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FEDERAL AVIATION ADMINISTRATION



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Revision History

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ACRONYMS AND DEFINITIONS

ACRONYMS

3-D	Three-dimensional
14 CFR	Title 14 of the Code of Federal Regulations
AC	Advisory Circular
ACO	Aircraft Certification Office
ADDS	Aviation Digital Data Service
AD	Airworthiness Directive
AEST	Atmospheric Environment Safety Technologies
AIAA	American Institute for Aeronautics and Astronautics
AICSG	Aircraft Icing Certification Steering Group
AIM	Aeronautical Information Manual
AIP	Aeronautical Information Publication
AIRA	Aircraft Icing Research Alliance
AIR	Aerospace Information Report
AIRMET	Airman's Meteorological Information
ALPA	Airline Pilots Association
ALPHA	Algorithm for the Prediction of High Ice Water Content Areas
ANSP	Air Navigation Service Provider
AOPA	Aircraft Owners and Pilots Association
ARAC	Aviation Rulemaking Advisory Committee
ARP	Aerospace Recommended Practice
ASOS	Automated Surface Observing System
ATC	Air Traffic Control
ATP	Airline Transport Pilot
AVS	FAA Aviation Safety Office
AWC	Aviation Weather Center
AWOS	Automated Weather Observation System
AWRP	Aviation Weather Research Program
CDF	Centralized deicing facilities
CFD	Computational fluid dynamics
CIP	Current Icing Product
CONUS	Continental United States
COS	Continued Operational Safety
DER	Designated Engineering Representative
EASA	European Aviation Safety Agency
ECO	Engine Certification Office
EHWG	Engine Harmonization Working Group
ESRL	Earth System Research Laboratory
ETSO	European Technical Standard Order
EUROCAE	European Organisation for Civil Aviation Equipment
FAA	Federal Aviation Administration
FAASTeam	FAA Safety Team
FIP	Forecast Icing Product

ACRONYMS (Continued)

FITS	FAA Industry Training Standards
FMH-1	Federal Meteorological Handbook No. 1
FZDZ	Freezing drizzle
FZRA	Freezing rain
FY	Fiscal year
GAO	Government Accountability Office
HIWC	High ice water content
HOT	Holdover time
HOTDS	Holdover Time Determination System
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICTS	Ice contaminated tailplane stall
IDM	Icing discipline manual
IFR	Instrument Flight Rules
IMC	Instrument meteorological conditions
InFO	Information for Operators
IPA	Icing Product Alaska
IPW	Integrated precipitable water
IPHWG	Ice Protection Harmonization Working Group
ISC	Icing Steering Committee
JPDO	Joint Planning Development Office
LWC	Liquid water content
LWE	Liquid water equivalent
METAR	Aviation routine weather reports
MICRO	Model of Icing Conditions for Real-time Operations
MOC	Means of compliance
MOU	Memorandum of Understanding
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCEP	NWS – National Centers for Environmental Prediction
NextGen	Next Generation Air Transportation System
NexRad	Next Generation Weather Radar
NOAA	National Oceanic and Atmospheric Administration
NSIP	NextGen Segment Implementation Plan
NSSL	National Severe Storms Laboratory
NTSB	National Transportation Safety Board
NWP	Numerical weather prediction
NWS	National Weather Service
ODA	Organization Designation Authorization
OEM	Original equipment manufacturer
ONERA	Office National d’Etudes et de Recherches Aerospatiales
PIREP	Pilot Report
POI	Principal operations inspector
R&D	Research and development

ACRONYMS (Continued)

REDAC	Research and Development Advisory Committee
RTCA	Radio Technical Commission for Aeronautics
SAFO	Safety Alert for Operators
SCR	Special Certification Review
SAIB	Special Airworthiness Information Bulletin
SAE A-4	Aircraft Instruments Committee
SAE AC-9C	Aircraft Icing Technology Committee
SAE EG-1E	Test Cells Committee
SAE G-10	Aerospace Behavioral Engineering Technology Committee
SAE G-12	Aircraft Ground Deicing Committee
SIGMET	Significant meteorological information
SLD	Supercooled large drops
SPECI	Aviation special weather report
SRW	Subsonic Rotary Wing
TAIWIS	Terminal Area Icing Weather Information System
TAMDAR	Tropospheric Airborne Meteorological Data Reporting
TC	Transport Canada
TCRG	Technical Community Representative Group
TRACON	Terminal Radar Approach Control
TSO	Technical Standard Order
UIUC	University of Illinois at Urbana-Champaign
VFR	Visual Flight Rules
WVSS	Water Vapor Sensing System

DEFINITIONS

1. **HOT** The estimated time that deicing/anti-icing fluid will prevent the formation of frost or ice and the accumulation of snow on the critical surfaces of an aircraft. HOT begins when the final application of deicing/anti-icing fluid commences and expires when the deicing/anti-icing fluid loses its effectiveness. HOTs are determined using the results from endurance time testing of fluids in natural conditions or a cold chamber.
2. **IWC** Ice Water Content, the total mass of water contained in ice particles within a unit volume or mass of cloud or precipitation, usually given in units of grams of ice per cubic meter or kilogram of dry air (g/m^3 , g/kg).
3. **LWC** Liquid Water Content, the total mass of water contained in liquid drops (droplets) within a unit volume or mass of cloud or precipitation, usually given in units of grams of water per cubic meter or kilogram of dry air (g/m^3 , g/kg).
4. **LWE** Liquid Water Equivalent, the depth of liquid that has accumulated in a gage from frozen or freezing precipitation.

DEFINITIONS (Continued)

5. **METAR** Routine Aviation Weather Observations), a report of weather observations in an international standard format issued at regular intervals (mostly hourly) from airport and weather stations. [Reference: FMH-1] METAR contains a report of wind, visibility, runway visual range, present weather, sky condition, temperature, dew point, and altimeter setting collectively referred to as "the body of the report". In addition, coded and/or plain language information which elaborates on data in the body of the report may be appended as "Remarks".
6. **Nowcast** A diagnosis of existing weather conditions, ordinarily based on observations from weather sensors and output from a numerical weather prediction computer model. The nowcast is used as a short-term forecast of weather conditions, typically for the next hour.
7. **SIGMET** Significant Meteorological Information – an aviation weather advisory that contains meteorological information concerning the safety of all aircraft due to hazards such as turbulence, volcanic ash, dust/sandstorms, visibility, severe weather, and icing. As related to icing, it means there is severe or greater icing within a 3,000-square-mile (7,800 km²) area.
8. **SPECI** An unscheduled "Special" meteorological report at an airport or weather station than is given outside the regular reporting time of the METAR. A SPECI is issued as soon as possible after any of certain specified criteria have occurred, for example, freezing precipitation begins, ends, or changes intensity.
9. **Supercooled** Water drops that remain unfrozen at temperatures below 0°C. Supercooled drops exist in clouds, freezing drizzle, and freezing rain in the atmosphere. These drops may impinge and freeze after contact on aircraft surfaces. [References: AC 20-73A, AIM 7-1-22.]
10. **SLD** Supercooled Large Drop, supercooled water drop with diameter greater than 50 µm, including freezing drizzle and freezing rain drops.
11. **TWC** Total Water Content, the sum of the liquid and ice water contents in cloud or precipitation, usually given in units of total grams of water plus ice per cubic meter or kilogram of dry air (g/m³, g/kg).

1. INTRODUCTION

The new Federal Aviation Administration (FAA) Aircraft Icing Plan addresses both in-flight and ground icing issues. The FAA Aircraft Icing Plan (for the purpose of this document, this will be referred to as “Icing Plan) describes the processes for internal and external coordination to promote a comprehensive strategy for addressing aircraft icing safe operations. The Icing Plan does not address runway contamination issues or fuel icing. The Aircraft Icing Plan reassesses past approaches and actions, identifies activities that need additional attention, addresses new issues in certification and operations, aligns current icing operations with NextGen capabilities, supports icing training, and examines emerging technologies.

In preparing the Icing Plan, the FAA benefitted greatly from views and information provided by aerospace industry members and research organizations through technical exchanges, international conferences, standards meetings, and other venues. The FAA intends to continue to work with other agencies and organizations across the aviation community to identify vulnerabilities and mitigations needed to improve icing operations. The Icing Plan has been developed by the FAA Icing Steering Committee (ISC), whose responsibility it will be to track progress and update the plan. The Icing Plan is approved by FAA senior management in the Aviation Safety Office. The FAA sponsoring organizations are the Aviation Safety Office Aircraft Certification and Flight Standards Services, and the NextGen Aviation Weather Division. The Aviation Research Division and the Aviation Weather Division are responsible for conducting the tasks in the plan identified in Section 6 and Appendix A.

The Icing Plan provides in-depth descriptions of the many FAA icing activities, including explanations of the reasons they are needed to enhance safety. The integration of these various icing activities provides a systems approach to solutions for improved operational safety in icing conditions. Tracking each icing activity task separately ensures accountability for the execution of the Icing Plan.

The Icing Plan content is composed of six main sections and two task-tracking appendices:

- Overview
- Addressing Past Icing Issues
- Next Generation Air Transportation System (NextGen)
- Overview of Activities That Affect Icing
- Listing and Brief Description of Current Icing Plan Tasks
- Coordination of Icing Activities
- Appendix A: Current Icing Plan Tasks – Detailed Review
- Appendix B: Recent Accomplishments / Completed Tasks From Icing Plan

The *Overview* and *Addressing Past Icing Issues* sections describe how the FAA addresses safe operations in icing conditions through policy actions, partnerships with industry, developing an icing program and icing plan, and creating a steering committee to implement and oversee coordinated solutions.

The *NextGen* section identifies icing operations in relation to the modernized national airspace system.

The section on *Overview of Activities That Affect Icing* provides general perspective on the influences that impact icing operations. All tasks in the Icing Plan fall into one of the sub-sections of this *Overview of Activities*. The section *Listing and Brief Description of Current*

Icing Plan Tasks provides a quick introduction to the breadth of tasks in each area. Each task and its status are then described in depth in *Appendix A: Current Icing Plan Tasks – Detailed Review*. Appendix A will be updated as work is accomplished, milestones are met, and tasks are completed. When tasks identified in Appendix A are completed, they will be moved to *Appendix B: Recent Accomplishments / Completed Tasks From Icing Plan* to provide a record of the completed activities. Thus, Appendices A and B provide the primary means by which progress under the plan can be tracked. Depending on need and resources, new tasks will be initiated and tracked.

The section on *Coordination of Icing Activities* describes how the FAA works with stakeholders to develop solutions that support safe operations in icing conditions.

This Icing Plan will be updated annually and the information will be posted, along with other information that supports the FAA’s Aircraft Icing Program at: [<AVS Sharepoint URL>](#) **{Not active yet}**

2. OVERVIEW

The FAA uses a number of approaches and processes which comprise a comprehensive strategy designed to ensure safety of flight for all aircraft certificated to operate in icing conditions. There are regulatory and advisory materials, and other policy methods that support aircraft airworthiness and operational integrity, and safety bulletins to inform operators and pilots of current icing operational concerns and how to mitigate them. See Appendix E for further discussion of these materials. The FAA develops and supports aircraft icing training materials for pilots, operators, and FAA staff and their representatives. The FAA works with industry in the development of technical standards that support design, testing, performance, and operations for icing. The FAA supports research through both its own efforts and in coordination with other government agencies and industry to improve certification compliance capabilities, fill gaps in icing operations knowledge, develop new and enhanced forecast and nowcast icing weather tools, and understand the impact and use of emerging technologies.

Safe operations in icing conditions, both in-flight and on the ground prior to takeoff, requires accurate and timely weather information in nowcasts and forecasts. The FAA works with the National Weather Service (NWS) and research organizations in an effort to ensure that reliable weather information is available and to improve the quality of that information with respect to accuracy, timeliness, and spatial resolution.

The FAA and industry work aggressively to ensure safety in icing conditions. The FAA carefully tracks and evaluates incidents, events, and accidents in order to identify and assess possible problems or shortcomings. The FAA has a number of tools and methods for addressing areas of concern, the choice of approach depending on the nature and severity of the problem.

This FAA Aircraft Icing Plan describes areas of concern and how the FAA is addressing them currently and for the future. The Icing Plan emphasizes several key elements. One is the problem solving approach that the FAA takes in areas of concern, selecting the approach best suited to its assessment of the nature and severity of problems or shortcomings. Another is the FAA’s recognition that ensuring safety is a shared pursuit and commitment with the entire aviation industry. Finally, the FAA works with airworthiness authorities in other nations to achieve harmonization in regulations and processes across international boundaries.

The responsibility for overseeing and coordinating the Icing Plan resides with the FAA ISC. This committee includes the FAA's chief scientific and technical adviser for flight environmental icing, and specialists in aircraft certification, aircraft operations, weather diagnosis and forecasting, and icing research. It meets twice a year to review and update the Icing Plan, review any issues from the previous icing season, and address outstanding and new issues. The ISC reports to FAA senior management on the progress under the Icing Plan, emphasizing critical or key areas.

The FAA established a national icing program led by a precursor of the ISC in the early 1980s prior to the January 1982 AirFlorida Flight 90 accident¹ at Washington National Airport, Washington, DC. It adopted a number of measures to address factors in the accident, but takeoff accidents continued to occur.

In March 1992, USAir Flight 405 had a ground icing accident² at LaGuardia Airport, New York, NY. Two months later, the FAA hosted an international conference to address all aspects of ground icing and establish a new approach working with industry and international partners. The outcome was a new rule governing ground icing operations for airplanes operated in domestic, flag, and supplemental operations, adopted as a revision to Title 14 of the Code of Federal Regulations (14 CFR) Section 121.629, along with supporting advisory circulars (ACs) and other information. The FAA also established the Aircraft Icing Certification Steering Group (AICSG) to assess compliance with and the success of the new rule and procedures, as well as to investigate other icing issues.

In October 1994, there was an American Eagle Flight 4184 accident^{3,4} in Roselawn, IN. The airplane had been holding in icing conditions, awaiting clearance to land in Chicago. In the spring of 1996, the FAA organized an international conference to address in-flight icing safety issues with industry and international partners. All recommendations made as a result of the conference proceedings were reviewed by the AICSG in developing the *FAA Inflight Aircraft Icing Plan* that was published in early 1997. The AICSG added Flight Standards service representatives, weather specialists, and research specialists, and later changed its name to the ISC. More information on the icing conferences in 1992 and 1996 and the *FAA Inflight Aircraft Icing Plan* of 1997 are provided in the next section.

The FAA's response to the above and other icing accidents/incidents included new rule-making and a number of approaches and actions to address potential safety concerns. In response to a major recommendation from the forecasting and working group at the 1996 Conference, the Aviation Weather Research Program developed automated forecast guidance supporting the first ever diagnosis and forecasting of freezing precipitation aloft by the NWS Aviation Weather Center. Regarding the potential safety concerns, the FAA uses the following tools to improve the level of safety for operations in icing conditions: fact finding investigations and special certification reviews, airworthiness directives (ADs), issue papers, special conditions, safety bulletins, regulations and advisory materials, training, standards development, and targeted research. A description of these tools and an example of how the FAA has used them to address unsafe conditions made evident from a past accident can be found in *Appendix E*.

In addition, the FAA engaged extensively with industry and with other government agencies through the Joint Safety Analysis Team (JSAT) and Joint Safety Implementation Team (JSIT) processes. Chartered by the Commercial Aviation Safety Team (CAST), two of these teams studied icing-related incident and accident reports, academic studies, and engineering analyses to gain insight into accident causal factors and to develop interventions and plans aimed at reducing

icing threat to aviation. The efforts of these teams are provided in JSAT Loss of Control Final Report, and General Aviation Weather JSIT Final Report⁵.

The FAA has made significant progress in addressing potential safety issues while operating in icing conditions. It has moved from a primary strategy of analyzing accidents and implementing actions to address unsafe conditions to a more proactive approach of examining events and precursor information, evaluating new technologies to assess their capabilities to improve icing certification and operations, and working closely with industry to ensure that standards and practices are updated and disseminated within the aviation community.

The FAA has developed a comprehensive new Icing Plan to mitigate safety risks posed by icing conditions for both the in-service aircraft fleet and for new certifications. It employs all available FAA tools and methods to promote safe operations and improve the level of safety when operating in icing conditions. This Icing Plan is described in detail in the rest of this document.

3. ADDRESSING PAST ICING ISSUES

The FAA has utilized international icing conferences to work with industry to address unsafe conditions in icing affecting significant portions of the fleet in revenue service operations. The FAA held three icing conferences in the 1990s that had significant impact on addressing safety awareness for operations in icing conditions. The conferences confirmed the need for new rules for certification and operations of aircraft, development of new guidance material and FAA policy, new standards from technical societies that provided specifications, recommended practices, and technical criteria to assure minimum performance criteria for equipment, testing, and procedures. These conferences also provided feedback and advocacy for establishing research and development (R&D) plans to improve knowledge of the effects of ground and in-flight icing conditions on aircraft systems and operations. This approach provided a means to identify and address gaps in safe operations in icing conditions.

The FAA addressed specific concerns on ground icing operations due to a series of accidents that happened between 1982 and 1992. There were seven ground icing accidents of turbine-powered commercial aircraft in North America with hundreds of fatalities. The first of these occurred in Washington, DC, in January 1982 when an air carrier taking off from Washington National Airport crashed into the 14th Street Bridge, and the last in March 1992 when an air carrier taking off from La Guardia Airport crashed into Flushing Bay. The FAA and industry had taken a number of steps during the period from 1982 to 1992, including extensive investigation of the aerodynamic effects of deicing and anti-icing fluids and the development of standardized tests of fluid effectiveness. The first holdover time tables (the estimated time of effectiveness of anti-icing fluids in the existing weather conditions) were published in 1990, but because the times had not been rigorously validated through testing, they were advisory only and were not to be used as a substitute for pre-takeoff inspection. Following the La Guardia accident, the FAA initiated a six-month effort working with industry, Transport Canada, and other authorities to improve the safety of winter flight operations before the next winter. On May 28-29, 1992, the FAA held the International Conference on Airplane Ground Deicing to develop a better understanding of airplane deicing and anti-icing issues. The FAA organized the conference into five working groups: Aircraft Design Considerations; Ground Deicing and Anti-icing Systems; Air Traffic Control (ATC) and Sequencing; Deicing Personnel, Procedures and Training; and Ice Detection and Recognition and Crew Training. The conference produced suggestions for corrective actions

that should be taken before the next winter's icing season and possible long-term improvements to existing systems⁶.

In October 1994, there was an in-flight icing accident of an American Eagle commuter airplane with 69 fatalities. Following this accident, the FAA held the 1996 International Conference on Aircraft In-flight Icing. It was attended by over 400 participants from the U.S. and 19 other countries. The conference included a review of major aspects of airworthiness when operating in icing conditions, with five working group sessions addressing: (1) Icing Environmental Characterization, (2) Ice Protection and Ice Detection, (3) Forecasting and Avoidance, (4) Requirements for and Means of Compliance in Icing Conditions (Including Icing Simulation Methods), and (5) Operational Regulations and Training Requirements. One of the primary areas of concern at the conference was icing due to supercooled large drops (SLD). The working groups began with technical presentations describing the state-of-the-capabilities and were followed by discussions which yielded recommendations for short term and long term actions. These recommendations and consensus items were provided to the FAA for consideration in an icing plan and the proceedings were published as two technical reports^{7,8}.

The first formal icing plan was released publicly in 1997 and was called the *FAA Inflight Aircraft Icing Plan*⁹. It described various activities, including rulemaking, development and revision of advisory material, research programs, and other initiatives to promote safe operations in icing conditions. The content topic areas were:

1. Flight Standards Regulations and Guidance Material
2. Icing Forecasting
3. In-flight Ice Detection
4. Certification Regulations and Guidance Material
5. Icing Simulation Methods
6. Ice Accretion and Its Effects on Performance/Stability and Control
7. SLD Characterization and Mixed Phase Conditions Assessment
8. Coordination of Icing Activities

The tasks in this 1997 *FAA Inflight Aircraft Icing Plan* were developed by the FAA Aircraft Icing Certification Steering Group (later called the ISC) with input from industry, academia, other federal agencies, and foreign airworthiness authorities. The FAA invited outside subject matter experts to help develop content and support working groups through both leadership and membership roles in implementing a number of the tasks.

The tasks were based on operational issues and National Transportation Safety Board (NTSB) findings resulting from the October 1994 American Eagle Flight 4184 ATR-72 Roselawn accident; from observations and insights on areas to improve aircraft icing safety within the FAA by members of the ISC, Aircraft Certification Service, Flight Standards Service, Air Traffic, and the FAA Technical Center; and recommendations from the May 1996 FAA International Conference on Aircraft In-Flight Icing.

The final international icing conference in the 1990s was held in February 1999 and was called the FAA International In-Flight Icing Operations Conference. Conference working groups met separately and discussed issues provided by the conference organizers for each working group and formulated recommendations, and then reported out their recommendations at a final conference session. Key areas of discussion included operation of mechanical ice protection

systems in icing conditions, determination of minimum speeds in icing conditions, and icing material in aircraft flight manuals¹⁰.

The FAA also works with industry and other airworthiness authorities to address urgent safety issues as described above by supporting international icing conferences where papers are presented on progress in ice protection and detection technologies, means of compliance with certification requirements, operations in ground icing conditions, and current icing safety issues. The FAA worked with the SAE International to develop and promote international conferences in Chicago in 2003, Spain in 2007, and Chicago in 2011.

The 1997 *FAA Inflight Aircraft Icing Plan* was used until recently to track the tasks identified in the plan. After a Government Accountability Office review of the FAA icing program that included a final report in July 2010 (see Appendix D), it was decided to close-out the 1997 plan and develop this new FAA Aircraft Icing Plan. The close-out report¹¹ describes the work done on the 1997 *FAA Inflight Aircraft Icing Plan* tasks and additional research that was not tracked in that plan.

4. NEXTGEN

NextGen integrates new and existing technologies, policies and procedures to reduce delays, save fuel and lower aircraft exhaust emissions to deliver a more reliable travel experience. Under the new Aircraft Icing Plan, the FAA will work to align icing operations and research with NextGen goals as they develop and mature. The principle element of NextGen with which icing operations relates is “Reduce Weather Impact” with the focus on improvements to icing weather information and its use in the NAS. In order to achieve these goals for aircraft icing, the FAA must improve the spatial and temporal accuracy of icing weather forecasts and diagnoses, define symbology and graphical representations of icing conditions, specify data streaming criteria to transmit weather information to users, deliver highly-resolved, timely updates to flight crews, ATC personnel, and weather dispatchers for improved collaborative decision-making, and develop appropriate guidance for the new technologies and operations.

Specific needs for significantly improved in-flight icing operations in icing conditions for NextGen are described below. These needs have already been identified as NextGen goals.

1. NextGen icing operations will require the capability to sense the icing cloud micro-physical parameters using ground-based and airborne detectors for classification of icing conditions. Enabling technologies to sense the presence of icing conditions aloft will require detection and measurement of liquid water content, drop size, and temperature.
2. The need to identify operational threat(s) by developing icing condition characterization assessment for individual aircraft configurations. Operational threat assessment and mitigation for individual aircraft configurations require the determination of icing hazard threat envelopes relative to that specific aircraft type.
3. Flight deck/flight manager threat display design and symbology to support accurate, rapid decision-making for flight crews. The information displayed would rely on data encoding, severity characterization, data transmission (including up, down, and cross-linking), and hazard classification. This would contribute to icing hazard monitoring and guidance, eventually incorporating flight path hazard evaluation through processing weather and aircraft state information.

There are some activities within the Icing Plan that support improvements to in-flight icing operations that will yield benefits to NextGen operations. The Icing Plan also supports further development and improvements of the microphysics models that are incorporated in the numerical weather prediction (NWP) models to enhance the forecasting and diagnosis of atmospheric icing weather conditions. The outcome of this research is to provide forecasts and diagnoses of liquid water content, representative drop size, and temperature of an improved spatial and temporal accuracy. The in-flight portion of the Terminal Area Icing Weather Information System project described in more detail below and in Appendix A, Task 6.6.7, also supports technology capability improvements that will directly benefit icing weather information aloft in the terminal area. As current work is completed on in-flight icing weather tasks, the Aircraft Icing Plan will continue to support technology solutions and operational capability improvements required to meet NextGen goals.

A number of tasks in the Icing Plan address ground icing and anti-icing operations that also support NextGen goals, including:

1. Develop automated, sensor-based reporting of liquid water equivalent (LWE) to provide a common data source to facilitate departure queuing and enhance safety.

The determination and dissemination of holdover times (HOTs) prescribes how long an aircraft can await takeoff after being deiced/anti-iced in different types and intensities of freezing and frozen precipitation and not risk fluid failure. Currently, flight crews depend on HOT tables to determine the time of effectiveness, which depends on the intensity of the freezing or frozen contamination. The intensity value is established using FAA visibility tables and an estimate of visibility, ordinarily from the aviation routine weather reports (METAR).

The Icing Plan supports an improved method for the determination of snow intensity from LWE rate provided by a system that also provides the HOTs for the given precipitation type and rate using correlations developed from previous testing. This approach will eliminate dependence on visibility-based tables and provide HOTs based on accurate, sensor-based determination of ground precipitation conditions.

2. Develop a comprehensive terminal area icing weather product for use by air traffic, flight crews, and ground de-icing operations.

The Icing Plan supports development of a Terminal Area Icing Weather Information System (TAIWIS), Task 6.6.07, that will manage terminal area icing weather information for operational collaborative decision-making for both ground and in-flight icing conditions. The system will combine products of LWE research, winter weather ground icing research, weather radar, remote sensors and other new technology developments, and terminal area in-flight icing weather research. The ground icing weather reporting will provide rapid updating of conditions that will feed into an automated process supporting HOT determination system technologies for flight crews.

Goals for TAIWIS include more accurate and more highly resolved information on many of the variables similarly addressed in NextGen documents on terminal area weather information, such as LWE at the ground, liquid water content aloft, representative drop size, and temperature.

The Icing Plan will continue to identify new tasks that are needed to support NextGen goals as those targets are defined. The expertise within the ISC on icing operations will oversee the

investments in technology solutions that can be implemented to meet capability changes based on those NextGen goals.

5. OVERVIEW OF ACTIVITIES THAT AFFECT ICING

5.1. Regulations and Policy Materials

Regulations and guidance policy provide the framework and the basis for FAA oversight of aviation safety. In order to achieve the mission of promoting aviation safety in civil aviation, the FAA establishes regulatory standards and requirements. FAA guidance policy is often used to define methods that can be used to meet the minimum standards defined in the CFRs.

FAA tools for addressing safety issues are surveyed and briefly described in Appendix E. As discussed there, modification of major regulations, or introduction of new regulations, is most often done to increase the minimum level of safety expected for new designs or future operations.

When regulatory changes are needed, the FAA consults extensively with industry and other airworthiness authorities. The ground icing rule, contained in § 121.629, which grew out of the deliberations at the 1992 International Conference on Airplane Ground Deicing, provides an example. A new in-flight icing certification rule § 25.1420¹² proposed to cover conditions not encompassed within the existing icing certification atmospheric envelopes was recommended by the Ice Protection Harmonization Working Group, which included airworthiness authorities and aircraft manufacturers from the United States, Canada, and Europe.

5.2. Advisory Circulars

Advisory circulars are used by the FAA to provide a means, but not the only means, for showing compliance with icing certification rules. As technology improves and new methods for showing compliance are proposed, it is through ACs that the FAA is able to provide guidance on the use of new methods. An example is AC 20-73, *Aircraft Ice Protection*. When first issued in 1970, it was a document of about 40 pages that addressed means of compliance with certification rules available at that time. The update, published in 2006 as AC 20-73A, is approximately 230 pages in length. It addresses technologies, such as the use of computational fluid dynamics for ice accretion prediction, which did not exist in 1970 but now have developed and continue to improve for various certification applications, increasingly in recent years.

ACs are also used by the FAA to provide guidance to pilots on compliance with icing operations rules and use of icing information, such as weather nowcasts and forecasts, and to provide guidance to operators on the development of ground deicing and anti-icing programs

5.3. Ground Icing

Ground icing operations from ramp operations through to takeoff of transport category airplanes have witnessed a number of accidents in the past that brought significant attention to addressing deicing and anti-icing procedures and operational gaps. During the period from 1982 to 1992, there was a series of icing accidents on takeoff with over 100 fatalities. The FAA and industry established a new regulatory framework for ground icing operations in 1992 included in 14 CFR § 121.629, and associated advisory material, in particular AC 120-60, *Ground Deicing and Anti-Icing Program*. This process is still in place, with the FAA and airline operators working proactively to improve ground icing procedures, examine emerging safety issues, and conduct research to investigate and resolve issues. This continuing vigilance by the FAA and industry is

needed to maintain takeoff safety in icing conditions of the transport fleet, and has contributed to a much improved safety record, with one accident and three fatalities on takeoff in icing conditions of a transport category aircraft in the U.S. since 1992. Takeoff accidents in icing do continue to occur for part 23 airplanes that are not regulated under § 121.629 and the FAA is working to address this issue, as described in this plan. Updates to AC 135-17, *Pilot Guide, Small Aircraft Ground Deicing* (Task 6.2.06), and current project plans in Ground Icing R&D (Task 6.6.02) support efforts to improve part 23 ground icing operations. There also continue to be takeoff accidents in revenue service in other parts of the world. The FAA works through the SAE G-12 Aircraft Ground Deicing Committee and now in concert with the International Civil Aviation Organization to support development of international guidance and standards to promote safer ground icing operations in other parts of the world.

The FAA Flight Standards Service, Air Transportation Division is the lead for FAA activities pertaining to ground operations in icing conditions. Each year the Air Transportation Division issues a notice providing guidance on ground winter operations, updating the previous year's notice to incorporate any policy changes resulting from research by the Aviation Research Division or other investigative action and information that supports improvements to safe operations. The notice incorporates Holdover Time Tables, which in recent years have been published independently, prior to the release of the entire notice. The "2012-2013 Holdover Time Tables"¹³ were published on July 31, 2012 and the "FAA Approved Deicing Program Updates, Winter 2012-2013" were released on the same web site on August 17, 2012. In accordance with § 121.629, operators submit a Ground Deicing /Anti-Icing Program plan each year that must be approved by the air carrier's FAA principal operations inspector (POI). Both the operator and the FAA POI rely upon the notice to ensure that the operator's plan addresses current issues and information.

AC 120-60B (updated twice since the original version) provides an industry-wide means for obtaining approval of a Ground Deicing /Anti-Icing Program in accordance with § 121.629. In addition, it provides a means acceptable to the Administrator for a certificate holder to deice or anti-ice aircraft using another certificate holder's personnel and procedures or contract personnel who have been trained by the other certificate holder. The FAA Air Transportation Division is in the process of developing a major update, AC 120-60C, to address ground personnel training requirements, standardization, and quality control. The development process has included several meetings with industry.

The annual notice contains HOT tables for anti-icing fluids, updated each year as necessary. The HOT tables are developed from tests conducted in a cold chamber or outdoors in accordance with Aerospace Recommended Practice (ARP) 5485, "Endurance Time Tests for Aircraft Deicing/Anti-Icing Fluids SAE Type II, III, and IV," developed by the Holdover Time Committee of the SAE International G-12 Aircraft Ground Deicing Committee. The HOTs provide a conservative estimate of the time for which anti-icing fluids provide protection against various kinds of freezing and frozen precipitation. The HOT tables also contain allowance times for anti-icing fluids in conditions of ice pellet precipitation, including ice pellets mixed with other forms of precipitation. These times are determined through testing of the flow-off behavior and effect on lift by contaminated fluids in an icing wind tunnel.

The FAA works very closely with Transport Canada (TC) on ground deicing and anti-icing research and operational issues. This relationship started after the investigation of the March 10, 1989, Air Ontario Flight 1363 accident that occurred in Dryden, Canada. The Canadian

government Commission of Inquiry¹⁴ results released in 1992 prompted policy changes by Transport Canada Civil Aviation and a significant increase in research efforts to understand ground icing operational effects and improve safety. The TC Transportation Development Centre and the FAA together have provided international leadership to industry and to other airworthiness authorities. Through their participation in the G-12 Aircraft Ground Deicing Committee, they have provided much of the funding for research that underlies key SAE documents containing standards, guidance, and other information related to ground operations in icing conditions. Both regulatory agencies are recognized for their safety initiatives, research into ground fluids performance, and failure data, providing a basis for test methods, standards, and guidance material for use within the U.S., Canada, and throughout the world.

Research activities are developed based on ground icing operations needs within the FAA, interactions with airplane operators and trade organizations, and a review of previous winter events. Recent issues on critical surfaces testing and sloped surfaces fluid retention have initiated new activities and collaborative testing with industry. Other areas of interest focus on ground icing issues for aircraft with low rotation speeds. The aerodynamic acceptance test for deicing and anti-icing fluids has been established and is based on testing with a transport airplane. Compatibility and performance of anti-icing fluids for smaller airplane types are now being identified as areas of concern. The latter have drawn more attention as ice protected general aviation airplanes enter routine use in winter operations. Ground deicing and anti-icing of these airplanes present challenges and issues different than those for transport aircraft, and they must be addressed to ensure safe operations for all aircraft operating in icing conditions.

5.4. In-flight Icing

Aircraft fall into two broad categories with respect to in-flight icing: those that are certificated to fly in icing conditions and those that are not. If a manufacturer elects not to certify an aircraft for flight in icing conditions, as is often the case for small General Aviation aircraft, the aircraft is not to be operated in those conditions. Some aircraft that are not certificated for flight in icing conditions nonetheless carry some ice protection equipment, but the proper use of this equipment is only to provide time to exit icing conditions if they are inadvertently encountered. AC 91-74A, "Pilot Guide: Flight In Icing Conditions," contains information on how to determine if an aircraft is certificated for flight in icing conditions, how to avoid those conditions if it is not, and how to safely exit from an inadvertent encounter. The Icing Plan promotes strategies to improve icing weather information for flight mission planning, research to "identify and avoid" icing conditions, and training that can improve safety for aircraft that are not certificated for flight in icing conditions. The rest of this section addresses aircraft that are certificated for flight in icing conditions.

In-flight icing encounters can occur in any portion of the enroute mission: takeoff climb, cruise, hold, approach, and landing. For each of these flight segments, the effects of icing must be addressed for evaluation of aircraft ice protection and detection system performance.

Additionally, for instances of ice contamination on aircraft surfaces, whether an unprotected surface or from a failed ice protection system, the performance and handling qualities of the aircraft must be assessed.

Icing should not affect powerplant or turbine engine performance in any way that compromises thrust or adversely affects engine operability. These effects are addressed through aircraft and engine certification and operations regulations that define minimum standards to maintain engine thrust and aircraft performance and handling qualities, and by operations criteria for flight

mission planning, routine operations in icing weather, and severe icing conditions which require immediate departure from those conditions. The FAA, the U.S. NTSB, and other national accident investigation boards have studied a number of in-flight icing accidents in order to determine causal factors and develop findings to address the unsafe conditions that precipitated the events. Severe icing encounters include conditions which exceed the capability of the ice protection system or result in accretions on unprotected surfaces that were not considered during the aircraft design. An example of the FAA's aggressive work to address unsafe conditions can be found in Appendix E on the actions taken for the October 31, 1994, American Eagle Flight 4184, ATR-72, Roselawn, IN accident. The final action to address the causal factors that contributed to this accident and others in SLD icing conditions is the development of new regulations to define standards beyond the current atmospheric certification standards of 14 CFR part 25 Appendix C.

Applicants for certification in icing conditions typically use a number of test and analysis methods to determine the impact of ice on wings, stabilizers, other lifting surfaces, and other aircraft systems. These methods support the conclusions about the aircraft's ability to operate in icing conditions. The FAA addresses ice protection for airplanes certificated to operate in icing conditions with requirements and policy to either maintain clean critical aircraft surfaces throughout the ice protection system coverage area during the icing encounter (anti-icing), or show through flight testing that any ice shapes that may form on the protected surfaces between deicing cycles, or from runback ice, do not result in inadequate airplane performance and handling qualities. Flight testing is required for ice shapes on non-ice-protected surfaces that represent the most critical ice accretions to which those surfaces will be exposed. Since it is very difficult to routinely find critical icing encounters in natural icing conditions, these certification flight tests with ice shapes are typically done in dry-air conditions with simulated ice shapes for flight safety reasons. Additionally, flight testing in natural icing conditions is required to corroborate the simulated ice accretions, and the handling characteristics and performance results obtained in flight testing with the simulated ice accretions.

There are separate challenges for rotorcraft in-flight ice protection requirements. Rotorcraft manufacturers do not put simulated ice shapes on the rotating blades due to the potential for release of the shapes and subsequent damage to the following blade. Rotorcraft certification testing for performance and handling qualities are typically addressed through static blade testing of the ice protection system performance in an icing wind tunnel and natural conditions testing, or by using an icing tanker to provide artificial icing conditions. The former flight testing presents the challenge of finding icing environments that represent critical conditions of the atmospheric icing envelopes for the full rotorcraft.

The above flight testing option poses testing constraints due to icing tanker spray size and evaporation and other environmental effects on drops sprayed into dry-air atmospheric conditions. Experience over the years has resulted in the development of a number of techniques for flight testing that have proven successful for evaluating aircraft performance and handling qualities with respect to the regulatory requirements.

Ice detection systems are typically reactive, sensing ice on the airframe that indicates the aircraft is in icing conditions. These systems are often advisory, but can be primary. (An advisory system provides an alert to the flight crew but is not to be used as the sole means for ice detection. A primary system may be used as the sole means of ice protection.) Ice detection systems have come under scrutiny due to activation criteria and determination of a location on

the airframe to indicate the initial onset indications of an ice encounter before ice accretes on critical surfaces. Significant R&D has been applied to solving these issues; new standards, guidance material, and analysis methods have provided improvements in operational performance. There are systemic limitations for some detection techniques, especially for identifying large drop icing conditions (outside of Appendix C). This is an area in which emerging technologies may provide improvements.

As test methods have improved, researchers have gained an understanding of ice accretion physics resulting in improvements to models used in computational tools. Aerodynamic effects of icing have been investigated and incorporated into icing computer codes. And, as computational efficiency has increased, the capabilities and use of computational engineering tools have grown significantly for design and certification of aircraft and aircraft sub-systems for operation in icing conditions. An array of engineering tools (experimental, computational, analytical, and facilities) are currently being used to support analysis for in-flight icing effects in aircraft and systems designs. This is a current challenge to both industry users of these tools and the regulatory authorities who must evaluate their performance and accuracy. The use of engineering tools can substantially decrease the design cycle time and potentially reduce the costs for icing certification. Many of the analysis methods currently used will soon be adapted to application for SLD icing conditions analysis. The FAA supports the use of these design tools when their performance can be assessed through validation and verification methods in order to ensure that there is no compromise in safe design practices. A cooperative effort between regulatory authorities, industry, and research organizations to promote a path for acceptance of these engineering tools needs to be developed to allow their routine use and acceptance.

5.5. Icing Weather

Icing weather information is key to the success of both ground and in-flight icing planning and updates to the weather dispatchers, ground operations personnel, air traffic control, and flight crews for making flight mission decisions on icing weather conditions.

New integrated icing weather diagnostic and forecast tools have entered the aviation user stream, providing much more accurate and better-resolved information than was previously available. However, atmospheric icing science studies and cloud properties research investigations are still needed to further improve capabilities. Current tools rely on NWP computer models that, despite significant improvement in recent years, do not yet have the necessary grid resolution for localized *in-situ* updating for tactical use. Real-time aircraft-specific icing threat information is not available. Large-scale icing weather phenomena and the formation mechanics of icing clouds (large drops, mixed phase, etc.), and the cloud microphysics, are not sufficiently well understood for accurate diagnosis and forecasting of icing conditions. Thus NWP model accuracy of icing information and data is limited which ultimately plays an important role in diagnoses. The FAA has research tasks to address many of the above issues; these activities will be discussed further in the Sections 5.6, Research, and the research tasks in Section 6 and Appendix A.

The NWS provides weather information, including icing information, to the aviation community. An important source for pre-flight planning icing information is the NWS Aviation Digital Data Service (ADDS) Web site at: <http://www.aviationweather.gov/adds/icing>. This site provides significant meteorological information (SIGMET) reports on in-flight weather of operational significance for the safety of all aircraft, including severe icing. It also includes airman's

meteorological information (AIRMET) reports on in-flight weather of lesser severity, including moderate icing, as well as a number of graphical products, such as depiction of freezing levels.

Relatively recent additions to the ADDS site include the Current Icing Product (CIP) and the Forecast Icing Product (FIP). The CIP is a graphical planning product that combines data from sensors and output from a NWP model to provide an hourly three-dimensional diagnosis of the probability and severity intensity of icing, plus the potential for the presence of SLD. The FIP relies upon NWP model output, initialized with observations from various sources, to provide similar information as CIP out to 12 hours.

The NWS issues METARs once an hour. When specified weather variables change sufficiently (e.g., freezing rain starts or stops), or specified weather variable thresholds are exceeded (e.g., decreasing visibility, lowering ceiling, etc), an aviation special weather report or SPECI is issued. METARs and SPECIs are the primary source for weather information for ground icing. They are based on information from Automated Surface Observing System (ASOS), Automated Weather Sensing System (AWSS), or Automated Weather Observation System (AWOS), which may be augmented by human observers. Each is a suite of sensors that measure, collect, and disseminate weather data.

For flights extending over oceanic regions, NWS is evaluating a global FIP product at the National Centers for Environmental Prediction. The United States, as operators of a World Area Forecast Center, is responsible for the forecasting of icing conditions around the globe. Research that leads to improvements in numerical weather prediction needs to be incorporated into both the CONUS forecast models and the global forecast models. NWP methodologies, such as FIP and its eventual successors, are improved greatly by tuning them against observations. The best observations are from automated sensors carried on commercial aircraft. Securing these observations from around the globe would lead to long term continuous improvements in the ability to forecast icing conditions.

The FAA Aviation Weather Division works with the NWS on improvement of weather information provided to the weather community. The CIP and FIP are products of research investment by the Aviation Weather Research Program (AWRP), sponsored by the Aviation Weather Division. The AWRP currently invests in two other icing weather research projects. The Algorithm for the Prediction of High Ice Water Content Areas (ALPHA) seeks to diagnose and forecast these high ice water content areas that appear to have very high concentrations of ice crystals in deep convective clouds and present a threat to aircraft turbine engines and air data probes. The aviation industry has become more aware and concerned about these conditions due to recent evaluations of turbine engine events and pitot probe failures (Research Tasks 6.6.01 and 6.6.06). The other project is TAIWIS, a system that will provide accurate real-time icing conditions information to air traffic staff, weather dispatchers, ground operations staff, and flight crews (see Research Task 6.6.07).

The primary sources for weather information during ground icing operations are METARs and SPECIs. Information from METARs and SPECIs is used during ground deicing and anti-icing operations to aid in the determination of the occurrence and intensity (from visibility) of snow and freezing rain. The occurrence and intensity of freezing drizzle and ice pellets is only reported at airports with a human weather observer.

An area of importance during ground icing operations is the determination of snow intensity, currently done using visibility. The FAA has supported the development of LWE capabilities

that determine the liquid content of frozen as well as freezing precipitation. This provides an alternate, automated and reliable means to determine the intensity of snow and other precipitation conditions.

The FAA also supports issuing SPECIs when snow starts, stops, or changes in intensity, and has completed a safety risk assessment of this change and provided a formal request for a change to the NWS. Research on LWE systems was supported by the AWRP, and the technology is sufficiently mature that the FAA is developing standards and specifications for evaluation and approval for commercial systems.

After the ASOS Operating System software is upgraded, the FAA will consider plans to implement the capability to determine LWE rate for snow in ASOS. This will encompass providing LWE rate information for snow in the remarks section of the METAR/SPECI as well as determining the snow intensity in the main body of the METAR/SPECI from LWE rate. More discussion on LWE systems can be found in Section 4, *NextGen*.

Investments in improving the accuracy and availability of icing weather will result in a large increase in safety in the existing fleet. An examination of part 23 airplane icing accidents¹⁵ shows that detecting and reporting SLD in the terminal area will increase safety for icing certificated airplanes, and increased accuracy and resolution of icing aloft will increase safety for airplanes not certificated for flight in icing conditions. The Icing Plan has a task to develop standards for icing weather in the cockpit (Task 6.7.05). This will streamline the approval of getting icing weather in the cockpit as new icing weather products become available.

Significant investment of resources is still required by the FAA to develop solutions for icing weather that will support NextGen airspace management. The Icing Plan should continue supporting new strategies to improve icing weather information content, accuracy, resolution, and timeliness. In addition, the FAA aviation weather specialists that are responsible for icing weather improvements should continue to oversee and coordinate research plans that develop those new strategies into capabilities that will provide weather information to the airspace system and the flight deck.

5.6. Research

5.6.1. FAA Research

The FAA conducts research to support safe operations in icing conditions. Research strategies are based on the needs of the FAA for support continued operational safety (COS), regulatory and guidance materials that improve certification processes, new rulemaking and operational capability, new and enhanced engineering tools for improved means of compliance, requirements for NextGen, and emerging technologies. Icing weather research supported by the FAA has focused on the improvement of systems for nowcasting and forecasting icing weather information, both aloft and in the terminal area.

Recent research is focused on high-altitude, high-concentration ice crystal conditions in deep convection that have resulted in hazardous ice accumulations in turbine engines resulting in loss of power, and in the malfunction of air data probes. There are continued efforts to develop or improve engineering tools for showing compliance with requirements for operation in the atmospheric icing envelopes in the current Appendix C of part 25, the proposed Appendix O of part 25, and the proposed Appendix D of part 33¹⁶. Research activities are underway to improve the capabilities of test facilities (both ground and icing tankers) and to continue developing new and enhanced experimental and computational tools for all three atmospheric icing envelopes. In

ground icing, the research focus is on providing technical information and guidance for icing operations, with increasing focus on modernization that is responsive to industry needs and supports NextGen operational requirements¹⁷.

Icing research is based on direction and advice from a number of sources. Within the FAA, current icing research investments respond to issues raised in the ISC, requirements from the Aviation Safety Office Technical Community Representative Groups (TCRG) for Aircraft Icing and Weather, and requirements from the Aviation Weather Division. Research direction and advice from outside the FAA is provided by the NTSB, the Research and Development Advisory Committee's (REDAC) Subcommittee on Aviation Safety, and the U.S. aerospace industry. In conducting research, the FAA works with US Federal government research organizations (e.g., National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration, and the Department of Defense), academic institutions, the aerospace industry, and international partners.

The Icing Plan contains research tasks intended to improve the overall level of safety while operating in icing conditions. The research tasks in the Icing Plan are sponsored within the FAA by two organizations: Aviation Safety (AVS), Safety Management and Research Planning Division and the NextGen, Aviation Weather Division. The AVS-sponsored research efforts support COS, improved certification processes for new and emerging technologies and operations, and transformation of AVS processes to data-driven safety management principles. AVS-sponsored research is managed and executed by the Aircraft Research Division at the William J. Hughes Technical Center. The Aviation Weather Division research is managed and executed by the AWRP; aircraft icing research is directed at supporting areas that address terminal area and in-flight weather: detecting, diagnosing, forecasting, and reporting information and data related to weather hazards, and providing means to mitigate these threats. The AWRP-sponsored research coordinates some of these activities with the Aircraft Research Division.

5.6.2. NASA and Other Research Organizations

Other sources for FAA aircraft safety research are through inter-agency or international memoranda of understanding (MOUs) and collaborative research. These sources of research have become increasingly important to the FAA because of the alignment of outside research activities to common goals with FAA plans, and a number of these research programs have funding capability which exceeds that of the FAA. Developing partnerships for collaborative research provides benefits to all organizations involved. The partnership between NASA and the FAA has long been and continues to be extremely important to the success of FAA's research in aircraft icing. NASA has its own mission and focus in research, but there are many instances where NASA's research in aircraft icing directly relates to FAA needs, providing substantial benefit to the FAA.

NASA currently has three aeronautics programs that work on icing-related topics. They are the Aviation Safety Program, Atmospheric Environment Safety Technologies (AEST) Project, the Fundamental Aeronautics Program, Subsonic Rotary Wing (SRW) Project, and the Aeronautics Test Program (ATP). The icing research plans of the AEST project overlap with the FAA's defined research needs on aircraft icing issues, including swept wing ice accretion experimental studies, engine icing, icing physics and scaling, 3-D icing computational fluid dynamics (CFD) improvements, and remote detection of icing conditions. AEST and ATP work together to improve ground facilities (icing wind tunnel and engine test cell) capabilities for expanded icing/ice crystal conditions. AEST also supports improvements in SLD engineering tools for

means of compliance. The SRW project supports investigations into improving the understanding of rotor blade ice accretion and shedding, computational tools for assessing rotor icing performance, and improvements in test methods and engineering tools for design, testing, and certification. This research effort directly benefits FAA Aircraft Icing Plan activities by improving compliance methods for rotorcraft certification. More information is available on NASA's aeronautics projects at: <http://www.aeronautics.nasa.gov/>.

The FAA has strong ties for collaborative research with other research and regulatory organizations. The FAA has worked for years with the Canadian government on an array of research tasks in aircraft icing: characterization of atmospheric icing environments and the instrumentation to measure atmospheric icing conditions with Environment Canada; engine icing, ice crystal simulation in engine test cells and engine icing and ice crystal test methods, facility altitude scaling, and total water content instrumentation with National Research Council Canada; and all aspects of ground icing research with Transport Canada. The latter relationship is described in more detail in Section 5.3, *Ground Icing*). The FAA has also recently developed other collaborative research relationships that strengthen the scope and expertise available to solve complex technical problems for aircraft icing. Further descriptions can be found in Section 7, *Coordination of Icing Activities*. The Aircraft Icing Research Alliance (AIRA) is an example of a group that promotes international collaboration of aircraft icing research. Information on AIRA can be found at: <http://icingalliance.org/>. The federal partners that participate in AIRA examine common research priorities and work together to develop collaborative research projects. The FAA regularly attends the AIRA meetings and has recently participated in collaborative weather sensor field projects that have been coordinated under the auspices of AIRA.

The collaborative research described above affords the FAA to have a significantly greater impact on developing solutions to improve safe operations in icing conditions. The FAA plans to continue these relationships and is in the process of expanding international cooperation with the European Union through recently approved icing projects funded by the European Commission: High Altitude Ice Crystals (HAIC) and Weather Hazards for Aeronautics (WEZARD) projects

5.7. Standards and Discipline Manual Development

5.7.1. Technical Standards

The development of technical standards for operating experimental facilities and conducting tests, specifications for aerospace equipment design and performance criteria, and aerospace recommended practices for the use of engineering tools (experimental, computational, and test facilities) have greatly increased the FAA's ability to develop guidance material for means of compliance for certification and to improve confidence in operational capabilities. There are a number of standards organizations that promote the development and dissemination of technical standards information for aircraft icing. The FAA participates as a member of these organizations, along with many representatives from the aerospace industry, research organizations, and academia. The technical committees within these standards organizations address complicated technical issues and translate that information, with aerospace community subject matter experts as volunteers, into standards. This is of great value to the aerospace community and provides a critical service that is necessary to maintaining high-quality practices and standards for ever-changing technological capabilities that effect design, certification, and operation of aircraft.

SAE International has three committees that specifically support aircraft icing: (1) G-12, *Aircraft Ground Deicing*; (2) SAE AC-9C, *Aircraft Icing Technology*; and (3) EG-1E, *Aerospace Propulsion System Support Equipment – Test Cells*. G-12 addresses all facets of ground deicing; it is comprised of eight committees that create, prepare, and maintain all relevant specifications, standards, and requirements for aircraft ground deicing systems. AC-9C addresses all facets of aircraft in-flight icing, including ice protection and detection technologies and systems design, meteorological and operational environments, maintenance, regulation, certification, and in-service experience. EG-1E addresses all facets of aerospace propulsion equipment-design, maintenance, and in-service experience. It focuses on support equipment and facilities related to gas turbine engine testing. The FAA maintains strong ties with these committees and receives significant benefit in the development and use of technical standards. The FAA also supports the Atmospheric and Space Environments Technical Committee of the American Institute for Aeronautics and Astronautics (AIAA) and participates in other international icing-related working groups with EUROCAE (European Organisation for Civil Aviation Equipment) and ICAO (International Civil Aviation Organization) that directly relate to aircraft standards and aviation weather standards development.

The above organizations are responsible for publishing many documents that define acceptable practices, equipment specifications, and operational criteria for ground and in-flight icing and for the test facilities routinely used for icing simulation. The FAA will continue to support these activities and make specific requests for standards development that support guidance materials development as identified in Section 6.7.

5.7.2. Icing Discipline Manuals (IDMs)

The FAA plans to begin development of IDMs starting in the near future. The intent of these manuals will be to document certification procedures, test processes, defined acceptance criteria, out-of-limits and other non-conformance notification conditions, and auditable practices that provide enough detail to allow the delegation of authority to an applicant for the activities described in the manual. Although development of the IDM is voluntary and not directly required by regulation, it does support FAA policy initiatives for delegation through organizational designation authorization.

The IDM would allow certification testing and analysis of agreed upon elements of the icing certification plan through acceptance of results by the applicant. The FAA will determine specific areas where the IDM can be applied through interaction and development of the IDM contents with industry. An IDM would be significantly different from a technical standards document described in section 5.7.1. An IDM would be based on best practices and test or analysis capabilities relating to specific certification criteria or proven company practices. These practices would not be minimum standards, as is frequently the case for technical standards.

5.8. Training

A key element to maintaining aircraft safety in icing conditions is the training of those responsible for certifying aircraft, overseeing flight operations, maintaining aircraft and equipment, and managing air traffic, as well as for the users who plan flights and fly aircraft in these conditions. The FAA works to ensure that training is provided for each of these groups. The FAA provides introductory courses for new employees through the Training Academy at the Mike Monroney Aeronautical Center. However, the expertise for most employees is gained through on-the-job experience and mentoring by senior employees. Mentoring is a training

technique, but does not target some areas of either re-current or changing policy and knowledge of new technology that can support the ability to perform more effectively.

The Icing Plan addresses training that supports aircraft icing within Aviation Safety organization. Members of the ISC support requests from the Training Academy and ATC to develop training materials, or work as instructors, in their areas of subject matter expertise.

Members of the ISC have developed aircraft icing-specific training courses tailored to the needs of the Aircraft Certification and Flight Standards Services. There are Aircraft Certification Office workshops for parts 23, 25, and 33 that provide basic training on icing conditions and their effects on aircraft and engines, and updates on new rulemaking, guidance materials, issue papers, and the use of engineering tools for certification. Training has been offered through workshops to POIs on ground icing and the implementation and oversight under § 121.629, *Operating in Icing Conditions*, and the associated advisory material AC 120-60B.

Designated Engineering Representative (DER) and ODA unit members receive recurrent training through courses developed by the Aircraft Certification Service, Delegation Procedures Branch. The icing lectures are developed and taught by icing specialists from Aircraft Certification. As the courses go on-line, the content will be re-formatted and developed by the same icing specialists. New materials will have to be developed in order to address new rulemaking for SLD, mixed phase, and ice crystal icing conditions and the requisite guidance materials.

The FAA has participated in the development of icing training materials for pilots through internal course content development and through collaboration with NASA and the Aircraft Owners and Pilots Association (AOPA). The former content is organized and made available through the FAA Safety Team (FAASafetyTeam), whose web site is: <http://www.faasafety.gov/>. The FAASafetyTeam mission is to improve the nation's general aviation safety record by conveying safety principles and practices through training, outreach, and education. The ISC will leverage FAASafetyTeam capabilities to implement some of the training recommendations in the "Part 23 Icing Aviation Rulemaking Report", Rev. B, February 2012¹⁵. The Small Airplane Directorate also developed an educational aid on icing for general aviation airplanes, which can be found at: <http://www.faasafety.gov/files/notices/2008/Nov/GAIcing.pdf>.

The FAA worked with NASA, manufacturers, and industry associations to develop icing education and training products for pilots. This work was sponsored at NASA by the Aviation Safety Program; pilot training materials content development took place from 1996 to 2006, when this NASA program element was discontinued. The products developed started with videos and DVDs for specific subjects: *Icing for General Aviation Pilots*, *Icing for Regional and Corporate Pilots*, *Tailplane Icing*, and *Supercooled Large Droplet Icing*. Information on these products can be found at: <http://aircrafticing.grc.nasa.gov/resources/products.html>. The format evolved to allow more universal access and to accommodate a change in training strategies. Two free, on-line training courses can be found at:

http://aircrafticing.grc.nasa.gov/courses_ground.html. The courses are:

1. *A Pilot's Guide to Ground Icing*: primarily intended for pilots who make their own operational deicing and anti-icing decisions. This includes private pilots as well as those who fly business, corporate, air taxi, or freight operations in fixed-wing aircraft.
2. *A Pilot's Guide to In-Flight Icing*: primarily intended for the general aviation pilot who flies aircraft certificated for icing, although much of the information is applicable to all pilots. With an operational focus, this course provides tools pilots can use to deal with in-flight icing.

Training is one of the most important investments the FAA can make in promoting aviation safety for aircraft icing. The FAA needs to update many of the pilot training materials described above and to expand icing training content in general reflecting new rulemaking for SLD and ice crystals and the operational changes these regulations will entail. The Icing Plan has identified a number of tasks under Section 6.8 that relate to updating training materials.

6. LISTING AND BRIEF DESCRIPTION OF CURRENT ICING PLAN TASKS

This section will provide a top-level description of each task that the FAA tracks in the Aircraft Icing Plan. The activity, outcome, and partners supporting this work are described. A partner is an organization outside the FAA which contributes resources to execution of a task. A partner may also receive funding from the FAA. More detailed information can be found for each task in Appendix A.

6.1. Regulations and Policy

Task 6.1.01

Activity: Airplane and Engine Certification Requirements in Supercooled Large Drop, Mixed Phase, and Ice Crystal Icing Conditions
Outcome: New rule expanding aircraft certification to include SLD, mixed phase, and ice crystal icing conditions for part 25 and part 33.

Task 6.1.02

Activity: New rulemaking plans for part 23 – Airplane and Engine Certification Requirements in SLD, Mixed Phase, and Ice Crystal Icing Conditions
Outcome: New rule expanding aircraft certification to include SLD, mixed phase, and ice crystal icing conditions for part 23.

Task 6.1.03

Activity: PS-ANM-25-XX, PS-ACE-23-XXX; Type Certification Policy for Approval of Type II, III, and IV Deicing/Anti-icing Fluids
Outcome: New certification policy for approving Type II, III, and IV deicing and anti-icing fluids.

6.2. Advisory Circulars

Task 6.2.01

Activity: AC 20-147A, *Turbojet, Turboprop, and Turbofan Engine Induction System Icing and Ice Ingestion*
Outcome: Update guidance materials to reflect new rulemaking activities for parts 25 and 33 regarding SLD, mixed phase, and ice crystal icing conditions, and other harmonized standards that were reviewed by the Aviation Rulemaking Advisory Committee, Engine Harmonization Working Group.

Task 6.2.02

Activity: AC 25-XX, *Compliance of Transport Category Airplanes with Certification Requirements for Flight in Icing Conditions*

Outcome: Develop new guidance materials to reflect rulemaking activities for part 25 regarding SLD, mixed phase, and ice crystal icing conditions.

Task 6.2.03

Activity: Update AC 25-25, *Performance and Handling Characteristics in the Icing Conditions Specified in Part 25, Appendix C*

Outcome: Update guidance materials to reflect new rulemaking activities for part 25 regarding SLD, mixed phase, and ice crystal icing conditions.

Task 6.2.04

Activity: Update AC 120-60B, *Ground Deicing and Anti-icing Program*

Outcome: New AC materials needed to establish training, procedural, equipment, and quality control requirements for service providers.

Task 6.2.05

Activity: Update AC 00-45G, *Aviation Weather Services*

Outcome: Provide updated materials on new weather products.

Task 6.2.06

Activity: Update AC 135-17, *Pilot Guide – Small Aircraft Ground Deicing*

Outcome: New AC materials needed to establish training and acceptable procedures and equipment for airplanes operating under parts 91 and 135.

Task 6.2.07

Activity: Update AC 20-73A, *Aircraft Ice Protection*

Outcome: Consolidate guidance common to directorates (e.g., SLD) and update with latest research, changes in engineering tools capabilities, and rulemaking and means of compliance for SLD, mixed phase, and ice crystal icing conditions.

Task 6.2.08

Activity: Update AC 120-109, *Stall and Stick Pusher Training*

Outcome: Incorporate icing information – icing speeds; means of stall warning on certain airplanes.

Task 6.2.09

Activity: Update AC 91-74A, *Pilot Guide: Flight in Icing Conditions*

Outcome: Need to incorporate SLD icing conditions operations to support targeted release of new SLD rule.

6.3. Ground Icing Operations

Task 6.3.01

Activity: Holdover Time Determination Systems (HOTDS) using Liquid Water Equivalent (LWE) rate

Outcome: Develop specification document and advisory circular providing specifications and an acceptable means for approval of HOTDS using LWE rate. Such systems are now commercially available and provide a

means of more accurately determining HOTs than visibility-based intensity tables.

Task 6.3.02

Activity: Standardized International Ground Icing Program
Outcome: Ensure defined ground deicing practices outside the U.S. until new policy is implemented.
Partners: Airlines for America, UPS, Delta Airlines, U S Air, United Airlines, AeroMag Inc, and Kilfrost.

Task 6.3.03

Activity: FAA Approved Deicing Program Updates, Winter 2012-2013
Outcome: Annual notice - ensure that the required airline plans address new issues, FAA guidance on technological and other developments, guidance, and policy changes resulting from research or investigations by the FAA.
Partners: Transport Canada

6.4. In-flight Icing Operations

Task 6.4.01

Activity: AIM/AIP icing terminology definitions
Outcome: Update the AIM/AIP with new intensity definitions that include criteria for ice accumulation on the aircraft surface. Identify advisory circulars that will need to be modified and initiate change process.
Partners: None

6.5. Icing Weather

Task 6.5.01

Activity: Snow SPECI and Snow Intensity Table
Outcome: Ultimately, snow intensity should be determined by LWE rate systems. Until they are available, the new Snow Visibility Table provides a more accurate determination of intensity than does the current FMH-1 Table.
Partners: National Weather Service

Task 6.5.02

Activity: ASOS Improvement
Outcome: Determine if ASOS can provide an interim means of detecting and reporting SLD and equip all airports with part 135 service. Evaluate longer term solution for a plan to consider implementation of LWE rate for snow in ASOS.
Partners: National Weather Service

6.6. Research

Task 6.6.01

Activity: Research on convective weather ice crystal icing conditions to support improved means of compliance.

Outcome: The outcome of this R&D will be to provide new test capabilities and test methods to support improved means of compliance for certification.

Partners: NASA, National Research Council Canada, and Transport Canada

Task 6.6.02

Activity: Research to maintain safe operations and takeoff in ground icing conditions.

Outcome: The outcome of this R&D will provide better test methods and analysis tools, updated HOTS or allowance times for new environmental conditions, new operational guidance, and data packages in support of guidance and standards.

Partners: Transport Canada and NASA

Task 6.6.03

Activity: Enhance icing simulation methods for improved means of compliance to support Appendix C icing certification.

Outcomes: Provide new test methods, analysis tools, and a 3-D ice accretion database to support validation of computer codes and improved means of compliance for certification.

Partners: NASA, ONERA (Office National d'Etudes et de Recherches Aérospatiales)

Task 6.6.04

Activity: Develop improved compliance criteria for rotorcraft seeking approval for flight into known icing conditions.

Outcome: Minimum evaluation criteria for normal and transport category rotorcraft to identify critical icing conditions.

Partners: Partners not identified at this time.

Task 6.6.05

Activity: Provide diagnostic and forecast icing products based on Numerical Weather Prediction (NWP) models and real-time weather observations from satellites, dual-polarization radar, and other systems.

Outcomes: Develop diagnostic/ forecast tools to assist flight crews in detecting, avoiding, and managing in-flight icing environments in CONUS and Alaska; develop global icing product

Partners: NOAA – NWS, AWC, ESRL, and NSSL and NASA – Glenn Research Center and Langley Research Center

Task 6.6.06

Activity: Mitigate the convective weather ice crystal safety concerns for aircraft turbine engines and air data systems.

Outcome: Provide new test capabilities and test methods to support improved means of compliance for certification, such as new guidance materials for advisory circulars, and new ice crystal weather diagnosis and forecast tools that will provide pilots and airline operators better capability to avoid these conditions.

Partners: NASA, Environment Canada, Australian Bureau of Meteorology, Transport Canada, National Research Council Canada, Boeing, Airbus

Task 6.6.07

Activity: Manage terminal area icing weather information for operational decision making for both ground and in-flight icing conditions.

Outcome: Provide a prototype terminal area icing weather information system that will provide accurate real-time icing conditions information to air traffic staff, weather dispatchers, ground operations staff, and flight crews.

Partners: NASA

Task 6.6.08

Activity: Determine the probability of icing conditions aloft using data linked aircraft-sensed weather information.

Outcome: Provide processed aircraft sensed weather data to end-users to support “identify and avoid” strategies for high probability areas of known icing conditions.

Partners: Partners not identified at this time.

6.7. Standards Development

Task 6.7.01

Activity: Develop guidance materials for draft of future AC 29.1419, § 29.1419 (Amendment 29-21), *Ice Protection*

Organization: SAE AC-9C, Aircraft Icing Technology Committee

Outcome: Revise rotorcraft icing certification advisory materials to reflect new practices by industry for use of engineering tools for rotorcraft icing certification.

Task 6.7.02

Activity: Aerospace Information Report (AIR) – 6189 Calibration and Test Methods for Turbine Engine Icing Test Facilities

Organization: SAE EG-1E, Aerospace Propulsion System Support, Test Cells and SAE AC-9C

Outcome: Provide engine icing test facilities owners, users, and the FAA certification specialist standards documents that describe acceptable practices for calibration, operation, and testing to icing certification.

Task 6.7.03

Activity: SAE AC-9C: AS 5562, Ice and Rain Qualification Standards for Airdata Probes and EUROCAE WG-89: Pitot Qualification to Ice & Rain

Organization: SAE AC-9C and EUROCAE Working Group 89

Outcome: AC-9C: develop updated criteria for pitot probe testing in icing conditions, and EUROCAE; establish ice and rain standards for pitot and pitot-static probes; harmonize the SAE and EUROCAE air data probe standards documents.

Task 6.7.04

Activity: Globalized Aircraft Deicing Standards

Organization: International Air Transport Association, SAE International G-12 Aircraft Deicing Committee, and International Civil Aviation Organization.
Outcome: Harmonize the application of deicing fluid and include: 1) aircraft ground deicing methods; 2) training procedures for aircraft ground deicing; and 3) quality control procedures. Provide standardized communication between the members of the ground deicing crew.

Task 6.7.05

Activity: Display Icing Weather in the Cockpit
Organization: SAE G-10, Aerospace Behavioral Engineering Technology Committee and RTCA SC-206 Aeronautical Information Services (AIS) Data Link Standards for disseminating and displaying icing weather in cockpit
Outcome:

6.8. Training

Task 6.8.01

Activity: Part 25 & 23 Engineering Tools to Support Icing Certification
Outcomes: Conduct training of Aircraft Certification Office staff responsible for icing certification, address SLD engineering tools and compliance methods.
Partners: NASA

Task 6.8.02

Activity: Part 33, Engineering Tools to Support Icing Certification
Outcomes: Conduct training of Engine Certification Office staff responsible for icing certification, address SLD and ice crystal engineering tools and compliance methods.
Partners: NASA

Task 6.8.03

Activity: Revise icing training videos and courses for pilots
Outcomes: Updated training materials to reflect current icing operations and any changes in FAA regulations from training materials original release time
Partners: NASA and AOPA

Task 6.8.04

Activity: Training / No training for Ice Contaminated Tailplane Stall (ICTS)
Outcomes: Develop FAA notices and ICTS training as well as no ICTS training procedures to provide operators with the correct information and training criteria for the aircraft they operate.
Partners: None

Task 6.8.05

Activity: Review Pilot Knowledge Exam Materials and Draft Icing Questions
Outcomes: Prioritize and draft icing-related questions for instrument flight rules (IFR), private, commercial, and ATP.
Partners: AOPA

Task 6.8.06

Activity: Review and Revise Icing Materials on FAA Web sites

Outcomes: Clean up and update icing material on FAA web sites; update Airplane Flying Handbook icing information (Chapter 12) and add inadvertent icing encounter information to Emergency Procedures (Chapter 16); add icing to FAA Industry Training Standards (FITS).

Partners: AOPA

Task 6.8.07

Activity: Review of operators (parts 91K, 121 and 135 pneumatic boot equipped airplanes) training programs

Outcomes: Verification that operators are emphasizing icing speeds, means of stall warning, airplane limitations.

Partners: None

6.9. Gap Analysis

The FAA will perform a gap analysis to assess current Icing Plan capabilities and to determine if upcoming operational needs are adequately addressed. The following are areas for review:

- Certification, advisory material, training, and operational needs not identified or properly supported for current, or planned rulemaking projects for operating in icing conditions;
- Compliance methods that support certification for operating in icing condition for both current and new rulemaking;
- Research activities that adequately support COS;
- Research activities that address the development of capabilities to meet NextGen initial and mid-term operating requirements;
- Operational capabilities, on-board technologies, aircraft state information, and icing weather information requirements to meet UAS needs for operating in icing conditions.
- Support and resources to implement the scope of the tasks identified; and
- Identified current and near-term technology changes and the ability to address their influences on the NAS.

7. COORDINATION OF ICING ACTIVITIES

The members of the ISC work within their respective FAA lines of business to ensure that icing activities within the Icing Plan reflect their needs regarding icing certification and operations issues, identify research investments that support improvements to aviation safety, and develop strategies that address the changing technology and future airspace requirements. Cross-organizational needs are discussed at semiannual meetings of the ISC. Activities falling under the various lines of business are presented by the ISC members, and those activities that may need coordination among different lines of business are identified and discussed. For example, ground icing operations are the primary responsibility of the Flight Standards Service, but it is important that the Aircraft Certification Service be aware of operational changes that may call for consideration of changes in certification practices. The ISC is responsible for the development and updating of the Icing Plan and coordinates this through the respective member groups.

The ISC members work with other regulatory authorities, research organizations, and original equipment manufacturers (OEMs) and trade organizations throughout the aerospace industry. Their relationships and interaction with icing practitioners with specialized expertise outside the

FAA provide insights into industry needs and aviation safety issues, contributing to ISC reviews and actions.

The most common partnerships described in the Icing Plan are relationships with research organizations. These partnerships are focused on specific research activities where the FAA is collaborating with another U.S. federal agency or a federal agency (including other regulatory authorities) of another government, and sometimes directly with industry. In developing these relationships, the FAA defines areas of common interest and what skills, expertise, facilities, and other unique capabilities we can combine to leverage these resources to solve the identified problem of interest. These partnerships provide substantial benefit to the FAA both in terms of cost sharing and acquiring the resident expertise outside of FAA skill areas and test facility capabilities that directly support the solution of a research task. The complexity and costs of many of our current research tasks requires national or international partnerships and coordination of resources. The FAA pursues these relationships with others based on the following:

- Common focus on solving aircraft icing safety issues;
- Expertise required across multiple disciplines that does not reside in a single organization;
- Facilities and test assets owned or operated by multiple organizations across national boundaries; and
- Reduction of duplicating efforts and development of complementary research strategies.

These partnerships and combined resources afford a substantially greater investment in solving the activity, and in many cases, bring skills and diversity of views that benefit the work effort. The FAA has many relationships with other countries that increase our ability to support aviation safety-related research in aircraft icing. The table below describes examples of these relationships and the research tasks and partners.

Organization	Partnering Vehicle	Areas of Common Interest
United States		
National Aeronautics and Space Administration	U.S. Interagency Agreement	Ice accretion physics, icing scaling, experimental and computational simulation methods, icing test facilities, icing flight research, iced aerodynamics and iced flight dynamics, remote ice detection, sensor and instrumentation development, icing weather, and the development of engineering tools for means of compliance
National Center for Atmospheric Research	Interagency Agreement with National Science Foundation	Characterization of atmospheric icing environments, micro-physical properties studies and numerical prediction models, ground, satellite, and on-board detection methods, development of diagnostic and forecast tools, and implementation of icing products into the AWC user stream.
National Oceanic and Atmospheric Administration	Interagency Agreements and MOUs*	Evaluation and acceptance for use of new icing weather tools, implementation of products into ADDS, and delivery of icing weather to users of

		the NAS.
Other Regulatory Agencies		
Transport Canada	Project Arrangement	Collaborative research: operations in ground icing conditions. Also, shared funding of tasks that support ice crystal research through other organizations.
European Aviation Safety Agency	No agreement at this time	Engine icing, ice crystal issues on sensors and engines, SLD means of compliance issues, and harmonization of icing regulations and guidance materials
Other National Organizations		
Bureau of Meteorology, Australia	Memorandum of Cooperation	Forecast / nowcast capabilities for flight research field campaigns, atmospheric characterization and modeling of convective weather ice crystals, atmospheric modeling of ice crystal conditions.
Environment Canada	Memorandum of Cooperation	Characterization of atmospheric icing environments and the instrumentation to measure atmospheric icing conditions
National Research Council Canada	Memorandum of Cooperation	Engine icing, ice crystal simulation in engine test cells and engine icing/ice crystal test methods, facility altitude scaling, and total water content instrumentation.
ONERA (Office National d'Etudes et de Recherches Aeronautiques), France	In discussion, will be a Memorandum of Cooperation	Swept wing experimental testing, ice accretion modeling, drop dynamics, and ice accretion physics.

* The FAA has: Order 7000.2B, FAA/NWS Memorandum Of Understanding for Policy Agreements, Interagency Agreement between FAA and NWS for Center Weather Service Units, Attachment I, Statement of Work (delivery to Centers and TRACONS), and Interagency Agreement between FAA and NWS for World Area Forecast System (WAFS) Internet File Service (WIFS) (global delivery) (Draft).

The FAA has recently started discussions with the Meteorological Research Institute, Japan, to determine the potential to work together on atmospheric studies of ice crystal environments.

The success of the FAA in implementing a number of the research tasks in the Icing Plan is directly related to the partnerships that the FAA maintains with aerospace organizations, other federal agencies both within and outside the U.S., other regulatory agencies, and academia.

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APPENDIX A

CURRENT ICING PLAN TASKS – DETAILED REVIEW

Appendix A follows by parallel construction to Section 6 for each of the icing tasks listed there. The tasks are laid out in tables, with the table format changing for differing tasks based on the content of the task and how the FAA tracks and reports on the activity. Two examples are:

1. Tasks in 6.1 (Regulations and Policy) and 6.2 (Advisory Circulars) do not have project plans and deliverables, other than the final policy/AC document. The tables for these tasks do define the activity, problem/issue, actions, and status.
2. Tasks in 6.6 (Research) have project plans and deliverables and milestones the FAA tracks and these table have a different format to reflect that.

The headings above the tables contain an “Activity” description similar to the one found in Section 6, the FAA sponsor and the FAA performing organization. The sponsor is an FAA organization which determines the requirements for a task. The performer is an FAA organization responsible for management and execution of a task.

Within the tables, where needed, partners and performing organizations outside of the FAA are identified. A partner is an organization outside the FAA which contributes resources to execution of task. It may also receive funding from the FAA. A performing organization outside the FAA has a contract or other agreement to deliver specific services to support a task.

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.1.01

Regulations: New rule – Airplane and Engine Certification Requirements in Supercooled Large Drop, Mixed Phase, and Ice Crystal Icing Conditions*
Sponsor: Aircraft Certification, Transport Airplane & Engine and Propeller Directorates

Description	Problem/Issue	Action(s)	Status
Airplane and Engine Certification Requirements in Supercooled Large Drop, Mixed Phase, and Ice Crystal Icing Conditions – the FAA is developing new regulations for part 25 and 33 certification for SLD, mixed phase, and ice crystal icing conditions.	Accidents in SLD icing conditions and engine events in ice crystal icing conditions have resulted in the FAA expanding the current engineering standards for icing certification to include SLD and convective weather ice crystal icing conditions.	Develop and release new regulations for SLD, mixed phase, and ice crystal icing conditions for part 25 and 23.	NPRM published June 2010. Final rule near completion.

* Supports Task 5 of 1997 Inflight Aircraft Icing Plan

TASK # 6.1.02

Regulations: New Rulemaking for Part 23 – Airplane and Engine Certification Requirements in Supercooled Large Drop, Mixed Phase, and Ice Crystal Icing Conditions*
Sponsor: Aircraft Certification, Small Airplane Directorate

Description	Problem/Issue	Action(s)	Status
Part 23 SLD: the FAA Aviation Rulemaking Committee completed deliberations in 2011 and provided recommendations to the Small Airplane Directorate for new regulations for part 23 airplanes and engine certification for SLD, mixed phase, and ice crystal icing conditions.	Accidents in SLD icing conditions and engine events in ice crystal icing conditions have resulted in the FAA expanding the current engineering standards for icing certification to include exceedance conditions for large drops and convective weather ice crystal icing conditions.	Develop and release new regulations for SLD, mixed phase, and ice crystal icing conditions for part 23.	Small Airplane Directorate review of new rulemaking in process.

* Supports Task 5 of 1997 Inflight Aircraft Icing Plan

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.1.03

Regulations: PS-ANM-25-XX, PS-ACE-23-05; Type Certification Policy for Approval of Type II, III, and IV Deicing/Anti-icing Fluids

Sponsor: Aircraft Certification, Transport and Small Airplane Directorates

Description	Problem/Issue	Action(s)	Status
<p>PS-ANM-25-XX, and PS-ACE-23-05</p> <p>Establishes FAA certification policy for approving Type II, III, and IV deicing/anti-icing fluids. These fluids can be characterized as non-Newtonian, pseudoplastic fluids, also known as “thickened” fluids. These fluids can affect airplane performance and handling characteristics and their residue may cause stiff or frozen flight controls.</p>	<p>The FAA has received reports of safety concerns regarding airplanes treated with thickened anti-icing fluids. Those reports came from flight crews that conducted rejected takeoffs after their airplanes were treated with thickened anti-icing fluids. The flight crews reported that the airplanes did not respond to normal, and in some cases, higher than normal control column back pressure for rotation to the takeoff attitude. The flight crews assessed the need for unusually high back pressure forces to be a flight control malfunction.</p> <p>They elected to reject the takeoff at speeds in excess of V_1. Fortunately, these rejected takeoffs did not occur during takeoffs that were limited by runway length. If they had, these rejected takeoffs could have resulted in runway overruns with potentially catastrophic outcomes.</p>	<p>This policy statement describes an approval process that may be used by type certificate holders and applicants for a type certificate under parts 23 and 25 to support operational use of these fluids on their airplanes.</p>	<p>On-going, draft policy completed and reviewed by Icing Steering Committee. Now in record clearance review within FAA business lines.</p>

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK #6.2.01 **Advisory Circulars:** **AC 20-147A, Turbojet, Turboprop, and Turbofan Engine Induction System Icing and Ice Ingestion**
Sponsor: **Aircraft Certification, Engine and Propeller Directorate**

Description	Problem/Issue	Action(s)	Status
AC 20-147A, Turbojet, Turboprop, and Turbofan Engine Induction System Icing and Ice Ingestion	Update guidance materials to reflect new rulemaking activities for activities for engine (part 33) and engine installations (part 23 and 25) regarding supercooled large droplet (SLD), mixed phase, and ice crystal icing conditions, and other harmonized standards that were reviewed by the Aviation Rulemaking Advisory Committee, Engine Harmonization Working Group.	Update AC20-147A to reflect rulemaking activities for Task 6.1.01 and other harmonized standards reviewed by the Aviation Rulemaking Advisory Committee, Engine Harmonization Working Group.	Proposed guidance published for public comment in June 2010. Final guidance to be published with rulemaking in Task 6.1.01 (AC will be issued with revised rule).

TASK #6.2.02 **Advisory Circulars:** **AC 25-XX, Compliance of Transport Category Airplanes with Certification Requirements for Flight in Icing Conditions**
Sponsor: **Aircraft Certification, Transport Airplane Directorate**

Description	Problem/Issue	Action(s)	Status
AC 25-XX, Compliance of Transport Category Airplanes with Certification Requirements for Flight in Icing Conditions	Rulemaking Task 6.1.01 requires documentation of an acceptable means of compliance to explain how the new rulemaking can be complied with.	Develop new guidance materials to reflect rulemaking activities for Task 6.1.01.	Proposed guidance published for public comment in June 2010. Final guidance to be published with rulemaking in Task 6.1.01 (AC will be issued with revised rule).

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK #6.2.03 Advisory Circulars: Update to AC 25-25x, Performance and Handling Characteristics in the Icing Conditions Specified in Part 25, Appendix C
Sponsor: Aircraft Certification, Transport Airplane Directorate

Description	Problem/Issue	Action(s)	Status
AC 25-25, Performance and Handling Characteristics in the Icing Conditions Specified in Part 25, Appendix C.	AC 25-25x does not reflect rulemaking created in accordance with Task 6.1.01.	Update guidance materials to reflect new rulemaking activities for Task 6.1.01.	Proposed guidance materials published for public comment in June 2010. Final guidance is near completion.

TASK # 6.2.04 Advisory Circulars: AC 120-60C, Ground Deicing and Anti-icing Program
Sponsor: Flight Standards, Air Transportation Division

Description	Problem/Issue	Action(s)	Status
AC 120-60C Ground Deicing and Anti-icing Program.	Original AC written based on airline operators doing their own ground deicing procedures and training. Now, airlines often use 3 rd party service providers. The service providers use non-specific deicing programs due to the large number of operators they support. New AC materials needed to establish training, procedural, equipment, and quality control requirements for service providers. Current deicing practices by service providers leads to a lack of standardization, quality control and traceability for the FAA and the air carriers. Significant safety gain would be made with a win-win for the air carriers, service providers, and the FAA.	Draft advisory materials nearly complete. Letter of Authorization (LOA) process to establish a means for service providers independent of an air carriers deicing program, that would address the current day practices is not complete – need to resolve use of LOA program and implementation within FAA. Need AFS mgmt approval for release and implementation.	The draft of AC 120-60C is being prepared by a joint FAA – industry working group. Completion is anticipated in 2013. The LOA/Third Party approval process proposal is in preparation.

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK #6.2.09 **Advisory Circulars:** **Update AC 91-74A, Pilot Guide: Flight In Icing Conditions**
Sponsor: **Flight Standards, General Aviation and Commercial Division**

Description	Problem/Issue	Action(s)	Status
AC 91-74B, Pilot Guide: Flight In Icing Conditions, updated AC materials – last release was 12/31/2007. AC contains information on safe flight in icing conditions, what conditions should be avoided, and information on how to avoid or exit those conditions if encountered	AC 91-74A does not include information related to operations in SLD or ice crystal icing conditions as discussed in rulemaking activity in Task 6.1.01. Need to incorporate SLD, mixed phase and ice crystal icing conditions operations to support targeted release of new rules. Need to revise and augment existing ice crystal icing guidance information.	Update AC 91-74A to include SLD and ice crystal icing conditions operations to support targeted release of new rule in Task 6.1.01.	Plan to initiate this Task in FY 2013.

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.4.01

In-flight Icing: AIM/AIP Icing Terminology Definitions

Sponsor: Flight Standards, Air Transportation Division

Performing Organizations: Aviation Weather Division and Aviation Research Division

Description	Problem/Issue	Outcome	Action(s)	Status
<p>Airman’s Information Manual (AIM) and (AIP) – icing intensity terminology.</p>	<p>The FAA Icing Terminology Working Group proposed new icing definitions for the AIM and AIP and all these definitions were incorporated in the mid 2000s except for those relating to icing intensity. Changes to the intensity definitions have a greater operational impact, affecting AIRMETs, SIGMETs, the CIP and FIP, pilot reports (PIREPs), and FAA controllers. Coordination is required among all effected FAA organizations and the National Weather Service. Need to update effected advisory circulars and other documents where the terms are used, and training for controllers on the use of the new terms.</p>	<p>Update the AIM/AIP with new intensity definitions that include criteria for ice accumulation on the aircraft surface. The term “trace icing” will be discontinued and the term “heavy icing” will be introduced to indicate the highest rate of accumulation, i.e., the accumulation-based terms will be light, moderate, and heavy. No rate of accumulation should be included for the term “severe icing,” since it is reserved for an adverse effect on the aircraft (whatever the rate of accumulation) requiring immediate exit of icing condition.</p>	<p>Form icing intensity terminology working group of all groups in the FAA that will be affected by the changes and the National Weather Service</p> <p>Identify advisory circulars that will need to be modified and initiate change process.</p> <p>Coordinate and oversee development of training material for groups affected by change, in particular, controllers, pilots, and NWS forecasters.</p> <p>Ensure needed software upgrades to FAA operational systems are accomplished prior to implementation of changes to AIM/AIP.</p>	<p>Ongoing.</p> <p>A working group is being organized by Flight Standards and the Aviation Weather Office to organize and carry out the process to change the icing intensity definitions.</p>

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.6.01

Research: Aircraft Icing TCRG – Ice Crystal R&D*

Sponsor: Aviation Safety Office

Performing Organization: Aviation Research Division

Description	Project Plans	Milestones / Deliverables	Status
<p>Activity: Research on convective weather ice crystal icing conditions to support means of compliance</p> <p>Outcomes: The outcome of this R&D will be to provide new test capabilities and test methods to support means of compliance for certification, and new guidance materials for ACs.</p> <p>Partners:</p> <ul style="list-style-type: none"> • NASA • NRC Canada • Transport Canada 	<p>Improve existing capabilities and develop new engineering tools to support means of compliance and new guidance material for engine and airframe rulemaking for aircraft certification and operations in ice crystal icing conditions.</p> <ol style="list-style-type: none"> 1. Examine ice crystal accretion and growth mechanisms in engine compressor-type environments, and 2. Support ground facilities simulation to develop and validate means of compliance for engine ingestion ice crystal testing. <p>The research supports two tasks of the Engine Harmonization Working Group (EHWG) Technology Plan: (a.) Experimental studies and simulation development (EHWG Task 3), and (b.) Data and technical information for rulemaking (EHWG Task 4)</p> <p>Phase I: Evaluate current capabilities to simulate convective weather ice crystals. Develop a parametric study of variables that influence ice crystal ingestion & ice formation inside an engine compressor.</p> <p>Phase II: Conduct test studies of ice formation mechanisms in warm environments representing an engine compressor. Develop ice crystal spray cloud generation methods for ground simulation facilities. Develop an understanding of the effects of altitude versus sea level engine cell testing for ice crystals.</p> <p>Phase III: Data analysis and technical reports</p> <p>Phase IV: Guidance materials for means of compliance methods.</p>	<p>Phase I: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Identify the variables that influence ice crystal ingestion and formation inside a turbine engine. • Evaluate the current capabilities for ground simulation testing of ice crystal conditions. <p><u>Deliverable:</u> Report on ice crystal test plans and ice crystal spray capabilities for ground test facilities.</p> <p>Phase II: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Complete test studies of ice formation mechanisms in warm environments using a “wedge airfoil”. • Deliver preliminary strategy for representative physical models based on modeling of ice formation. • Determine altitude-to-sea level engine test facility ice crystal scaling strategies. <p><u>Deliverable:</u> Data package of the test results that can be utilized in modeling of ice crystal accretions.</p> <p>Phase III: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Report on ice crystal physical models. • Report methods to test engines in simulated ice crystal environments, including altitude scaling effects. <p><u>Deliverable:</u> Report on engine formation model(s).</p> <p>Phase IV: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Determine the performance capabilities, accuracy, and use of ice crystal test techniques for MOC. • Report on ice crystal altitude scaling tests & methods. <p><u>Deliverable:</u> Develop guidance materials for the use of new ice crystal engineering tools for MOC.</p>	<p>Project on-going.</p> <p>Phase I completed, Initial results for Phase I published:</p> <p>SAE 2011-38-0018, “Fundamental Ice Crystal Accretion Physics Studies”, Struk et al</p> <p>AIAA, June 1012 “Fundamental Study of Mixed-Phase Icing, with Application to Ice Crystal Accretion in Aircraft Jet Engines,”, Curie et al</p> <p>AIAA, June 1012 “Ice Growth Measurements from Image Data to Support Ice-Crystal and Mixed-Phase Accretion Testing”, Struk, et al</p>

* Supports Tasks 13 of 1997 Inflight Aircraft Icing Plan

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.6.02

Research: Aircraft Icing TCRG – Ground Icing R&D

Sponsor: Aviation Safety Office

Performing Organization: Aviation Research Division

Description	Project Plans	Milestones / Deliverables	Status
<p>Activity: Research to maintain safe operations and take-off in ground icing conditions.</p> <p>Outcomes: The outcome of this R&D will provide better test methods and analysis tools, updated hold over times or allowance times for new environmental conditions, new operational guidance, and data packages in support of guidance and standards.</p> <p>Partners:</p> <ul style="list-style-type: none"> • Transport Canada • NASA 	<p>Provide Flight Standards the data and information needed from previous winter research testing and analyses of results that update the hold-over time tables and annual winter notice on ground deicing.</p> <p>Phase I:</p> <ol style="list-style-type: none"> 1. Identify natural conditions that are currently not accounted for in HOT and allowance time tables. 2. Evaluate capability of snow generation system to simulate heavy snow. 3. Develop plan for investigation of aero issues relating to the determination of allowance times and the SAE standards for anti-icing fluids tests. 4. Identify technical and operational issues important to the safety and efficiency of ground operations. <p>Phase II:</p> <ol style="list-style-type: none"> 1. Simulate selected natural conditions in chamber. 2. Modify snow generation system to enhance its capability to simulate specified conditions. 3. Conduct research on key issues identified in Phase I. Identify tunnel and analytical test methods. 4. Investigate technical and operational issues identified in Phase I. <p>Phase III:</p> <ol style="list-style-type: none"> 1. Evaluate natural conditions simulation capabilities developed for use in chamber / tunnel. 2. Snow machine. Evaluation of capability of enhanced snow generation systems. 3. Analyze Phase II processed data, write report. 4. Analyze findings from investigations of selected technical and operational issues. 	<p>Phase 1:</p> <p><u>Milestones:</u></p> <ol style="list-style-type: none"> 1. Define type, characteristics, and priority of natural conditions for simulation in cold chambers/tunnels. 2. Evaluation of capability of snow machine. 3. Determine research plan to carry out investigations on aerodynamic issues related to AAT standard. 4. Complete survey of selected technical/ops issues. <p><u>Deliverables:</u> Reports on identification of natural conditions of high priority for chamber or tunnel simulation, the capabilities of snow machine, aero issues and research plans, and survey of selected technical and operational issues.</p> <p>Phase II:</p> <p><u>Milestones:</u></p> <ol style="list-style-type: none"> 1. Complete capability to simulate natural conditions. 2. Complete modified snow machine. 3. Completion of wind tunnel testing and CFD studies. 4. Investigation of selected issues identified in Phase I. <p><u>Deliverables:</u> Report on results of Phase II milestones.</p> <p>Phase III:</p> <p><u>Milestones:</u></p> <ol style="list-style-type: none"> 1. Complete natural conditions simulation testing. 2. Complete evaluation of snow machine capabilities. 3. Analyze data from wind tunnel testing and CFD. 4. Analysis of findings from selected investigations. <p><u>Deliverables:</u></p> <ol style="list-style-type: none"> 1. Report son on results of Phase II milestones. 	<p>Test plans have been developed and implemented to provide data to support required policy development. Collaborative agreement with airline operator to test aircraft on ramp. Phase I deliverables are not completed. Planned additional testing winter 2012-13 on expanded precipitation conditions, and operational issues. Required weather criteria and resource availability determine completion timeline.</p>

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.6.03

Research: Aircraft Icing TCRG – Simulation Methods Development / Validation to Support Appendix C Icing Certification*

Sponsor: Aviation Safety Office

Performing Organization: Aviation Research Division

Description	Project Plans	Milestones / Deliverables	Status
<p>Activity: Enhance icing simulation methods for means of compliance.</p> <p>Outcomes: Provide new test methods, analysis tools, and a 3-D ice accretion database to support validation of computer codes and means of compliance for certification.</p> <p>Partners:</p> <ul style="list-style-type: none"> • NASA • ONERA <p>Performing Org.:</p> <ul style="list-style-type: none"> • University of Illinois at Urbana-Champaign 	<p>This swept wing ice accretion experiment includes icing wind tunnel tests to develop 3-D ice shapes, new simulation techniques to generate simulated ice shapes to attach to swept wing airfoils in dry-air wind tunnels, and testing in dry-air wind tunnels to determine the aerodynamic effects of these ice shapes.</p> <p>Phase I: Complete partnership development, project plans, test plans, and test methods strategies for a FAA, NASA, and ONERA collaborative swept wing ice accretion experimental project. Develop 3-D image capture software, evaluate artificial ice generation methods, and develop experimental requirements for airfoil models and test plans.</p> <p>Phase II: Conduct low-Reynolds number tests in an icing wind tunnel to determine ice shape feature classifications and final ice shapes for use in aerodynamic testing, complete 3-D image analysis, and conduct tests of a swept wing airfoil in a dry-air wind tunnel with simulated ice shapes.</p> <p>Phase III: Complete high-Reynolds number model tests with ice shapes in the pressurized dry-air wind tunnel.</p> <p>Phase IV: Analyze test results data for swept wing experiment, develop benchmark public database, and provide guidance materials for means of compliance methods for swept wing icing test methods and icing CFD tools.</p>	<p>Phase 1: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Identify swept wing ice accretion experiment airfoil. • Develop project plans, test and measurement techniques, and imaging techniques for 3-D ice shapes, experimental & scaling test methods. <p><u>Deliverables:</u> Complete draft project plans and report approach for 3-D ice accretions simulation methods.</p> <p>Phase II: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Design 3 swept wing models, initiate fabrication. • Conduct icing and low-Reynolds number dry-air wind tunnel tests. <p><u>Deliverable:</u> Analysis of test results and report on test methods.</p> <p>Phase III: <u>Milestone:</u></p> <ul style="list-style-type: none"> • Complete high-Reynolds number dry-air tunnel test. • Incorporate results/correlations into analysis methods. <p><u>Deliverable:</u> Evaluation of test results in support of 3-D ice accretion prediction code use to produce swept wing ice shapes.</p> <p>Phase IV: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Determine the capabilities, accuracy, and ability for data to support means of compliance (MOC). <p><u>Deliverables:</u></p> <ul style="list-style-type: none"> • Guidance materials for engineering tools for MOC. • Report of 3D ice aerodynamics test and database. 	<p>A 3-D imaging tool has been selected. Project plans have been developed. A NASA funded research agreement is underway to identify the method for creating the ice shapes for this project. The Common Research Model geometry was selected for wind tunnel tests.</p>

* Supports Task 11 of 1997 Inflight Aircraft Icing Plan

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.6.04

Research: Aircraft Icing TCRG – Rotorcraft Flight In Icing Compliance Criteria

Sponsor: Aviation Safety Office

Performing Organization: Aviation Research Division

Description	Project Plans	Milestones / Deliverables	Status
<p>Activity: Develop improved compliance criteria for rotorcraft seeking approval for flight into known icing conditions.</p> <p>Outcomes: Minimum evaluation criteria for normal and transport category rotorcraft to identify critical icing conditions.</p> <p>Partners:</p> <ul style="list-style-type: none"> • None 	<p>Develop improved evaluation criteria for normal and transport category rotorcraft to identify critical icing conditions data, test conditions, and test results to insure a safe and compliant installation during operation throughout the Appendix C icing envelope. These success criteria will address normal, degraded, and failed operations of the rotorcraft ice protection systems, including evaluating rotor ice accretion and ice shedding</p> <p>Phase 1: Evaluate rotorcraft flight into icing data, methods, technology, and analytical tools.</p>	<p>Phase 1:</p> <p><u>Milestones:</u></p> <ul style="list-style-type: none"> • Obtain and analyze existing civil rotorcraft compliance data for flight in icing conditions and develop minimum requirements for natural icing and icing wind test data, test methods, analytical data, and instrumentation. <p><u>Deliverables:</u> Define minimum rotorcraft requirements for natural icing and icing wind test points, test methods, analytical data, and instrumentation</p>	<p>Research task starts in FY 2013.</p>

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.6.05

Research: Forecast/Diagnostic Tools Development for Managing In-flight Icing Weather Threat*

Sponsor: Aviation Weather Division

Performing Organization: Aviation Weather Research Program

Description	Project Plans	Milestones / Deliverables	Status
<p>Activity: Provide diagnostic and forecast icing products based on Numerical Weather Prediction (NWP) models and real-time weather observations from satellites, dual-polarization radar, and other systems.</p> <p>Outcomes: Develop diagnostic/forecast tools to assist flight crews in detecting, avoiding, and managing in-flight icing environments in CONUS and Alaska; develop global icing product.</p> <p>Partners: NOAA – NWS, AWC, ESRL, NSSL</p> <ul style="list-style-type: none"> • NASA – Glenn Research Center, Langley Research Center <p>Performing Org.:</p> <ul style="list-style-type: none"> • NCAR 	<p>The long-term goal for in-flight icing diagnosis and forecasting is a high-resolution, frequently-updated field of liquid water content (LWC), drop size distribution, and temperature. It will incorporate a gridded depiction of IFI severity and probability (as required and feasible) of an encounter based on integration of meteorological model output with real-time sensor data and pilot reports. A goal is a depiction of icing conditions residing within the current certification atmospheric envelopes in Appendix C, 14 CFR § 25 and the proposed Appendix O supercooled large drop (SLD) conditions. Details on time and space resolution and expected accuracy and coverage will be defined by NextGen Functional and Operational Requirements.</p> <p>Phase I: Improvement to CIP and FIP for NextGen Segment Implementation Plan (NSIP) Segment Alpha (CIP-FIP-High Resolution)</p> <p>Phase II: Complete Software Transition Tasks for CIP/FIP-High Resolution</p> <p>Phase III: Develop Icing Products for Alaska. Initially, develop Icing Product Alaska (IPA) which will contain a combined diagnosis and forecast. Eventually, algorithms to diagnose and forecast icing parameters such as LWC and drop size will enhance IPA.</p> <p>Phase IV: Development of a new icing algorithm, Model of Icing Conditions for Real-time Operations (MICRO), whose outputs will include LWC, a drop size metric as icing probability, estimate of severity and SLD.</p>	<p>Phase I: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Implement and test upgrades to CIP/FIP-High Res • Coordinate verification activities <p><u>Deliverables:</u></p> <ul style="list-style-type: none"> • Report on improvements to CIP/FIP-High Resolution • Verification report on CIP/FIP-High Resolution <p>Phase II: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Complete source code and documentation <p><u>Deliverables:</u></p> <ul style="list-style-type: none"> • Source code and documentation for CIP/FIP-High Resolution to Aviation Weather Center (AWC) <p>Phase III: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Experimental, then operational version of IPA <p><u>Deliverable:</u></p> <ul style="list-style-type: none"> • IPA diagnostic and IPA forecast documents <p>Phase IV: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Improvement of NWP model bulk microphysical parameterization for prediction of water and ice • Utilize improved satellite and radar information • Use research aircraft for verification of MICRO output • Prepare for NSIP for Segment Bravo. <p><u>Deliverables:</u></p> <ul style="list-style-type: none"> • Report on use of improved satellite and radar and regionalization information in MICRO • Report on the sensitivity of LWC and MVD estimates to changes in the microphysics and analyze the resulting output from the first version of MICRO • Report on MICRO verification with research aircraft 	<p>Upgraded CIP/FIP, code and documentation to AWC.</p> <p>CIP/FIP Hi-res in development.</p> <p>Continued icing product for Alaska – combine diagnosis and forecast tools into one product.</p> <p>Improving microphysics in model, and evaluating sensor data to improve parameter inputs.</p>

* Supports Tasks 2 of 1997 Inflight Aircraft Icing Plan

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.6.06

Research: Weather TCRG – High Ice Water Content (HIWC) Flight Research*

Sponsors: Aviation Safety Office and Aviation Weather Division

Performing Organizations: Aviation Research Division and Aviation Weather Research Program

Description	Project Plans	Milestones / Deliverables	Status
<p>Activity: Mitigate the convective weather ice crystal weather threat to aircraft turbine engines.</p> <p>Outcomes: Provide new test capabilities and test methods to support means of compliance for certification, new guidance materials for advisory circulars, and new ice crystal weather diagnosis and forecast tools</p> <p>Partners:</p> <ul style="list-style-type: none"> • NASA • Environment Canada • Australian Bur Met • Transport Canada • National Research Council Canada • Boeing • Airbus <p>Performing Org:</p> <ul style="list-style-type: none"> • NCAR 	<p>Conduct flight research field campaigns in HIWC environments to acquire atmospheric measurements of high altitude ice crystal conditions, typically found in the outgrowths of convective weather systems. Develop HIWC diagnosis and forecasting algorithms for use in evaluating and mitigating the ice crystal weather threat to engines. Analyze database from the field campaigns for potential rulemaking and validate the HIWC diagnosis and forecasting algorithms.</p> <p>Phase I: Prepare for Trial Field Campaign Support development of flight test platform for ice crystal research and instrumentation to measure ice crystals for atmospheric characterization. Develop version 1 of HIWC diagnosis and forecasting algorithms.</p> <p>Phase II: Trial campaign, post-campaign analysis Conduct trial field campaign. Analyze selected data sets collected. Use results to improve instrumentation and flight strategies for field campaign. Modify HIWC algorithms and the diagnostic product based on trial field campaign data experience.</p> <p>Phase III: Field campaign Provide resources to conduct full field campaign. Provide forecasting and flight scientist support for field campaign. Collaborate and coordinate with HIWC partners on forecast support methods.</p> <p>Phase IV: Analyze the ice crystal properties Complete analysis of data from field campaigns.</p> <p>Phase V: Evaluate the ice crystal flight data against Appendix D envelopes, simulation capabilities, and complete operational test and evaluation of HIWC nowcast tools.</p>	<p>Phase I: Milestones:</p> <ul style="list-style-type: none"> • Prepare of aircraft flight platform for trial campaign • Complete version 1 of HIWC algorithms. <p>Deliverables:</p> <ul style="list-style-type: none"> • Aircraft flight platform for trial campaign • Version 1 of HIWC algorithms <p>Phase II: Milestones:</p> <ul style="list-style-type: none"> • Complete trial campaign, version 2 of HIWC algorithms <p>Deliverables:</p> <ul style="list-style-type: none"> • Flight data from trial field campaign. • Version 2 of HIWC algorithms <p>Phase III: Milestone:</p> <ul style="list-style-type: none"> • Complete full campaign, version 3 of HIWC algorithms <p>Deliverable:</p> <ul style="list-style-type: none"> • Data from full field campaign available for analysis. • Version 3 of HIWC algorithms <p>Phase IV: Milestones:</p> <ul style="list-style-type: none"> • Complete analysis of ice crystal atmospheric properties. • Complete verification of Version 3 HIWC algorithms <p>Deliverables:</p> <ul style="list-style-type: none"> • Report on analysis methods and results. • Report on the verification of Version 3 HIWC algorithms <p>Phase V: Milestones:</p> <ul style="list-style-type: none"> • Appendix D evaluation and facility simulation guidance <p>Deliverables:</p> <ul style="list-style-type: none"> • Update Appendix D engineering standard • Guidance materials for ice crystal ground facility testing 	<p>On-going. Instrumentation mods for high-altitude, high speed flight research completed. HIWC partners developed Science Plan and flight operations plan. NASA contract underway for ice crystal research aircraft. Started coordination & integration of HIWC flight operations with European Union HAIC operations.</p>

* Supports Tasks 2 & 13 of 1997 Inflight Aircraft Icing Plan

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.6.07

Research: Weather TCRG – Terminal Area Icing Weather Information System (TAIWIS)*

Sponsors: Aviation Safety Office and Aviation Weather Division

Performing Organization: Aviation Research Division and Aviation Weather Research Program

Description	Project Plans	Milestones / Deliverables	Status
<p><u>Activity:</u> Manage terminal area icing weather information for operational decision making for both ground and in-flight icing conditions.</p> <p><u>Outcome:</u> Provide a prototype terminal area icing weather information system that will provide accurate real-time icing conditions information to air traffic staff, weather dispatchers, ground operations staff, and flight crews.</p> <p><u>Partners:</u></p> <ul style="list-style-type: none"> • NASA <p><u>Performing Org.:</u></p> <ul style="list-style-type: none"> • NCAR 	<p>Develop a measurement and analysis suite of sensors that combine the products of liquid water equivalent (LWE) research, winter weather ground icing research, and remote sensors and other new technology developments into a comprehensive terminal area icing weather product</p> <p><u>Phase I: Operational Definition</u> Develop a concept of use document for the information needed for operations in terminal area icing conditions. Include operational extent of coverage, current and forecast icing weather requirements and cloud properties, updating and resolution requirements, and any other details that will provide the basis for determining the measurement criteria and technologies needed. Conduct a gap analysis.</p> <p><u>Phase II: Research/laboratory system</u> Develop, integrate, and field a research-level TAIWIS built around existing ground-based remote detection technologies: Next Generation Weather Radar (NexRad), surface observations from the Automated Surface Observation System (ASOS), a LWE rate sensing package, and current icing weather products that can nowcast and forecast icing weather in the terminal area.</p> <p><u>Phase III: Prototype TAIWIS</u> Develop and field a prototype TAIWIS enhanced with technologies identified in Phase II. operational needs based on concept requirements.</p> <p><u>Phase IV:</u> Identify any further enhancements needed for the prototype TAIWIS. Make improvements to the system.</p>	<p>Phase I: <u>Milestone:</u></p> <ul style="list-style-type: none"> • Develop concept of use and system design documents. <p><u>Deliverable:</u></p> <ul style="list-style-type: none"> • concept of use and system design documents <p>Phase II: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Develop research system. <p><u>Deliverable:</u> Field system at a selected airport. Identify current system capabilities and make recommendations for improvements</p> <p>Phase III: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Develop prototype TAIWIS. • Field test prototype TAIWIS., and analyze results of the field test. <p><u>Deliverables:</u></p> <ul style="list-style-type: none"> • Evaluate and report on the prototype system capability. • Determine if system can meet the concept of use requirements for the targeted operations community. <p>Phase IV: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Develop Collect and analyze data. <p><u>Deliverable:</u></p> <ul style="list-style-type: none"> • Determine if system can fulfill intended concept of use. 	<p>Task started FY 2012.</p> <p>Developing draft concept of use. Technology review of current ground-based remote detection and terminal area dual-pol radar. Initial measurement capabilities to deliver icing conditions aloft.</p>

* Supports Tasks 2 of 1997 Inflight Aircraft Icing Plan

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.6.08

Research: Weather TCRG – Using Data Linked Aircraft Sensed Weather Information to Determine Probability of Icing Conditions Aloft*

Sponsors: Aviation Safety Office and Aviation Weather Division

Performing Organizations: Small Airplane Directorate and Aviation Weather Research Program

Description	Project Plans	Milestones / Deliverables	Status
<p><u>Activity:</u> Determine the probability of icing conditions aloft using data linked aircraft-sensed weather information.</p> <p><u>Outcome:</u> Provide processed aircraft sensed weather data to end-users to support “identify and avoid” strategies for high probability areas of known icing conditions.</p> <p><u>Partners:</u></p> <ul style="list-style-type: none"> • None at this time 	<p>The outcome of this research will provide processed aircraft-sensed weather data to the end-users (i.e. operators, Air Navigation Service Providers (ANSPPs), etc.), allowing the users to clearly understand where high probability areas of known icing conditions exist. This will support operations for “identify and avoid” icing conditions for aircraft, especially GA airplanes. The data can also be used for “go/no-go” decision making, ground de-icing operations, and inclusion in weather prediction models to support decision making for operations in icing conditions.</p> <p><u>Phase I: Establish Icing Conditions Criteria</u> Determine meteorological conditions that indicate a high probability of icing conditions, i.e., specific temperature range, high relative humidity, integrated precipitable water (IPW), specific cloud characteristics, etc.</p> <p><u>Phase II: Acquire and Compare Data</u> Acquire a complete dataset of past records of aircraft sensed weather containing both temperature and water vapor and/or icing data. Water Vapor Sensing System (WVSS) data and Tropospheric Airborne Meteorological Data Reporting (TAMDAR) data may be included. Update dataset on a daily basis as new data becomes available. Compare the data to known icing encounters derived from PIREPS, CIP, FIP, and other data sources.</p> <p><u>Phase III: Correlate Sensed Weather to Icing</u> Develop correlating aircraft sensed weather information (i.e., temperature, water vapor, icing data, etc.) that identify areas of known icing conditions aloft with a high confidence.</p>	<p>Phase I: <u>Milestone:</u></p> <ul style="list-style-type: none"> • Establish icing conditions criteria. <p><u>Deliverable:</u> Report on meteorological conditions that indicate a high probability of icing conditions.</p> <p>Phase II: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Acquire past and current data from on-board sensing systems that support evaluation of icing conditions aloft. • Compare aircraft-sensed data to other data records from PIREPs, weather radar, forecast/diagnostic icing weather tools, surface observations, and other information. <p><u>Deliverable:</u> Report on data collection and analysis: methods, approach, and comparison results.</p> <p>Phase III: <u>Milestones:</u></p> <ul style="list-style-type: none"> • Correlate aircraft-sensed meteorological data to a probability index for icing conditions aloft. • Define probability index and relation to icing conditions. <p><u>Deliverables:</u></p> <ul style="list-style-type: none"> • Report results and evaluate icing conditions probability methodology for use in an operational test. • Implement results into icing weather products, PIREPS and other reporting tools, and recommendations/incorporation into meteorological and operational documents. 	<p>Research requirement approved, FY 2014 start.</p>

* Supports Tasks 2 of 1997 Inflight Aircraft Icing Plan

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.7.01 **Standards Development:** **Draft AC 29.1419. §29.1419 (Amendment 29-21) Ice Protection**
Sponsor: **Aircraft Certification, Rotorcraft Directorate**

Description	Problem/Issue	Outcome	Action(s)	Status
<p>Activity: Develop Draft AC 29.1419 materials.</p> <p>Revise draft ice protected rotorcraft advisory materials.</p> <p>Note: This Task is being developed through a panel in the SAE AC-9C committee.</p>	<p>Need to update outdated FAA rotorcraft advisory circular.</p> <p>The FAA has requested that SAE International support the updating of rotorcraft advisory materials through the represented rotorcraft icing industry specialists in the AC-9C committee.</p>	<p>Once AC-9C completes developing draft materials, the FAA Rotorcraft Directorate will revise rotorcraft icing certification advisory materials to reflect new practices by industry for use of engineering tools for rotorcraft icing certification</p>	<p>Coordinate with SAE AC-9C industry members and rotorcraft icing specialists to revise rotorcraft icing certification advisory materials to reflect new practices by industry for use of engineering tools for rotorcraft icing certification. Provide descriptions of new means of compliance now used by rotorcraft industry with supportable validation or test/analysis experience.</p>	<p>Started draft AC 29-1419 materials development in May 2009. Target completion of draft document for FAA use is by September 2013 (target).</p>

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.7.02 Standards Development: Aerospace Information Report (AIR) – 6189 Calibration and Test Methods for Turbine Engine Icing Test Facilities
Sponsor: Aircraft Certification, Engine and Propeller Directorate

Description	Problem/Issue	Outcome	Action(s)	Status
<p>Activity: AIR 6189, Calibration and Test Methods for Turbine Engine Icing Test Facilities</p> <p>Provide descriptions of test procedures and established practices for the application, use, and administration of conducting turbine engine icing testing in ground test facilities for icing certification purposes.</p> <p>Note: This Task is being developed through a working group supported jointly by the SAE EG-1E and SAE AC-9C committees.</p>	<p>The FAA has requested that SAE International develop standards document(s) to establish current practices and guidelines for the acceptable use of aircraft turbine engine icing test facilities and test methods to support certification.</p> <p>At this time, the industry consensus is that the current facilities and their historical test experiences can be significantly different and there are not a set of common test practices across their use. The intent is to first create an AIR to identify the methods and equipment currently used, followed by an ARP to define industry wide acceptable standards for operating turbine engine icing test facilities for use in certification.</p>	<p>Provide engine icing test facilities owners, users, and the FAA Aircraft Certification Office certification specialist standards documents that describe acceptable practices for calibration, operation, and testing to icing certification.</p>	<p>Develop current practices through an AIR, and then develop Aerospace Recommended Practices (ARP) that defines industry-wide acceptable standards for operating turbine engine icing test facilities for use in certification.</p>	<p>Started AIR 6189 in May 2011. Target completion of draft document for review and balloting by the SAE development committees by June 2013.</p> <p>Meet twice a year coincident with SAE EG-1E and AC-9C committee meetings. SAE members, engine and icing experts, and engine test cell owners / developers and users, working on document sections to complete first draft.</p>

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.7.03 **Standards Development:** **SAE Aerospace Standard (AS) 5562, Ice and Rain Qualification Standards for Airdata Probes, and EUROCAE Pitot Qualification to Ice & Rain**

Sponsors: **SAE AC-9C (Aircraft Icing Technology Committee), and EUROCAE Working Group 89**

Description	Problem/Issue	Outcome	Action(s)	Status
<p>Activity: SAE AC-9C: AS 5562, Ice and Rain Qualification Standards for Airdata Probes, and EUROCAE WG-89: Pitot Qualification to Ice & Rain standards development.</p> <p>Note: 1. This Task is being developed through the SAE AC-9C committee, and the EUROCAE Working Group 89. 2. AS 5562 in conjunction with AS 8006* will form the overall Pitot and Pitot Static standard. AS 8006 will reference AS 5562 for the ice and rain conditions. AS 8006 is maintained by the SAE A-4 committee.</p>	<p>SAE AC-9C Develop updated criteria for pitot probe testing in icing conditions. Document is outdated. New issues have arisen recently with pitot probe and other air data probes failures during operations in convective weather, high-altitude ice crystal conditions. The current icing regulations and TSO standards do not address these conditions and the general content of the current version of the SAE standard AS 8006 needs to be updated. The events in high altitude ice crystal conditions are characterized by short term loss or misleading display of air data parameters (pressure, temperature or airspeed) from one or all air data systems. This can lead to flight crew confusion and potential degradation in flying qualities.</p>	<p>Define the static upstream ice/rain conditions based on the possible clouds or atmosphere ice/rain conditions in which an aircraft can fly, and to match these conditions down to the probe to determine ice/rain conditions that are actually applied to probes in flight.</p> <p>Complete new technical standards documents for air data probes, then update TSO C-16 to improve new performance criteria.</p>	<p>Airplane manufacturers, airline operators, and other users of air data probes need updated standards for certification to support meteorological event conditions and installation issues that have resulted in failures of current probes. Standards need to be updated to provide design, test, and installation criteria that support acceptable operational use without failures. Need to harmonize the SAE and EUROCAE air data probe standards documents.</p> <p>Then, AS 5562 and EUROCAE standard can be used as the basis for updating TSO/ETSO C-16, and a recommendation to Aircraft Certification AIR-120 to update this TSO. Along with the EASA counterpart in Europe.</p>	<p>Documents in development.</p> <p>Target for AS 5562: Complete final draft of standards documents by Aug. 2012. SAE AC-9C document review and ballot to follow and AS 5562 to be released by Dec. 2012.</p>

* **AS 8006** - Minimum Performance Standard for Pitot and Pitot-Static Tubes

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK # 6.7.04 **Standards Development:** **Globalized Aircraft Deicing Standards**
Sponsor: **International Air Transport Association, SAE International, and**
International Civil Aviation Organization

Description	Problem/Issue	Outcomes	Action(s)	Status
<p>Activity: Globalized Aircraft Deicing Standards - develop globally harmonized de-icing procedure. Major airline members of the International Air Transport Association (IATA) approached their Operations Committee with a request to develop globally harmonized de-icing procedure – safety and costs would be improved by the adoption of such harmonized standards. IATA requested collaboration with SAE G-12 and ICAO to develop globalized deicing standards. Note: FAA participation through Flight Standards, Air Transportation Division and the Aviation Research Division.</p>	<p>The problem of multiple standards became more apparent as centralized deicing facilities (CDF) started operating in many countries. In some instances, over 80 airlines fly into a centralized facility, each attempting to impose its own standard for deicing on the staff for its own aircraft. Many CDF were faced with impossible tasks of training its staff to many procedures, imposed their own procedures with the approval of the national regulatory authority.</p> <ul style="list-style-type: none"> • Flight crews have to learn the difference between each CDF, which adds to complexity of their tasks. • Service providers are being audited to different standards. 	<p>Harmonize:</p> <ul style="list-style-type: none"> - Application of deicing fluid and include 1) aircraft ground deicing methods, 2) training procedures for aircraft ground deicing and 3) quality control procedures. - Standardized communications between the ground deicing crew. <p>Reduction of the complexity level of deicing procedures for ground crews leading to improved safety</p> <ul style="list-style-type: none"> • Simplified processes for flight crews • Reduce # of training events and standards • More commonality in audit standards 	<p>The Council on Globalized Aircraft Deicing Standards is composed of members of SAE G-12 Aircraft Ground Deicing Committee, IATA, and ICAO. Regulatory authorities currently represented are: EASA, FAA, and Transport Canada. The Council will meet and review existing documentation on procedures for aircraft deicing standards that fall within the scope of this task, and work to harmonize the collected procedures using the following SAE documents as the basis for developing acceptable, harmonized standards:</p> <ul style="list-style-type: none"> • ARP 4737 Aircraft Deicing/Anti-Icing Methods • ARP 5149 Training Program Guidelines for Deicing/Anti-Icing of Aircraft on Ground, and • ARP5646 Quality Program Guidelines for Deicing/Anti-Icing of Aircraft on the Ground. 	<p>On-going.</p> <p>The Council on Globalized Aircraft Deicing Standards started meeting in November 2011 and is developing the work plans to complete this project.</p> <p>Completed draft Terms of Reference, identified and developed members with requisite skills and experience to harmonize guidance, and pulled together training and deicing operations documents across industry use to review current practices.</p>

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK #6.8.01

Training: Part 25 & 23 Engineering Tools to Support Icing Certification
Sponsors: Aircraft Certification

Description	Problem/Issue	Action(s)	Status
<p>Activity: Develop course materials to support Aircraft Certification Office (ACO) training on SLD and ice crystal engineering tools, and the effects SLD icing have on aircraft..</p> <p>Partner:</p> <ul style="list-style-type: none"> NASA 	<p>The ACOs need training for the new regulations and guidance materials for SLD, mixed phase, and ice crystal icing conditions. The engineering tools capabilities that support means of compliance MOC for SLD are quite different than current experience with Appendix C conditions.</p>	<p>Coordinate the development of new training materials for SLD engineering tools that includes new regulations, advisory materials, SLD and ice crystal icing conditions, means of compliance using current facility, experimental, and computational capabilities.</p> <p>Conduct training for ACOs</p>	<p>Course outline developed, instructors identified, course content under development.</p>

TASK #6.8.02

Training: Part 33 Engineering Tools to Support Icing Certification
Sponsors: Aircraft Certification

Description	Problem/Issue	Action(s)	Status
<p>Activity: Develop course materials to support Engine Certification Office (ECO) training on ice crystal and SLD engineering tools, and the effects ice crystal icing has on aircraft turbine engines.</p> <p>Partner:</p> <ul style="list-style-type: none"> NASA 	<p>The ECOs need training for the new regulations and guidance materials for ice crystal, SLD, and mixed phase icing conditions. The engineering tools capabilities that support MOC for ice crystals are different than current experience with Appendix C conditions, and the test points that are conducted for icing certification.</p>	<p>Coordinate the development of new training materials for ice crystal engineering tools that includes new regulations, advisory materials, ice crystal and SLD icing conditions, means of compliance using current facility, experimental, and computational capabilities.</p> <p>Conduct training for ECOs.</p>	<p>Course outline developed, instructors identified, course content under development.</p>

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK #6.8.03

Training: Revise NASA developed icing training videos and courses for pilots
Sponsors: Aircraft Certification and Flight Standards Services

Description	Problem/Issue	Action(s)	Status
<p>Activity: NASA, in collaboration with the FAA, ALPA, AOPA and other organizations developed pilot training materials that have been widely distributed and used. Update pilot training materials related to flight in icing.</p> <p>Partners:</p> <ul style="list-style-type: none"> • NASA • AOPA 	<p>The training videos/DVDs were developed over 10 years ago, and the internet training materials for ground and in-flight icing were completed and released approximately 8 years ago. The training content is still relevant in many areas, but updates are needed to reflect current icing operations and any changes in FAA regulations from training materials original release time.</p> <p>Training must address airplanes not certificated for icing, with an emphasis on avoidance strategies, as well as airplanes certificated for icing.</p>	<ul style="list-style-type: none"> • Develop a review plan with NASA for the updating and future distribution of these training materials. • Prioritize a review process to edit and update specific training content. • Develop a team of subject matter experts to review the content and update the training materials. • Examine the materials previously completed by NASA for ice-protected rotorcraft pilot training for operations in icing conditions (training aid was never completed), and develop plans to complete this work in coordination with NASA, the FAA, and rotorcraft operators. 	<p>Plan to initiate this Task in FY 2013.</p>

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK #6.8.04

Training: Training / No training for Ice Contaminated Tailplane Stall (ICTS)

Sponsor: Flight Standards and Aircraft Certification Services

Description	Problem/Issue	Action(s)	Status
<p>Activity: Develop training for ICTS susceptible aircraft, and remove all training materials for those operators who do not have aircraft susceptible to ICTS.</p>	<p>Airworthiness actions and changes to airplane certification requirements keep airplanes from being susceptible to tailplane stall. Based upon the NTSB recommendation A-10-25, the FAA needs to address the issue of airplane operators providing Ice Contaminated Tailplane Stall training for airplanes that are not susceptible to this condition*.</p>	<p>Establish if any airplanes currently in operation may still be susceptible to ICTS and under what conditions and update training requirements for those airplanes. Include review and possible updating of the NASA Tailplane Stall video. Direct operators of airplanes not susceptible to ICTS to inform pilots of this lack of susceptibility and not to train the ICTS recovery procedure.</p>	<p>FAA survey of airplanes that are/are not susceptible is on-going. Issue Notices in FY 2013.</p>

* **A-10-25:** Identify which airplanes operated under 14 *Code of Federal Regulations* Part 121, 135, and 91K are susceptible to tailplane stalls and then (1) require operators of those airplanes to provide an appropriate airplane-specific tailplane stall recovery procedure in their training manuals and company procedures and (2) direct operators of those airplanes that are not susceptible to tailplane stalls to ensure that training and company guidance for the airplanes explicitly states this lack of susceptibility and contains no references to tailplane stall recovery procedures.

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK #6.8.05

Training: Review Pilot Knowledge Exam Materials and Draft Icing Questions
Sponsor: Flight Standards, Regulatory Support Division

Description	Problem/Issue	Action(s)	Status
<p>Activity: Prioritize and draft icing-related questions for instrument flight rules (IFR), private, commercial, and ATP. Task to be supported by FAA Flight Standards, General Aviation and Commercial Division and Aircraft Certification Services</p> <p>Partners:</p> <ul style="list-style-type: none"> • AOPA 	<p>Pilots still maintain and perpetuate many false beliefs. Focused icing knowledge testing will combat deeply ingrained misconceptions among the pilot population with respect to the level of their aircraft’s icing certification as well as best procedures and practices to follow in icing conditions.</p> <p>Training must address airplanes not certificated for icing, with an emphasis on avoidance strategies, as well as airplanes certificated for icing.</p>	<p>Coordinate the development of new icing related pilot knowledge questions that incorporates new regulations, advisory materials, use of aircraft flight manuals and other practical means of operating safely in this environment.</p>	<p>Plan to initiate this Task in FY 2013.</p>

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK #6.8.06

Training: Review and Revise Icing Materials on FAA Websites
Sponsor: Flight Standards and Aircraft Certification Services

Description	Problem/Issue	Action(s)	Status
<p>Activity: Review and revise icing materials that are outdated or no longer current with policy on FAA websites.</p>	<p>Previous attempts to educate the pilot population on the dangers associated with icing conditions went into great detail in some areas, but provided little practical training on airplane limitations, certification assumptions, and procedures. A number of icing materials on FAA websites are not current and need to be reviewed, updated, organized, and to have non-current content removed.</p> <p>Weather related personal minimums used in FAA-Industry Training Standards (FITS) usually focuses on winds, ceiling and visibility. The part 23 SLD ARC recommended FITS increase emphasis on icing related personal minimums which include “identify and avoid” as well as exit strategies based on pilot/aircraft capabilities, icing reports, and forecasts.</p> <p>Training must address airplanes not certificated for icing, with an emphasis on avoidance strategies, as well as airplanes certificated for icing</p>	<p>Clean up and update icing material on FAA web sites;</p> <ul style="list-style-type: none"> • Update Airplane Flying Handbook icing information (Chapter 12) • Add inadvertent icing encounter information to (Chapter 16) Emergency Procedures • Add icing to FAA Industry Training Standards (FITS). 	<p>Plan to initiate this Task in FY 2013.</p>

APPENDIX A: CURRENT ICING PLAN TASKS – DETAILED REVIEW

TASK #6.8.07

Training: Review of operators (parts 91K, 121 and 135 pneumatic boot equipped airplanes) training programs

Sponsor: Flight Standards, Air Transportation Division and General Aviation and Commercial Division

Description	Problem/Issue	Action(s)	Status
<p>Activity: Review training programs for part 91K, 121, and 135 operators, and part 142 training center curriculums, for pneumatic boot equipped airplanes.</p>	<p>Verify that revisions to icing related training are incorporated and certain items are made special emphasis items. Examples include, stick pusher/stall warning; icing speeds, SLD, weather tools.</p>	<p>The Program Tacking and Reporting Subsystem (PTRS) will be used to verify that revisions to icing related training are incorporated for existing operators. Order 8900.1 inspector guidance will be updated, as required to ensure these items are included when certifying new applicants.</p>	<p>Initiate after the following are completed:</p> <ul style="list-style-type: none"> • The development of ACs in Tasks 6.2.04 through 6.2.06, and 6.2.08, • The updating of training materials in Tasks 6.8.03 through 6.8.06.

APPENDIX B

Completed Icing Plan Tasks and Recent Icing Policy & Safety Actions

A. Completed FAA Aircraft Icing Plan Tasks

B. Recent Icing Policy & Safety Actions

The following is a catalog of actions taken by the FAA to support safe operations in icing conditions.

1. Airworthiness Directives related to icing:

From 1985 to 2008, the FAA issued approximately 200 ADs related to icing on 50 different aircraft models.

Severe Icing	43
Boot Activation	30
Airplane Flight Manual	36
Equipment	57
Engine Operation in Ice Crystal Conditions	9
Engine	16
Takeoff	11
Training	3

2. Recent rulemaking efforts in icing:

- 2.1 Amendment 25-121, *Airplane Performance and Handling Qualities in Icing Conditions for Transport Category Airplanes*, dated October 9, 2007.
- 2.2 Amendment Nos. 91-310, 125-58, 135-119, Removal of Airplane Operating Regulations Allowing Polishing of Frost on Wings of Airplanes, December 1, 2009. The final rule removes language from part 91 subpart F, and parts 125 and 135, which permits aircraft to takeoff with frost that has been polished to make it smooth (“polished frost”) on critical surfaces. Under the final rule, operators will be required to remove any frost adhering to critical surfaces prior to takeoff. Additionally, the rule restructures language in parts 91, 125, and 135 to clarify that aircraft must have functioning deicing or anti-icing equipment to fly under IFR into known or forecast light or moderate icing conditions, or under VFR into known light or moderate icing conditions.
- 2.3 Amendment 25-129, *Activation of Ice Protection (for Transport Category Airplanes)*, dated September 2, 2009
- 2.4 Amendment 121-356, “Activation of Ice Protection (for Certain Airplanes Used in Domestic, Flag, or Supplemental Operations), dated October 21, 2011.
- 2.5 Requirements for Exiting Icing Conditions for Certain Airplanes Used in Domestic, Flag, or Supplemental Operations, NPRM is in work.

- 2.6 Part 25 and 33: Airplane and Engine Certification Requirements in Supercooled Large Drop, Mixed Phase, and Ice Crystal Icing Conditions – NPRM published June 29, 2010, final rule is in work.
- 2.7 Part 23: Certification Requirements in Supercooled Large Drop, Mixed Phase, and Ice Crystal Icing Conditions – Aviation Rulemaking Committee completed its recommendations to the FAA, review for determining next steps by the Small Airplane Directorate is in progress.

3. Recently updated ACs:

This list includes several but may not include all AC materials related to icing. ACs can be found at: http://www.faa.gov/regulations_policies/advisory_circulars/.

- 3.1 20-73A, *Aircraft Ice Protection*, dated August 8, 2006.
- 3.2 20-147, *Turbojet, Turboprop, and Turbofan Engine Induction System Icing and Ice Ingestion*, dated May 2, 2004. An updated version of this AC, 20-147A, is in final review.
- 3.3 23-8C, *Flight Test Guide for Certification of Part 23 Airplanes*, dated November 16, 2011.
- 3.4 23.1419-2D, *Certification of Part 23 Airplanes for Flight in Icing Conditions*, dated April 19, 2007.
- 3.5 25.1419-1A, *Certification of Transport Category Airplanes for Flight in Icing Conditions*, dated May 7, 2004.
- 3.6 25-25, *Performance and Handling Characteristics in the Icing Conditions Specified in Part 25, Appendix*. An updated version of this AC will be released when part 25 new rulemaking for SLD, mixed phase, and ice crystals is adopted.
- 3.7 91-74A, *Pilot Guide: Flight in Icing Conditions*, dated December 31, 2007
- 3.8 120-89, *Ground Deicing Using Infrared Energy*,” dated December 13, 2005.
- 3.9 120-60B, *Ground Deicing and Anti-Icing Program*, dated December 20, 2004.

4. Special Airworthiness Information Bulletins (SAIBs)

An SAIB is an information tool that alerts, educates, and makes recommendations to the aviation community. SAIBs contain non-regulatory information and guidance that does not meet the criteria for an AD. The listing below includes several but may not include all icing-related SAIBs, The SAIBs can be found at:

http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgSAIB.nsf/MainFrame?OpenFrameSet

- 4.1 NE-02-28, 05/23/2002 Emergency Landing in Inclement Weather.
- 4.2 SW-03-08R1, 11/10/2003 Continued Accidents Due to Loss of Power From Snow or Ice Ingestion on Turbohaft Powered Rotorcraft.
- 4.3 NE-07-01, 10/12/2006 Dual Engine Flameouts on Twin Engine Airplanes.
- 4.4 NE-07-03, 10/12/2006 Dual-Engine Flameouts.
- 4.5 NM-08-27R1, 12/31/2008 Landing gear: Catalytic Oxidation of Aircraft Carbon Brakes due to Runway De-icing (RDI) Fluids.
- 4.6 CE-09-35, 06/30/2009 Carburetor Icing Prevention.

- 4.7 SW-08-03R2, 1/15/2010 Recommendations for Rotorcraft During Icing Conditions.
- 4.8 CE-11-18, 1/24/2011 Ice/Rain Protection System – Stall Warning.
- 4.9 NM-11-48, 08/22/2011 Ice and Rain Protection: Wing Transverse Duct Assembly
- 4.10 CE-12-05, 11/02/2011 Navigation: Water freezing in Pitot-Static System

5. Safety Alerts For Operators (SAFOs) on icing:

SAFOs contain important safety information and may contain recommended actions. SAFO content should be especially valuable to air carriers in meeting their statutory duty to provide service with the highest possible degree of safety in the public interest. The information and recommendations in a SAFO are often time critical. The listing below includes several but may not include all icing –related SAFOs. The SAFOs can be found at:

http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo/all_safo/

- 5.1 March 29, 2006, the FAA issued SAFO 06002 on ground deicing practices for turbine airplanes in nonscheduled part 135 and part 91 service.
- 5.2 October 6, 2006, the FAA issued SAFO 06014 to warn against the hazards posed by polished frost.
- 5.3 November 11, 2006, the FAA issued SAFO 06016 to increase awareness of in-flight icing dangers for pilots flying turbo-propeller powered airplanes.
- 5.4 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.
- 5.5 January 25, 2008, the FAA issued SAFO 08006 to clarify the definition for severe icing and the need to immediately exit these conditions when encountered (part 91/135).
- 5.6 May 20, 2008, the FAA issued SAFO 08012 on aircraft taxi operations during snow and ice conditions.
- 5.7 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.
- 5.8 February 4, 2010, the FAA issued SAFO 10001 to alert operators and pilots of airplanes with unpowered elevator control surfaces that increased elevator control forces may be required for proper rotation to the takeoff attitude after treatment with Type II or IV anti-icing fluids.
- 5.9 March 16, 2010, the FAA issued SAFO 10006 concerning approved training programs for flight crew and inadvertent encounters of in-flight icing conditions, including freezing drizzle (FZDZ) and freezing rain (FZRA).

6. Information For Operators (InFOs) on icing:

InFOs contain information or a combination of information and recommended action to be taken by the respective operators identified in each individual InFO. The listing below includes several but may not include all icing –related InFOs. The InFOs can be found at:

http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/info/

- 6.1 May 16, 2008, the FAA issued *InFO 08024* to provide guidance to operations inspectors concerning the use and limitations of the Automated Surface Observing System (ASOS) freezing Rain Sensor to measure ice accretion.
- 6.2 May 16, 2008, the FAA issued *InFO 08033* to provide guidance and information for pilots and operators regarding icing encounters at high altitudes
- 6.3 May 5, 2009, the FAA issued *InFO 09007* to ensure that all pilots of pneumatic deicing boot-equipped airplanes understand and receive training on proper operation of those systems and on maintaining an appropriate airspeed in icing conditions.
- 6.4 October 1, 2009, the FAA issued *InFO 09016* to emphasize the significance of unsafe conditions regarding performance and controllability caused by small amounts of contamination on aircraft aerodynamic and control surfaces.
- 6.5 March 28, 2011, the FAA issued *InFO 11008* to alert all users to a revision to the 2010-2011 Ground Deicing Holdover Time tables and guidance.
- 6.6 August 10, 2011, the FAA issued *InFO 11013* to inform operators of two things: 2011-2012 HOTs and AFS-200's Aircraft Ground Deicing website's notification feature

APPENDIX C

Icing Steering Committee

The Icing Steering Committee (ISC) was developed by Aviation Safety to oversee and coordinate safe operations in icing conditions.

The ISC is composed of FAA icing specialists in aircraft certification, flight standards, icing weather, and research who work together as a team to resolve aircraft icing issues. The group currently meets twice a year to address current issues of concern, review the status of research plans, and coordinate policy and guidance needs for Aviation Safety. The group is composed of members from Aircraft Certification Service Engine and Propeller, Rotorcraft, Small Airplane, and Transport Airplane Directorates, from Flight Standards Service Air Transportation Division, the Flight Safety Branch at the FAA Technical Center, the Aviation Weather Division, the FAA Headquarters Aircraft Engineering Division, and the Chief Scientist and Technical Advisor for Flight Environmental Icing.

The ISC reviews current rulemaking and operations actions, any accidents/incidents and previous winter operations events, and international certification/ operations issues. The group highlights areas of concern and identifies actions that need to be addressed. The Icing Steering Committee was recently renamed from its original chartered group and re-cast to include an expanded membership within the FAA business lines.

Committee Members (current members based on FY 2013 committee membership)

<u>Name</u>	<u>Org Code</u>	<u>E-mail</u>
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APPENDIX D

GAO Review of FAA Icing Program

In 2009, there were two accidents that occurred in the U.S. during operations in icing, one was a cargo aircraft¹ and the other was during a revenue service flight². After those accidents, the U.S. Congress tasked the Government Accountability Office (GAO) to review the FAA aircraft icing program and provide a report on their findings³.

GAO Recommendation 1 to the FAA:

“Develop a comprehensive plan, in consultation with public and private stakeholders, to guide efforts to address challenges to improving safety in icing and winter weather conditions. The plan should focus on winter operations holistically, be clearly communicated to all affected parties, and include detailed goals, milestones, and time frames that can be used to gauge performance and progress, identify gaps, and determine areas for improvement. FAA should also periodically report to affected parties on its progress in implementing the plan, as well as any updates to the plan.”

As the FAA responded to this GAO request, it became apparent that a significant number of the tasks in the 1997 *Inflight Aircraft Icing Plan* had been completed and some set aside as no longer required. Furthermore, other activities on ground icing and more recent issues such as turbine engine ice crystal ingestion and icing weather research were not identified in the 1997 plan. The ISC made a determination that there was a need to provide a report documenting the status of all tasks in the 1997 *Inflight Aircraft Icing Plan*, close-out the tasks from that plan and develop a new Icing Plan that was more comprehensive in nature.

The new Icing Plan will reassess past ideas and actions and address new issues and emerging technology. This approach is intended to not only keep the FAA’s focus on the effectiveness of past efforts but to also use current data and technology to improve aviation safety in the areas associated with winter operations. With the new Icing Plan, the FAA intends on continuing to work with other agencies and organizations in identifying vulnerabilities and mitigations needed to improve on icing operations across the aviation community.

¹ Cargo: January 27, 2009, an Aerospatiale Alenia ATR-42-320, operating as Empire Airlines flight 8284, sustained substantial damage when it landed short of the runway threshold at Lubbock Preston Smith International Airport (LBB), Lubbock, Texas. NTSB accident report: AAR 11/02; <http://www.nts.gov/doclib/reports/2011/aar1102.pdf>

² Revenue Service: February 12, 2009, a Colgan Air Inc., Bombardier Dash 8-Q400, N200WQ, d.b.a. Continental Connection flight 3407, crashed during an instrument approach to Buffalo-Niagara International Airport (BUF), Buffalo, New York. NTSB accident report: AAR 10/01; <http://www.nts.gov/doclib/reports/2010/aar1001.pdf>

³ GAO Report GAO-10-678: “Aviation Safety, Improved Planning Could Help FAA Address Challenges Related to Winter Weather Operations,” July 2010. Report can be found at: <http://www.gao.gov/new.items/d10678.pdf>

APPENDIX E

FAA Tools to Address Safety Issues

The FAA uses an array of safety tools when reviewing certification and/or operations issues resulting from accidents, incidents, or other events that indicate potential unsafe conditions: post certification evaluations – fact finding investigations and special certification reviews, airworthiness directives, issue papers, special conditions, safety bulletins, regulations, advisory materials, training, standards development, and targeted research.

The following is a description of these tools with examples of how many of them were used by the FAA to insure immediate actions in some cases, and timely follow-on responses in others, to address safety concerns that were identified from the October 31, 1994 American Eagle Flight 4184, ATR-72, Roselawn, IN accident.

1. Fact Finding Investigations are used by the FAA to acquire information necessary to decide what FAA action, if any, should be taken.

Example: Testing was conducted on an ATR-72 in simulated SLD conditions behind the United States Air Force Icing Tanker within 6 weeks of accident. Results showed that SLD ice accretions formed a ridge of ice behind the pneumatic boots. Tests with simulated ice shapes representing the ridge resulted in a roll event with a trajectory that nearly replicated the initial accident profile. These results supported FAA actions: first for the ATR-42/72, then for all aircraft operating with pneumatic boots and unpowered controls.

Example: FAA initiated a fact-finding investigation of airplanes certificated under 14 CFR parts 23 and 25 that are used in regularly scheduled passenger service in the U.S. and equipped with pneumatic deicing boots and unpowered ailerons

2. Special Certification Reviews (SCRs) are used by the FAA to address potential safety problem areas (e.g., unsafe features or unsafe operational characteristics) on previously approved products.

Example: The FAA initiated a SCR on ATR 42/72 airplanes and found they were properly certificated to the current requirements of the federal regulations. The SCR found that the icing conditions of the Roselawn accident were well outside the 14 CFR Part 25, Appendix C icing atmospheric envelopes, and recommended the current fleet of airplanes should be examined for means of detection, exit procedures, and safe operations through exiting conditions which exceed those defined in appendix C.

3. Airworthiness Directives (ADs) are used by the FAA to address immediate safety of flight issues by mandating actions in accordance with 14 CFR Part 39 for the affected fleet.

Example: As a result of the October 31, 1994 ATR-72 accident at Roselawn, IN, the FAA issued over 40 severe icing ADs on airplanes with pneumatic boots and unpowered controls. The ADs required the addition of visual cues into specific AFMs to be used by the flight crew to determine when the airplane is in severe icing conditions that exceed those for which the airplane is certificated, and procedures to require the flight crew to exit icing conditions.

The FAA has issued over 200 ADs on 50 different aircraft models, addressing severe icing, deicing boot activation, ice protection equipment, and engine operation in icing conditions, flight crew procedures and other issues related to flight in icing conditions

4. Issue Papers may be used by the FAA to apply lessons learned from Fact-Finding Investigations, SCRs, and ADs to address potential unsafe conditions in new aircraft certifications.

Example: The FAA issued policy for all Aircraft Certification Offices (ACOs) requiring an issue paper to evaluate newly designed or derivative part 23 and 25 airplanes with unpowered ailerons and pneumatic deicing boots. This evaluation addressed roll control anomalies in certain SLD conditions. The issue paper documents the certification procedures used to avoid the unsafe condition addressed by the ADs.

5. Special Conditions are developed by the FAA for specific aircraft certification projects to address new technology that existing regulations do not cover. [Special conditions were not part of the FAA response to the October 31, 1994 ATR-72 accident.]

6. Safety Bulletins are used in several forms by the FAA to provide information about best practices and airworthiness concerns that do not rise to the level of an unsafe condition. These information tools alert, educate, and make recommendations to the aviation community. [All safety/information bulletins that are given below are more recent events related to large droplet icing or ice crystal conditions.]

Example: Special Airworthiness Information Bulletins (SAIBs) are an information tool that alerts, educates, and makes recommendations to the aviation community. SAIBs contain non-regulatory information and guidance that does not meet the criteria for an Airworthiness Directive (AD).

Example: SAIB # NE-07-03 was issued by the Engine Certification Office following power loss events (including four confirmed dual-engine flameouts) which occurred at high altitude in suspected high ice water content ice crystal conditions on Raytheon Aircraft Company Model 400 series airplanes. The SAIB explained airworthiness concerns and provided recommendations on actions to be taken in the event of a power loss event.

Example: Safety Alerts for Operators (SAFOs) contain important safety information that is often critical. A SAFO may contain information alone or a combination of information and recommended (non-regulatory) action to be taken voluntarily by the respective operators identified in each SAFO.

A recent SAFO (# 08006) was issued to clarify the definition for severe icing and the need to immediately exit these conditions when encountered.

Example: Information for Operators (InFOs) contain valuable information for operators to help them meet administrative requirements or certain regulatory requirements with relatively low urgency or impact in safety. InFOs contain information or a combination of information and recommended action to be taken by the respective operators identified in each InFO.

A recent InFO (# 08024) provides guidance to operations inspectors concerning the use and limitations of the Automated Surface Observing System (ASOS) freezing rain sensor.

7. Regulations are established by the FAA to increase the minimum standards expected for new type certificate aircraft.

Example: Two recommendations from the October 31, 1994 ATR-72 accident NTSB Report AAR 96-01⁴, (Page 212), A-96-54 “Revise the icing criteria published in 14 Code of Federal Regulations (CFR),...” and A-96-56 “Revise the icing certification testing regulation...” were addressed by the FAA in publishing Terms of Reference to impanel a working group through the Aviation Rulemaking Advisory Committee (ARAC) to consider new regulations. The Terms of Reference were published in 1997, and the ARAC Ice Protection Harmonization Working Group (IPHWG) first met in February 1998. Final rulemaking recommendations were completed in 2005 with a follow-on review of available compliance methods (2009).

8. Advisory Circulars (ACs) are developed and updated by the FAA to support the implementation of regulations by describing means, but not the only means, for showing compliance, as well as for other purposes. [Draft advisory materials directly related to new rulemaking on SLD icing conditions have been completed, but will not be available until the new regulations on SLD are released.]

Example: The FAA did release ACs with supporting information on SLD icing conditions related to its October 31, 1994 ATR-72 accident investigation. ACs 91-74A, “Pilot Guide: Flight in Icing Conditions”; 23.1419-2D, “Certification of Part 23 Airplanes for Flight in Icing Conditions”; and 20-73A, “Aircraft Ice Protection,” all contain information on SLD icing conditions.

9. Training materials for pilots and other aviation users are developed and promoted by the FAA to improve knowledge and decision-making for icing. Evaluation of incidents, events, and accidents indicates that many could be avoided through improved knowledge and decision-making by pilots.

Example: The FAA has worked with NASA, manufacturers, and industry trade associations to develop icing educational and training products for pilots. These include videos/DVDs for specific subjects such as SLD icing and ice contaminated tailplane stall (ICTS). There are also free on-line, individual-paced icing training courses, including *A Pilot's Guide to Ground Icing* and *A Pilot's Guide to In-Flight Icing*⁵.

10. Standards Development is pursued by the FAA by means of requests to technical societies and other international standards bodies to support new/updated practices, industry accepted computational and experimental methods, aerospace specifications and standards for aircraft equipment, and engineering tools capabilities for design and certification of aircraft and aircraft components. [Standards development was not used during the near-term subsequent actions to address any safety concerns from the October 31, 1994 ATR-72 accident. Standards development in the mid-2000s did support aerospace recommended practices associated with SLD icing conditions.]

11. Targeted Research is conducted by the FAA to support safe operations in icing conditions. The research is primarily in support of the development new regulations and operational guidance, and means of compliance associated with certification rules and operational rules.

⁴ NTSB Report AAR 96-01; In-flight Icing Encounter and Loss of Control Simmons Airlines, d.b.a. American Eagle Flight 4184 Avions de Transport Regional (ATR) Model 72-212, N401AM, Roselawn, Indiana October 31, 1994; Volume I

⁵ *A Pilot's Guide to Ground Icing* and *A Pilot's Guide to In-Flight Icing* can be found on-line at: <http://aircrafticing.grc.nasa.gov/courses.html>

Example: After the October 31, 1994 ATR-72 accident it was clear to the FAA, NASA, NCAR, Atmospheric Environment Services – Canada (now known as Environment Canada), and others, that there was a lack of knowledge on the scope of atmospheric SLD conditions. As a result, a multi-partner, multi-year flight research project was initiated to gather data in SLD conditions⁶. During the initial evaluations by the ARAC Ice Protection Harmonization Working Group on the amount and quality of large droplet atmospheric data available, they determined that additional characterization of SLD atmospheric icing conditions was required to support the development of new engineering standards. The FAA continued its flight research with NASA, NCAR, and Environment Canada and collected further SLD data to support evaluation of these conditions.

Table E-I.
Actions the FAA Took After the October 31, 1994 ATR-72
Accident to Address Current Fleet Safety Concerns.

Date	Action	Tool
11/1994	ATR-42/72 Operators	Flight Standards Info Bulletin
11/1994 start	ATR-42/72	Special Certification Review
12/1994-1/1995	AF Tanker Testing	Fact-Finding Investigation
~ 3/1995	FAA report on results	Fact-Finding Investigation
3/1995	ATR-42/72 ADs	Airworthiness Directives
3/1995	Policy to evaluate roll control anomalies	Policy Memo to ACOs
Summer 1995	Meeting with airframers	Coordination with industry
~ 9/1995	Simulated ice shape testing completed	Fact-Finding Investigation
7/1997	ACOs – new Type Certificates / Supplemental Type Certificates	SLD Issue Paper
5/1996	ADs on affected aircraft	Airworthiness Directives
5/1996	FAA International Icing Conference	Coordination with industry
12/1997	Terms of Reference – ARAC SLD rulemaking	New rulemaking start

Conclusions:

By 1998, when the ARAC process was put in place to deliberate on new rulemaking concerns for SLD, the FAA had already addressed many of the airworthiness concerns for the current fleet regarding operations in SLD conditions (see Table I). The FAA had taken a series of steps to ensure quick action to address the unsafe conditions from this accident prior to the rulemaking exercise.

⁶ AIAA-98-0577, “NASA/FAA/NCAR Supercooled Large Droplet Icing Flight Research: Summary of Winter 96-97 Flight Operations”, January 1998

The ARAC process to consider regulatory changes to include SLD, mixed phase, and ice crystal icing conditions is the most time consuming of the tools the FAA used. The FAA is near completion of this final action, publication of a final rule.