runways pose substantial risk to aviation safety. FAA's database of incidents includes 200 icing-related incidents involving large commercial airplanes that occurred from 1998 through 2007.<sup>5</sup> These data covered a broad set of events, such as the collision of two airplanes at an ice-covered gate, and an airplane that hit the right main gear against the runway and scraped the left wing down the runway for about 63 feet while attempting to land with ice accumulation on the aircraft. During this same time period, NASA's Aviation Safety Reporting System (ASRS) received over 600 icing and winter weather-related incident involving large commercial airplanes.<sup>6</sup> These incidents reveal a variety of safety issues such as runways contaminated by snow or ice, ground deicing problems, and in-flight icing encounters. This suggests that risks from icing and other winter weather operating conditions may be greater than indicated by NTSB's accident database and by FAA's incident database. FAA officials point out that there is no defined reporting threshold for ASRS reports and because they are developed from personal narrative, they can be subjective. However, these officials agree that the ASRS events must be thoroughly reviewed and evaluated for content to determine the relevancy

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<sup>3</sup>By large commercial airplanes, we mean those airplanes operating under part 121 of title 14 of the Code of Federal Regulations (CFR). Among other things, part 121 applies to air carrier operations involving turbojet airplanes or any airplane with a seating capacity of more than 9 passengers or a maximum payload capacity of more than 7,500 pounds.

<sup>4</sup>An incident is defined by NTSB as an occurrence other than an accident associated with the operation of an aircraft that affects or could affect the safety of operations.

<sup>5</sup>FAA's database contains data generated by FAA investigations of aviation incidents. These data are generated by officials charged with investigating incidents.

<sup>6</sup>This voluntary system is administered by NASA. It contains voluntary reports, which are later de-identified, from pilots, controllers, maintenance technicians, and other operating personnel about human behavior that resulted in unsafe occurrences or hazardous situations. NASA seeks to avoid double counting of incidents by ensuring that multiple reports for a single incident are grouped together under that incident. Because ASRS reporting is voluntary, it is unlikely to cover the universe of safety events. It is also possible that ASRS incident data may overlap with FAA incident data, because a single incident may be entered into FAA's incident database by an FAA inspector and reported to ASRS by a pilot or bystander. However, the extent to which overlap occurs is unknown.

to icing and the extent and severity of the safety issue. The contents of the ASRS data system also demonstrate the importance of aggregating data from all available sources to understand a safety concern.<sup>7</sup> See table 1 for the number of icing and winter weather-related incident reports from ASRS for large commercial airplanes.

**Table 1: Icing and Winter Weather-Related Incident Reports for Large Commercial Airplanes by Category of Incident, 1998 to 2007**

Category	Number of Reports
Anti-ice or deicing incident/procedure	179
Controllability issue—ground	72
In-flight encounter—aircraft equipment problems	72
In-flight encounter—airframe and/or flight control icing	69
Other winter weather incident	42
Surface marking and signage obstruction	41
Runway, ramp, or taxiway excursion	36
Runway, ramp, or taxiway incursion	34
Controllability issue—air	32
Maintenance incident	19
Ramp safety—personnel risk or injury	17
In-flight encounter—sensor type incident	15
<b>Total</b>	<b>628</b>

Source: GAO analysis of NASA ASRS data.

Note: An excursion occurs when an aircraft unintentionally exits a runway, ramp, or taxiway. An incursion occurs when an aircraft enters a runway, ramp, or taxiway without authorization.

While this testimony focuses on large commercial airplanes, I would like to note that from 1998 to 2007, small commercial airplanes and noncommercial airplanes experienced more icing-related accidents and

<sup>7</sup>We plan to report in the spring of 2010 on FAA's use of data to be proactive in its oversight of key safety areas.

fatalities than did large commercial airplanes, as shown in table 2.<sup>8</sup> This is largely because, compared to large commercial airplanes, small commercial airplanes and noncommercial airplanes (1) operate at lower altitudes that have more frequent icing conditions, (2) have a higher icing collection efficiency due to their smaller scale, (3) are more greatly impacted by ice as a result of their smaller scale, (4) tend to have deicing equipment rather than fully evaporative anti-icing equipment, (5) may not have ice protection systems that are certified, nor are they required to be, because the airplane is not approved for flight in known icing conditions, and (6) may not have ice protection systems installed.

**Table 2: Icing and Winter Weather-Related Accidents and Fatalities for 1998 to 2009, Incidents for 1998 to 2007**

	Large commercial airplanes	Small commercial airplanes	Noncommercial airplanes
Icing-related accidents, including in-flight and runway	6	49	510
Fatalities in icing-related accidents	0	27	202
Icing-related incidents in FAA's database	200	119	567
Icing-related incidents in NASA's ASRS database	628	102	422

Source: NTSB for accidents and fatalities, FAA and NASA for incidents.

Notes: For all three types of airplanes, accident data for 2008 and 2009 are incomplete because NTSB has not completed all of its accident investigations that occurred during those years. For small commercial and noncommercial airplanes, the number of accidents and incidents also includes carburetor icing.

<sup>8</sup>By small commercial airplanes, we mean those airplanes operating under part 135 of title 14 CFR. Among other things, part 135 covers commuter operations on airplanes, other than turbojet powered airplanes, with 9 passenger seats or less, and a payload capacity of 7,500 pounds or less. Most commuter, air tour, and air taxi operators and medical services (when a patient is on board) fall under the purview of part 135. By noncommercial airplanes, we mean airplanes that are privately operated under 14 CFR part 91. These types of operations are often referred to as "general aviation" and include flights for recreation and training. Although noncommercial flights usually involve small aircraft, the definition depends on the nature of the operation not the size of the aircraft.

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## FAA and Other Aviation Stakeholders Have Undertaken a Variety of Efforts Aimed at Improving Safety in Icing/Winter Weather Conditions

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### FAA Adopted a Plan to Increase Safety in Icing Conditions and Has Taken Other Actions to Improve Safety in Winter Weather

Following the 1994 fatal crash of American Eagle Flight 4184 in Roselawn, Indiana, FAA issued a multiyear plan in 1997 for improving the safety of aircraft operating in icing conditions and created a steering committee to monitor the progress of the planned activities.<sup>9</sup> Over the last decade, FAA made progress on the implementation of the objectives specified in its multiyear plan by issuing or amending regulations, airworthiness directives (ADs), and voluntary guidance to provide icing-related safety oversight.<sup>10</sup> For example, FAA issued three final rules on icing:

- in August 2007, a rule introduced new airworthiness standards to establish comprehensive requirements for the performance and handling characteristics of transport category airplanes in icing conditions;<sup>11</sup>
- in August 2009, a rule required a means to ensure timely activation of the ice protection system on transport category airplanes; and

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<sup>9</sup>FAA's 1997 Inflight Aircraft Icing Plan describes various activities planned to improve safety for aircraft operating in icing conditions. Recent FAA documentation indicates that the agency aims to provide better icing forecast technology and to develop ice-resistant pavement surfaces, improved deice/anti-ice technology, and more efficient ground icing detection.

<sup>10</sup>An airworthiness directive is a legally enforceable rule that may apply to aircraft, aircraft engines, propellers, and appliances. FAA issues an airworthiness directive when it determines that (1) an unsafe condition exists in the product and (2) the condition is likely to exist or develop in other products of the same type or design.

<sup>11</sup>In general, a transport category airplane is an airplane with maximum takeoff weight (MTOW) greater than 12,500 pounds or with 10 or more passengers, except for propeller-driven, multi-engine airplanes, in which case the transport category airplanes are those with MTOW greater than 19,000 pounds or with 20 or more passengers. Transport category airplanes operate under 14 CFR part 25.

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- in December 2009, a rule required pilots to ensure that the wings of their aircraft are free of polished frost.<sup>12</sup>

FAA has also proposed an icing-related rule in November 2009, on which the public comment period closed February 22, 2010; this rule would require the timely activation of ice protection equipment on commercial aircraft during icing conditions and weather conditions conducive to ice formation on the aircraft.<sup>13</sup> In addition, FAA is developing a proposed rule to amend its standards for transport category airplanes to address supercooled large drop icing, which is outside the range of icing conditions covered by the current standards.<sup>14</sup> Since 1997, FAA has issued over 100 ADs to address icing safety issues involving more than 50 specific types of aircraft, including ADs that required the installation of new software on certain aircraft and another that required operators and manufactures to install placards displaying procedures for use of an anti-icing switch on certain aircraft. Additionally, FAA has issued bulletins and alerts to operators emphasizing icing safety issues. As part of our ongoing review, we will conduct a more comprehensive evaluation of FAA's progress on the implementation of the objectives specified in its multiyear in-flight icing plan. Among other things, we will also analyze the results of FAA's surveillance activities related to monitoring air carriers' compliance with existing regulations and ADs.

FAA also provided funding for a variety of icing-related purposes. For example, FAA has supported NASA research related to severe icing conditions and the National Center for Atmospheric Research (NCAR) research related to weather and aircraft icing. Furthermore, FAA has provided almost \$200 million to airports through the Airport Improvement Program (AIP) to construct deicing facilities and to acquire aircraft deicing equipment from 1999 to 2009. See appendix I for a detailed listing of AIP icing-related funding by state, city, and year.

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<sup>12</sup>14 CFR Part 135, §135.227 and 14 CFR Part 91, §91.527. Frost-polishing is accomplished by scraping or buffing frost accumulations so as to obtain a smooth surface. The polished frost requirement does not apply to large commercial aircraft (part 121) because part 121 did not permit operations with polished frost prior to the implementation of this new rule.

<sup>13</sup>This proposed rule only applies to airplanes with an MTOW of 60,000 pounds being operated under 14 CFR part 121.

<sup>14</sup>Supercooled large drops have a diameter greater than 50 microns and include freezing drizzle and freezing rain. These droplets can form into ice beyond the normally protected areas of aircraft.



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Runway safety is a key concern for aviation safety and especially critical during winter weather operations. For example, in December 2005, a passenger jet landed on a snowy runway at Chicago's Midway Airport, rolled through an airport perimeter fence onto an adjacent roadway, and struck an automobile, killing a child and injuring 4 other occupants of the automobile and 18 airline passengers.<sup>15</sup> According to the Flight Safety Foundation, from 1995 through 2008, 30 percent of global aviation accidents were runway-related and "ineffective braking/runway contamination" is the fourth largest causal factor in runway excursions that occur during landing. In fiscal year 2000, FAA's Office of Airport Safety and Standards initiated a program, which includes making funds available to airports through AIP, to accelerate improvements in runway safety areas at commercial service airports that did not meet FAA design standards.

Since 2000, FAA has provided about \$200 million per year in AIP funding for the creation of runway safety areas. According to FAA officials, of the 619 runways that FAA determined needed improvement, 465 (74 percent) have been completed and 154 (26 percent) remain to be completed by 2015. The estimated cost to complete the remaining project is about \$835 million.<sup>16</sup> In some cases where (1) land is not available, (2) it would be very expensive for the airport sponsors to buy land off the end of the runway, or (3) it is otherwise not possible to have the 1,000 foot safety area, FAA has approved the use of an Engineered Materials Arresting System (EMAS).<sup>17</sup> FAA supports EMAS installations through AIP funding, and currently, EMAS installations have been completed for 44 runways at 30 airports in the United States, with 4 more installations scheduled for

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<sup>15</sup>NTSB concluded that the probable cause of the accident was the pilot's failure to use available reverse thrust in a timely manner to safely slow or stop the airplane after landing, which resulted in a runway overrun. NTSB's accident investigation report indicated that contributing to the severity of the accident was the absence of an Engineering Materials Arresting System, which was needed because of the limited runway safety area beyond the end of the runway.

<sup>16</sup>Public Law 109-115 adopted FAA's 2015 goal. FAA considers runway safety areas that meet 90 percent of the standards to be substantially compliant.

<sup>17</sup>EMAS uses materials of closely controlled strength and density placed at the end of the runway to stop or greatly slow an aircraft that overruns the runway. According to FAA, the best material found to date is a lightweight crushable concrete.

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2010.<sup>18</sup> To date there have been five successful EMAS captures of overrunning aircraft.

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**Other Stakeholders  
Support and Augment FAA  
Efforts to Increase Safety  
in Winter Weather/Icing  
Conditions**

Government and industry stakeholders, external to FAA, also contribute to the effort to increase aviation safety in winter weather/icing conditions. For example, NTSB investigates and reports on civil aviation accidents and issues safety recommendations to FAA and others, some of which it deems most critical and places on a list of “Most Wanted” recommendations.<sup>19</sup> Since 1996, NTSB has issued 82 recommendations to FAA aimed at reducing risks from in-flight structural icing, engine and aircraft component icing, runway condition and contamination, ground icing, and winter weather operations. NTSB’s icing-related recommendations to FAA have called for FAA to, among other things, strengthen its requirements for certifying aircraft for flying in icing conditions, sponsor the development of weather forecasts that define locations with icing conditions, and enhance its training requirements for pilots.<sup>20</sup> NTSB has closed 39 of these recommendations (48 percent) as having been implemented by FAA, and has classified another 25 (30 percent) as FAA having made acceptable progress.<sup>21</sup> This combined 78 percent acceptance rate is similar to the rate for all of NTSB’s aviation recommendations.

For more than 30 years, NASA has conducted and sponsored fundamental and applied research related to icing. The research addresses icing causes, effects, and mitigations. For instance, NASA has conducted extensive research to characterize and simulate supercooled large drop icing conditions to inform a pending FAA rule related to the topic. NASA

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<sup>18</sup>Airports that are scheduled for 2010 installation of EMAS beds are Areta, California; Winston-Salem, North Carolina; Wilmington, Delaware; and Key West, Florida.

<sup>19</sup>This list, which NTSB has maintained since 1990 and revises annually, includes important safety recommendations identified for special attention and intensive follow-up.

<sup>20</sup>According to FAA, in response to NTSB’s recommendation related to weather forecasts the agency sponsored the development of the Current Icing Product (CIP) and Forecast Icing Potential (FIP), which are computer-generated three-dimensional graphics containing information on the likelihood of an aircraft encountering icing conditions.

<sup>21</sup>In addition, NTSB has closed 8 of these recommendations as “unacceptable response” by FAA; has classified 6 of the open recommendations as “unacceptable response” by FAA; has closed 3 of these recommendations after concurring with FAA’s rationales for disagreeing with the recommendations; and is awaiting FAA’s response on 1 of these recommendations.

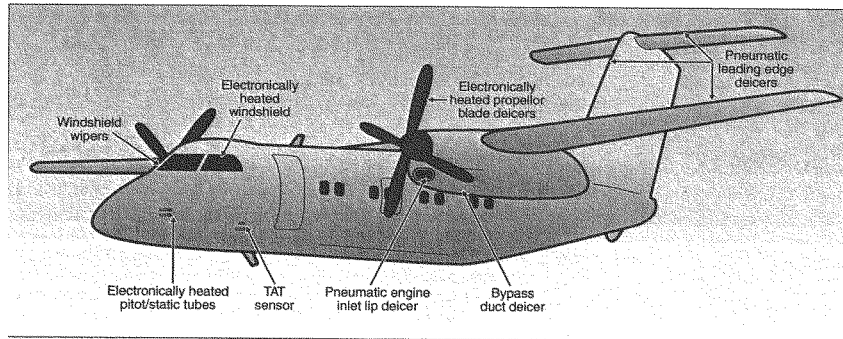
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participated in research activities, partially funded by FAA, that developed additional knowledge and strategies which allowed forecasters to more precisely locate supercooled large drop icing conditions. Furthermore, NASA has an icing program, focused generally on research related to the effects of in-flight icing on airframes and engines for many types of flight vehicles. NASA has developed icing simulation capabilities that allow researchers, manufacturers, and certification authorities to better understand the growth and effects of ice on aircraft surfaces. NASA also produced a set of training materials for pilots operating in winter weather conditions. In recent years, NASA's funding decreased significantly, limiting the capability of its icing research program.

NOAA, the National Weather Service (NWS), and NCAR have efforts directed and funded by FAA related to predicting the location and severity of icing occurrences. NWS operates icing prediction systems and NCAR conducts research to determine more efficient methods to complete this task. For example, in 2006, NCAR introduced a new Web-based icing forecast tool that allows meteorologists and airline dispatchers to warn pilots about icing hazards up to 12 hours in advance. NCAR developed this tool using FAA funding and NWS facilitates the operation of the new icing forecasting tool. NWS also posts on the agency's Web site maps of current icing conditions, pilot reports, forecasts, and freezing level graphics.

The private sector has also contributed to efforts to prevent accidents and incidents related to icing and winter weather conditions. For example, as shown in figure 2, aircraft manufacturers have deployed various technologies such as wing deicers, anti-icing systems, and heated wings.

**Figure 2: Aircraft Ice Protection Systems**



Source: GAO, based on information from NTSB.

Notes: Pneumatic leading edge deicers are inflatable rubber "boots" on the leading edges of airfoil surfaces (including wings, horizontal stabilizers, and vertical stabilizers) that can be rapidly inflated and deflated with air pressure to break up ice accumulation. Similar technology is used for the pneumatic engine inlet lip and bypass duct deicer. The TAT (Total Air Temperature) sensor helps the pilot determine critical flight parameters such as true airspeed computation and static air temperature. Electronically heated propeller blade deicers, windshield, and pitot/static tubes operate in-flight to rid the aircraft of ice buildup and to prevent ice accumulation.

In addition, airports operate ground deicing and runway clearing programs that help ensure clean wings (see fig. 3) and runways. While critical to safe, efficient winter operations, these programs involve treating aircraft and airport pavement with millions of pounds of deicing and anti-icing compounds annually. According to the Environmental Protection Agency, these compounds contain chemicals that can harm the environment. Some airports can control deicing pollution by capturing the fluids used to deice aircraft using technologies such as AIP-funded deicing pads, where aircraft are sprayed with deicing fluids before takeoff and the fluids are captured and treated; drainage collection systems; or vacuum-equipped vehicles. Third-party contractors, rather than individual air carriers, are increasingly performing deicing operations at commercial airports. FAA does not currently have a process to directly oversee these third-party contractors but indicates that it has one under development.

Figure 3: Example of Ground Deicing to Help Ensure Clean Aircraft



Source: Gerald R. Ford International Airport.

**Continued Attention to Regulation, Training, and Coordination Issues Could Further Mitigate the Risks of Winter Weather Operations**

While FAA and others are undertaking efforts to mitigate the risks of aircraft icing and winter weather operations, through our interviews and discussions with government and industry stakeholders, we have identified challenges related to these risks that, if addressed by ongoing or planned efforts, could improve aviation safety. These challenges include (1) improving the timeliness of FAA's winter weather rulemaking efforts, (2) ensuring the availability of adequate resources for icing-related research and development (R&D), (3) ensuring that pilot training is thorough, relevant, and realistic, (4) ensuring the collection and distribution of timely and accurate weather information, and (5) developing a more integrated approach to effectively manage winter operations.

*Improving the timeliness of FAA's winter weather rulemaking efforts.* FAA's rulemaking, like that of other federal agencies, is a complicated, multistep process that can take many years. Nonetheless, NTSB, FAA, and we have previously expressed concerns about the efficiency and timeliness

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of FAA's rulemaking efforts. In 2001, we reported that a major reform effort begun by FAA in 1998 did not solve long-standing problems with its rulemaking process, as indicated both by the lack of improvement in the time required to complete the rulemaking process and by the agency's inability to consistently meet the time frames imposed by statute or its own guidance.<sup>22</sup> External pressures—such as highly-publicized accidents, recommendations by NTSB, and congressional mandates—as well as internal pressures, such as changes in management's emphasis continued to add to and shift the agency's priorities. For some rules, difficult policy issues continued to remain unresolved late in the process. The 2001 report contained 10 recommendations designed to improve the efficiency of FAA's rulemaking through, among other things, (1) more timely and effective participation in decision-making and prioritization; (2) more effective use of information management systems to monitor and improve the process; and (3) the implementation of human capital strategies to measure, evaluate, and provide performance incentives for participants in the process. FAA implemented 8 of the 10 recommendations.<sup>23</sup>

NTSB's February 2010 update on the status of its Most Wanted recommendations related to icing characterized FAA's related rulemaking efforts as "unacceptably slow." In December 2009, at FAA's International Runway Safety Summit, NTSB's Chairman commented, "How do safety improvements end up taking 10 years to deliver? They get delayed one day at a time . . . and every one of those days may be the day when a preventable accident occurs as the result of something we were 'just about ready to fix.'" In particular, NTSB has expressed concern about the pace of FAA's rulemaking project to amend its standards for transport category airplanes to address supercooled large drop icing, which is outside the range of icing conditions covered by the current standards. FAA began this rulemaking effort in 1997 in response to a recommendation made by NTSB the prior year, and the agency currently expects to issue its proposed rule in July 2010 and the final rule in January 2012. However, until the notice of proposed rulemaking is published and the close of the comment period is known, it will be unclear as to when the final rule will be issued.<sup>24</sup> Much of

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<sup>22</sup>GAO, *Aviation Rulemaking: Further Reform Is Needed to Address Long-standing Problems*, GAO-01-821 (Washington, D.C.: July 9, 2001).

<sup>23</sup>Additional information about the status of these recommendations is available at <http://www.gao.gov/products/GAO-01-821>.

<sup>24</sup>FAA is required by statute to issue a final regulation within 16 months of the last day of the comment period.

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the time on this rulemaking effort has been devoted to research and analysis aimed at understanding the atmospheric conditions that lead to supercooled large drop icing.

In 2009, FAA completed an internal review of its rulemaking process that concluded that several of the concerns from 1998 that led to the agency's major reform effort remain issues, including:

- inadequate early involvement of key stakeholders;
- inadequate early resolution of issues;
- inefficient review process;
- inadequate selection and training of personnel involved in rulemaking; and
- inefficient quality guidance.

According to FAA's manager for aircraft and airport rules, the agency is taking steps to implement recommendations made by the internal review, such as revising the rulemaking project record form and enhancing training for staff involved in rulemaking. In addition, in October 2009, FAA tasked its Aviation Rulemaking Advisory Committee (ARAC) with reviewing its processes and making recommendations for improvement within a year. We believe these efforts have the potential to improve the efficiency of FAA's rulemaking process. Recently, moreover, FAA has demonstrated a commitment to making progress on some high-priority rules that have languished for a long time. For example, FAA officials have said that they intend to expedite FAA's rulemaking on pilot fatigue, which has been in process since 1992. The issue of insufficient rest emerged as a concern from NTSB's investigation of the February 12, 2009, crash of Continental Connection/Colgan Air Flight 3407 near Buffalo, New York.<sup>25</sup>

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<sup>25</sup>In 1992, in response to NTSB recommendations, FAA established the flight crewmember flight/duty rest requirements working group of ARAC. However, by mid-1994 the working group had concluded its work, having failed to reach a consensus. Nevertheless, FAA issued a notice of proposed rulemaking in December 1995 to update the flight and duty regulations for airline pilots; however, in the intervening 14 years, the regulations have not been revised. In recent years, FAA has stated that it is developing a fatigue risk management system (FRMS) to provide an alternative to prescriptive limitations. Additionally, FAA has supported the adoption of FRMS programs among certain air carriers for their ultra-long-range operations.

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Moreover, a capacity for progress in rulemaking will be critical because, as we have reported to this Subcommittee in our recent reviews of the transition to the Next Generation Air Transportation System (NextGen), many of the procedures that are proposed to safely enhance the efficiency and capacity of the national airspace system to address current delays and congestion in the system and to accommodate forecasted increases in air traffic will be dependent on the timely development of rules and standards.

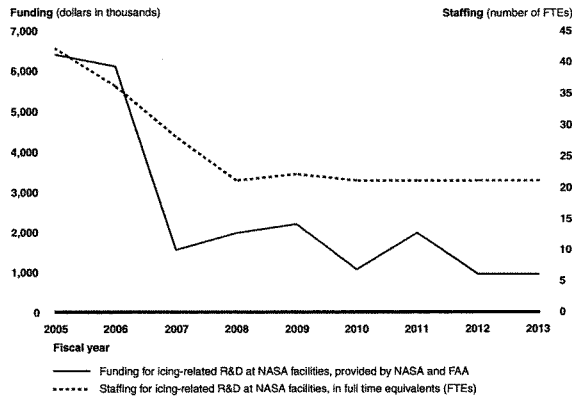
*Ensuring the availability of adequate resources for icing-related R&D.* NASA is a key source of R&D related to icing. The agency performs fundamental research related to icing in house and sponsors such research at universities and other organizations. According to NASA officials, possible areas for increased support for R&D that could be helpful include pilot training, supercooled large drop simulation (both experimental and computational), engine icing, and the effects of icing on future aircraft wing designs. However, the amount of NASA resources (including combined amounts of NASA's budget and funding from FAA for aircraft icing R&D at NASA facilities) and staffing for icing research have declined significantly since fiscal year 2005, as shown in figure 4. According to NASA officials, there were several contributing factors to the decline in available resources including the fiscal constraints on the overall federal budget, a shift in the Administration's priorities for NASA, as well as a restructuring within the NASA's aeronautical programs to reflect the available resources and priorities. Because the outcomes of R&D are often required for the development of rules and standards, as well as for technological innovation, a decline in R&D resources can delay actions that would promote safe operation in icing conditions.

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In June 2008, the FAA sponsored a symposium on fatigue management that provided an opportunity for subject matter experts to come together and discuss fatigue's effects on flight crews, maintenance personnel, and air traffic controllers. NTSB believes that fatigue management plans may hold promise as an approach to dealing with fatigue in the aviation environment. However, NTSB considers fatigue management plans to be a complement to, not a substitute for, regulations to prevent fatigue.



**Figure 4: NASA Funding and Staffing for Icing-Related R&D, Fiscal Years 2005-2013**



Sources: GAO presentation of NASA data.

Notes: Funding data represents three sources of funding for icing research at NASA. According to NASA, complete data are available for one source, while data for another source are only available for fiscal years 2005-2010, and data for the third source are only available for fiscal years 2005-2009. Amounts do not reflect icing-related funds received or could be received through other government programs or external partnership (i.e. Boeing) agreements. The funding costs do not include amounts for staffing.

According to FAA's chief scientist for icing, NASA's research to understand how icing affects various makes and models of aircraft in real time, which would ultimately help pilots determine how to respond to specific icing encounters, has been adversely affected by cuts to NASA's icing research budget. He further said that without NASA's research efforts, it would be uncertain who would conduct potentially important icing research.

*Ensuring that pilot training is thorough, relevant, and realistic.* Another icing-related challenge to aviation safety is pilot training. Aviation experts told us that pilots are likely to encounter icing conditions beyond their aircraft's capabilities at least once in their career. It is therefore important that pilots be trained to handle such conditions. Currently, icing must be covered in a commercial pilot's initial training and, while recurrent

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training may not always emphasize icing, it is covered on a rotational basis. Different weather conditions affect aircraft performance in a variety of ways, making it critical that pilots receive training relevant to the conditions they are likely to encounter. For example, it is important that regional airline operators provide region-specific training to their pilots as regional airline consolidations may cause pilots to fly a geographically wider variety of routes with more variation in weather conditions. Regarding pilot training, in January 2010, the FAA Administrator said, "The flying public needs to have confidence that no matter what size airplane they board, the pilots have the right qualifications, are trained for the mission, are fit for duty. . . . We know we need to reexamine pilot qualifications to make sure commercial pilots who carry passengers have the appropriate operational experience—they need to be trained for the mission they are flying." As part of our ongoing work, we will examine FAA pilot training requirements and the extent to which FAA ensures pilots are adhering to FAA training requirements in our final report.

Simulators are used to train pilots of large commercial airplanes for in-flight icing because it is not feasible to train in actual icing conditions, as they are difficult to predict and hazardous. However, reliance on simulators for training means that pilots may not be sufficiently prepared for a variety of real-world icing conditions. According to representatives of the Aerospace Industries Association, some characteristics of icing cannot currently be replicated and to improve simulators, researchers need to develop engineering tools to characterize ice shapes such as those resulting from supercooled large drops.

*Ensuring the collection and distribution of timely and accurate weather information.* Improving the quality of weather information could reduce the safety risks associated with winter weather operations. Pilots and operators use weather forecasts to decide whether it is safe to start a flight or, once aloft, whether it is preferable to continue on to the destination or divert to an alternate airport. Weather experts explained that weather forecasters are still far from being able to precisely predict icing conditions in the atmosphere and the impact of such conditions on individual aircraft. For this reason, FAA said icing forecasters generally provide overly cautious forecasts that cover a broad area. While this serves to warn pilots that icing could occur, representatives of the Air Line Pilots Association said that too many false alarms result in pilots ignoring subsequent forecasts of icing. These representatives also said that pilots do not know when they are entering severe conditions, as they are only given generalized statements about icing conditions.

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Providing pilots with accurate weather information has been a long-standing concern: FAA's 1997 Inflight Aircraft Icing Plan recommended improving the quality and dissemination of icing weather information to dispatchers and flight crews. Since 1997, FAA, in conjunction with NOAA and NCAR, has developed improved icing forecasting products to improve icing weather information. Icing-related research is an important component of planning for the NextGen initiative. Currently, NextGen weather researchers are focused on creating technology and procedures that enable forecasters to provide pilots with more precise predictions of icing conditions, which they believe will address the problem of pilots ignoring traditionally unreliable icing forecasts. According to NWS and NCAR, real-time information about weather conditions could help forecasters create more precise forecasts and communicate the existence of dangerous weather conditions to pilots.

*Developing a more integrated approach to effectively manage winter operations.* FAA indicated that developing an integrated approach to effectively manage winter operations is among its top challenges related to aviation icing. It is important for FAA and the aviation industry to focus on how components of the aviation system interact and affect one another during winter operations. Airport surface conditions, aircraft ground deicing, aircraft in-flight icing and icing certification, the dissemination of airport condition information, air traffic handling of aircraft in icing conditions, and air traffic arrival and departure sequencing should be considered together as vital to safe operations in icing conditions and should not be viewed in isolation.

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Mr. Chairman, we are continuing to collect and analyze information related to the issues that we have presented here today and expect to provide this Subcommittee and the co-requesters of this study a final report as soon as possible. This concludes my prepared statement. I would be happy to respond to any questions you or other Members of the Subcommittee may have at this time.

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### GAO Contact and Staff Acknowledgments

For further information about this testimony, please contact Gerald Dillingham at (202) 512-2834. Individuals making key contributions to this testimony included Laurel Ball, Shareea Butler, Colin Fallon, David Goldstein, Brandon Haller, David Hooper, Joshua Ormond, and Sally Moino.

## Appendix I: FAA's Funding to the Airport Improvement Program for Icing-Related Projects, 1999—2009, by State and City

State/City	Year	Acquire aircraft deicing equipment	Construct deicing containment facility	Total amount
<b>AK</b>				
Fairbanks	2003		✓	\$2,069,333
<b>CO</b>				
Denver	2000		✓	299,974
Denver	2001		✓	6,200,000
Denver	2004		✓	7,700,000
Denver	2005		✓	9,909,845
Denver	2005		✓	3,211,130
Denver	2006		✓	2,634,739
<b>CT</b>				
New Haven	2001		✓	67,092
<b>IA</b>				
Dubuque	2006	✓		221,417
<b>IL</b>				
Belleville	2005		✓	202,572
Belleville	2009	✓		507,900
<b>IN</b>				
Indianapolis	1999		✓	5,654,999
<b>KS</b>				
Wichita	1999	✓		128,350
Manhattan	2001	✓		37,438
Manhattan	2002	✓		123,971
<b>KY</b>				
Covington	1999		✓	1,210,000
Covington	2000		✓	269,057
Lexington	2000		✓	198,000
Lexington	2001		✓	2,399,244
Paducah	2007		✓	91,037
<b>MD</b>				
Baltimore	1999		✓	3,403,519
<b>ME</b>				
Bangor	2004		✓	399,599
Bangor	2005		✓	1,384,222

State/City	Year	Acquire aircraft deicing equipment	Construct deicing containment facility	Total amount
<b>MI</b>				
Detroit	2005		✓	\$2,950,000
Detroit	2008		✓	3,800,000
Detroit	2009		✓	1,889,237
Kalamazoo	2004		✓	203,468
<b>MN</b>				
Bemidji	2005		✓	12,065
Bemidji	2005	✓		161,478
Brainerd	2008	✓		204,250
Hibbing	2005	✓		280,690
International Falls	2007	✓		205,899
Minneapolis	2001		✓	7,660,984
Minneapolis	2003		✓	10,204,941
St. Cloud	2000		✓	58,500
St. Cloud	2007	✓		204,250
<b>MO</b>				
Kansas City	2003		✓	150,000
Kansas City	2005		✓	5,589,005
Kansas City	2006		✓	4,463,462
<b>MT</b>				
Bozeman	1999		✓	91,328
Missoula	2008		✓	4,363,460
<b>NC</b>				
Charlotte	1999		✓	145,051
Kinston	2001	✓		167,943
<b>NJ</b>				
Morristown	2004		✓	1,579,259
<b>NM</b>				
Roswell	2008	✓		116,051
<b>NY</b>				
Buffalo	2006		✓	816,891
Buffalo	2008		✓	500,000
Islip	2009	✓		288,591
Islip	2007		✓	46,550
Ithaca	2009	✓		113,735

State/City	Year	Acquire aircraft deicing equipment	Construct deicing containment facility	Total amount
New York	2003		✓	\$6,856,488
Newburgh	2000		✓	1,400,000
Rochester	2000		✓	1,858,022
Rochester	2001		✓	973,860
White Plains	2003		✓	369,855
White Plains	2003	✓		262,678
White Plains	2007	✓		581,613
White Plains	2008	✓		296,283
White Plains	2009	✓		473,991
<b>OH</b>				
Akron	2005		✓	4,993,313
Akron	2006		✓	5,000,000
Columbus	2002		✓	5,173,023
Toledo	2006		✓	861,735
Toledo	2007		✓	77,524
Toledo	2005		✓	746,756
Youngstown/ Warren	2008	✓		246,687
Youngstown/Warren	2007		✓	22,609
<b>OK</b>				
Tulsa	2004		✓	381,239
<b>OR</b>				
Portland	2000		✓	6,173,126
Portland	2001		✓	9,645,738
Portland	2002		✓	488,743
<b>PA</b>				
Bradford	2003	✓		144,425
Harrisburg	2000	✓		86,920
Latrobe	2006	✓		118,883
Philadelphia	2000	✓		17,915,168
Pittsburgh	2001		✓	1,000,000
Pittsburgh	2002		✓	2,430,965
Pittsburgh	2007		✓	6,115,219
Pittsburgh	2008		✓	6,775,000
Slate College	2002		✓	89,092

State/City	Year	Acquire aircraft deicing equipment	Construct deicing containment facility	Total amount
State College	2003		✓	\$221,883
State College	2004		✓	3,919,476
<b>TN</b>				
Memphis	2007		✓	1,440,412
Memphis	2008		✓	286,591
Nashville	1999		✓	1,356,970
Nashville	1999	✓		214,294
Nashville	2000		✓	832,306
Nashville	2000	✓		131,416
Nashville	2007		✓	44,491
<b>TX</b>				
Beaumont/Port Arthur	2006	✓		88,825
Dallas-Fort Worth	1999		✓	7,878,022
Dallas-Fort Worth	2000		✓	1,223,254
Dallas-Fort Worth	2003		✓	750,000
Fort Worth	2003		✓	13,075
<b>VA</b>				
Roanoke	2002	✓		387,827
<b>WA</b>				
Bellingham	1999		✓	75,000
<b>WI</b>				
Eau Claire	2005	✓		220,000
Green Bay	2001		✓	605,700
<b>WV</b>				
Clarksburg	2001		✓	66,825
Clarksburg	2002		✓	230,683
Clarksburg	2004	✓		220,139
Huntington	1999		✓	577,789
<b>WY</b>				
Sheridan	1999		✓	58,850

Source: GAO analysis of FAA data.

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**National Transportation Safety Board**  
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(202) 314-6000



**Deborah A.P. Hersman**  
**Chairman**

**Testimony of Deborah A.P. Hersman, Chairman**  
**National Transportation Safety Board**  
**Before the Aviation Subcommittee, Committee on Transportation and Infrastructure**  
**U.S. House of Representatives**  
**Aircraft Icing**  
**February 24, 2010**

Chairman Costello, Mr. Petri, and Members of the Subcommittee:

Thank you for the opportunity to join the discussion today regarding the safety of aircraft in icing conditions. This is an issue of great concern to the National Transportation Safety Board (NTSB), and we appreciate the opportunity to offer our viewpoint.

The NTSB is an independent Federal agency chartered by Congress with investigating every civil aviation accident in the United States and significant accidents in other modes of transportation. Last week, the NTSB adopted its Most Wanted List of Transportation Safety Improvements for 2010, which includes a number of open recommendations, including four which seek to reduce the dangers to aircraft flying in icing conditions. The Board voted to retain the issue area "Reduce Dangers to Aircraft Flying in Icing Conditions" on the Most Wanted List and also to retain the red classification which reflects an unacceptable response to this issue area which has been on the Most Wanted List since 1997.

Since its inception in 1990, the Most Wanted List represents a group of safety recommendations selected for intensive follow-up. The recommendations are combined into issue areas, such as in-flight structural aircraft icing. These recommendations are selected because they will benefit or enhance the safety of the national transportation system; have a high level of public visibility or interest; or will benefit from this special form of encouragement and heightened attention.

From 1998 to 2007, the NTSB has investigated fifty Part 121 and 135, and 214 General Aviation accidents involving airplane icing, resulting in 202 fatalities. The accidents have involved aircraft, powerplants, aircraft systems (excluding carburetor icing) and/or runway and surface conditions. During that same period of time, the NTSB has issued 48 recommendations addressing various safety issues that, if addressed, would improve aviation safety. While the NTSB relies on others to implement our recommendations, we have worked to educate the pilot community about some of the hazards associated with icing conditions through Safety Alerts (Ground Aircraft Icing – December 2006; De-ice Boot Activation – December 2008).

The following two tables represent the range of investigations and recommendations that the NTSB has addressed between 1998 and 2007. However, my testimony today will focus on the areas addressed in our Most Wanted List.

<b>NTSB Accident Records 1998-2007 Involving U.S.-Registered Airplanes</b>			
<b>Aircraft/Powerplant/Systems Icing (other than carburetor icing)</b>			
	Total Accidents	Fatal Accidents	Fatalities
Part 121	1	0	0
Part 135	36	15	27
Part 91, 137, and 125	163	79	175
Total	200	94	202
<b>Runway/Surface Icing</b>			
	Total Accidents	Fatal Accidents	Fatalities
Part 121	4	0	0
Part 135	10	0	0
Part 91, 137, and 125	54	0	0
Total	68	0	0

\* One Part 135 accident (CHI00LA073) and three part 91 accidents (FTW00LA084, CHI01LA086, and CHI03LA038) cited both airframe/powerplant/systems and runway/surface icing and appear in both tables.

<b>Safety Recommendations Issued 1998-2007 Involving Icing</b>		
	Total	
Engine Icing	1	
In-flight Icing	32	
Runway and Ground	9	
Total	48	
Status of Recommendations	Total	Percentage of Recommendations
Open – Acceptable	16	35%
Open - Unacceptable	4	9%
Open – Awaiting Response	1	2%
Closed – Acceptable	19	41%
Closed - Unacceptable	6	13%
Total	46	

\* 2 of the 48 recommendations were “Closed –Reconsidered” and therefore not included in the status count.

The NTSB has long been concerned about aircraft operating in icing conditions. In September 1981, the NTSB published a report entitled "Aircraft Icing Avoidance and Protection," which recommended that the FAA review the icing certification criteria. The report was the result of a special study following a series of icing-related accidents in which the NTSB identified concerns about aircraft operations in icing conditions and the varying consequences that ice accretions had on different aircraft types. As a result of two accidents during the 1990s, the NTSB became concerned about airplanes that fly in supercooled large droplet (SLD) conditions, and that use pneumatic boots to deice the aircraft in flight. These aircraft are typically, but not exclusively, turbo-prop aircraft that use pneumatic boots and fly at altitudes where they are more likely to encounter SLD conditions.

A significant icing accident occurred in 1994 in Roselawn, Indiana, involving an American Eagle ATR-72 in-flight icing encounter and subsequent loss of control, resulting in a crash that claimed 68 lives. That accident investigation prompted the NTSB to re-examine the issue of airframe structural icing and conclude that the icing certification process continued to be inadequate because it did not require manufacturers to demonstrate the airplane's flight handling and stall characteristic under a realistic range of adverse ice accretion conditions, including supercooled large droplets.

The consequences of operating an airplane in icing conditions without first having thoroughly demonstrated adequate handling/controllability characteristics in those conditions are sufficiently severe that they warrant a thorough certification test program, including application of revised standards to airplanes currently certificated for flight in icing conditions.

On January 9, 1997, a Comair Embraer EMB-120 departed controlled flight and crashed in icing conditions over Monroe, Michigan, while on approach to Detroit Metropolitan Airport. All 29 people on board were killed. The investigation of this accident, and of several control upset incidents that occurred prior to the Monroe accident that involved a delayed activation of the deice boots, revealed a widespread and firmly held, but incorrect, belief within the aviation community that the activation of deice boots should be delayed until  $\frac{1}{4}$  to  $\frac{1}{2}$  inch of ice builds up to prevent "ice bridging." As a result, in many cases, flight crews do not activate the deice boots until after the build up of dangerous accumulations of ice on the aircraft.

In both the Roselawn and Monroe accidents, the pilots were using the autopilot before the icing-induced upset began. Because the pilots were not manually flying the aircraft, they were not aware that the autopilot was having increasing difficulty maintaining stable flight until the autopilot suddenly disconnected, and the airplane entered an uncontrollable flight regime.

NTSB recommendations stemming from the Roselawn and the Monroe accidents called on the FAA to use current research on freezing rain and SLD to revise the way aircraft are designed and approved for flight in icing conditions; to apply revised icing requirements to currently certificated aircraft; and to require the pilots of airplanes with pneumatic deice boots to activate the boots as soon as the airplane enters icing conditions. The FAA referred this work to an Aviation Rulemaking Advisory Committee (ARAC) more than 10 years ago. Six years later, the ARAC approved a concept to revise the icing design requirements for new airplanes. In December 2005, the ARAC completed its final report and recommended appropriate revisions to

the design and operational requirements for flight in icing conditions. In the more than four years since that report, the FAA has yet to issue a notice of proposed rulemaking (NPRM) to require consideration of more realistic icing conditions.

In the last few years the FAA has issued a number of final and proposed rules; some of those actions have been responsive to NTSB recommendations. On August 3, 2007, the FAA issued a final rule that revised the certification standards for the handling and controllability characteristics of newly designed Part 25 aircraft in icing conditions; however the rule did not include revisions to reflect SLD conditions, a particularly dangerous flight environment that the NTSB asked the FAA to address. On August 3, 2009, the FAA issued a final rule regarding the activation of ice protection systems on newly designed Part 25 aircraft certified for flight in icing conditions. On November 23, 2009, the FAA issued an NPRM regarding activation of the ice protection system on aircraft operated under Part 121. The NTSB has commented on the NPRM which does not address other categories of aircraft such as business aircraft and Part 135 air-taxi operations or those aircraft weighing over 60,000 pounds, effectively exempting some aircraft types operating in regional airline operations such as the Bombardier DHC-8, Q-400. In addition, the NTSB recommendation that prompted this NPRM resulted from the Pueblo, Colorado crash of a business jet operating under Part 91. Therefore, the NPRM would not have prevented that accident.

While the FAA's rules have addressed some of the recommendations relating to deice boot operations, not all of the NTSB recommendations have been fully addressed. In particular, the NTSB has recommended that the FAA use a full range of icing conditions, including SLD, for icing certification testing. This would include freezing rain, freezing drizzle, and freezing mist.

Unfortunately, the NTSB continues to investigate accidents and incidents in which in-flight icing has been a factor. Each of the following incidents or accidents reinforces the need for the FAA to address SLD in icing certification:

- On March 19, 2001, an Embraer EMB-120, operated by Comair Airlines, Inc., as flight 5054, encountered icing conditions while in cruise flight at 17,000 feet and departed controlled flight, descending to an altitude of about 10,000 feet. The pilots recovered control of the airplane and diverted to West Palm Beach, Florida, where they landed without further incident. The 2 flight crewmembers, 1 flight attendant, and 25 passengers were uninjured, but the airplane sustained substantial damage to the elevators and horizontal stabilizer due to the high forces encountered during the recovery from the uncontrolled descent.
- On February 16, 2005, a Cessna Citation 560, operated by Martinair, Inc., for Circuit City Stores, Inc., crashed about 4 nautical miles east of Pueblo Memorial Airport, Pueblo, Colorado, while on approach in icing conditions. The two pilots and six passengers on board were killed, and the airplane was destroyed by impact forces and postcrash fire.
- In January 2006, an American Eagle flight 3008, a Saab-Scania AB SF340B+, departed from San Luis County Regional Airport (SBP), San Luis Obispo, California, destined for Los Angeles International Airport (LAX), Los Angeles, California. After it encountered icing conditions during the en route climb, the airplane departed controlled flight and lost 5,000 feet of altitude before the pilots were able to recover control. The 2 flight

crewmembers, 1 flight attendant, and 25 passengers were not injured, and the airplane did not sustain any damage.

Finally, the NTSB is investigating an accident that occurred in January 2009, in Lubbock, Texas, involving an ATR-42 that was on a final approach to the airport. During the NTSB's two-day public hearing in September 2009, factual information established that this accident involved a flap asymmetry and the autopilot disconnected when the stick shaker activated. The captain declined to perform a go-around, even when it was suggested by the first officer. The captain took control of the aircraft and it subsequently crashed 300 feet short of the runway and was destroyed in post-crash fire. Airframe icing was noted by the flightcrew. The National Weather Service had forecast light freezing drizzle, which by definition is an SLD condition. However, because severe icing conditions were not forecast or reported, the air carrier operating specification, approved by the FAA, allowed the flight to be dispatched into such conditions. Testimony at the public hearing indicated that this information affected the captain's decision on the go-around.

This investigation is ongoing, but it suggests, as did the accidents in the early 1990s, that flightcrews are encountering icing conditions for which their aircraft are not suitably designed to handle, and for which their training is inadequate. Although the FAA received a proposal from the ARAC for an expanded icing envelope to include SLD in 2005, the publication of an NPRM has been delayed numerous times, and the FAA now expects to issue an NPRM in June of this year.

While there has been progress on the part of the FAA, the NTSB is concerned that the process for incorporating these recommended changes is slow. In March 2009, 13 years after the NTSB issued the recommendations regarding expansion of icing conditions considered when certifying an aircraft, the FAA decided to form an advisory committee for Part 23 aircraft. Part 23 airplanes tend to be smaller aircraft such as are used in business jet and air taxi operations.<sup>1</sup> As of our most recent update at the end of 2009, this advisory committee had not yet been formed or met. At the current rate, we would not expect these regulatory changes to be in place until almost 20 years after the Roselawn accident.

Although not an in-flight aircraft icing recommendation, the Safety Board has been concerned with the broader issue of excursions due to runway contamination. Performing landing distance assessments, which assure an adequate safety margin for landing, is another important issue included on the Safety Board's Most Wanted List. The recommendation asks the FAA to require operators to incorporate a 15 percent safety margin for landing on contaminated runways and was issued as a result of the NTSB's investigation of a fatal runway excursion involving Southwest Airlines at Chicago-Midway Airport in December 2005.

When the NTSB issues a safety recommendation with an "urgent" designation, it expects that the action can be completed within one year after the recommendation is issued. However, in this case, the FAA has only issued guidance and encouraged operators to conduct a landing distance assessment. The FAA has not made this a requirement and recent investigations have revealed

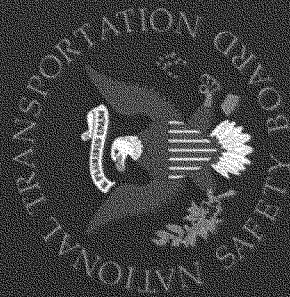
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<sup>1</sup> Part 23 Normal category is Max TOW 12,500 pounds or less, nine seats or less (excluding pilot seats); Commuter category multiengine aircraft may be certified under Part 23 if propeller driven, 19 seats or less (excluding pilot seats) and Max TOW less than 19,000 pounds.

that some of the FAA's inspectors are not aware the guidance exists. Since the guidance was issued, the Safety Board has investigated several accidents involving runway overruns on wet or contaminated runways, including Shuttle America flight 6448 in Cleveland; Pinnacle Airlines flight 4712 in Traverse City, Michigan; a Hawker Beechcraft Part 135 flight in Owatonna, Minnesota; and, we are supporting the Jamaican authorities as they investigate the recent American Airlines runway excursion that occurred on December 22, 2009, in Kingston.

Mr. Chairman, this concludes my testimony. I look forward to answering any questions that you and the members of the Subcommittee may have.





**NTSB** National Transportation Safety Board

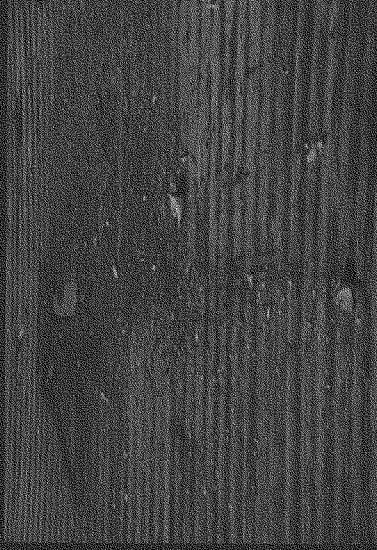
**Testimony of  
Deborah A.P. Hersman  
Chairman**

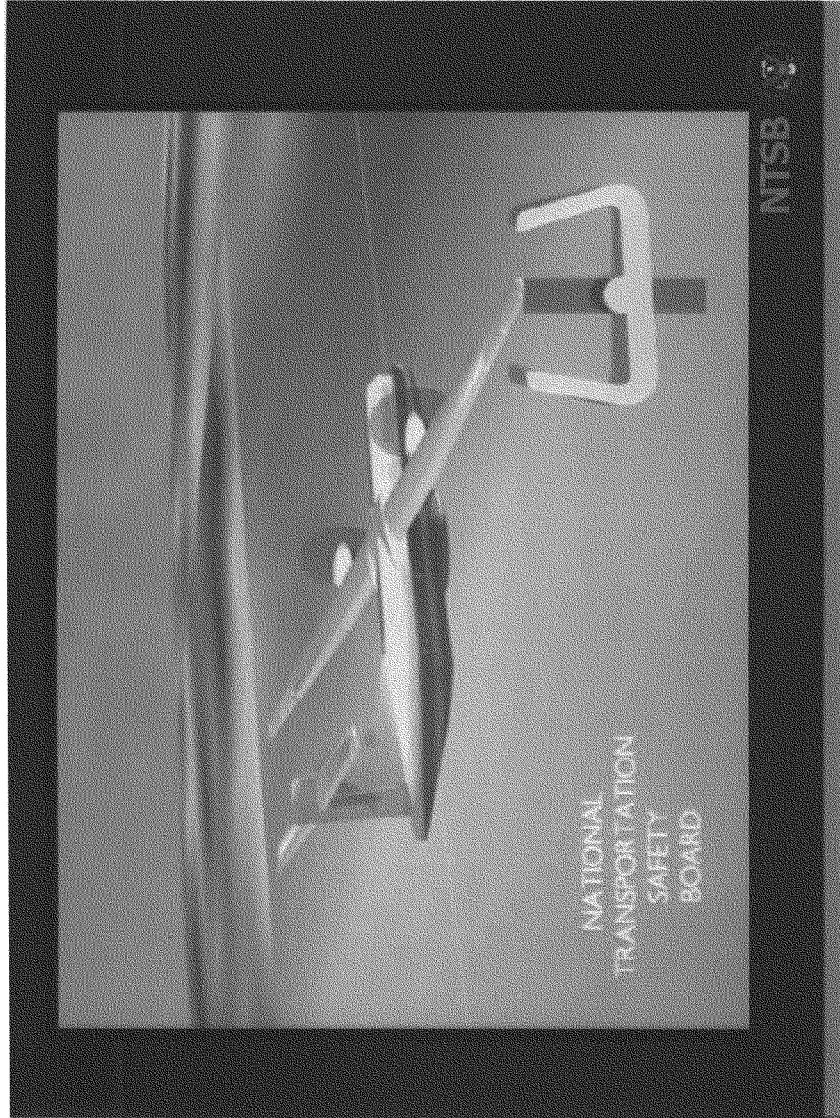
*before the*

**U.S. House of Representatives  
Committee on Transportation  
and Infrastructure  
Subcommittee on Aviation**

## Roselawn, IN, American Eagle ATR-72

- 68 fatalities
- Involved Supercooled Large Droplets
- Created ridge of ice aft of deice boots
- Caused ailerons to deflect, resulting in loss of control





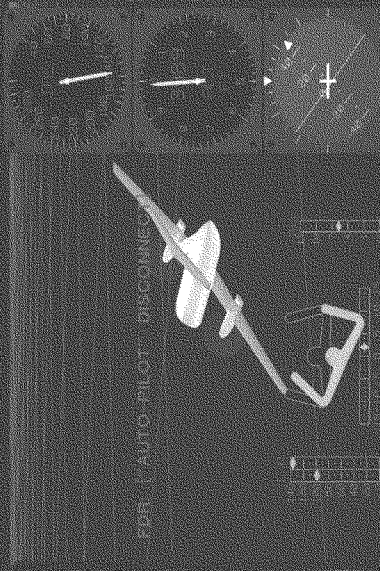
## Why is SLD important to consider?

- Accretions can cause stall or control anomalies at higher airspeed than normally expected
- Ice can accrete aft of ice protection system
- Sometimes difficult to see or detect
- Pilots may not detect an unsafe condition



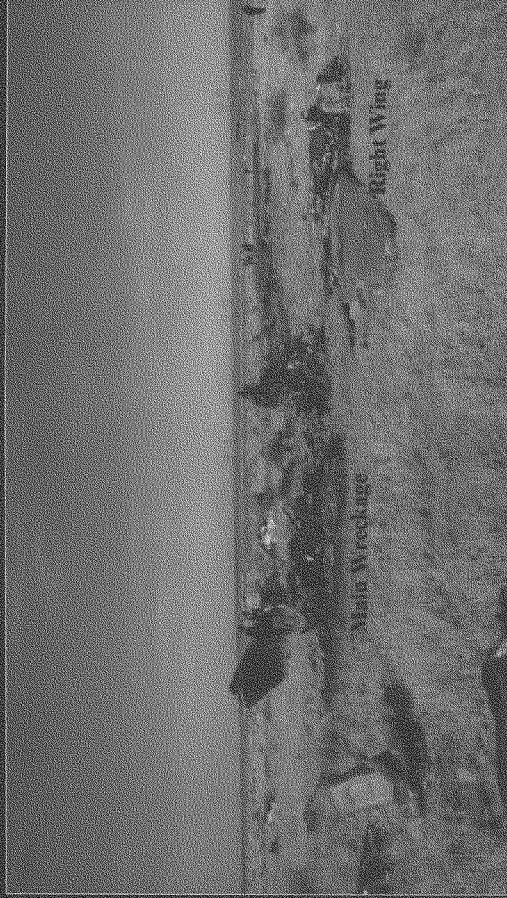


# Fatal Accidents



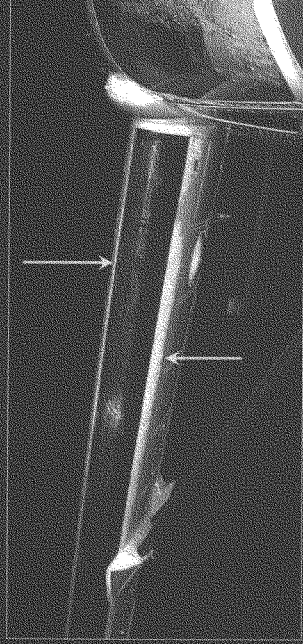
- Comair Embraer EMB-120  
Monroe, MI – January, 1997  
– 39 fatalities

## Fatal Accidents



- Circuit City Cessna 560  
Pueblo, CO – February, 2005  
– 8 fatalities

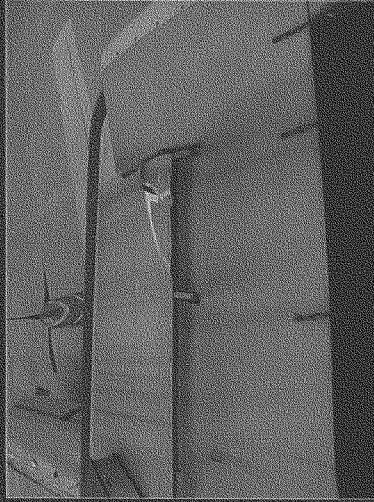
# Fatal Accidents



- Cessna 208B Caravans

- Totaling 10 fatalities
- 7 recommendations issued in 2004 and 2006

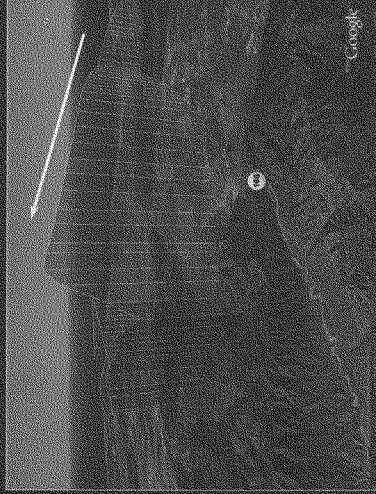
## Incidents



- Comair Embraer EMB-120  
West Palm Beach, FL – March, 2001
  - 7500 ft altitude loss
  - Structural damage to horizontal tail and elevator

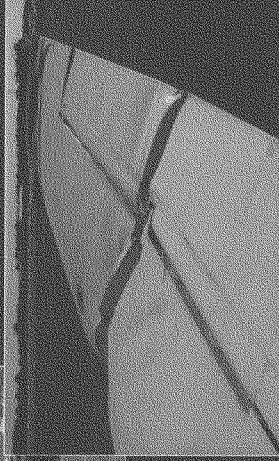
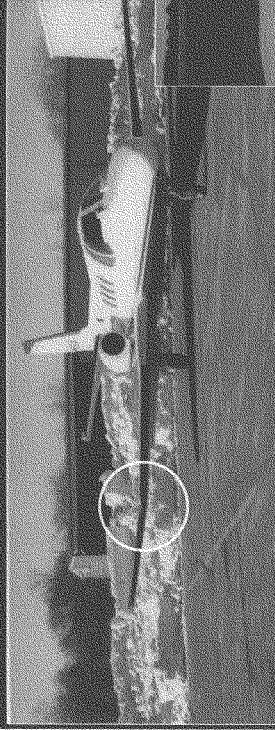


# Incidents



- American Eagle Saab 340B  
San Luis Obispo, CA - January, 2006
  - Lost 5000 feet altitude
  - Nearly inverted

## Incidents



- Cessna 500 – Air Ambulance  
Beverly, MA – March, 2007
  - Uncommanded roll during landing
  - Struck wing on runway

# Safety Board Recommendations

- Currently 15 open in-flight icing safety recommendations to FAA
  - 12 Open - Acceptable
  - 3 Open - Unacceptable
- NTSB Federal Most Wanted
  - *“Reduce Dangers to Aircraft Flying in Icing Conditions”*
  - Condition RED (Unacceptable response)

**NTSB MOST WANTED LIST**  
 FEDERAL AGENCY ACTIONS NEEDED TO IMPROVE AVIATION SAFETY  
 Actions Requested by Federal Agencies

**Rail**  
 The Federal Railroad Administration should:

- Improve Transit Signal Design
  - Provide advance warning for safe and rapid emergency response only and
  - Prevent the possibility of these safety violations.
- Provide updated technical standards to meet the new standards.

**The U.S. Coast Guard should:**

- Research Safety Management Systems (SMS) for Domestic Vessels
  - Require, promote, support, and encourage the development and implementation of SMS to improve their safety programs and reduce risk.
- Reduce Accidents and Incidents Caused by Human Factors in the Marine Industry
  - Conduct research, based on human factors, accident analysis, and other data, to identify and address the causes of human factors accidents and incidents.

**AVIATION**  
 The Federal Aviation Administration should:

- Improve Oversight of Pilot Proficiency
  - Develop and implement a pilot proficiency monitoring program for flight attendants and additional crewmembers that considers performance factors for flight attendants demonstrating performance deficiencies.
- Require Image Recorders
  - Require image recorder installation in aircraft to give investigators more information to work complex accidents.
- Improve the Safety of Emergency Medical Services (EMS) Flights
  - Coordinate flights with medical personnel on board in accordance with AICR.
  - Develop and implement flight deck evacuation programs for EMS operators.



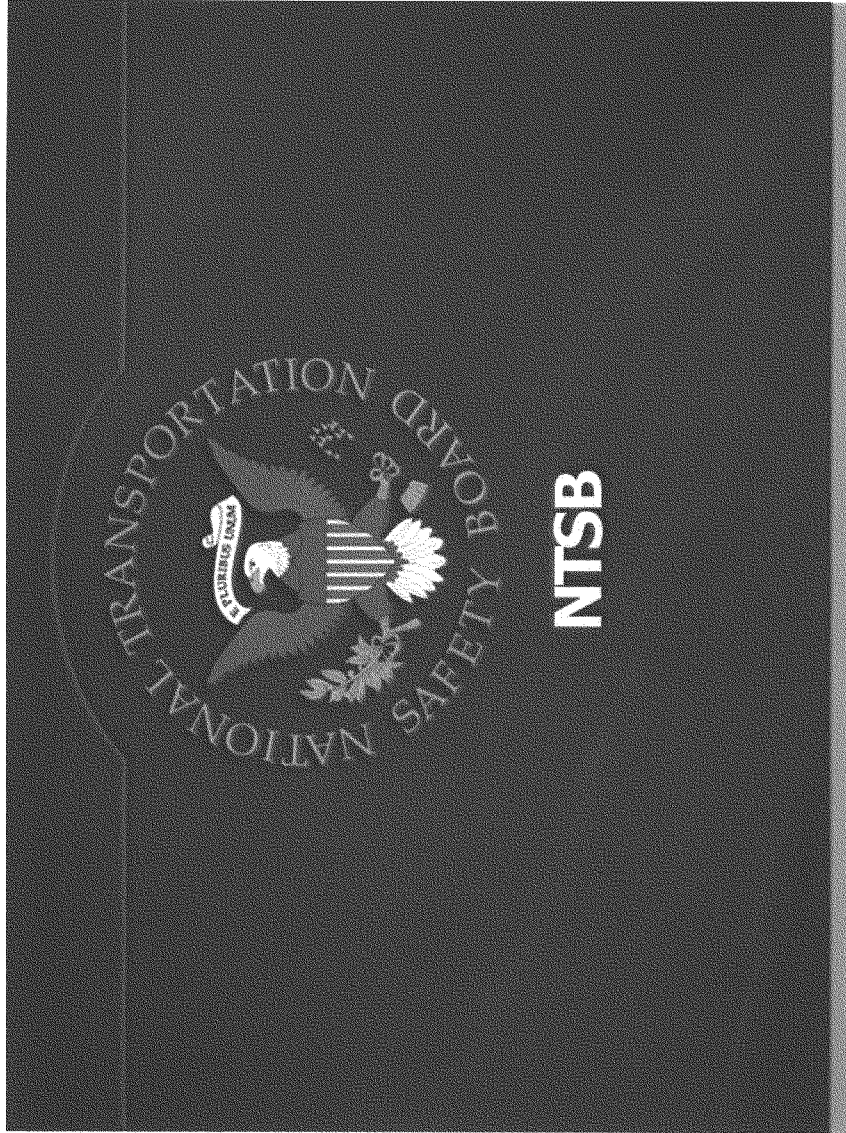
## Positive FAA Actions

- AD's regarding operation in severe icing and identifying SLD
- AD's regarding deice boot operation
- Part 25 performance and handling in icing conditions
- Part 25 ice protection system operation
- NPRM Part 121 ice protection system operation
- Advisory material has been upgraded



## What still needs to be done?

- Final rule for SLD icing conditions to be used in certification
- Ensure all airplanes certified for flight in icing conditions can either safely operate in SLD, or can detect it and exit safely
- Deice boots for all equipped airplanes need to be operated as soon as airplane enters icing conditions



**Actions needed by States**

**HIGHWAY**

**Improve Child Occupant Protection**

- Enact State laws requiring booster seats for young children up to age 8.
- Enact Primary Seat Belt Enforcement Laws
- Increase number of people who wear seat belts through stronger enforcement laws that don't restrict officers to observing another offense first.

**Eliminate Distractions for Young Drivers**

- Prohibit use of interactive wireless communications devices by young novice drivers.
- Restrict the number of teen passengers traveling with young novice drivers.

**Eliminate Hard Core Drinking Driving**

- Enact legislation to reduce crashes involving repeat offenders who drink large amounts of alcohol, including:
  - Frequent, statewide sobriety checkpoints.
  - More effective measures (sanctions/treatment) for first time arrests with high blood alcohol concentration and repeat offenders.
  - Zero blood alcohol requirement for those already convicted of driving while intoxicated.

- Administrative license revocation for refusing to take or failing an evidential test for alcohol.
- Vehicle sanctions for DWI offenders to separate drinking from driving.
- Elimination of plea-bargaining DWI offenses and programs that divert offenders and purge offense records.

- DWI offense records retention for at least 10 years to identify repeat offenders.
- Special sanction court-based programs such as DWI courts for hard core DWI offenders.

**MARINE**

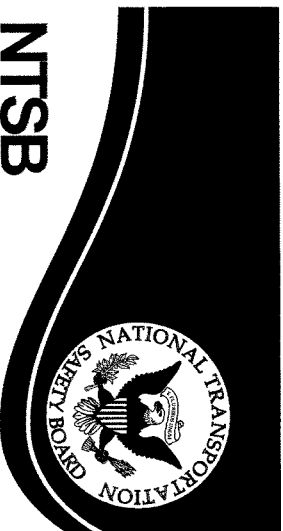
**Enhance Recreational Boating Safety**

- Require mandatory education of boat operators.
- Require use of life jackets by children.



**National Transportation Safety Board**  
 490 L'Enfant Plaza, SW • Washington, DC 20594  
 (202) 314 6000 • <http://www.ntsb.gov>

February 2010



**NTSB MOST WANTED LIST**  
 Transportation Safety Improvements

**2009 - 2010**

*Critical changes needed to reduce transportation accidents and save lives.*

**NTSB**

<ul style="list-style-type: none"> <li>● <b>RAIL: The Federal Transit Administration should:</b> <ul style="list-style-type: none"> <li>• Improve Transit Railer Design                             <ul style="list-style-type: none"> <li>• Provide adequate means for safe and rapid emergency responder entry and passenger evacuation.</li> <li>• Prevent the telescoping of transit railcars in collisions.</li> <li>• Remove equipment that cannot be modified to meet the new standards.</li> </ul> </li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>● <b>MARINE: The U. S. Coast Guard should:</b> <ul style="list-style-type: none"> <li>• Require Safety Management Systems (SMS) for Domestic Vessels                             <ul style="list-style-type: none"> <li>• Require domestic vessel operators to develop, implement, and maintain a systematic and documented SMS to improve their safety practices and minimize risk.</li> </ul> </li> <li>• Reduce Accidents and Incidents Caused by Human Fatigue in the Marine Industry                             <ul style="list-style-type: none"> <li>• Set working hour limits for mariners based on fatigue research, circadian rhythms, and sleep and rest requirements.</li> </ul> </li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>● <b>AVIATION: The Federal Aviation Administration should:</b> <ul style="list-style-type: none"> <li>• Improve Oversight of Pilot Proficiency                             <ul style="list-style-type: none"> <li>• Evaluate prior flight check failures for pilot applicants before hiring.</li> <li>• Provide training and additional oversight that considers full performance histories for flight crewmembers demonstrating performance deficiencies.</li> </ul> </li> <li>• Require Image Recorders                             <ul style="list-style-type: none"> <li>• Install crash-protected image recorders in cockpits to give investigators more information to solve complex accidents.</li> </ul> </li> <li>• Improve the Safety of Emergency Medical Services (EMS) Flights                             <ul style="list-style-type: none"> <li>• Conduct all flights with medical personnel on board in accordance with stricter commuter aircraft regulations.</li> <li>• Develop and implement flight risk evaluation programs for EMS operators.</li> <li>• Require formalized dispatch and flight-following procedures including up-to-date weather information.</li> <li>• Install terrain awareness and warning systems (TAWS) on aircraft used for EMS operations.</li> </ul> </li> <li>• Improve Runway Safety                             <ul style="list-style-type: none"> <li>• Give immediate warnings of probable collisions/incursions directly to flight crews in the cockpit.</li> <li>• Require specific air traffic control (ATC) clearance for each runway crossing.</li> <li>• Require operators to install cockpit moving map displays or an automatic system that alerts pilots when a takeoff is attempted on a taxiway or a runway other than the one intended.</li> <li>• Require a landing distance assessment with an adequate safety margin for every landing.</li> </ul> </li> <li>• Reduce Dangers to Aircraft Flying in Icing Conditions                             <ul style="list-style-type: none"> <li>• Use current research on freezing rain and large water droplets to revise the way aircraft are designed and approved for flight in icing conditions.</li> <li>• Apply revised icing requirements to currently certified aircraft.</li> <li>• Require that airplanes with pneumatic deice boots activate the boots as soon as the airplane enters icing conditions.</li> </ul> </li> </ul> </li> </ul>

**Actions needed by Federal Agencies**

<ul style="list-style-type: none"> <li>● <b>Improve Crew Resource Management</b> <ul style="list-style-type: none"> <li>• Require commercial and on-demand air taxi flight crews to receive crew resource management training.</li> </ul> </li> <li>● <b>Reduce Accidents and Incidents Caused by Human Fatigue in the Aviation Industry</b> <ul style="list-style-type: none"> <li>• Set working hour limits for flight crews, aviation mechanics, and air traffic controllers based on fatigue research, circadian rhythms, and sleep and rest requirements.</li> <li>• Develop a fatigue awareness and countermeasures training program for controllers and those who schedule them for duty.</li> <li>• Develop guidance for operators to establish fatigue management systems, including a methodology that will continually assess the effectiveness of these systems.</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>● <b>HIGHWAY: The Federal Motor Carrier Safety Administration should:</b> <ul style="list-style-type: none"> <li>• Prohibit Cell Phone Use by Motorcoach Drivers                             <ul style="list-style-type: none"> <li>• Prohibit commercial driver's license (CDL) holders driving under the authority of the passenger-carrying or school bus endorsement from using a cellular telephone.</li> </ul> </li> <li>• Require Electronic Onboard Data Recorders to Maintain Accurate Carrier Records on Driver Hours of Service                             <ul style="list-style-type: none"> <li>• Improve collection and maintenance of data concerning hours of service (HOS) of motor carrier drivers by requiring use of electronic onboard recorders (EOBRs).</li> </ul> </li> <li>• Improve the Safety of Motor Carrier Operations                             <ul style="list-style-type: none"> <li>• Prevent motor carriers from operating if they put vehicles with mechanical problems on the road or unqualified drivers behind the wheels.</li> </ul> </li> <li>• Prevent Medically Unqualified Drivers from Operating Commercial Vehicles                             <ul style="list-style-type: none"> <li>• Establish a comprehensive medical oversight program for interstate commercial drivers.</li> <li>• Ensure that examiners are qualified and know what to look for.</li> <li>• Track all medical certificate applications.</li> <li>• Enhance oversight and enforcement of invalid certificates.</li> <li>• Provide mechanisms for reporting medical conditions.</li> </ul> </li> <li>• The National Highway Traffic Safety Administration should:                             <ul style="list-style-type: none"> <li>• Prevent Collisions by Using Enhanced Vehicle Safety Technology                                     <ul style="list-style-type: none"> <li>• Reduce rear-end collisions through use of adaptive cruise control and collision warning system technologies.</li> </ul> </li> <li>• Enhance Protection for Motorcoach Passengers                                     <ul style="list-style-type: none"> <li>• Redesign motorcoach window emergency exits so passengers can easily open them.</li> <li>• Issue standards for stronger bus roofs and require them in new motorcoaches.</li> </ul> </li> <li>• Devise new standards to protect motorcoach passengers from being thrown from their seats or ejected when a bus sustains a front, side, or rear impact or rolls over.</li> </ul> </li> </ul> </li> </ul>
<p><b>NTSB ACTION/TIMELINESS DESIGNATION</b></p> <ul style="list-style-type: none"> <li>● Unacceptable response</li> <li>○ Acceptable response, progressing slowly</li> <li>○ Acceptable response, progressing in a timely manner</li> </ul>





**NTSB**  
**SAFETY ALERT**  
 National Transportation Safety Board

**★ Activate Leading Edge Deice Boots  
 As Soon as Airplane Enters Icing Conditions**

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***Thin amounts of ice, as little as 1/4 inch, can be deadly***

***The problem***

- As little as 1/4 inch of leading-edge ice can increase the stall speed 25 to 40 knots. The danger is that some 1/4-inch accumulations have minimum impact and pilots become over confident.
- Sudden departure from controlled flight is possible with only 1/4 inch of leading-edge ice accumulation at normal approach speeds.
- For 60 years, pilots have been taught to wait for a prescribed accumulation of leading-edge ice before activating the deice boots because of the believed threat of ice bridging.
- In theory, ice bridging could occur if the expanding boot pushes the ice into a frozen shape around the expanded boot, thus rendering the boot ineffective at removing ice.
- The Safety Board has no known cases where ice bridging has caused an incident or accident, and has investigated numerous incidents and accidents involving a delayed activation of deice boots.
- Ice bridging is extremely rare, if it exists at all.
- Early activation of the deice boots limits the effects of leading-edge ice and improves the operating safety margin.
- Using the autopilot can hide changes in the handling qualities of the airplane that may be a precursor to premature stall or loss of control.
- Many airplanes still require pilots to visually identify ice on the wings and its thickness, which can be difficult to see from the cockpit.
- Many pneumatic deice boot systems only provide a means to manually cycle the system and have no provision for continuous operation.

***What should pilots do when they encounter leading edge ice?***

- Leading-edge deice boots should be activated as soon as icing is encountered, unless the aircraft flight manual or the pilot's operating handbook specifically directs not to activate them.

- If the aircraft flight manual or the pilot's operating handbook specifies to wait for an accumulation of ice before activating the deice boots, maintain extremely careful vigilance of airspeed and any unusual handling qualities.
- While icing conditions exist, continue to manually cycle the deice system unless the system has a provision for continuous operation.
- Turn off or limit the use of the autopilot in order to better "feel" changes in the handling qualities of the airplane.
- Be aware that some aircraft manufacturers maintain that waiting for the accumulation of ice is still the most effective means of shedding ice.

**Need more information?**

- Visit the NTSB website at <http://www.nts.gov> to access the following documents:
  - Accident brief addressing a non-fatal landing accident of a Cessna 500 on March 17, 2007, in Beverly, Massachusetts (NTSB Identification: NYC07LA081).
  - *Crash During Approach to Landing, Circuit City Stores, Inc., Cessna Citation 560, Pueblo, Colorado, February 16, 2005* (NTSB/AAR-07/02).
  - *In-flight Icing Encounter and Uncontrolled Collision with Terrain, Comair Flight 3272, Monroe, Michigan, January 9, 1997* (NTSB/AAR-98/04).
  - NTSB's Most Wanted List icing recommendations:  
<[http://www.nts.gov/Recs/mostwanted/air\\_ice.htm](http://www.nts.gov/Recs/mostwanted/air_ice.htm)>
- FAA Advisory Circular 25.1419-1A
- Professional Pilot Magazine: "NTSB advises immediate activation of deice boots on entering icing conditions," December 2008.  
<[http://www.propilotmag.com/archives/2008/Dec08/A2\\_Icing\\_p1.html](http://www.propilotmag.com/archives/2008/Dec08/A2_Icing_p1.html)>



**NTSB**  
**SAFETY ALERT**  
 National Transportation Safety Board

★ **Aircraft Ground Icing**

***Pilots urged to beware of aircraft upper wing surface ice accumulation before takeoff***

***The problem:***

- Fine particles of frost or ice, the size of a grain of table salt and distributed as sparsely as one per square centimeter over and airplane wing's upper surface, can destroy enough lift to prevent a plane from taking off.
- Almost virtually imperceptible amounts of ice on an aircraft wing's upper surface during takeoff can result in significant performance degradation.
- Small, almost visually imperceptible amounts of ice distributed on an airplane's wing upper surface cause the same aerodynamic penalties as much larger (and more visible) ice accumulations.



- Small patches of ice or frost can result in localized, asymmetrical stalls on the wing, which can result in roll control problems during lift off.
- It is nearly impossible to determine by observation whether a wing is wet or has a thin film of ice. A very thin film of ice or frost will degrade the aerodynamic performance of any airplane.
- Ice accumulation on the wing upper surface may be very difficult to detect from the cockpit, cabin, or front and back of the wing because it is clear/white.
- Accident history shows that non-slatted, turbojet, transport-category airplanes have been involved in a disproportionate number of takeoff accidents where undetected upper wing ice contamination has been cited as the probable cause or sole contributing factor.
- Most pilots understand that visible ice contamination on a wing can cause severe aerodynamic and control penalties, but it is apparent that many pilots do not recognize that minute amounts of ice adhering to a wing can result in similar penalties.
- Despite evidence to the contrary, these beliefs may still exist because many pilots have seen their aircraft operate with large amounts of ice adhering to the leading edges (including the dramatic double horn accretion) and consider a thin layer of ice or frost on the wing upper surface to be more benign.

***What should pilots know and do about airplane icing before takeoff?***

- Pilots should be aware that no amount of snow, ice or frost accumulation on the wing upper surface should be considered safe for takeoff. It is critically important to ensure, by any means necessary, that the upper wing surface is clear of contamination before takeoff.
- The NTSB believes strongly that the only way to ensure that the wing is free from critical contamination is to touch it.
- With a careful and thorough preflight inspection, including tactile inspections and proper and liberal use of deicing processes and techniques, airplanes can be operated safely in spite of the adversities encountered during winter months.
- Pilot should be aware that even with the wing inspection light, the observation of a wing from a 30- to 40-foot distance, through a window that was probably wet from precipitation, does not constitute a careful examination.
- Pilots may observe what they perceive to be an insignificant amount of ice on the airplane's surface and be unaware that they may still be at risk because of reduced stall margins resulting from icing-related degraded airplane performance.
- Depending on the airplane's design (size, high wing, low wing, etc.) and the environmental and lighting conditions (wet wings, dark night, dim lights, etc.) it may be difficult for a pilot to see frost, snow and rime ice on the upper wing surface from the ground or through the cockpit or other windows.
- Frost, snow, and rime ice may be very difficult to detect on a white upper wing surface and clear ice can be difficult to detect on an upper wing surface of any color.
- Many pilots may believe that if they have sufficient engine power available, they can simply "power through" any performance degradation that might result from almost imperceptible amounts of upper wing surface ice accumulation. However, engine power will not prevent a stall and loss of control at lift off, where the highest angles of attack are normally achieved.
- Some pilots believe that if they cannot see ice or frost on the wing from a distance, or maybe through a cockpit or cabin window, it must not be there – or if it is there and they cannot see it under those circumstances, then the accumulation must be too minute to be of any consequence.

***Need more information?***

- Crash During Takeoff in Icing Conditions, Canadair, Ltd., CL-600-2A12, N873G, Montrose, CO, November 28, 2004. Aircraft Accident Report NTSB/AAB-06/03: [www.nts.gov/publicctn/2006/AAB0603.htm](http://www.nts.gov/publicctn/2006/AAB0603.htm)
- Epps Air Service, Challenger 604, Birmingham International Airport, Birmingham, UK, January 4, 2002. Air Accidents Branch (AIB), Department of Transport, UK. Aircraft Accident Report 5/2004 (EW/C2002/1/2): [www.aib.gov.uk/cms\\_resources/dft\\_avsafety\\_pdf\\_030576.pdf](http://www.aib.gov.uk/cms_resources/dft_avsafety_pdf_030576.pdf)
- NTSB recommendation letter issued as a result of 26 Cessna 208 icing-related incidents and accidents: [www.nts.gov/Recs/letters/2004/A04\\_64\\_67.pdf](http://www.nts.gov/Recs/letters/2004/A04_64_67.pdf)
- Takeoff Stall in Icing Conditions, USAir flight 405, Fokker F-28, N485US, LaGuardia Airport, Flushing, NY, March 22, 1992. Aircraft Accident Report NTSB/AAR-93-02: [www.nts.gov/ntsb/brief.asp?ev\\_id=20001211X14270&key=1](http://www.nts.gov/ntsb/brief.asp?ev_id=20001211X14270&key=1)
- Loss of Control on Takeoff, Ryan International Airlines, DC-9-15, N565PC, Cleveland-Hopkins International Airport, Cleveland, OH, February 17, 1991. Aircraft Accident Report NTSB/AAR-91/09: [www.nts.gov/ntsb/brief.asp?ev\\_id=20001212X16434&key=1](http://www.nts.gov/ntsb/brief.asp?ev_id=20001212X16434&key=1)
- Crash During Takeoff in Icing Conditions, Continental Airlines, DC-9-14, N26TX, Stapleton International Airport, Denver, CO, November 15, 1987. Aircraft Accident Report NTSB AAR-88/09: [www.nts.gov/publicctn/1988/AAR8809.htm](http://www.nts.gov/publicctn/1988/AAR8809.htm)
- NTSB website: [www.nts.gov](http://www.nts.gov)
- NTSB Most Wanted List: [www.nts.gov/Recs/mostwanted/air\\_ice.htm](http://www.nts.gov/Recs/mostwanted/air_ice.htm)

STATEMENT OF JOHN HICKEY, DEPUTY ASSOCIATE ADMINISTRATOR FOR AVIATION SAFETY, FEDERAL AVIATION ADMINISTRATION, BEFORE THE HOUSE OF REPRESENTATIVES, COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE, SUBCOMMITTEE ON AVIATION, ON AIRCRAFT ICING. FEBRUARY 24, 2010.

Chairman Costello, Ranking Member Petri, Members of the Subcommittee:

Thank you for inviting me here today to discuss the challenges icing conditions pose to flight operations and the Federal Aviation Administration's (FAA) efforts to mitigate the safety risks posed by icing. For more than a decade, the FAA has been working to better understand the hazards posed by icing conditions and to improve regulations, policies and procedures to ensure safe airplane operation. Still, research into the complicated phenomenon of icing continues to yield new insights and mitigation measures.

Today, I want to highlight some of the known icing threats and mitigation measures as well as our icing program approach and a number of our recent efforts that have been crucial to further decreasing the risk associated with aircraft icing. First, however, it is important to understand the framework within which we work to address icing risks.

As the agency charged with setting the standards for safe aircraft operations, we establish the standards for operations during all types of meteorological conditions, including those that might result in icing on the ground or in flight. Aircraft manufacturers and operators meet these standards through a variety of means depending on where the icing risk occurs (on the ground or in flight), and the aircraft's system capabilities and intended usage.

Our standards for operations in icing conditions encompass both operational and aircraft certification requirements. Operational requirements include standards and aircraft specific operating procedures for icing encounters and pilot and dispatcher training. All pilots engaged in commercial operations must receive training on identification of, safe operation in, and how to avoid and exit icing conditions. They must also be trained on deicing system operation and capabilities of the particular aircraft they operate.

An aircraft design approval - what we call a "type certificate" - provides the design specifications that an aircraft must be built to, in order to meet the FAA's standards for safe design. Aircraft must also comply with operation requirements, as set forth by the rules under which the airplane is being operated. Design and operation requirements must both be met in order to satisfy the FAA's standards for safe operation. In order for an aircraft to be certificated for operations in icing conditions, the aircraft's manufacturer must be able to demonstrate that the aircraft can safely operate within the icing conditions specified by FAA regulations. We know today that these specified conditions represent 99% of all known atmospheric conditions that result in icing. For the remaining 1%, we are conducting research and are working to translate our findings into certification standards. I want to emphasize that airplanes are prohibited from operations in known icing conditions unless they meet the certification standards for operations in those conditions and at no time may any aircraft continue to operate in severe icing conditions.

**Aircraft Icing**

Unmitigated icing presents risks to aircraft. The accumulation of ice on an aircraft's wing changes the shape of the wing, and hence the aerodynamic capabilities of the wing to generate lift. For this reason, ice accumulation on an aircraft on the ground may impact the aircraft's ability to takeoff, while ice accumulation in flight has the potential to raise the minimum speed at which the wing is capable of creating sufficient lift, and potentially causing the aircraft to stall.

**Ground icing:** Ground icing is, as the name implies, the accumulation of ice, snow or frost on the aircraft while it is on the ground. This form of icing is both common and meteorologically predictable. During the winter months, the conditions in which ice accumulation on an aircraft is possible become more prevalent and vigilant action becomes necessary to ensure planes are properly deiced and cleared of snow and ice prior to takeoff. Winter precipitation poses a threat to aviation operations because airplane performance is predicated upon the wings being free of contamination. The accumulation of ice, snow, or frost has an adverse effect on the wing's ability to produce lift, potentially limiting an airplane's ability to takeoff and climb.

Currently, the FAA prohibits takeoff unless the airplane's critical surfaces are completely clear of wintry precipitation. As many of you have likely seen, this is typically achieved by applying deicing or anti-icing fluids to the critical surfaces of the airplane. To provide for a safe takeoff, it is important that a deiced airplane

not remain on the ground for an extensive period after deicing during precipitation. At the start of this winter season, as in years past, the FAA issued its annual winter “hold over times” and list of approved anti-ice and deicing fluids. “Hold over times” govern the amount of time that may elapse between deicing and takeoff. In the event that the aircraft exceeds the amount of wait time permitted between deicing and takeoff, FAA regulations require the aircraft to be reinspected for adhering contamination or exit the takeoff queue and be deiced again prior to departure. These holdover time tables are revised annually. Some of the reasons for the annual update include improvements in the effectiveness of deicing and anti-icing fluids, reduction of environmental impacts and new information learned through FAA fluid research.

**In-flight icing:** Unlike ground icing, in-flight icing knows no season and can be difficult to predict. In-flight icing results from atmospheric conditions that can occur at anytime of the year, regardless of the weather conditions on the ground. According to FAA regulations, any pilot who finds himself or herself in icing conditions while operating an aircraft that is not approved for operations in icing **must immediately** exit the icing conditions. This means redirecting the aircraft to a different altitude or route, or landing.

There are multiple atmospheric conditions that can result in the build-up of ice on an aircraft during flight. To mitigate the risk of ice build-up during flight, aircraft that are certificated to operate in icing conditions are equipped with devices that



shed ice from the aircraft, such as expandable pneumatic boots, or prevent the formation of ice through the use of heat. A pilot's ability to recognize icing conditions and activate deicing and anti-icing systems in a timely manner is critical to those systems' effectiveness. Because of the pilot's critical role in managing flight in icing conditions, we have used both our rulemaking and advisory authorities, to provide pilots with the latest information on how to identify icing, to require early and systematic use of deicing systems and to require exit from icing conditions under certain circumstances.

Some aircraft are also equipped with ice detection systems. Ice detection systems assist the flightcrew with ice detection and timely activation of the ice protection system. These systems automatically detect ice accretion and annunciate the presence of ice accretion to the flightcrew. Some ice detection systems are designed to automatically initiate the operation of the aircraft deicing systems while others are what we call "advisory" and require the flightcrew to ensure ice protection systems are activated at the first sign of ice accretion on the airplane.

Although our current regulations address the vast majority of all known icing conditions, we have steadily worked to address two types of in-flight icing phenomena outside of the existing icing certification envelope: supercooled large droplets (SLD) and ice crystals. SLD icing can occur in freezing rain and freezing drizzle conditions – turning water to ice upon contact with the airframe, which can lead to larger accumulations or build up on areas of the wing and tail

aft of the protected area. We expect to issue a Notice of Proposed Rulemaking (NPRM) to address this small area of vulnerability, by incorporating atmospheric conditions that are associated with SLD icing into our certification criteria. In the interim, we have taken immediate steps through our airworthiness directive authority to ensure that pilots can identify severe icing which may be produced by SLD conditions and execute exit procedures.

Ice crystals are also a newly identified threat. We now believe that flight into certain types of storm clouds can cause ice to build up deep inside the core of jet engines and cause temporary shutdowns. Understanding this threat has been particularly challenging because, typically, by the time an aircraft lands, the affected engine has restarted and there is no evidence for us to evaluate. We are currently working with industry and other governmental research partners on developing ways to recreate the atmospheric conditions in which ice crystals form and learn all that we can about how to mitigate the threat of this phenomenon. Although there is research that still needs to be done in this area, we are closely monitoring the condition and its possible causes. To mitigate the risk, the FAA issued Airworthiness Directives (ADs) requiring operational changes when in or near convective weather and engine design changes to make jet engines more tolerant of ice crystal conditions.

#### **Icing Safety Actions**

Safety concerns about the adequacy of the icing certification standards were brought to the forefront of public and governmental attention by a 1994 accident in Roselawn,

Indiana, involving an Avions de Transport Regional ATR 72 series airplane. The NTSB attributed this accident to what we now call SLD - an icing phenomenon that, at the time, was not fully understood. Shortly after this accident, the FAA initiated a review of aircraft safety in icing conditions to determine what could be done to increase safety. This review resulted in our current icing program.

As meteorologists will attest, simply understanding some of these icing phenomena are difficult and complex. Determining how to address these complex phenomena to support safe aircraft operations takes additional time and extensive research. That is why we tackle the dangers of icing with a multi-prong approach. To address those threats that are clearly understood or for which immediate mitigation is available, we take immediate safety action. In the meantime, concurrent research and development and rulemaking efforts are underway. To date, our icing program includes seven rulemaking initiatives - three have been adopted as final rules, while others are in various stages of development. Additionally, we have issued over 200 ADs on 50 different aircraft models, and have undertaken other operational training and mitigation initiatives.

**Immediate Actions:** The FAA's icing program addresses the immediate icing safety concerns for the current fleet of aircraft through the use of ADs. The FAA has the authority to issue an AD if we determine that some aspect of flying in icing conditions on a particular airplane model creates an unsafe condition that puts the flying public in immediate danger. ADs carry the same force as a regulation and are targeted to specific aircraft makes and models. ADs must be

complied with in order to continue operating a covered airplane. As described above, the FAA has been aggressive in issuing ADs when we determine they are needed. These ADs cover safety issues ranging from crew operating procedures and training, to design changes that have significantly reduced the icing risk to the overall fleet.

For example, with our AD authority, we require that pilots of airplanes equipped with deicing boots activate those boots at the first sign of icing conditions. We have also issued numerous ADs that direct the crews of certain airplane designs on how to monitor and detect early signs of the onset of severe icing and to exit the area immediately. Other ADs require stall warning systems of certain airplanes to be modified to provide an earlier warning of a potential stall in icing conditions and mandate changes to address any susceptibility to stalling of the horizontal tail in icing conditions. These ADs serve as effective safety measures for the current fleet.

**Longer Term Actions:** The FAA's icing program also includes a number of longer term actions to further improve the safety of flying in icing conditions both for the current fleet and for future airplane designs. These actions include rulemaking, issuing safety bulletins, developing improved training material, drafting new or updating existing Advisory Circular guidance material, and further research. We recognize that fast action is an important goal for implementing any safety improvement. We also acknowledge that some actions, such as rulemaking, take longer than others. Rulemaking is a deliberative process

that must involve the input of those stakeholders who are affected by the rules. Also, in some cases, developing and implementing rules depends on extensive research to understand the particular phenomena and its effect on safety, and to develop appropriate risk mitigations.

For example, in order to understand SLD icing sufficiently to identify an appropriate set of requirements that airplane manufacturers could comply with, a significant amount of research had to be done. We needed to learn how to characterize SLD, then reproduce it, and finally, understand its effect on airplane operations and designs. For these reasons, at the same time that we tasked the Aviation Rulemaking Advisory Committee (ARAC) to develop certification criteria for the safe operation of airplanes in SLD icing conditions, we also began supporting research efforts by NASA and Environment Canada to gather additional SLD data. Using existing and new SLD data and analysis, the ARAC completed the majority of the work defining the SLD icing envelope. But even after the SLD icing envelope was defined, we continued to learn more about the complexities of SLD, which led us to focus analysis of the impact of SLD on aircraft engines and determine that new standards for smaller aircraft should be considered in a separate rulemaking. The process took time, more time than we anticipated and more time than we wanted, but once we had a sufficient understanding of the science and the technical solutions, we moved forward with the SLD rulemaking. I am pleased to report that the SLD NPRM is now in executive coordination within the Department.

In the meantime, we formed and tasked an Aviation Rulemaking Committee (ARC) to review the proposed regulations applicable to transport category aircraft for SLD, mixed phase, and ice crystals and recommend how they should be modified for smaller aircraft. The SLD research we conducted for the transport category SLD rulemaking provides the basis for our scientific understanding of SLD, upon which we can develop additional technological solutions for smaller aircraft.

In addition to the intensive efforts to understand and revise our regulations to address SLD and ice crystals, since 2007, FAA has completed three icing rules and just this week closed the comment period on an additional NPRM. The completed icing rules include:

- Performance and Handling Qualities in Icing Conditions for Transport Category Airplanes, adding new airworthiness requirements that require designers to demonstrate specific airplane performance and handling qualities for flight in icing conditions.
- Activation of Airframe Ice Protection System for Transport Category Airplanes, requiring either the automatic activation of ice protection systems or a method to alert pilots when they should be activated. Further, after the initial activation, the ice protection system must operate continuously, automatically turn on and off, or alert the pilots when the system should be cycled.

- Removal of Airplane Operating Regulations Allowing Polishing of Frost on Wings of Airplanes, effectively prohibiting all aircraft from taking off with polished frost on the wings.

The NPRM, for which the comment period just closed, would require certain scheduled airlines either to retrofit their existing fleet with ice-detection equipment or make sure the ice protection system activates at the proper time. For those aircraft with an ice-detection system, the FAA proposes that the system alert the crew each time they should activate the ice protection system. The ice protection system would either turn on automatically or pilots would manually activate it. For aircraft without ice-detection equipment, the crew would activate the protection system based on cues listed in their airplane's flight manual during climb and descent, and at the first sign of icing during cruise.

We are also evaluating the comments received in response to an additional NPRM that included proposed changes to training and checking requirements for pilots operating flights under part 121. In addition to many other revisions, this NPRM proposed changes that would further specify training requirements for icing operations.

I want to acknowledge that throughout our ongoing and comprehensive effort to mitigate the risks presented by airplane icing, the National Transportation Safety Board icing recommendations have been instructive. Although we are not always able to take the exact action the Board recommends, we value and fully analyze

their recommendations and benefit from their investigations of icing-related accidents. We firmly believe that our actions meet the intent of the vast majority of the Board's icing recommendations.

Although we have made significant advancements in our understanding of icing since the tragic 1994 Roselawn accident, icing related threats continue to be a focus of the FAA's safety experts. The total number of accidents related to environmental icing of airplanes has been decreasing steadily, year after year, for the last 13 years. This safety achievement is the direct result of our intensive focus on improving our understanding of complex icing phenomenon and the best methods for avoiding and mitigating icing conditions. The FAA is proud of this growing safety record and is committed to expanding it.

Mr. Chairman, Congressman Petri, Members of the Subcommittee, this concludes my prepared remarks. I would be happy to answer any questions that you might have.



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STATEMENT OF  
CAPTAIN RORY F. KAY, EXECUTIVE AIR SAFETY CHAIRMAN  
AIR LINE PILOTS ASSOCIATION, INTERNATIONAL  
BEFORE  
THE SUBCOMMITTEE ON AVIATION  
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE  
UNITED STATES HOUSE OF REPRESENTATIVES  
WASHINGTON, D.C.

February 24, 2010

**AIRCRAFT ICING**

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Mr. Chairman and members of the Subcommittee, I am Captain Rory Kay, Executive Air Safety Chairman of the Air Line Pilots Association, International (“ALPA”) which represents the safety interest of over 53,000 professional pilots at 37 airlines in the United States and Canada. On behalf of our members, I thank you for this opportunity to testify before you on the issue of aircraft icing.

ALPA has long been an advocate for improvements to the way aircraft are operated in the presence of icing conditions, both on the ground and airborne. My focus today will primarily be on the impact of icing while airborne, however I do have concerns about the adequacy of the ground de-icing process which I have included in this statement.

ALPA brings a perspective to this discussion that no other organization can. Our members fly a vast range of aircraft types – everything from single-engine aircraft in airline service to wide-body, ultra-long range airliners – in all type of weather conditions, all around the globe. They have experienced first-hand the difficulties of determining the performance impacts, the uncertainties of knowing exactly what conditions are present and whether those conditions are compatible with the aircraft’s design and equipment capability, and the acceptable courses of action available to them when they encounter icing.

We are all too familiar with the reasons why icing related accidents and incidents remain an important flight safety issue in the airline community. Historically pilots have been expected to decide when icing conditions exceed the capabilities of their aircraft and when it is acceptable to proceed into icing conditions. Such decisions would appear to be no different than the thousands of critical decisions made by professional airline pilots on every flight, every day, resulting in the extraordinary safety record we now enjoy. However, even the most cautious and experienced pilots have been involved in icing accidents or incidents. We must take note of this

apparent disparity and continue to explore the reasons why. This is because the tools which pilots use to make these critical decisions have yet to be fully developed. In nearly every other aspect of airline operations, there is not only a significant body of knowledge, but also very advanced, redundant technologies which have eliminated “guess work,” but that guess work is still inherent in flying safely in icing conditions or avoiding them altogether. We know the effects of flying too fast or too slowly and have safeguards, including specific speed limits, throughout the system to avoid those regimes. We know the impact of improper loading on performance, and have established firm loading limits to ensure our aircraft remain controllable. Limitations for in-flight icing, however, remain a difficult problem to solve for a number of reasons. First, despite the fact that much research has been done on in-flight icing and our knowledge today is far superior to that of even a few years ago, we still have much more to learn. We still do not fully understand the nature of icing in the atmosphere, how to assess the risk of a specific icing encounter from the flight deck, and most importantly, we do not yet have the means necessary to avoid operating in conditions which exceed the capabilities of the aircraft’s ice protection system.

Secondly, the nature of the actual atmospheric phenomena that we refer to generally as “icing” vary widely and their effect on airplanes can be equally variable, making it extremely difficult to establish norms and limits for operations. Conditions acceptable for one airplane may very well prove hazardous for another airplane or even to the same airplane at a later time, but with only slightly different operating and atmospheric conditions. So we are faced with a dilemma. Just as inadequate training or limited experience may leave a pilot unaware of an icing hazard, considerable experience, but without hard data to know exactly what the experience was,

can leave a pilot erroneously believing he or she is operating in conditions which appear to match conditions that have been previously safely negotiated.

Part of the difficulty in establishing standard operating procedures and limitations that apply to all fleets and all operations is the difficulty of testing, during the certification process, how the aircraft will react across the spectrum of conditions that may be encountered in daily operations. We are making great strides in fully defining the icing environment in terms that can be used to establish limits and procedures, but there is more to be done. Airplanes are tested in a limited set of icing conditions during certification, but ultimately are approved for flight in icing conditions without quantifiable limits set to alert pilots that they are encountering icing conditions beyond what the airplane was tested for during the certification process. The expectation is that operating rules and pilot judgment will ensure that this broad condition known simply as “icing” will be safely negotiated at every encounter and this is simply not a reasonable assumption. Regardless of their level of experience or training, pilots need to know whether existing conditions are within the capability of the aircraft they are flying. They need to know what type of icing conditions they are entering, and what effects the icing is having on the controllability of the specific airplane they are flying at the specific time of the encounter. The pilot community has inconsistent information and guidance when having to decide how they should react after encountering in-flight icing conditions or whether they should takeoff or proceed into reported freezing rain or drizzle.

In 1995, following an outcry in the aftermath of an aircraft icing related accident near Roselawn, Indiana, the FAA began taking incremental steps to address icing issues and improve the safety standards for flight in icing conditions for all aircraft categories. A good first step was the creation of the Ice Protection Harmonization Working Group (IPHWG) organized under the

Aviation Rulemaking Advisory Committee (ARAC). The IPHWG included representatives from ALPA and other international and industry organizations that had a direct interest and expertise in aviation icing concerns. While much research in icing has been done since 1995 that has resulted in some new federal rules stemming from the IPHWG recommendations, the focus of these rules has been on new airplane type designs and smaller, so-called "regional" airplanes. These are the airplanes with the greatest history of accident/incident events involving icing. However, ALPA is concerned, and disappointed, that in the 15 years since that tragic icing accident near Roselawn; new rules have not expanded to include all aircraft categories that are certified for flight in icing conditions. Despite available information from research and studies, pilots are still facing the same dilemma of having to make subjective assessments about flying into an icing environment. The pilot must decide if it is safe to proceed into icing conditions without quantifiably knowing beforehand what the effects will be on the aircraft. And while pilots always have the final decision whether or not it is safe to fly in any situation, since neither pilots nor airlines have quantifiable data on which to base these critical safety decisions, pilots come under tremendous pressure from airlines to continue into conditions that they may feel are marginal for the sake of supporting the business aspects of the airline. Captain's authority is supported fully by some airlines, and less so by others. In any case, that authority must be based on and supported by clear and consistent rules that are backed by factual data. Consequently there is still more work needed by the FAA to establish rules that address all aircraft categories and to provide pilots with decision tools to ensure consistent standards of safety for flight into icing conditions.

**CONSISTENT GUIDANCE NEEDED**

Any amount of icing accumulation on an aircraft will begin to deteriorate its performance and controllability, and once airborne it is up to the pilot using whatever means available to first recognize and then respond accordingly when in-flight icing conditions are encountered. Current icing certification processes allow aircraft to legally operate, with limited exceptions, in icing conditions provided they are designed and properly equipped with working de-icing/anti-icing systems<sup>1</sup>. A known icing condition is generally defined as an atmospheric condition in which the formation of ice has been observed or detected in-flight. As long as the conditions do not deteriorate beyond the capabilities of the aircraft's ice protection systems, flight in icing is manageable. However, allowable flight into icing conditions does not include any quantifiable limits on the accumulation rate or type of icing the aircraft will encounter. This essentially results in subjective analyses by each pilot on each flight. This subjectivity means pilots never truly know if they are operating their aircraft in a manner consistent with its capabilities. The solution must ultimately be to provide pilots with defined parameters for operations, such as we have for nearly every other aspect of operating an airliner today.

An icing environment of particular concern is supercooled large droplets, or SLD icing which is defined as liquid droplets with diameters greater than 0.05 mm at temperatures less than 0° C. Research and testing have revealed that operations in an SLD environment can quickly deteriorate into a severe icing situation with ice forming in locations not normally prone to icing and perhaps overwhelming the ability of the airplane ice protection system to remove the ice from where it normally forms. Aircraft with inflatable deicing boots, typically used in small regional turboprop operations appear to be the most vulnerable to this phenomenon. Turbojets

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<sup>1</sup> Flight in "Severe Icing" should be avoided and is defined as when the rate of accumulation is such that deicing/anti-icing equipment fails to reduce or control the hazard. Immediate flight diversion is necessary.

are also affected by SLD but their time of exposure to these conditions is typically less than turboprops flying at the lower altitudes where SLD normally occurs. These SLD encounters are usually associated with conditions of freezing rain or freezing drizzle. Although flight in severe icing is universally prohibited once encountered, to date there has been no clear and concise position from regulators, with respect to operations in reported freezing rain and freezing drizzle in order to preclude a severe icing encounter involving SLD. Consequently, we see operators routinely flying a wide variety of aircraft in conditions of reported freezing rain or drizzle without measures to prevent flight into SLD conditions that may lead up to a severe icing encounter. For example, some carriers have a policy that takeoffs are prohibited in moderate or heavy freezing rain, and heavy freezing drizzle, while other carriers have no specific guidance or policy other than flight in severe icing is prohibited and a caution that flight in light freezing rain or freezing drizzle may exceed the capabilities of the aircraft's ice protection system. In either case there is no quantified or standard guidance provided by the FAA on operations in such conditions, and without consistent company policy and procedures to follow, it is up to the discretion of the pilot to determine whether to proceed or divert the flight. A policy to include quantifiable guidance is needed from the FAA to enable a more standardized level of safety regarding go/no-go decisions into known icing conditions that could quickly deteriorate into a severe icing encounter.

#### **DESIGN & CERTIFICATION**

Aircraft flight characteristics are unique to each aircraft type and vary depending upon the icing conditions encountered; consequently information about how a specific aircraft's flight handling characteristics will deteriorate in icing is often general in nature and inconsistent from airline to airline. Currently a pilot's own flight experience in icing and/or training is the most reliable

source for fulfilling that information gap. Unfortunately, there is a disparity between how aircraft are certified for flight in icing conditions and how information from the certification process is made available as operational guidance to pilots. Guidance and regulatory criteria provided to manufacturers for icing certification is highly quantifiable in terms of specific droplet sizes, liquid water content, and durations of icing encounters. These criteria establish a standard, repeatable flight test environment in which the aircraft icing protection systems and flight characteristics are evaluated by a test pilot during the certification process. After certification, the only certification information that may be available to a line pilot is a single sentence in the aircraft operations manual stating “certified for flight in icing.” There are usually no specific or quantifiable limits provided to the line pilots to enable a determination when icing conditions have exceeded those evaluated during the certification process. This disparity creates a gap in information between icing flight conditions tested during the development and certification process versus in-flight icing conditions encountered during revenue operations. The line pilot is the one who must bridge this gap when he or she encounters environmental icing conditions that have not been evaluated in the design and certification process. ALPA firmly believes, and has repeatedly commented, that evaluation of these conditions should occur in the design and certification process not on a revenue flight. New certification methods using either more flight testing or better simulations of icing conditions are needed to ensure that airplane performance is fully evaluated in all types of icing environments that will be encountered in revenue flight operations. Limitations must then be clearly established for operations in icing conditions, and these limits should be readily discernable to the line pilot through the onboard detection and alerting systems.



Once an aircraft has entered into an icing condition, the pilot must rely on experience and training, however limited it may be, to continuously monitor the ice accumulation rate and to know when the build-up appears to have the potential to exceed the capabilities of the aircraft. However, no amount of training or experience can substitute for an accurate, reliable means of determining whether icing conditions are within or outside the designed and certified capability of the specific airplane. Current methods to help the pilot monitor ice accumulation include ice detector systems that can be either manual or automated. Manual systems can be as simple as a probe or “post” mounted outside the cockpit in a position that collects ice and is visible to the pilot. Unfortunately in low visibility situations, as is typical of flights in icing conditions, flight crews can have difficulty seeing such devices outside the aircraft, particularly during night operations. Also due to workload and human factors issues associated with long periods of operation in what may be considered acceptable icing conditions, a manual ice detector that must be constantly checked but rarely changes is a poor means of alerting pilots to severe icing. An example of an automated detection system currently in use is an electronic probe that detects the presence of ice and then provides a signal to the flight deck that alerts the crew via a visible display and/or aural warning. Currently installed detectors merely alert the crew to the presence of ice accretion on the aircraft. After an alert has activated the crew must then monitor and assess the accumulation rate and icing type before deciding the next steps to ensure safety. ALPA contends that aircraft should be equipped with automated detector systems to provide the crew with information on the type of icing that their aircraft is experiencing and when it is exceeding conditions beyond certification criteria. It would automatically alert the crew to the fact that they are approaching conditions which may exceed the capabilities of their aircraft’s ice protection

system. With that information the flight crew can then take the necessary steps, which needs to be clearly defined to the crew, to escape those conditions (i.e., change altitude or route).

#### **TRAINING**

Although training alone is not the solution, to enhance safety in icing conditions, high quality training specific to the airplane being flown is needed to help the pilot not only recognize the presence of icing but to also assess the level of severity and to respond accordingly. This is not a trivial task that can be accomplished with a general statement such as “do not fly into severe icing.” It is important that training tools include example ice accretions that pilots might see on their airplane. NASA Glenn Research Center has done significant work in this area, so some information is already available. Also, because the loss of control due to severe icing can be much different than other loss of control events for which pilots train, flight simulator programming of such events and pilot training on recovery techniques must be developed. This is particularly important for airplanes that have a known susceptibility or accident history in severe icing.

#### **ADVISORY MATERIALS & COMPANY MANUALS**

FAA regulations, advisory materials, and company manuals can be vague and allow for conflicting interpretations. Specific prohibitions against flight into conditions not considered in certification are usually absent. Some manuals actually contain tacit approval for flight in these conditions for some types of aircraft. There is often not a consistent operational message presented to the pilots. For example, manuals from different airlines can vary significantly. Oversight by Certificate Management Units (CMUs) or Principal Operations Inspectors (POIs) of the individual airline’s guidance contained in manuals can vary considerably due to the differences in their knowledge and experience in aircraft icing. ALPA recommends that the

FAA develop and establish clear criteria for pilots and operators to use for go/no-go decisions for flight into known freezing rain and drizzle conditions. I have attached to my testimony extracts from several flight manuals to help illustrate the wide variation in information available to pilots, all of whom might be operating in the same environment.

#### **GROUND DE-ICING**

Significant progress has been made on the effectiveness of ground de-icing fluids. However methods to ensure that the de-icing fluids are providing the expected protection are often complicated and do not always account for the actual conditions encountered. Current procedures used by pilots to determine how long they can wait on the ground after being de-iced include tables that provide what is called “holdover time”. This is the time during which the anti-icing fluid remains effective and within which the aircraft should takeoff. This holdover time is a function of the anti-icing fluid type, outside air temperature, and the type of precipitation. Industry research determines the length of the holdover times for a variety of precipitation types to include freezing rain and light freezing drizzle. However, these precipitation types involve droplet sizes greater than that used during aircraft icing certification tests. But line pilots see that the holdover tables do include these precipitation types and infer that the aircraft was tested in these conditions. It is important to understand that anti-icing fluids applied to the aircraft prior to departure protect the aircraft while on the ground only. They are designed to flow off the aircraft upon takeoff, leaving only the certified aircraft ice protection system as protection. It is important that the FAA develop guides and processes for determining de-icing fluid holdover times that are representative of the actual conditions the aircraft will be exposed to prior to and during take-off.

**IN-FLIGHT ICING FORECASTING**

Finally, it must be emphasized that while I have discussed the need for training to understand how severe icing affects an airplane when it is encountered, the goal must still be to avoid any encounter that carries the potential for a hazardous situation to develop. This is a well-established strategy for coping with other kinds of severe weather in aviation. For example, I may have procedures I can employ in the event of an inadvertent entry into a thunderstorm, but I still attempt to avoid them in the first place using a combination of onboard equipment, training, judgment, and weather forecasting tools. Avoiding a hazardous icing encounter is no different. Under the leadership of the National Center for Atmospheric Research and other weather research organizations, forecasting of in-flight icing has improved and experimental products are available for operational use on the Internet. Use of them, especially by regional air carriers is increasing, and methods of delivering updated products to the cockpit for real-time decision making are being developed. At this point, the operational benefit of improving technology is not widespread, but is increasing. ALPA strongly supports continued adoption of tools to avoid areas of severe icing and urges the FAA to develop a process to educate and encourage companies to improve the safety of their operations through use of new weather forecasting technologies as they continue to develop and their benefits are proven.

Thank you again, for the opportunity to testify on this important subject.

Attachments

Example Information in Operator Flight Manuals Regarding Icing Operations

Example 1; Legacy Carrier Flight Manual: (prohibition on flight in Freezing Rain (FZRA) or Freezing Drizzle (FZDZ))

Cold weather operations:

**PROHIBITED OPERATIONS**

**CAUTION:** *Prior to taxiing in conditions where takeoff, approach, or landing is prohibited, verify that the taxiway conditions are suitable for operations (e.g., ATIS, braking action reports, friction Mu reports, etc.).*

Flights may not operate when, in the opinion of the Captain or dispatcher, icing conditions are expected that might adversely affect the safety of the flight.

• **Takeoff, approach, and landing are prohibited** under the following conditions:

- Moderate Freezing Rain (FZRA)
- Heavy Freezing Rain (+FZRA)
- Heavy Freezing Drizzle (+FZDZ)

• **Takeoff is prohibited** under the following conditions:

- Snow pellets/small hail (GS) of any intensity
- Heavy ice pellets (+PL)
- Moderate ice pellets (PL) mixed with any other form of precipitation

Example 2; Regional Carrier Flight Manual: (prohibition on flight in Freezing Rain (FZRA) or Freezing Drizzle (FZDZ))

**Takeoff in Freezing Precipitation Conditions.**

— Takeoffs are permitted under the following conditions:

- Frost;
- Freezing fog;
- Light or moderate snow/snow grains;
- Light freezing rain<sup>1</sup>;
- Light or moderate freezing drizzle<sup>1</sup>;
- Rain on a cold soaked wing

— Takeoffs are prohibited under the following conditions:

- Heavy snow;
- Snow pellets;
- Ice pellets<sup>2</sup>;
- Moderate or heavy freezing rain;
- Heavy freezing drizzle;
- Hail.

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1. When operating during light freezing rain/freezing drizzle using Type I fluid, the flight crew must have the aircraft anti-iced with Type IV fluid.

2. Flight crews operating in conditions of light and moderate ice pellets and light ice pellets mixed with other forms of precipitation may commence the takeoff up to the specific allowance time listed in Table x.x, "Ice Pellet Allowance Times, Winter 2008-2009" using the corresponding outside air temperature (OAT) subject to the provisions of Paragraph x.x, "Restrictions".

Example 3; Regional Carrier Flight Manual: (no prohibition on flight in FZRA or FZDZ)

### **Severe Weather Restrictions**

(FAR 121.601)

The Pilot in Command and Flight Dispatch personnel shall make every effort to be watchful for and continuously monitor the development and progress of severe weather which might adversely affect company flying operations and communicate the existence of such weather for dissemination to other flights as appropriate. Such weather phenomena as moderate or greater icing, severe turbulence or wind shear, severe thunderstorm activity, hail, tornados, water spouts and winds in excess of 50 knots shall be reported.

To avoid the most critical icing maintain an altitude below the freezing level or above the level of minus 15° Celsius.

### **In-flight Icing**

1. Severe icing conditions are defined as airframe icing accumulation such that deicing/anti-icing equipment fails to reduce or control the hazard, requiring immediate flight diversion.

2. Icing may be regarded as severe either because of the rate of accumulation or the location of the accumulation. If the ice accretion is on an unprotected part of the wing the icing is not controllable by ice protection equipment. A common cause of ice accumulation on unprotected portions of the wing is flight in super-cooled large droplets (SLD). These large droplets are found in freezing drizzle and freezing rain. Droplets of this size are able to penetrate the boundary layer, accumulating on areas of the wing aft of the protected surfaces (boots or heated wing).

3. If a flight crew finds itself in an SLD environment, they are encouraged to remain aware of freezing levels and anticipated time of exposure to potentially severe icing. Any prolonged exposure, especially in holding or on extended vectors, necessitates a request for an immediate altitude change to exit the conditions. Areas of freezing rain and freezing drizzle may be encountered on arrival as well as on departure.

**Note:** When operating in icing conditions, do not accept an ATC assigned airspeed that is at or below the minimum recommended for the conditions.

### **For Turboprop Airplane**

#### **Airframe Ice Protection**

For operation of wing and stabilizer de-icing boots and for adherence to minimum airspeed and autopilot/flight director limitations for icing conditions, icing conditions exist when:

*The OAT or SAT is +5 degrees C (plus 5°C) or colder and there is any type of visible moisture present (such as clouds, fog with visibility of one mile or less, rain, snow, sleet, or ice crystals), or Any amount of ice is observed on any part of the aircraft, or If it is not certain that there is no ice accumulation on the aircraft.*

The de-icing boots can be turned off when:

- The OAT or SAT is warmer than +5°C and there is no ice on the windshield wiper or
- No visible moisture (such as clouds, fog with visibility of one mile or less, rain, snow, sleet, ice crystals) is present and 5 de-icing boot cycles (15 minutes in continuous mode) have been completed after exiting visible moisture (shorter time may apply to meet the requirement to have completed boot inflation before landing flare). Both the Airfoil Boot De-icing Timer Control (Auto Cycling - ONE CYCLE and CONT modes) and the Airfoil De-icing Boot Manual Control System must operate normally prior to dispatch when icing conditions exist enroute or are forecast.

**Note:** If unacceptable propeller vibration occurs in the temperature range of -10° C to - 12° C SAT due to prop ice, use MAX as required until vibrations cease. Use caution in MAX mode as runback ice may occur.

Wing and stabilizer de-icing boots must be operated in icing conditions as defined for operations of wing and stabilizer deicing boots.

**Note:** Minimum airspeed and autopilot/flight director limitations for icing conditions must be maintained as long as operating in icing conditions as defined by "Airframe Ice Protection" on page xxx

**Note:** This supersedes any relief by the Master Minimum Equipment List (MMEL) or Minimum Equipment List (MEL), which may be contrary to this requirement.

Severe icing may result from environmental conditions outside of those for which the airplane is certificated. Flight in freezing rain, freezing drizzle, or mixed icing conditions (super cooled liquid water and ice crystals) may result in ice build-up on protected surfaces exceeding the capability of the ice protection system, or may result in ice forming aft of the protected surfaces. This ice may not be shed using the ice protection systems, and may seriously degrade the performance and controllability of the airplane.

During flight, severe icing conditions that exceed those for which the airplane is certificated shall be determined by the following visual cues. If one or more of these visual cues exists, immediately request priority handling from Air Traffic Control to facilitate a route or an altitude change to exit the icing conditions.

The use of maximum continuous power is allowed to exit severe icing conditions regardless of number of engines operating.

1. Unusually extensive ice collected on the airframe in areas not normally observed to collect ice.
2. Accumulation of ice on the surface of the wing aft of the protected area (deice boot).



3. Accumulation of ice on the propeller spinner farther aft than normally observed. If ice accumulated aft of the ring painted on the spinner this is an indication of accumulations farther aft than normally observed as stated above.

Since the autopilot may mask tactile cues that indicate adverse changes in handling characteristics, use of the autopilot is prohibited when any of the visual cues specified above exist, or when unusual lateral trim requirements or autopilot trim warnings are encountered while the airplane is in icing conditions.

All wing ice detection lights must be operative prior to flight into icing conditions at night.

1. Visible rain at temperatures below 0°C ambient air temperature.  
 2. Droplets that splash or splatter on impact at temperatures below 0°C ambient air temperature. During flight, severe icing conditions that exceed those for which the airplane is certificated shall be determined by the following visual cues. If one or more of the following visual cues exists while in-flight, immediately request priority handling from Air Traffic Control to facilitate a route or an altitude change to exit the icing conditions.

a. Unusually extensive ice collected on the airframe in areas not normally observed to collect ice.  
 b. Accumulation of ice on the wing aft of the protected area.

c. Accumulation of ice on the propeller spinner farther aft than normally observed.  
 Since the autopilot may mask tactile cues that indicate adverse changes in handling characteristics, use of the autopilot is prohibited when any of the visual cues specified above exist, or when unusual lateral trim requirements or autopilot trim warnings are encountered while the airplane is in icing conditions.

### 3. Procedures for Exiting Severe Icing

The following procedures are applicable to all flight phases from takeoff to landing. While severe icing may form at temperatures as cold as -18°C, increased vigilance is warranted at temperatures around freezing with visible moisture present (see previous section). If the visual cues are present that indicate the possible presence of severe icing, accomplish the following:

- a. Immediately request priority handling from ATC to facilitate a route or an altitude change to exit the severe icing conditions in order to avoid extended exposure to flight conditions more severe than those for which the airplane has been certificated.
- b. Max Continuous Power with both engines operating may / should be used.
- c. Avoid abrupt and excessive maneuvering that may exacerbate control difficulties.
- d. Do not engage the autopilot.
- e. If the autopilot is engaged, hold the control wheel firmly and disengage the autopilot.
- f. If an unusual roll response or uncommanded roll control movement is observed, reduce the angle-of-attack.
- g. Do not extend flaps during extended operations in icing conditions. Operation with flaps extended can result in a reduced wing angle of attack, with the possibility of ice forming on the upper surface further aft on the wing than normal, possibly aft of the protected area.
- h. If the flaps are extended, do not retract them until the airframe is clear of ice.
- i. Report these weather conditions to ATC.

## **For Turbojet Airplane**

### **F. Takeoff**

1. Normal takeoff techniques should be used, as applicable.
2. If wing leading edge roughness is observed or suspected in any way, DO NOT attempt a takeoff.
3. The use of reduced takeoff thrust settings is prohibited if the runway is contaminated or if wing and/or cowl anti-icing is being used.
4. Takeoffs in icing conditions require extra diligence in the monitoring and cross-checking of the engine instruments, particularly N1, to ensure that there is sufficient thrust available. 5. Power application should be done as symmetrically as possible to avoid yawing moments during the first portion of the takeoff roll.
6. Always be aware of the penalties to airplane performance (i.e. takeoff and landing distance, takeoff speed adjustments) incurred when taking off on contaminated runways, more so with the anti-ice in use.
7. Ensure that there is sufficient cleared runway width available for takeoffs on contaminated surfaces.
8. Takeoffs on contaminated runways are prohibited when:
  - a. Crosswind component exceeds 25 knots.
  - b. Standing water or slush is more than 0.50 inch (12.7 millimeters) in depth.
  - c. Wet snow is more than 1.00 inch (25.4 millimeters) in depth.
  - d. Dry snow is more than 3.00 inches (76.2 millimeters) in depth.
9. Apply brakes and advance engine thrust levers. If the airplane starts to creep or slide on the ice or snow during engine power check, release the brakes and begin the takeoff roll. Anticipate lags in nosewheel steering response and nosewheel skidding and apply corrections as necessary.

### **G. After Takeoff & Enroute**

Before entering icing conditions, select ENG COWL ANTI-ICE on. Do not delay use of Anti-Ice protection or rely only on visual icing cues to determine if anti-ice protection is required. Even small amounts of ice accumulations can dramatically affect the flight characteristics of the [aircraft type].

With Wing Anti-ice on, operations below 78% N2 are allowed unless:

- Flying through moderate or heavier icing
- Ice accretion is visible on the wings
- N1 vibration increases
- Wing or Cowl A/I caution message illuminates.

Enroute use of flaps is prohibited. Prolonged use of flaps in icing conditions should be avoided. The flaps should not be extended in icing conditions except when required for takeoff, approach, or landing. If the flaps are deployed in icing conditions for extended periods, or in severe icing, light to moderate buffet may be encountered. No handling difficulties result.

Example 4; Regional Carrier Flight Manual: (no prohibition on flight in FZRA or FZDZ)

**Severe Icing**

- Operation in areas of Severe Icing conditions is **Prohibited**
- Severe Icing conditions are indicated by ice accretion on the cockpit side windows
- If Severe Icing is encountered:
  - WING and Cowl Anti-icing Systems must be ON
  - Leave icing conditions

Example 5; A Regional Carrier Flight Manual: (no prohibition on flight in FZRA or FZDZ)

ADVERSE WEATHER

COLD WEATHER OPERATIONS

A. The winter season presents additional problems to airplane operation resulting from low temperatures, the potentially hazardous effects of precipitation contaminating the airplane and the aircraft movement area, and extreme turbulence. Removal of these contaminants on runway surfaces, taxiways, aprons, holding bays and other areas, rests on the administration of the airports concerned, based on flight safety and schedule considerations. However, it is the ultimate responsibility of the pilot-in-command to see to it that the airplane is in a condition for safe flight prior to takeoff. Use of the ATIS or other means to acquire accurate ambient temperature and other pertinent meteorological conditions cannot be overemphasized.

B. Cold weather operations refer to ground handling, takeoffs and landings conducted on surface conditions where frozen moisture is present.

ICING CONDITIONS (AC 91-74A)

A. [Ground operations]

B. At warm temperatures, the amount of moisture the air can hold is greater than at cold temperatures. However, there have been instances in which supercooled water has been found in cumulus clouds at temperatures as cold as  $-40^{\circ}\text{C}$ . Although there is very little chance of encountering this condition, it is normal to encounter moisture at outside air temperatures colder than  $0^{\circ}\text{C}$ . Significant accumulations of ice are possible in freezing rain and in clouds with considerable vertical activity.

C. Some turbine engine designs have shown a susceptibility to ice crystals that form in the atmosphere because of convective weather activity. Turbine engine upsets have occurred from ice accreting within the engine at altitudes up to 42,000 feet and temperatures colder than  $-45^{\circ}\text{C}$  ( $-50^{\circ}\text{F}$ ). These high altitude ice crystals in large concentrations, typically found near convective weather systems, do not accrete on external airframe surfaces, or trigger ice detectors, and may not be visible on current technology airborne radar systems.

NOTE Flight in areas of moderate or greater turbulence, icing and heavy precipitation require use of continuous ignition until clear of such areas.

ANTI-ICE SYSTEMS USAGE

Activate anti-ice (engine cowling and wing systems) prior to entering icing conditions (see Limitations section of this manual) or when ice is detected by the ice detection system. When in-flight, if ice detector is not working, turn anti-icing systems ON prior to entering icing conditions.

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## SUPER - COOLED LARGE DROPLET ICING

### A. Icing Conditions

Icing conditions exist when the total air temperature is 10°C (50°F) or less and visible moisture is present in any form. This includes cloud, fog, mist, rain, snow, sleet and ice crystals. Regardless of visible ambient moisture and temperature clues, icing conditions also exist when there are visible signs of ice accumulation on the airplane or when the ICE cautionary message is displayed.

### B. Cloud Forms

In discussion of icing, cloud types can be categorized into two general classifications; stratiform (layer type clouds) or cumuliform (rising, thunderstorm) clouds. The certification requirements define icing envelopes conforming to these cloud types corresponding to continuous (stratiform) icing and intermittent (cumulous) icing types.

### C. Icing Process

Icing results from super-cooled water droplets that remain in a liquid state at temperatures below freezing. In general, leading edge structures passing through such conditions will cause a certain number of these droplets to impact the leading edge surface and freeze. A relatively large or bluff body will generate a large pressure wave ahead of the leading edge which forces the air and many of the smaller droplets around it. Only droplets with sufficient mass and inertia will impact the surface and freeze. Conversely, a narrow leading edge radius generates a smaller pressure wave and so collects more of the lower mass inertia droplets. Ice will also tend to accumulate in greater quantities and cover a larger part of the leading edge if the ambient liquid water droplets are relatively large.

### D. Ice Form

Three recognizable ice forms exist; rime ice (opaque), glaze ice (clear) and frost. It is also common to observe mixed form icing comprising of mixed glaze and rime ice forms.

- (1) Rime ice is rough and opaque in appearance and generally forms a pointed or streamlined shape on the leading edge.
- (2) Glaze ice is transparent and often produces a wedge shape or concave ice shape with double horns. This is caused by partial run back of the impinging water droplets to positions aft of the stagnation point. Ice initially forms here as a thin layer of sandpaper ice which then grows to form the glaze horns.
- (3) Frost may form as a thin layer of crystalline ice on all exposed airplane surfaces. Frost is generally associated with ground operations.

**E. Super-Cooled Large Droplet Icing Conditions** Super-cooled large droplet conditions are distinct from the icing described above because of the propensity for the ambient liquid water to be contained in droplets of relatively large mass and inertia. This causes a larger proportion of the water to impact the leading edge surfaces.

In addition, the droplets impacting the surface will do so further aft than smaller droplets. On the protected wing surfaces this may result in formation of ice ridges on the trailing edges of the slats.

### F. Recognition of Super-Cooled Large Droplet Icing Conditions

(1) It is known that super-cooled large droplet (SLD) may be prevalent in pristine atmospheres typical of coastal maritime environments; however, there are no defined means for prior indication of SLD icing conditions or for differentiating SLD from other icing conditions.

(2) The presence of SLD can only be determined by observation of the resulting ice accumulation on unprotected surfaces.

(3) The indicator for differentiating SLD icing is observation of ice accumulation on the flight compartment (cockpit) side windows. Any ice accumulation on the side windows should be taken as the indication that SLD icing conditions are present.

#### G. Procedures

(1) Operation in SLD icing conditions is prohibited. Following recognition of SLD icing conditions by observation of side window icing, the engine cowl and wing anti-icing systems must be activated. Even with anti-icing systems being active, it is necessary to leave SLD icing conditions immediately.

(2) After leaving SLD icing conditions, the wing leading edges should be observed for signs of ice formation on the slat trailing edges or aft of the slat on the unheated wing upper surface. If ice is observed on or aft of the slats, then the Ice Dispersal Procedure should be accomplished.



**Testimony of Gregory Principato  
President  
Airports Council International-North America**

**before the**

**House Transportation and Infrastructure Committee  
Subcommittee on Aviation**

***“Aircraft Icing”***

**February 24, 2010**

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Chairman Costello, Chairman Oberstar, Ranking Member Petri and Ranking Member Mica, members and staff of the Subcommittee on Aviation, thank you for allowing me to participate in this important hearing. My name is Greg Principato, and I am President of Airports Council International-North America (ACI-NA). Our 334 member airports enplane more than 95 percent of the domestic and virtually all of the international airline passenger and cargo traffic in North America. Nearly 400 aviation-related businesses are also members of ACI-NA, providing goods and services to airports.

Deicing airplane and airfield pavement surfaces is critical to ensuring safe operations in winter weather conditions and requires the joint cooperation of airports, airlines, pilots, fixed-base operators, FAA, and others. Importantly, deicing activities are subject to federal, state and local regulations from both a safety and environmental perspective.

It is important to first make a distinction between airplane deicing and airfield deicing. Airplane deicing is conducted to ensure that critical aerodynamic airplane surfaces are free of contaminants that can compromise flight performance. Airfield deicing is conducted to improve the quality of runway surface conditions and assure adequate airplane braking performance on pavement surfaces contaminated with snow and ice.

#### **I. Airfield Pavement Deicing**

Airfield pavement deicing, including runways, taxiways, and ramp areas is routinely conducted by airports in the snow belt to delay the formation of physical bonding between runway surfaces and new snowfall, to penetrate and help break up hard packed



ice and snow, and to groom and clear remnants of snow and ice from runway surfaces after plowing and power brooming have occurred.

Maintaining runway and airfield pavement surfaces in safe conditions and accurately reporting on the conditions of those surfaces is a responsibility of airport operators under 14 CFR Part 139. Airfield pavement deicing is a critically important tool, allowing airports to more quickly clear residual ice and snow and deliver higher friction surfaces for safe airplane operations during winter storms. If this was not done, snow and ice removal would be significantly slower, potentially resulting in more delayed and diverted flights. The FAA is responsible for approving airfield deicing chemicals that airports use on airfield pavement surfaces.

Snow removal procedures at airports require significant coordination between airport operations personnel, airlines, fixed based operators, FAA air traffic control and other concerned parties. Snow removal plans are put in place long before the winter season, ensuring everyone involved in snow removal understands what to expect. Airport operators must have a snow control center (SCC) that can manage all snow clearing operations, assess field conditions, and inform all impacted parties.

During the progress of a storm, airports focus on priority areas such as runways and taxiways while using a variety of specialized equipment such as power rotary brooms, rollover plows, rotary plows, deicing chemical applicators or integrated multi-function machines that plow, sweep, and blow a 27 foot wide swath down to bare pavement in a

single pass. Airports in snow areas typically have systems of multiple sensors embedded in the runways to measure surface and air temperature, moisture, and other parameters that are relevant to contaminant management efforts.

Snow removal operations at airports are time-consuming and expensive. Although snow removal equipment purchases can be eligible for Airport Improvement Program (AIP) funds, the majority of removal costs—including staff time, fuel, and vehicle maintenance—are paid directly by airport operators without federal assistance. To give some sense of the level of effort involved, during a typical snow storm one large northeastern airport uses a crew of 30 personnel, 11 multi function units costing \$800,000 each, two large runway brooms, five 27 foot pusher plows, four rollover plows, ten 4500 tons per hour snow blowers and various front end loaders and miscellaneous equipment to clear 4,600,000 square feet of runway and 5,700,000 square feet of non-tenant apron.

In addition to the requirement to clear runways and taxiways as completely as practical, airport operators are obligated to issue timely reports on the surface contaminant type and depth. As in the case of extremely high snowfall rates, airports will note the length and width of the central portion of the surfaces that are cleared as well as the contaminant remaining on the portions that are not cleared. The goal of this reporting is to provide airplane operators with accurate current descriptions of the contaminant type and depth so that the operator can use airplane manufacturer provided data to determine if continued operation of an airplane is safe.

## **II. Airplane Deicing**

FAA essentially requires that critical airplane surfaces be free of contamination prior to takeoff. This requirement is met through a combination of deicing (removing snow, frost, and ice) and anti-icing (preventing additional accumulations). Airplane deicing and anti-icing--jointly referred to as deicing--is accomplished through both physical means and the application of specialized deicing products. Deicing products must meet strict performance standards developed by the Society of Automotive Engineers (SAE) Aerospace Council. Airplane deicing practices are governed by FAA regulations as well as through a number of advisory circulars, orders, and technical letters. Because of the paramount importance of safety, substantial discretion is also afforded to pilots, allowing for supplemental deicing as deemed necessary.

Airplane deicing is performed by airlines, or their handling agents, to ensure compliance with FAA regulations requiring clean airplane surfaces. Although airports play a role in assisting and facilitating airlines' performance of airplane deicing, the primary responsibility for this kind of deicing lies with individual airlines.

## **III. Deicing Stormwater Management**

Airline deicing activities are supported by airport operators in several ways. As I will later discuss, permits are most commonly issued to airport operators, as land owners of the facilities used by airlines and general aviation, allowing regulated discharges of deicing stormwater into waters of the U.S. In some occasions, airlines or other deicing entities may be co-permittees. Airports have spent hundreds of millions of dollars

constructing and maintaining various drainage and remediation facilities to assure that pollutant discharge levels during airplane deicing events remain within permit limits. Some airports, such as Pittsburgh, Detroit, and Denver, have constructed extensive centralized deicing facilities, commonly referred to as “pads,” that operate much like car washes and permit large numbers of airplanes to be deiced just before proceeding to their departure runway. Capital costs alone for such facilities can exceed \$100 million. Other airports, where land availability or other constraints do not permit construction of centralized facilities, have designated areas on taxiways or cargo aprons for airplane deicing. At some airports the only place available to perform deicing is at the terminal gates. Regardless, it is the airport operator who has been traditionally responsible for collecting and disposing of the spent deicing fluids in an environmentally acceptable manner.

Spent airplane deicing fluid may be captured at pads, aprons, or gates through specifically designed drainage collection systems, mobile collection equipment (such as vacuum sweepers or glycol recovery vehicles), or some combination. Once collected, fluid may be stored in tanks or ponds prior to treatment, recycling, and discharge. Some airports conduct on-site biological or physical treatment to reduce environmental impacts and meet specific permit limits prior to discharge. Many airports discharge deicing stormwater to their publicly owned treatment works (POTWs). Several airports have on-site recycling facilities, allowing for the productive reuse of recovered fluid. Airports may also send collected deicing stormwater off-site for treatment or recycling. Finally,

many airports discharge deicing stormwater into receiving waters, pursuant to permit requirements.

Airports continue to work with deicing products manufacturers to produce agents that have low environmental impact, while still being effective in controlling snow and ice accumulation on airplane and runways. Recent evolutions have resulted in the development of both airplane and airfield deicing products with reduced environmental impacts. Manufacturers are continuing to improve products over time. Until such a time when deicing agents reach the point of optimal low environmental impact, airports that discharge airplane deicing-impacted stormwater to waters of the U.S. will continue to manage discharges pursuant to the Clean Water Act. Such regulation is accomplished through the issuance of National Pollutant Discharge Elimination System (NPDES) permits that authorize deicing stormwater discharges and require the implementation of deicing runoff controls. Airports that instead capture runoff for treatment or recycling or send wastewater to POTWs may have pretreatment permits or specific agreements with their local POTW. The bottom line is that airports have undertaken significant efforts to control deicing stormwater discharges.

Over the last few years, the U.S. Environmental Protection Agency has been developing effluent limitation guideline regulations to address airport deicing discharges. On August 28, 2009, the U.S. Environmental Protection Agency published a notice of proposed rulemaking, "Effluent Limitation Guidelines and New Source Performance Standards for the Airport Deicing Category." These new national standards would be incorporated into

airport stormwater permits. The proposal consists of collection and treatment requirements for airplane deicing fluid, along with an essential ban on the use of urea for pavement deicing.<sup>1</sup> The requirements apply to all airports that conduct deicing operations and have more than 1,000 annual scheduled commercial jet departures. The proposed rule is expected to impact a number of airports across the U.S. EPA estimates the rule will cost the industry \$91.3 million annually – a cost we think is highly underestimated.

Comments on the proposed rule are due in two days – on February 26. ACI-NA supports EPA's goal of further reducing the environmental impacts of deicing activities. However, we will be submitting extensive comments emphasizing the need for each airport to be able to work with airlines and other deicing entities to determine the deicing management system that best accommodates a balance of the safety, operational, and environmental needs specific to that airport.

### **III. ACI-NA and Airport Involvement**

ACI-NA's member airports have been very active in several areas relating to deicing and have spent significant sums for deicing fluid collection systems, retention ponds, aeration facilities, distillation or reverse osmosis equipment to recover fluids from diluted stormwater and other technical remediation processes. In addition, we and our members have participated actively in forums that certify deicing fluid environmental compatibility and suitability for use on airframes. We were active participants in FAA recent Takeoff

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<sup>1</sup> Urea, while considered cheaper and more effective at treating airfield pavement in certain winter conditions, is known to have more significant environmental impacts compared to other available pavement deicing products.

and Landing Performance Assessment Aviation Rulemaking Committee, chairing the working group that evaluated sweeping changes to the process of measuring runway surface conditions and transmitting that information to air crews. We also devoted substantial resources to the EPA's Airport Deicing Effluent Limitation Guidelines rulemaking.

Safety is always an airport operator's top priority. This is why we have worked closely with the airlines, fixed based operators, pilots, FAA and others to improve winter operations for all who use our facilities, while also ensuring that we are well-equipped to clear runway and airfield pavement in snow and ice conditions.

Furthermore, airports have spent significant resources to ensure our compliance with local, state and federal environmental regulations with regard to the discharge of deicing stormwater. Airports take the charge to comply with the Clean Water Act very seriously, which is part of the reason why collection measures of deicing stormwater vary so significantly from airport to airport. There is almost never a one-size-fits-all approach to performing the same operation at different airports, and the collection and remediation of deicing discharge is not an exception.

As the EPA continues the rulemaking process with regard to the proposed Effluent Limitation Guidelines for airport deicing, the best way for us to meet the EPA's environmental goals is for airports to be provided the flexibility needed to collect deicing discharge for proper treatment and recycling. The mandating of unnecessary collection

practices will not only impede our ability to most efficiently meet environmental goals, but it will also place an unnecessary and significant financial burden on the airport industry. As the EPA moves forward with the collection of comments on the proposed rule and looks to finalize its rulemaking procedures, ACI-NA hopes that the EPA will carefully review our comments and give them the utmost consideration.



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**STATEMENT OF**  
**MARION C. BLAKEY, PRESIDENT AND CHIEF EXECUTIVE OFFICER**  
**AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA**  
**BEFORE**  
**HOUSE COMMITTEE ON TRANSPORTATION AND**  
**INFRASTRUCTURE**  
**SUBCOMMITTEE ON AVIATION**  
**HEARING ON AIRCRAFT ICING**  
**FEBRUARY 24, 2010**

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Chairman Costello, Mr. Petri, members of the committee – thank you for the opportunity to submit testimony for the record on aircraft operations in icing conditions. Aerospace Industries Association (AIA) represents nearly 300 aerospace manufacturing companies and the 657,000 highly-skilled employees who make the aircraft that fly in our airspace system every day – as well as the avionics and air navigation equipment that allow them to do that safely.

Over the last 20 years, the National Transportation Safety Board has investigated several well-publicized aircraft accidents involving turboprop passenger aircraft operating in icing conditions. The investigations revealed that ice buildup on areas of the aircraft can compromise stability, leading to a departure from controlled flight and in some cases resulting in unusual attitudes from which the pilot could not recover.

As a result of these investigations, the NTSB issued a number of Safety Recommendations calling for the Federal Aviation Administration to implement an aggressive safety agenda of specific actions to address icing hazards. The aviation industry and FAA continue to work together to research and develop better design standards guidelines and training regimes intended to mitigate flight operations up to moderate icing conditions. However, the NTSB remains concerned with the FAA's ability to address Board recommendations in a timely fashion.

Since the early 1980s, government authorities and the international aviation industry have issued a number of directives intended to provide guidance on safe flight operations in icing conditions. In doing so, international cooperative regulations have

been developed to mandate increasingly stringent aircraft icing certification standards. Additionally, aircraft manufacturers have developed aircraft ice detection systems to alert pilots of ice accumulation. In the event of dangerous ice accumulation, these systems will automatically adjust the aircraft flight controls to account for flight performance problems that might occur due to ice buildup.

It is important to acknowledge that at all times of a flight the pilot is always in command of the aircraft. Training remains paramount in detection and mitigation of icing conditions. Following a number of NTSB recommendations, FAA and other international civil aviation organizations have issued guidance to augment pilot training programs to emphasize specific operating methods in icing conditions. Pilot safety alerts, advisory material and operations manuals also have been issued to increase awareness.

With highly technical issues such as icing and related weather phenomena, it is often necessary for complex research to be performed first before appropriate standards can be determined and regulations produced. Although normal icing is very well understood, we are only now beginning to fully comprehend the complexities of icing phenomena associated with Supercooled Large Droplets (or SLD, which includes freezing rain and freezing drizzle) and glaciated ice (clouds composed primarily of ice crystals). SLD is associated with severe airframe icing conditions, and glaciated ice is associated with engine icing problems as discussed later.

The aviation industry, along with NASA and FAA, continue to research and examine the effects of SLD. While this research is critical in advancing aviation safety in icing conditions, research requires funding to develop the expensive and complicated engineering tools that are necessary to predict and test SLD ice shapes and determine their aerodynamic effect on an aircraft. Tools such as complex computational fluid dynamics codes, multi-million dollar icing wind tunnels, and flight-testing in natural icing conditions are critical to aircraft manufacturers, providing data on optimal aircraft designs and ice protection systems. Unfortunately, progress in the most recent research effort, which was largely performed by NASA, has slowed due to a steady decline in funding for NASA's Aeronautics Research Mission Directorate. We are hopeful that under the guidance of Administrator Bolden and ARMD Director Shin, the recent upward trend in funding for the NASA ARMD program will continue and aeronautics research will be revitalized.

In order to leverage both international and domestic research capabilities, industry has worked closely with civil authorities and research institutions to examine a variety of icing concerns and develop policies and plans for future mitigation efforts. This effort alone is indicative of the challenge ahead, comprising a two-pronged approach to first conduct foundational research needed to understand icing elements (both SLD and ice crystals) and, second, to determine how best to re-create these conditions in a laboratory environment.

Research continues and certification requirements are amended as determinations are made. The aircraft industry – including participants from both large and small

airplane manufacturers, engine and avionics manufacturers, pilot's groups and airline operators' representatives were instrumental in helping the FAA develop a rule to address ice protection systems in SLD conditions. The rule will require, a formal definition of the SLD icing environment; a means to warn the pilots of ice accumulation on critical surfaces; procedures for mitigating SLD accumulation; and requirements for assessing the flight envelope for aircraft operations within a SLD icing environment.

Until further research is accomplished to enable adequate SLD forecasting, determine its effect on aircraft performance and develop designs to avoid or preclude its hazards, government and industry will continue working to improve the level of safety of new aircraft designs. Without this knowledge, the NTSB's recommendation that the airplane certification process for each model of aircraft "adequately account for hazards that can result from all known icing conditions" cannot be realized.

Finally, it is important to discuss a relatively new icing phenomenon which has only recently been identified. Ice crystals formed at high altitudes above large intense thunderstorms can be drawn inside the engine of an aircraft flying above the weather, with the potential of causing an in-flight engine shutdown as well as damaging compressor blades. While ice crystals typically melt upon ingestion, in some cases, the crystals only partially melt and stick to relatively warm engine surfaces in the early compression stages. Eventually, ice can accumulate and either break apart inside the engine causing damage to compressor blades, or melt and overwhelm the engine combustion chamber leading to an engine shutdown.

In a proactive measure, the FAA and the aviation industry have taken several interim actions to address this phenomenon by developing and mandating new software for engine controls and raising awareness within the pilot community. However, continued funding for research into this new icing phenomenon is vital to ensure that safety hazards are better understood and can be fully addressed. AIA currently manages an industry research consortium made up of aircraft and engine manufacturers. Known as the Ice Crystal Consortium, it is conducting further research into ice crystal phenomena. While a portion of this research is conducted at the National Research Council of Canada, these studies are coordinated with the civil authorities FAA and the European Aviation Safety Agency.

While the aviation industry and civil authorities have done much over the past 20 years to protect aircraft and their passengers from the hazards of operations in icing conditions, we must remain ever vigilant. Future and current research endeavors such as the Ice Crystal Consortium continue to shed light on the climatic issues and aerodynamic effects of icing in all shapes and forms. Industry will remain an active participant in developing the necessary technology to reliably mitigate these hazards. Until that time, industry and government will continue to work together cooperatively to develop and implement solutions designed to efficiently improve the safety of aircraft operating in icing conditions.