Federal Aviation Administration
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area
Ice Protection Harmonization Working Group

Task 1 – Aerodynamic Performance Monitors

Task Assignment

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[Notices]
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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and Engine Issues; New Tasks

AGENCY: Federal Aviation Administration (**FAA**), DOT.

ACTION: Notice of a new task assignment for the Aviation Rulemaking Advisory Committee (ARAC).

SUMMARY: Notice is given of new tasks assigned to and accepted by the Aviation Rulemaking Advisory Committee (ARAC). This notice informs the public of the activities of ARAC.

FOR FURTHER INFORMATION CONTACT:
Stewart R. Miller, Manager, Transport Standards Staff, ANM-110, **FAA**, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Ave. SW., Renton, WA 98055-4056, telephone (425) 227-2190, fax (425) 227-1320.

SUPPLEMENTARY INFORMATION:

Background

The **FAA** has established an Aviation Rulemaking Advisory Committee to provide advice and recommendations to the **FAA** Administrator, through the Associate Administrator for Regulation and Certification, on the full range of the **FAA**'s rulemaking activities with respect to aviation-related issues. This includes obtaining advice and recommendations on the **FAA**'s commitment to harmonize its Federal Aviation Regulations (FAR) and practices with its trading partners in Europe and Canada.

One area ARAC deals with is Transport Airplane and Engine issues. These issues involve the airworthiness standards for transport category airplanes in 14 CFR parts 25, 33, and 35 and parallel provisions in 14 CFR parts 121 and 135. The corresponding European airworthiness standards for transport category airplanes are contained in Joint Aviation Requirements (JAR)-25, JAR-E, and JAR-P, respectively. The corresponding Canadian Standards are contained in Chapters 525, 533, and 535 respectively.

The Tasks

This notice is to inform the public that the **FAA** has asked ARAC to provide advice and recommendation on the following harmonization tasks:

Task 1. As a short-term project, consider the need for a regulation that requires installation of ice detectors, aerodynamic performance monitors, or another acceptable means to warn

flightcrews of ice accumulation on critical surfaces requiring crew action (regardless of whether the icing conditions are inside or outside of Appendix C of 14 CFR Part 25). Also consider the need for a Technical Standard Order for design and/or minimum performance specifications for an ice detector and aerodynamic performance monitors. Develop the appropriate regulation and applicable standards and advisory material if a consensus on the need for such devices is reached. (Schedule: September 1998, Reach agreement on proposed rule; January 1999, NPRM package delivered to **FAA** from ARAC; March 1999, Publish NPRM; March 2000, Publish Final Rule.)

As long-term projects:

Task 2. Review National Transportation Safety Board recommendations A-96-54, A-96-56, and A-96-58, and advances in ice protection state-of-the-art. In light of this review, define an icing environment that includes supercooled large droplets (SLD), and devise requirements to assess the ability of aircraft to safely operate either for the period of time to exit or to operate without restriction in SLD aloft, in SLD at or near the surface, and in mixed phase conditions if such conditions are determined to be more hazardous than the liquid phase icing environment containing supercooled water droplets. Consider the effects of icing requirement changes on 14 CFR part 23 and part 25 and revise the regulations if necessary. In addition, consider the need for a regulation that requires installation of a means to discriminate between conditions within and outside the certification envelope. (Schedule: September 1999, Reach technical agreement; January 2000, NPRM package delivered to **FAA** from ARAC; March 2000, Publish NPRM; March 2001, Publish Final Rule.)

Task 3. Propose changes to make the requirements of 14 CFR 23.1419 and 25.1419 the same (Schedule: September 1999, Reach technical agreement; January 2000, NPRM package delivered to **FAA** from ARAC; March 2000, Publish NPRM; March 2001, Publish Final Rule)

Task 4. Harmonize 14 CFR Secs. 23.1419, 25.1419, 25.929, and 25.1093 and JAR 23.1419, 25.1419, 25.929, and 25.1093. (Schedule: September 1999, Reach technical agreement; January 2000, NPRM package delivered to **FAA** from ARAC; March 2000, Publish NPRM; March 2001, Publish Final Rule)

Task 5. Consider the effects icing requirement changes may have on 14 CFR Secs. 25.773(b)(1)(ii), 25.1323(e), 25.1325(b) and revise the regulations if necessary. (Schedule: September 1999, Reach technical agreement; January 2000, NPRM Package delivered to **FAA** from ARAC; March 2000, Publish NPRM; March 2001, Publish Final Rule (if necessary)).

Task 6. Consider the need for a regulation on ice protection of angle of attack probes (Schedule: September 1999, Reach technical agreement; January 2000, NPRM package delivered to **FAA** from ARAC; March 2000, Publish NPRM; March 2001, Publish Final Rule (if necessary)).

Task 7. Develop or update advisory material pertinent to items 2 through 6 above. (Schedule: October 2000, Advisory material package delivered to **FAA** from ARAC; March 2001, Publish advisory material).

If ARAC determines rulemaking action (e.g., NPRM, supplemental NPRM, final rule, withdrawal) should be taken, or advisory material should be issued or revised, it has been asked to prepare the necessary documents, including economic analysis, to justify and carry out its recommendation(s).

ARAC Acceptance of Tasks

ARAC has accepted these tasks and has chosen to assign them to a new Ice Protection Harmonization Working Group (IPHWG) under the Transport Airplane and Engine issue. The new working group will serve as staff to ARAC to assist ARAC in the analysis of the assigned tasks. Working group recommendations must be reviewed and approved by ARAC. If ARAC accepts the working group's recommendations, it forwards them to the **FAA** as ARAC recommendations.

The IPHWG will coordinate with the Flight Test Harmonization Working Group, other harmonization working groups, organizations, and specialists as appropriate. Other affected groups, organizations, and specialists may include but not be limited to the Powerplant Installation Harmonization Working Group, Engine Harmonization Working Group, General Aviation Manufacturers Association (GAMA), human factors specialists, and meteorologists. Coordination with the Flight Test Harmonization Working Group will be necessary to ensure that the IPHWG does not initiate work on issues already being addressed by the Flight Test group. Coordination with GAMA will be necessary to ensure that the proposed NASA Advanced General Aviation Transport Experiment project is considered throughout the process of accomplishing the short and long term projects. The IPHWG will request ARAC assignment of tasks to existing working groups if necessary. The IPHWG will identify to ARAC the need for additional new working groups when existing groups do not have the appropriate expertise to address certain tasks.

Working Group Activity

The Ice Protection Harmonization Working Group is expected to comply with the procedures adopted by ARAC. As part of the procedures, the working group is expected to:

1. Recommend a work plan for completion of the tasks, including the rationale supporting such a plan, for consideration at the meeting of ARAC to consider Transport Airplane and Engine Issues held following publication of this notice.
2. Give a detailed conceptual presentation of the proposed recommendations, prior to proceeding with the work stated in item 3 below.
3. For each task, draft appropriate regulatory documents with supporting economic and other required analyses, and/or any other related guidance material or collateral documents the working group determines to be appropriate; or, if new or revised requirements or compliance methods are not recommended, a draft report stating the rationale for not making such recommendations.
4. Provide a status report at each meeting of ARAC held to consider Transport Airplane and Engine Issues.

Participation in the Working Group

The Ice Protection Harmonization Working Group will be composed of experts having an interest in the assigned tasks. A working group member need not be a representative of a member of the full committee.

An individual who has expertise in the subject matter and wishes to become a member of the working group should write to the person listed under the caption FOR FURTHER INFORMATION CONTACT expressing that desire, describing his or her interest in the tasks, and stating the expertise he or she would bring to the working group. The request will be reviewed by the assistant chair, the assistant executive director, and the working group chair, and the individual will be advised whether or not the request can be accommodated.

The Secretary of Transportation has determined that the formation and use of ARAC are necessary and in the public interest in connection with the performance of duties imposed on the **FAA** by law.

Meetings of ARAC will be open to the public. Meetings of the Ice Protection Harmonization Working Group will not

be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on November 24, 1997.
Joseph A. Hawkins,
Executive Director, Aviation Rulemaking Advisory Committee.
[FR Doc. 97-32034 Filed 12-5-97; 8:45 am]
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Recommendation Letter

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

Pratt & Whitney
A United Technologies Company

June 29, 2001

Federal Aviation Administration
800 Independence Avenue
Washington, D.C. 20591

Attention: Mr. Anthony Fazio, ARAC Executive Director, ARM-1

Subject: Icing Task 1 Part 25 Rule Report

Dear Tony,

Attached for FAA consideration is the Icing Protection HWG report on Task 1, regarding the need for additional Part 25 certification rules on ice protection. The Working Group details three proposed options as to how to proceed pending the WG's continued activity on its additional taskings. These options are identified as Options A, B and C and discussed on pages 4-8 of the report.

The Working Group could not reach consensus as to which option to recommend and appear to be "equally divided". After discussion at the TAEIG June 2001 meeting, the TAEIG voted to recommend Option C. Option C delays processing of the Part 25 rule until the WG makes further progress on Task 2 (Definition of the Icing Environment). The rationale behind the TAEIG recommendation is that the ARAC recently submitted proposed changes in operating rules would provide the needed safety improvement while the Ice Protection HWG completes Task 2.

Sincerely yours,

Craig R. Bolt

C. R. Bolt
Assistant Chair, TAEIG

*Copies: Chuck Huber (FAA-NWR)
Effie Upshaw (FAA-Washington, D.C.)
Dennis Newton (Boeing)
Jim Hoppins (Cessna)

*letter only

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Acknowledgement Letter

U.S. Department
of Transportation

**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

SEP 17 2001

Mr. Craig R. Bolt
Assistant Chair, Aviation Rulemaking
Advisory Committee
Pratt & Whitney
400 Main Street
East Hartford, CT 06108

Dear Mr. Bolt:

We have received your June 29 letter transmitting comments to the draft part 25 proposal concerning Operations in Icing Conditions. Included in the comments are options and the Aviation Rulemaking Advisory Committee's recommendation to defer action on the draft proposal pending further progress in defining the icing environment.

We have forwarded these recommendations to the Transport Airplane Directorate. Because this is a harmonized effort, we will work closely with the Joint Aviation Authorities and Transport Canada to develop a coordinated decision on how we will proceed. We expect to be in a position to advise you of our decision in October 2001.

Sincerely,

Tony

Anthony F. Fazio
Director, Office of Rulemaking

TASK 1

PART 121

U.S. Department
of Transportation

**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

SEP 17 2001

Mr. Craig Bolt
Assistant Chair, Transport Airplanes
And Engines Issues Area
400 Main Street
East Hartford, CT 06108

Dear Mr. Bolt

We have received your May 21 request for formal legal review of the draft advisory circular and formal legal and economic reviews of the draft rulemaking addressing operations in icing conditions. The Rulemaking Management Council approved resources for completing your requested reviews at its July meeting. We expect to complete the regulatory review by November 30, and the legal review by February 28, 2002. The documents will be returned to the Aviation Rulemaking Advisory Committee shortly thereafter.

Sincerely,

Tony

Anthony F. Fazio
Executive Director, Aviation Rulemaking
Advisory Committee

Recommendation

REPORT OBJECTIVE

This report is submitted to TAEIG in response to an IPHWG task to review a proposed Part 25 certification rule intended to address the certification aspects of Task 1. This proposed rule was drafted by the FAA with harmonization by the JAA prior to IPHWG review. The IPHWG was given one meeting for this review in order to formulate comments and concerns. Consensus was not an objective. The purpose of this report is to document these IPHWG member comments and concerns to the rule as proposed.

TASK STATEMENT

As the IPHWG Tasks 1 and 2 are the basis of much of the discussion on the proposed rule, the tasking language is provided for reference.

> Task 1. As a short-term project, consider the need for a regulation that requires installation of ice detectors, aerodynamic performance monitors, or another acceptable means to warn flightcrews of ice accumulation on critical surfaces requiring crew action (regardless of whether the icing conditions are inside or outside of Appendix C of 14 CFR Part 25). Also consider the need for a Technical Standard Order for design and/or minimum performance specifications for an ice detector and aerodynamic performance monitors. Develop the appropriate regulation and applicable standards and advisory material if a consensus on the need for such devices is reached.
>
> Task 2. Review National Transportation Safety Board recommendations A-96-54, A-96-56, and A-96-58, and advances in ice protection state-of-the-art. In light of this review, define an icing environment that includes supercooled large droplets (SLD), and devise requirements to assess the ability of aircraft to safely operate either for the period of time to exit or to operate without restriction in SLD aloft, in SLD at or near the surface, and in mixed-phase conditions if such conditions are determined to be more hazardous than the liquid phase icing environment containing supercooled water droplets. Consider the effects of icing requirement changes on 14 CFR Part 25 and revise the regulations if necessary. In addition, consider the need for a regulation that requires installation of a means to discriminate between conditions within and outside the certification envelope.

Task 1 was partially addressed by the development of a Part 121 Operations rule and Advisory Circular proposal. This work has been completed by the IPHWG and submitted to TAEIG 2-Mar-01 for transmittal to the FAA. Task 2 is still in work at the IPHWG level. A report on the challenges of Task 2 was submitted to TAEIG on 14-Feb-01. The proposed certification rules addressed in this report are intended to complete the IPHWG Task 1 requirements.

PROPOSED §25.1419 REVISIONS

The proposed revisions to §25.1419 would require either the installation of a primary ice detection system; or the definition of visual cues for recognition of ice accretion on a specified surface, combined with an advisory ice detector that provides an alert; or the identification of conditions conducive to airframe icing through the use of temperature and visible moisture cues. The requirements of the proposed rule are very similar to that previously proposed for the Part 121 operations rule. The IPHWG reviewed the proposed §25.1419 with minor changes made during the meeting. No other objections were made to this proposal. The IPHWG recommends that TAEIG transmit the proposed rule changes to §25.1419 to the FAA for processing as an NPRM with TAEIG approval.

PROPOSED §25.1420 ADDITION

The proposed addition of §25.1420 as prepared by the FAA and contained in the NPRM draft (which this report addresses) would require aircraft with reversible flight controls in the pitch or roll axis to have a method to indicate to the flightcrew that the airplane is in conditions conducive to ice accumulation aft of the airframe's protected areas. The proposal would require that such conditions be exited when encountered. During IPHWG deliberations, concerns were expressed regarding the proposed addition of §25.1420. The discussions centered on the discriminator that determines the applicability of the rule and the timing of the rule in relation to Task 2 deliverables.

The discriminator of unpowered flight controls was used in the previously submitted IPHWG Part 121 Operations Rule proposal. However, its applicability if used in a certification rule would be much different. The Operations Rule proposal was developed to apply to existing airplanes with known control system design features and flight characteristics, and for which a wealth of operational history is available. For reasons which are set forth and explained in the Operations Rule proposal, it was limited to airplanes in Part 121 revenue service. Inserting this discriminator into a Part 25 Certification Rule would make it applicable to all new designs of presently unknown control system design features and flight characteristics, and regardless of their intended types of operation. It could have the unintended consequence of driving manufacturers to employ complicated and expensive powered flight control systems on airplanes which don't need them.

The relationship with Task 2 lies in the definition of the large droplet icing environment and the ability to assess that an aircraft is capable of safely operating in these conditions for the period to exit or to operate without restriction.

The IPHWG identified three options for the proposed §25.1420. Option A would accept the rule language as proposed for the time being, with the intent of revisiting it as progress is made on Task 2. Option B would remove the discriminator of unpowered flight controls, but would allow the manufacturer to demonstrate that exiting the conditions is not required. Option C would delay the release of the proposed §25.1420 until further progress is made towards Task 2. These options are described in detail with the applicable rational analysis in the following sections.

OPTION A

Option A would accept the rule language as proposed. The rule as written would require all aircraft with reversible roll or pitch controls to provide a means for the flight crew to determine that the aircraft is in conditions conducive to ice accumulation aft of the airframe's protected areas and establish procedures for exiting the icing conditions. No options other than exiting the conditions are permitted under this proposal. As written, this rule captures the existing class of aircraft that are dominant in the safety record as discussed in the proposed preamble materials.

The rule as drafted does not address any requirements for safely exiting the conditions or requirements for aircraft with other than reversible flight controls.

It is restrictive in that there are no alternatives to exiting the conditions. This burden was the impetus to applying the reversible flight control discriminator in the Operations Rule proposal to limit the applicability to aircraft that might be susceptible to roll and pitch deviations and to implicitly exclude types not susceptible due to their size and design features and as verified by their absence from the event database. However, there are also aircraft with reversible pitch or roll axis flight controls which have no accident and incident history in the database. This proposed rule could be a significant burden on new certifications of these types of aircraft. There is a need to define a criterion that would allow aircraft to safely operate for the time required to exit or to operate unrestricted in such an environment and minimize the requirement to exit the conditions.

There currently are no accepted engineering standards to define the large droplet conditions or to evaluate the effects of these conditions on an aircraft. The ability to show that an aircraft can be operated safety in conditions outside of Appendix C is largely dependent the completion of Task 2. Given the definition of an icing environment as required by Task 2, additional factors are required to adequately assess the capability of aircraft to operate in these conditions. The engineering tools to simulate the ice accretions formed from these clouds are required as well as definitions of acceptable performance degradations with the large droplet accretions. The Flight Test Harmonization Working Group has proposed rule changes to define acceptable flight characteristics in icing conditions. It is expected that these proposed rules will be used in defining acceptable standards for large droplets. However, the acceptability of these standards for large droplet accretions requires review. Given the infrequency of the encounter and the potential severity of the effects on small Part 25 aircraft, consideration of alternate criterion such as "safe return and landing" may be appropriate. The issues surrounding the completion and challenges of Task 2 were discussed in detail in the IPHWG Task 2 report as presented to TAEIG.

As there is no engineering standard for large droplet icing, no validated methods of simulation and no performance criterion to evaluate whether an aircraft is capable of safely operating in the conditions, the best "short-term" alternative (as required by Task 1) may be to require an exit from the conditions until more progress as made. The proposal as written could accomplish this. As part of this option, Task 2 could be revised to reconsider the rulemaking language in the proposed 25.1420 when the ability to assess whether an aircraft can operate in this environment is more mature. This option provides a balance in what can be achieved in a short-term task without unduly restricting all Part 25 aircraft from exiting large droplet conditions or imposing overly conservative test methods that will penalize small Part 25 aircraft. However, there is a burden on possible new types of aircraft with reversible roll or pitch flight controls which may not be susceptible to controllability hazards in large droplet conditions. These aircraft will still be required to exit the large droplet icing conditions.

Another concern was discussed regarding the use of the reversible flight controls as a discriminator. The concern is that the proposed rule would not directly address performance-based effects of large droplet accretions. While a direct means to address this concern is not apparent, the concern is addressed to a significant degree. The design choice of using irreversible flight controls is a function of the aerodynamic loads on the control surfaces. These loads are typically a function of aircraft speed envelope and/or of aircraft scale. Large-scale aircraft are less susceptible to all icing conditions due to the reduced collection efficiency of the airfoils. High-speed aircraft typically have significant power margin when operating at low altitude holding speeds where the large droplets would likely be encountered. Because of these design factors, small scale and low speed aircraft that could be susceptible to performance-based effects are included implicitly with the reversible flight control discriminator.

OPTION B

This option would be to eliminate reversible controls discriminator and make the FAR 25.1420 proposal applicable to all new Part 25 certifications, but would allow demonstration that exiting the conditions is not required. The major difficulty with this option is that there is no existing means of compliance with such a no exit provision. The FAA concern is that the large droplet conditions would have to be defined to release the rule in this state, and this requires the completion of IPHWG Task 2.

Three members commented on the substance of Section 25.1420. All recommended to eliminate the reversible flight control discriminator and to allow demonstration that exiting the conditions is not required. The commenting members expressed a number of concerns, the foremost of which is that the rule as currently written is focused on one specific type of event involving uncontrollable hinge-moment characteristics. While this is a valid and well-documented scenario, the proposed rule does not address potential performance degradations (lift loss and/or drag increase) which may be associated with large droplet ice accretions. The effects of large droplet ice accretions on performance characteristics will manifest on any airplane, regardless of the type of flight controls. The database examined by the group contains 48 events in which the IPS was activated prior to the event; 11 of these contained evidence of large droplet icing conditions. Yet, of the 48, only 3 involved tailplane flow separation and only 1 accident was due to increased hinge moments causing loss of lateral control with large droplet ice accretion. The rule ignores the remaining large droplet icing events, the causes of which are either unknown or in some cases can be surmised to have been loss of performance. In addition, the members noted concerns related to unaccounted-for runback in large droplet conditions (another performance-degradation aspect); the potentially significant degradation of propeller performance with large droplet ice accretion; and the fact that this certification rule for future aircraft targets a current design feature, presupposing how future designs will perform with large droplet ice accretions.

The commenting members do not believe that either completion of Task 2 or a concretely established definition of large droplet icing conditions is required to allow demonstration that exiting large droplet conditions is not necessary. While the question of how to show that an airplane need not exit large droplet icing conditions was approached somewhat differently by each member within the context of the rule and associated AC material, they all proposed rule language allowing a manufacturer to do so. These members are of the opinion that currently available tools and methods, along with conservative engineering judgment, can be employed for this purpose until improved methods are developed. One method proposed was to use the icing cloud physics as described in the FAA Generic Issue Paper published July 23, 1997 as a starting point for defining an SLD environment for the purposes of this rule.

There are objections to this approach, however. Previous work on this issue has used rudimentary approximations of the large droplet icing conditions. As a result of the ATR 72 icing accident in 1994, an investigation of the effects of potential large droplet conditions was performed on regularly scheduled revenue passenger service aircraft in the United States. These investigations used approximations of the environment thought to have been present in the accident situation. These investigations relied on the use of the 1" quarter round (facing forward behind the protected area) and the use of a tanker aircraft with approximated large droplet conditions. The duration used was the approximate time the accident aircraft was in the conditions prior to the event, not the time required to exit the conditions. The icing environment in terms of water content, drop size and distribution were an estimate, as was the duration of the encounter. No sampling of the actual icing environment in terms of droplet size and distribution was available. The estimates were specific to the accident and do not account for SLD variations in the atmosphere. These conditions were intended to provide a conservative test of the susceptibility of certain aircraft to large droplet conditions. There was no intent to show safe operation in the large droplet environment. This type of first-order approximation is appropriate for a safety investigation, but does not represent the long-term solution that should be the objective of rulemaking.

It is generally accepted that the aerodynamic effects of ice accretions on an airfoil are largely a function of location and the relative size of the disturbance. Part 25 rulemaking covers aircraft ranging from 12,500 lbs up to aircraft in excess of 800,000 lbs. Given this broad range of aircraft, an overly conservative approach to large droplet icing (such as 1" quarter rounds) may not have a significant effect on large Part 25 aircraft, but can have a severe effect on small Part 25 aircraft. The actual size of accretions that can form behind the protected area is a function of the protection limits, the airfoil type and planform characteristics (e.g. taper ratio, thickness ratio, washout).

While a conservative method of screening aircraft is desired, if the methods are overly conservative, smaller Part 25 aircraft with unpowered flight controls could be excluded from future certification in large droplet icing conditions for the period required to exit. It may not be feasible or even technically possible to design small Part 25 aircraft for extended operations in all large droplet-icing conditions with a large degree of conservatism. The safety record for small Part 25 aircraft (such as business jets) indicates that a measure this far reaching may not be warranted.

OPTION C

This option would delay the release of the proposed §25.1420 until further progress is made towards Task 2. The rule could then be written to eliminate the reversible pitch or roll control discriminator and would require a demonstration of the ability of an aircraft to operate safely in the large droplet conditions either for the time required to exit or for continued operation in such conditions.

For the period until Task 2 matures, an increased level of safety would be maintained by the adoption of the IPHWG proposed Part 121 Operations rule. The Part 121 rule is applicable to aircraft less than 60,000 lbs. with reversible pitch or roll flight controls. The draft language in the Part 121 rule would require an exit from conditions conducive to ice accumulation behind the aircraft's protected area. This rule will provide an enhanced level of safety for the traveling public until a more complete approach to large droplet icing is feasible.

Motivation for this option is the lack of agreed upon icing physics definitions for large droplet clouds, the immature state of the simulation and validation tools and the lack of an engineering standard to evaluate the handling quality and performance decrements against.

The susceptibility of an aircraft to ice accumulation effects aft of the protected areas is a combination of many aspects of aircraft design. Airfoil sensitivity, sweep angle, airfoil loading, chord lengths, flap effectiveness, the use of trimmable stabilizers, alternate roll control means (such as roll spoilers) as well as the use of reversible flight controls are all generally accepted factors that can contribute to or reduce the susceptibility to pitch or roll events due to ice accumulations aft of the protected areas. As discussed briefly in option A, the use of reversible flight controls as the sole discriminator will penalize a large category of Part 25 aircraft that have not exhibited an accident or incident history that would indicate a safety issue. Option C accomplishes the majority of the Task 1 directive without penalizing aircraft with reversible pitch or roll controls that are not adversely affected by large droplet icing.

Specifically, many business aircraft use reversible flight controls with no indications of susceptibility to ice accumulation aft of the protected areas. Many of these aircraft use reversible flight controls on both the roll and the pitch axis in conjunction with various combinations of de-ice and anti-ice methods including pneumatic de-ice boots, bleed air, electro-thermal, and TKS systems. Many of the aircraft use running wet thermal systems. These aircraft have been certified with significant amounts of runback ice accumulation behind the protected areas. While runback ice is not identical to ice accretions as the result of large droplet impingement, this certification evaluation ensures reduced sensitivity to contamination behind the protected areas.

As discussed briefly in Option A, to show that no crew action is required to exit the conditions requires some means to evaluate the aerodynamic effects of such accretions. Currently accepted techniques of accomplishing this is with simulated ice shapes. The effects of these simulated ice shapes are evaluated with wind tunnel testing or by flight-testing. For Appendix C icing conditions, the ice shapes are generally defined using analytical techniques (such as LEWICE), by icing tunnel testing using droplet sizes and water contents as defined by Appendix C or by icing tanker testing. In order to evaluate the effect of large droplet accretions a definition of the icing environment is required. This definition must define droplet size and distribution, water content and horizontal extent. Initial indications are that the distribution has a significant effect on large droplet accretions, which differs from Appendix C icing. It has generally been shown that monotonic distributions provide near equivalent ice shapes within Appendix C conditions. Indications from analyses such as published in AIAA 98-0487 (Anil Shah, et.al.) are that droplet distribution will have a significant effect on the shape characteristics of large droplet accretions, particularly in the aft most impingement regions. Actual measured distributions have a significant proportion of small droplets in combinations with the large droplets. Assuming that SLD distributions consist entirely of larger sized drops (Langmuir type distributions) will artificially increase the collection efficiency (due to the direct relationship between drop size and collection efficiency) in the aft most regions. The aft most accretion regions are of particular significance as they are likely to be the regions immediately behind the protected areas. With initial indications of impingement limits ranging back to 50% of the chord length, it may be impractical to protect against all large droplet accretions. The ability to simulate accretions behind protected regions will be essential in the certification of large droplet conditions.

In addition to the lack of definition of the icing environment, there are also shortfalls in the technology available to simulate a large droplet condition. Analytical simulation techniques such as LEWICE have not been validated for large droplet icing environments. Research is underway to examine some of the known effects such as splashing, droplet breakup and gravitational effects. However there are challenges in these methods such as the ability to simulate distributions with a wide range of droplet sizes and the limited plume size available in horizontal icing tunnels. Further work and funding has been planned for these areas, but is still a minimum of 2-3 years away.

It is not reasonable to expect that the large droplet engineering tools need to reach the same state of maturity that current Appendix C tools are at prior to future rulemaking. Task 2 includes language that directs the regulations to be revised as required. Appropriate advisory materials would need to be drafted to provide guidance on an acceptable means of compliance. Releasing a rule with no guidance on compliance methods will place an undue burden on both the manufacturers and the local Aircraft Certification Offices when finding compliance on the rule. It is not feasible to release rules with no known means of compliance. This would negate any benefit of using the ARAC process to consider these issues.

Delaying the release of proposed §25.1420 until further progress is made on Task 2 would allow the rule to be drafted in a manner that would eliminate the reversible pitch or roll control discriminator. This option would require a demonstration of the ability of an aircraft to operate safely in the large droplet conditions either for the time required to exit or for continued operation in such conditions. This method would also address member concerns regarding the exclusion of potential performance effects due to large droplet accretions and would require all Part 25 aircraft to be evaluated for potential adverse affects of large droplet conditions. As previously stated, the Task 1 requirements would be met with the proposed Part 121 operations rule for regularly scheduled air carriers. This would provide an enhanced level of safety for the interim period.

CONCLUSIONS AND RECOMMENDATIONS

The proposed rulemaking was deliberated at length during the IPHWG review. In addition, formal comments were solicited from IPHWG membership on specific points of recommendation. Some of the comments were resolved without issue, while others were recommended to be included in the IPHWG report for further consideration by the authorities during the rulemaking process. These specific comments are included in Appendix A. With regard to the proposed changes to §25.1420, there were strong supporters for each of the options presented. Multiple technical factors both add and detract from each of the options. Many of the factors presented under each individual option can be equally applied to support or diminish alternate options. No clear majority opinion could be achieved during the review period. The technical factors supporting each of the options are as presented in the body of this report. It is recommended that the FAA and JAA consider these factors, as presented, for future rulemaking proposals on this topic.

Appendix A

Comments Received through IPHWG Review Process

Comment # 1

Document, Section Title & Paragraph (ex: NPRM, 5. Technology, 2nd Paragraph)
Cert Rule NPRM

Existing Text (excerpt, page, etc.)

§ 25.1420 Exit large droplet conditions.

(a) For airplanes with reversible roll or pitch controls: if certification for flight in icing conditions is desired, one of the following must be provided to alert the flightcrew that they must exit icing conditions

(1) Substantiated visual cues that enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or

(2) A system that alerts the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.

(b) Procedures for exiting icing conditions must be established.

Proposed Text Language

§ 25.1420 Exit large droplet conditions for airplanes with reversible controls.

For airplanes with reversible roll or pitch controls where certification for flight in icing conditions is desired in 25.1419,

(a) one of the following must be provided to alert the flightcrew that they must exit icing conditions :

(1) Substantiated visual cues that enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or

(2) A system that alerts the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.

(b) Procedures for exiting icing conditions must be established.

Justification

Change wording in 25.1420 to be consistent with existing 25.1419

Comment # 2

Document, Section Title & Paragraph
NPRM, § 25.1420 Exit large droplet conditions.

Existing Text
Page 22 of 22:
§ 25.1420 Exit large droplet conditions.
(a) For airplanes with reversible roll or pitch controls: if certification for flight in icing conditions is desired, one of the following must be provided to alert the flightcrew that they must exit icing conditions
(1) Substantiated visual cues that enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or
(2) A system that alerts the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.

Proposed Text Language
§ 25.1420 Exit icing conditions outside Appendix C.
(a) If certification for flight in icing conditions is desired, one of the following must be provided to alert the flightcrew that they must exit icing conditions
(1) A system that alerts the flightcrew that the airplane is in icing conditions outside Appendix C, or
Substantiated visual cues that enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.
unless these icing conditions are included in the certification for flight in icing conditions.

Justification
It is known that icing conditions outside Appendix C occur. If an airplane is in icing conditions where it is not certified for, it has to exit icing conditions.

All airplanes will be affected by ice accretion due to supercooled large droplets, especially if the aircraft has clean protected areas. Runback ice due to SLD can be significant. Also remember the significant effect of so-called sandpaper ice. It has to be demonstrated that the effect of ice accretion due to supercooled large droplets on airplane performance and handling is acceptable if continued operation in those conditions is desired.
The difference in performance margin during all engine flight between jet and turboprop airplane is certainly not always in favor of jet aircraft but depends on the design.

Also the effect of SLD on propeller performance has to be considered. Runback ice on a propeller can reduce the thrust with about 30 %, although "normal" icing reduces the thrust with only a few percent.

Regarding airplanes with reversible roll or pitch controls: The protected areas (for instance de-icing boots) can be of constant chord percentage (more recent designs optimized by calculations?), or constant chord wise length (more older designs demonstrated extensively in flight tests?), or a combination of those two. If the protected parts are of constant chord percentage then ice accretion aft of the protected areas has to be expected to occur first at the thinnest profiles such as on the wingtip i.e. in front of the roll controls. In that case no warning due to increased drag will occur but suddenly roll problems might occur (still depending on control design). In the other cases ice accretion aft of the protected area will start more inboard resulting "only" in a gradual degradation of drag and lift, which might be recognized by the flightcrew before it becomes hazardous. It has to be noted that sufficient boot coverage will also reduce the lift and drag degradation significantly.

Comment # 3

Document, Section Title & Paragraph (ex: NPRM, 5. Technology, 2nd Paragraph)

NPRM, proposed 25.1420 rule

Existing Text (excerpt, page, etc.)

§ 25.1420 Exit large droplet conditions.

(a) For airplanes with reversible roll or pitch controls: if certification for flight in icing conditions is desired, one of the following must be provided to alert the flightcrew that they must exit icing conditions

(1) Substantiated visual cues that enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or

(2) A system that alerts the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.

(b) Procedures for exiting icing conditions must be established.

Proposed Text Language

§ 25.1420 Exit large droplet conditions.

If certification for flight in icing conditions is desired, compliance with either (a) or (c) below must be demonstrated.

(a) One of the following must be provided to alert the flightcrew that they must exit icing conditions

(1) Substantiated visual cues that enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or

(2) A system that alerts the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.

(b) If compliance with (a) is to be demonstrated, procedures for exiting icing conditions must be established.

(c) The aerodynamic effects of ice accumulation aft of the protected areas must be shown to be such that exiting icing conditions is not required.

Justification

The language of the existing proposal suggests that airplanes with irreversible flight controls are not at risk when ice accumulates aft of the protected areas. With respect to hinge moment effects, this is true. However, depending on the chordwise extent of the protected surfaces and the airfoil section characteristics, ice accumulations aft of such areas may have significant impact on lift coefficient. These effects will be present regardless of whether the flight controls are reversible or not.

In fact, the database reviewed by the IPHWG contains 48 events in which the IPS was operated prior to the event taking place. It is not possible to know how many of these events involved ice accumulation aft of the protected areas. However, 11 of these contained evidence of SLD, including 1 in which ice aft of the protected areas was specifically reported. On the other hand, of the 48, only 3 involve tailplane flow separation of some type, and 1 involves a clear case of large droplet icing leading to a hinge moment shift in lateral control (Roselawn, October 1994).

Thus, hinge moment effects represent only a portion, albeit a well documented portion, of the events which may be associated with ice accumulation aft of the protected areas.

The work done by Bragg, et.al., investigating the effects of step shapes on aerodynamic characteristics concluded that the chordwise location which yielded the largest degradation in hinge moment coefficient also resulted in the largest degradation in lift coefficient. This location corresponded to 10% chord on the NACA 23012 airfoil section. An airfoil such as this which was equipped with irreversible flight controls would not need to meet the requirements set forth by the proposed 25.1420, yet may still experience significant lift degradations due to ice accretions aft of the protected area.

Whether or not sufficient aerodynamic warning of a loss in lift coefficient would be perceptible to the flight crew is not clear, and is certainly not sufficiently clear to rely on for the purpose of new design. In a dynamic flight environment, a drag rise associated with a loss of lift may not be detected until past the point at which the available power will allow recovery. When combined with low altitude, this situation could be very serious.

This rule is being promulgated at a time when the perspective on inflight icing has changed considerably from what it was the last time icing certification rules were changed. Today, high density operations are conducted using structured traffic flows into several airports geographically positioned to experience considerable icing per annum. These include Chicago and Detroit. The strong pressure exerted on design by rising fuel costs creates incentive to minimize the energy available for ice protection. A great deal more is known about the character and probability of large droplet icing conditions than was known before. These factors together make a compelling case for a cautious approach to the interpretation of past data, such as accident/incident histories, for direct relevance to future designs. A new certification rule which encompasses a wise consideration of the future operating environment, and which anticipates those situations which cannot be clearly excluded based on engineering knowledge, would seem to be the most prudent course to follow.

Comment #4

Document, Section Title & Paragraph (ex: NPRM, 5. Technology, 2nd Paragraph)

NPRM, 5. Technology, starting with 5th paragraph (I think)

Existing Text (excerpt, page, etc.)

p. 12:

However, an ice detection system with the capability to alert the flightcrew when to exit icing conditions would have to be able to detect when:

a. the icing conditions encountered exceed the criteria to which the airplane was certified;

or

b. ice is accreting on surfaces of the airplane where it could prove hazardous and that were not addressed in the airplane's icing certification.

Some ice detection systems . . . . However, these detectors only measure ice accretions and are not able to perform either of the functions identified as a. and b., above.

Due to the limitations . . . .

It is feasible for the current ice detector technology to identify the existence of ice aft of the protected areas . . . .

Proposed Text Language

[same from "However, an ice detection . . . . " through "Some ice detection systems . . . 0.5 mm or less are detectable."] However, these detectors only measure ice accretions and are not able to perform the function identified as (a) above.

It is feasible for the current ice detector technology to identify . . . .

Due to the limitations . . . .

The IPHWG also acknowledged . . . .

Justification

I think there's a problem here with being contradictory. First we say that detectors are NOT able to detect ice as per (b), and then further down the page, we say it IS feasible for current detectors to detect ice aft of the protected areas – but we'd just said they can't do that. I propose eliminating (b) from the statement of what the detectors can't do.

The "Due to the limitations . . . " paragraph seems out of place when you read the paragraphs above and below; it also loses some teeth if the reference to (b) is eliminated, particularly since we say a detector would only have do either (a) OR (b). It seems to work to move that paragraph down below the "It is feasible . . . ." paragraph, which then leads into discussion of means other than detectors.

Comment #5

Document, Section Title & Paragraph (ex: NPRM, 5. Technology, 2nd Paragraph)

NRPM, § 25.1420

Existing Text (excerpt, page, etc.)
p. 22:

§ 25.1420 Exit large droplet conditions.
(a) For airplanes with reversible roll or pitch controls: if certification for flight in icing conditions is desired, one of the following must be provided to alert the flightcrew that they must exit icing conditions
(1) Substantiated visual cues that enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or
(2) A system that alerts the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.
(b) Procedures for exiting icing conditions must be established.

Proposed Text Language

§ 25.1420 Exit large droplet conditions.
If certification for flight in icing conditions is desired:
(a) One of the following must be provided to alert the flightcrew that they must exit icing conditions:
(1) Substantiated visual cues . . . .
(2) A system that alerts the flightcrew . . . .
(b) Procedures for exiting icing conditions must be established.
(c) Compliance with (a) and (b) is not required if it can be shown that it is not necessary for the airplane to exit large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.

Justification

Given that there are a number of events which could well have been performance degradation situations (loss of lift and/or increase in drag) rather than hinge-moment anomalies, as well as a number of events in which the cause is unknown, this rule should not be focused on one specific (type of) event. Nor should it be limited to a current design feature; like the rest of the cert rule, it should not presume to know what designs might appear in the future and how they will behave in SLD.

At the same time, it would not be prudent to penalize all new airplanes. The "out" provided by paragraph (c) can be accomplished prior to completion of Task 2 by applying reasonable assumptions and engineering judgment to existing methods (with agreement of the certifying agencies, of course) – as an example, see the corresponding AC Comment 21b.

Comment #6

Document, Section Title & Paragraph (ex: NPRM, 5. Technology, 2nd Paragraph)

AC, 9. Compliance with § 25.1420

Existing Text (excerpt, page, etc.)
p. 12:

a. Requirement of the Rule. Section 25.1420 is applicable to aircraft equipped with reversible flight controls in either the pitch or roll axis. The paragraph requires . . . .

Proposed Text Language

a. Requirement of the Rule. Section 25.1420 is applicable to all aircraft unless the applicant can show that it is not necessary for the aircraft to exit large droplet conditions conducive to ice accumulation aft of the airframe's protected areas. It requires . . . .

* * *

c. [New Paragraph] Showing That It Is Not Necessary to Exit.

(1) In the absence of another accepted definition, the following may be used as a representative environment for testing and analyses: 20 minute icing encounter, maximum droplet diameters of 400 microns, median volumetric diameter of 170 microns, liquid water content approximately 0.6 grams per cubic meter, and temperature near freezing.

(2) Ice shapes may be derived for representative airfoil sections by icing wind tunnel or icing tanker tests. Interpolation and extrapolation may be used to complete the ice shape estimate for the surface. Once representative ice shapes have been determined, fabricated ice shapes may be used for dry air wind tunnel or flight testing.

(3) With the ice shapes determined above affixed to the airplane, all handling qualities and performance requirements for flight-in-icing certification, in accordance with the airplane's certification basis, must be met.

Justification

Obviously a lot more could, and should, go into this but it's just an example of what might be written to allow an "out." It can all be updated as we get smarter with Task 2 and as tools for generating SLD ice shapes mature.

(1) This definition comes from the FAA's generic Issue Paper on Roll Control in SLD.
(2) Icing tunnels and tankers are allowed for numerous applications throughout this AC; it is absurd to say that they cannot be used to generate representative ice shapes.
(3) This might be rulemaking but you get the idea.

Comment # 7
Document, Section Title & Paragraph (ex: NPRM, 5. Technology, 2nd Paragraph)

Proposed Advisory Circ., Section 3. Related Documents, Applicable regulations.

Existing Text (excerpt, page, etc.):

Reference to § 25.1321 & § 25.1333, page 2

Proposed Text Language:

Delete

Justification

§25.1321 address flight, navigation and powerplant instruments. Flight and navigation instruments are defined in §25.1303. Powerplant instruments are defined in §25.1305.

§25.1333 is stated to be applicable to systems that operate the instruments required by §25.1303(b).

These paragraphs are directed towards primary flight instruments. Don't believe there was any intent to raise the status of an ice detector indication to the same level as primary flight, navigation or powerplant instruments.

Comment # 8
Document, Section Title & Paragraph (ex: NPRM, 5. Technology, 2nd Paragraph)

Proposed Advisory Circ., Section 3. Related Documents, Advisory Circulars, Section 5, Page 7

Existing Text (excerpt, page, etc.):

(a) Field of View. The visual cue should be developed with the following considerations:
(i) Visual cues should be within the flightcrew's vision scan area while seated and performing their normal duties.
(ii) The visual cue should be visible during all modes of operation (day, night).
(b) Verification. During the certification process, the applicant should verify the ability of the crew to observe the visual cue and reference surface. The visual cue should not be dependent upon the location of the flightcrew's seats. The visual cue should be evaluated from the most adverse flightcrew seat locations in combination with the range of flightcrew heights. The visual cues should be visible from both the left and right seats. Consideration should be given to the difficulty of observing clear ice. If a reference surface is used, the applicant should validate that it correlates with ice accumulation on the airframe's protected areas. Such visual cues should be validated by testing in measured natural icing.

Proposed Text Language:

(a) Field of View. The visual **cues** should be developed with the following considerations:
(i) Visual cues should be within the flightcrew's vision scan area while seated and performing their normal duties.
(ii) The visual **cues** should be visible during all modes of operation (day, night).
(b) Verification. During the certification process, the applicant should verify the ability of the crew to observe the visual **cues** ~~and~~ **or** reference **surfaces**. The visual **cues** should not be dependent upon the location of the flightcrew's seats. The visual **cues** should be evaluated from the most adverse flightcrew seat locations in combination with the range of flightcrew heights**, within the approved range of eye reference point locations, if available. A visual cue is required for both the left and right seats. If a single visual cue is used, it should be** ~~The visual cues should be~~ visible from ~~both the left and right~~ **either seat.** ~~seats.~~ Consideration should be given to the difficulty of observing clear ice. If a reference surface is used, the applicant should validate that it correlates with ice accumulation on the airframe's protected areas. Such visual cues should be validated by testing in measured natural icing.

Justification

Multiple visual cues or reference surfaces may be required for a specific aircraft. For example, a visual cue may be readily visible from the left seat, but not the right seat. However, a symmetric location on the right side of the aircraft could be defined as a second visual cue. This would meet the intent of having a cue available from either position. As written, seems to indicate that if a visual cue is not visible from either crew position, it is unacceptable. Do not believe this is the intent.

Also under (b) phrase "visual cues and references surfaces" implies both are required. Again, do not believe this is the intent.

Phrase "within the approved range of eye reference point locations, if available." was inserted in section addressing 25.1420. Appears to be equally appropriate here.

Comment # 9
Document, Section Title & Paragraph (ex: NPRM, 5. Technology, 2nd Paragraph)

Proposed Advisory Circ., Section 3. Related Documents, Advisory Circulars, Section 5, Page 8

Existing Text (excerpt, page, etc.):

(2) Section 25.1419 also requires a combination of tests and analysis to demonstrate the performance of the ice detector and the system as installed on the airplane. This could include icing tunnel and icing tanker tests to evaluate the ice detector performance. Also required are analysis and flight tests in measured natural atmospheric conditions to demonstrate satisfactory performance of the system as installed on the airplane. It should be demonstrated that the airplane can be safely operated with the ice accretions formed at the time the ice protection system becomes effective, following activation of the ice detector.

Proposed Text Language:

(2) Section 25.1419 also requires a combination of tests and analysis to demonstrate the performance of the ice detector and the system as installed on the airplane. This could include icing tunnel and icing tanker tests to evaluate the ice detector performance. Also required are analysis and flight tests in measured natural atmospheric conditions to demonstrate satisfactory performance of the system as installed on the airplane. **Droplet impingement analysis may be used in determining that the ice detector functions properly over the droplet range of Appendix C *when validated through natural or artificial icing tests (tanker, icing tunnel).*** It should be demonstrated that the airplane can be safely operated with the ice accretions formed at the time the ice protection system becomes effective, following activation of the ice detector.

Justification

It may be impractical to test the ice detector system performance over a wide range of droplet sizes with icing tankers. Icing tunnel tests may not be practical depending on the aircraft geometry surrounding the detector installation. Analysis is the most practical means of determining droplet trajectories over a wide range of drop sizes.

Comment # 10
Document, Section Title & Paragraph (ex: NPRM, 5. Technology, 2nd Paragraph)

Proposed Advisory Circ., Section 9. Compliance with §25.1420 b(3)(a)

Existing Text (excerpt, page, etc.):

(a) Field of View. The visual cue should be developed with the following considerations:
(i) Visual cues should be within the flightcrew's vision scan area while seated and performing their normal duties.
(ii) The visual cue should be visible during all modes of operation (day, night).
(b) Verification. During the certification process, the applicant should verify the ability of the crew to observe the visual cue and reference surface. The visual cue should not be dependent upon the location of the flightcrew's seats. The visual cue should be evaluated from the most adverse flightcrew seat locations in combination with the range of flightcrew heights, within the approved range of eye reference point locations, if available. The visual cues should be visible from both the left and right seats. Consideration should be given to the difficulty of observing clear ice. If a reference surface is used, the applicant should validate that it correlates with ice accumulation on the airframe's protected areas. Such visual cues should be validated by testing in measured natural icing. ……

Proposed Text Language:

(a) Field of View. The visual **cues** should be developed with the following considerations:
(i) Visual cues should be within the flightcrew's vision scan area while seated and performing their normal duties.
(ii) The visual **cues** should be visible during all modes of operation (day, night).
(b) Verification. During the certification process, the applicant should verify the ability of the crew to observe the visual **cues** ~~**and**~~ **or** reference **surfaces**. The visual **cues** should not be dependent upon the location of the flightcrew's seats. The visual **cues** should be evaluated from the most adverse flightcrew seat locations in combination with the range of flightcrew heights, within the approved range of eye reference point locations, if available. **A visual cue is required for both the left and right seats. If a single visual cue is used, it should be** ~~The visual cues should be~~ visible from ~~both the left and right~~ **either seat** ~~seats~~. Consideration should be given to the difficulty of observing clear ice. If a reference surface is used, the applicant should validate that it correlates with ice accumulation on the airframe's protected areas. Such visual cues should be validated by testing in measured natural icing.

Justification (same as comment 8)

Multiple visual cues or reference surfaces may be required for a specific aircraft. For example, a visual cue may be readily visible from the left seat, but not the right seat. However, a symmetric location on the right side of the aircraft could be defined as a second visual cue. This would meet the intent of having a cue available from either position. As written, seems to indicate that if a visual cue is not visible from either crew position, it is unacceptable. Do not believe this is the intent.

Also under (b) phrase "visual cues and references surfaces" implies both are required. Again, do not believe this is the intent.

Phrase "within the approved range of eye reference point locations, if available." was inserted in section addressing 25.1420. Appears to be equally appropriate here.

Comment # 11
Document, Section Title & Paragraph (ex: NPRM, 5. Technology, 2nd Paragraph)

Preamble, Summary

Existing Text (excerpt, page, etc.):

SUMMARY: This proposal would amend the regulations applicable to transport category airplanes certificated for flight in icing. The proposal would require either the installation of a primary ice detection system; or the definition of visual cues for recognition of ice accretion on a specified surface, combined with an advisory ice detector that provides an alert. For airplanes with reversible flight controls in the pitch or roll axis, the proposal would also require a means to indicate to the flightcrew that the airplane is in conditions conducive to ice accumulation aft of the airframe's protected areas. This proposed regulation is the result of information gathered from a review of icing accidents and incidents, and it is intended to improve the level of safety when airplanes are operated in icing conditions.

Proposed Text Language:

SUMMARY: This proposal would amend the regulations applicable to transport category airplanes certificated for flight in icing. The proposal would require either the installation of a primary ice detection system; ~~or~~ the definition of visual cues for recognition of ice accretion on a specified surface, combined with an advisory ice detector that provides an alert**; or the identification of conditions conducive to airframe icing through the use of temperature and visible moisture cues.** For airplanes with reversible flight controls in the pitch or roll axis, the proposal would also require a ~~means~~ **method** to indicate to the flightcrew that the airplane is in conditions conducive to ice accumulation aft of the airframe's protected areas. This proposed regulation is the result of information gathered from a review of icing accidents and incidents, and it is intended to improve the level of safety when airplanes are operated in icing conditions.

Justification

The third method of operating the ice protection systems needs to be addressed in the summary.

With the recent FAA legal interpretation that "a means" is a device. The use of means is inappropriate given that other compliance methods rather than devices are acceptable.

Comment # 12
Document, Section Title & Paragraph (ex: NPRM, 5. Technology, 2nd Paragraph)

Preamble, Operating Regulations (Page 4)

Existing Text (excerpt, page, etc.):

Operating Regulations. There also are relevant regulations that apply to airplane operations, which are found in 14 CFR part 121 ("Operating Requirements: Domestic, Flag, and Supplemental Operations"). Specifically, § 121.629(a) ("Operation in icing conditions") states:
"No person may dispatch or release an aircraft, continue to operate an aircraft en route, or land an aircraft when in the opinion of the pilot in command or aircraft dispatcher (domestic and flag operations only), icing conditions are expected or met that might adversely affect the safety of the flight."

Also, § 121.341 ("Equipment for operations in icing conditions") requires the installation of certain types of ice protection equipment and wing illumination equipment.

Neither the operating regulations nor the certification regulations require a means for the pilot-in-command specifically to identify that hazardous icing conditions have been encountered.

Proposed Text Language:

Operating Regulations. There also are relevant regulations that apply to airplane operations, which are found in **14 CFR part 91 ("General Operating and Flight Rules"),** 14 CFR part 121 ("Operating Requirements: Domestic, Flag, and Supplemental Operations") **and 14 CFR part 135 ("Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft").**

Specifically, § 91.527 ("Operation in icing conditions") and § 135.227 ("Icing conditions: Operating limitations") address limitations in icing conditions for aircraft operated under this flight rules.

Specific comments regarding exiting hazardous icing conditions are found in Part § 121.629(a) ("Operation in icing conditions") ***which*** states:
"No person may dispatch or release an aircraft, continue to operate an aircraft en route, or land an aircraft when in the opinion of the pilot in command or aircraft dispatcher (domestic and flag operations only), icing conditions are expected or met that might adversely affect the safety of the flight."

Also, § 121.341 ("Equipment for operations in icing conditions") requires the installation of certain types of ice protection equipment and wing illumination equipment.

Neither the operating regulations nor the certification regulations require a means for the pilot-in-command specifically to identify that hazardous icing conditions have been encountered.

Justification

Don't believe we can discuss a part 25 certification rule and only address part 121. There are plenty of small part 25 aircraft operating under parts 91 & 135. It may be sufficient to just mention the other parts and not get into the dilemma that part 91 & 135 don't address the concept of prohibiting operation in icing conditions that might adversely affect the safety of flight. The last sentence "Neither the operating regulations ..." still follows when the other parts are included.

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: COMPLIANCE WITH ICING REQUIREMENTS OF §§ 25.1419(e), (f) and (g) And 25.1420	**Date:** Draft 05/3/01	**AC No: 25-XX**
	Initiated By: ANM-110	**Change:**

WORKING DRAFT -- NOT FOR PUBLIC RELEASE.

1. PURPOSE.

a. This Advisory Circular (AC) describes an acceptable means for showing compliance with the requirements of § 25.1419(e), (f) and (g), "Ice Protection," and § 25.1420, "Exit large droplet conditions," of Title 14, Code of Federal Regulations (14 CFR) part 25, commonly referred to as part 25 of the Federal Aviation Regulations (FAR). Part 25 contains the applicable certification requirements for transport category aircraft. The means of compliance described in this document are intended to provide guidance to supplement the engineering judgment that must form the basis of any compliance findings relative to the requirements of §§ 25.1419(e), (f) and (g) and 25.1420. Guidance includes considerations for :

- installing a primary ice detection system;
- developing a method to alert the flightcrew that the airframe ice protection system must be activated and revising the Airplane Flight Manual (AFM) concerning procedures for activating the airframe ice protection system; and
- a means for the flightcrew to determine that they must exit icing conditions.

b. The guidance provided in this document is directed to airplane manufacturers, modifiers, foreign regulatory authorities, and Federal Aviation Administration airplane type certification engineers and their designees.

c. Like all advisory circular material, this AC is not in itself mandatory, and does not constitute a regulation. It is issued to describe an acceptable means, but not the only means, for demonstrating compliance with the requirements for transport category airplanes. Terms such as "shall" and "must" are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described in this document is used. While these guidelines are not mandatory, they are derived from extensive Federal Aviation Administration and industry experience in determining compliance with the pertinent regulations.

d. This advisory circular does not change, create any additional, authorize changes in, or permit deviations from regulatory requirements.

2. APPLICABILITY. The guidance provided in this AC applies to certification of part 25 transport category airplanes for flight in icing conditions.

3. RELATED DOCUMENTS.

a. **Regulations contained in Title 14, Code of Federal Regulations (CFR).**

Section	Title
§ 25.1301	Equipment - Function and installation
§ 25.1309	Equipment, systems, and installations
§ 25.1316(b)	System lightning protection
§ 25.1321	Instruments Installation - Arrangement and visibility
§ 25.1322	Warning, caution, and advisory lights
§ 25.1333	Instrument systems
§ 25.1419	Ice protection
§ 25.1420	Exit large droplet conditions
§ 25.1585(a)(6)	Operating procedures
Appendix C to part 25	

b. **Advisory Circulars (AC).** The AC's listed below may be obtained from the U.S. Department of Transportation, Subsequent Distribution Office, SVC-121.23, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785:

Number	Title and Date
AC 20-73	Aircraft Ice Protection, dated April 21, 1971.
AC 20-117A	Hazards Following Ground Deicing and Ground Operations in Conditions Conducive to Aircraft Icing, dated December 17, 1982.

AC 20-115B	Radio Technical Commission for Aeronautics, Inc. (RTCA) Document RTCA/DO-178B, dated January 11, 1993.
AC 21-16D	RTCA Document DO-160C, dated July 21, 1998.
AC 25-7A	Flight Test Guide for Certification of Transport Category Airplanes, dated March 31, 1998.
AC 25-11	Transport Category Airplane Electronic Display Systems, dated July 16, 1987
AC 25.1309-1A	System Design Analysis, dated June 21, 1988.
AC 25.1419-1	Certification of Transport Category Airplanes for Flight in Icing Conditions, dated August 18, 1999.

c. **Other FAA Documents:**

Number	Title
DOT/FAA/CT-88/8-1	"Aircraft Icing Handbook," issued March 1991, updated September 1993

d. **Industry Documents.** The following documents can be obtained from Radio Technical Commission for Aeronautics (RTCA), Inc., 1140 Connecticut Ave., NW, Suite 1020, Washington, DC 20036.

Number	Title
RTCA/DO-178B	Software Considerations in Airborne Systems and Equipment Certification
RTCA/DO160D	Environmental Conditions and Test Procedures for Airborne Equipment

4. DEFINITION OF TERMS. For the purposes of this AC, the following definitions should be used.

a. **Advisory ice detection system:** An advisory system annunciates the presence of icing conditions or ice accretion. The flightcrew is responsible for monitoring the icing conditions or ice accretion as defined in the AFM, typically using total air temperature and visible moisture criteria, visible ice accretion, or specific airframe ice accretion thickness, and activation by the flightcrew of the anti-icing or de-icing system(s) remains a requirement. The advisory system provides information to advise the flightcrew of the presence of ice accretion or icing conditions, but it can only be used in conjunction with other means to determine the need for, or timing of, activating the anti-icing or de-icing system.

b. **Airframe icing:** Ice accretions on portions of the airplane, with the exception of the propulsion system, on which supercooled liquid droplets may impinge.

c. **Anti-Icing:** The prevention of ice formation or accumulation on a protected surface, either:

- by evaporating the impinging water or
- by allowing it to run back and off the surface or freeze on non-critical areas.

d. **Automatic cycling mode:** A mode of operation of the airframe de-icing system that provides repetitive cycles without the need for the pilot to select each cycle. This is generally done with a timer, and there may be more than one timing mode.

e. **Deicing:** Removal or the process of removal of an ice accretion after it has formed on a surface.

f. **Irreversible flight controls:** All of the force required to move the pitch, roll, or yaw control surfaces is provided by hydraulic or electric actuators, the motion of which is controlled by signals from the flight deck controls. Loads generated at the control surfaces themselves are reacted against the actuator and its mounting and cannot be transmitted directly back to the flight deck controls.

g. **Large droplet conditions conducive to ice accumulation aft of the airframe's protected area:** Conditions containing a population of supercooled droplets sufficiently larger than those provided for in appendix C (of 14 CFR part 25) to cause ice accretions aft of the protected areas. The accumulation mechanism aft of the protected surface may be by direct impingement and accretion or delayed freezing of large droplets that impinge further forward. These conditions may be aircraft-dependent as a consequence of the geometry of the airfoil and the limits of protected areas.

h. **Monitored Surface:** The surface of concern regarding ice hazard (for example, the leading edge of the wing).

i. **Primary ice detection system:** The means used to determine when the IPS must be activated. The system annunciates the presence of ice accretion or icing conditions and may also provide information to other aircraft systems. A primary <u>automatic</u> system automatically activates the anti-icing or de-icing systems. With a primary <u>manual</u> system, the flightcrew activates the IPS upon indication from the system.

j. **Reference Surface:** The surface where an ice detection sensor is located or where a visual cue is located remotely from the surface of concern regarding ice hazard (for example, a propeller spinner).

k. **Reversible flight controls:** The flight deck controls are connected to the pitch, roll, or yaw control surfaces by direct mechanical linkages, cables, or push-pull rods such that pilot effort produces motion or force about the hinge line. Conversely, force or motion originating at the control surface (through aerodynamic loads, static imbalance, or trim tab inputs, for example) is transmitted back to flight deck controls.

(1) Aerodynamically boosted flight controls: Reversible flight control systems that employ a movable tab on the trailing edge of the main control surface linked to the pilot's controls or to the structure in such a way as to produce aerodynamic forces that move, or help to move, the surface. Among the various forms are flying tabs, geared or servo tabs, and spring tabs.

(2) Power-assisted flight controls: Reversible flight control systems in which some means is provided, usually a hydraulic actuator, to apply force to a control surface in addition to that supplied by the pilot to enable large surface deflections to be obtained at high speeds.

l. **Static air temperature:** The air temperature as would be measured by a temperature sensor not in motion with respect to that air. This temperature is also referred to in other documents as "outside air temperature," "true outside temperature," or "ambient temperature."

m. **Substantiated visual cues:** Ice accretion on a reference surface identified in the Airplane Flight Manual (AFM) that is observable by the flightcrew. (NOTE: Visual cues used to identify ice addressed in Appendix C will differ from those used to identify large droplet ice.)

NOTE: These definitions of terms are intended for use only with respect to §§ 25.1419(e),(f) and (g), and 25.1420.

5. COMPLIANCE WITH § 25.1419(e)(1) and (e)(2).

a. **Requirements of the Rule.** This section of the rule requires either a primary ice detection system, or substantiated visual cues and an advisory ice detection system, to alert the flightcrew that the airframe ice protection system must be activated.

(1) One of the following provides an acceptable means of compliance with § 25.1419(e)(1):

- A primary manual ice detection system that provides an alert that the airframe ice protection system must be activated, or
- A primary automatic ice detection system.

(2) Substantiated visual cues, in conjunction with an advisory ice detection system, is an acceptable means of compliance with § 25.1419(e)(2). The visual cues can

range from direct observation of ice accretions on the airplane's protected surfaces to observation of ice accretions on reference surfaces. Examples of visual means could be:

- accretions forming on the windshield wiper posts,
- accretions forming on propeller spinners,
- accretions forming on radomes,
- accretions on the protected surfaces

If accretions on the protected surfaces cannot be observed, consideration should be given to providing a reference surface which can be periodically de-iced to allow better observation of the rate of ice accretion.

(a) *Field of View.* The visual cue should be developed with the following considerations:

(i) Visual cues should be within the flightcrew's vision scan area while seated and performing their normal duties.

(ii) The visual cue should be visible during all modes of operation (day, night).

(b) Verification. During the certification process, the applicant should verify the ability of the crew to observe the visual cue and reference surface. The visual cue should not be dependent upon the location of the flightcrew's seats. The visual cue should be evaluated from the most adverse flightcrew seat locations in combination with the range of flightcrew heights. The visual cues should be visible from both the left and right seats. Consideration should be given to the difficulty of observing clear ice. If a reference surface is used, the applicant should validate that it correlates with ice accumulation on the airframe's protected areas. Such visual cues should be validated by testing in measured natural icing.

(3) The applicant should present an icing certification plan, as suggested by AC 25.1419-1, to the cognizant Aircraft Certification Office. The plan should include the ice detector system's compliance with §§ 25.1301, 25.1309, 25.1419, and any other applicable sections.

b. **System Performance when Installed.** The applicant should accomplish a droplet impingement analysis and/or tests to ensure that the ice detector is properly located. The detector and its installation should minimize nuisance warnings.

c. **System Safety Considerations.** The applicant should consult AC 25.1309-1A for guidance on compliance with § 25.1309. In accordance with the AC, the applicant should accomplish a functional hazard assessment to determine the hazard level associated with failure of the ice detection system. The unannunciated failure of a primary ice detection system is assumed to be a catastrophic failure condition, unless the characteristics of the airplane in icing conditions without activation of the airframe ice protection system(s) are demonstrated to result in a less severe hazard category. If visual cues are primary, failure of an advisory ice detection system is considered to be minor.

d. **Software and Hardware Qualification.** For guidance on hardware and software qualification, the applicant should consult RTCA/DO-178B, "Software Considerations in Airborne Systems and Equipment Certification," and RTCA/DO160D, "Environmental Conditions and Test Procedures for Airborne Equipment."

e. **Safe Operations in Icing Conditions.**

(1) Section 25.1419 requires that the applicant demonstrate that the airplane is able to operate safely in the icing conditions defined in Appendix C to part 25. The ice detection system should be shown to operate in the range of conditions defined by Appendix C.

(2) Section 25.1419 also requires a combination of tests and analysis to demonstrate the performance of the ice detector and the system as installed on the airplane. This could include icing tunnel and icing tanker tests to evaluate the ice detector performance. Also required are analysis and flight tests in measured natural atmospheric conditions to demonstrate satisfactory performance of the system as installed on the airplane. It should be demonstrated that the airplane can be safely operated with the ice accretions formed at the time the ice protection system becomes effective, following activation of the ice detector.

f. **Airplane Flight Manual (AFM).** The AFM should address the following:

(1) Operational use of the in-flight ice detection system and IPS and any limitations; and

(2) Failure indications and appropriate crew procedures.

(3) Procedures for deactivating the IPS

6. COMPLIANCE WITH § 25.1419(e)(3)

a. **Requirements of the Rule.** This section of the rule provides an alternative to the primary ice detection system and the visual cues plus advisory ice detection system as defined in paragraph (e)(1) and (2). This alternative requires the operation of the ice protection system when the airplane is in conditions conducive to airframe icing during all phases of flight. If the ice protection system requires repeated cycling, an automatic cycling system must be provided.

b. The temperature cue used in combination with visible moisture should consider static temperature variations due to local pressure variations on the airframe. A minimum temperature limitation may be required on some types of systems due to equipment temperature limitations (such as elastomer pneumatic de-ice boot systems).

c. If this provision is used, the flightcrew should be able to easily determine the static air temperature. A display of static air temperature or a placard can be provided showing corrections for temperature vs. air speed to the nearest degree Centigrade in the region of interest (i.e., around 0° C). Requiring the flightcrew to access hand-held charts or calculators in lieu of a placard is not an acceptable means.

d. The limitations section of the AFM should identify specific static or total air temperature and visible moisture conditions which must be considered as conditions conducive to airframe icing, and should specify the phases of flight in which the IPS must be operated when these conditions are encountered.

7. COMPLIANCE WITH § 25.1419(f)

a. **Requirements of the Rule.** This section requires that if the ice protection system requires repeated cycling after initial activation:

(1) the airplane must be equipped with a system that automatically cycles the ice protection system, or

(2) an ice detection system must be provided to alert the flight crew each time the ice protection system must be cycled.

Some examples of systems which automatically cycle the IPS are:

1. A system that senses ice accretion on a detector and correlates to ice accretion on a protected surface. This system then cycles the IPS at a predetermined condition.
2. A system which cycles the IPS based on the use of a timer. Such a system may have more than one cycling time.
3. A system that directly senses the ice thickness on a protected surface and cycles the IPS.

The common attribute of all these systems is that the pilot is not required to manually cycle the IPS after initial activation.

Some examples of an ice detection system which alerts the flight crew each time the ice protection system must be cycled could be the same as 1 and 3 above, except that the system alerts the crew each time the IPS must be manually cycled. A timer that does not have ice sensing capability cannot be used to meet this requirement.

b. **System Performance when Installed.** The applicant should accomplish a droplet impingement analysis and/or tests to ensure that the ice detector is properly located. The detector and its installation should minimize nuisance warnings.

c. **System Safety Considerations.** The applicant should consult AC 25.1309-1A for guidance on compliance with § 25.1309. In accordance with the AC, the applicant should accomplish a functional hazard assessment to determine the hazard level associated with failure of the ice detection system. If visual cues are not available to indicate repeated cycles of a manually cycled de-icing system, the ice detection system may become primary under § 25.1309. The unannunciated failure of a primary ice detection system is assumed to be a catastrophic failure condition, unless the characteristics of the airplane in icing conditions without activation of the ice protection system(s) are demonstrated to result in a less severe hazard category. If visual cues are primary, failure of an advisory ice detection system is considered to be minor.

d. **Hardware and Software Qualification.** For guidance on hardware and software qualification, the applicant should consult RTCA/DO-178B, "Software Considerations in Airborne Systems and Equipment Certification," and RTCA/DO160D, "Environmental Conditions and Test Procedures for Airborne Equipment."

8. COMPLIANCE WITH § 25.1419(g)

Procedures for operation of the IPS should be provided in the AFM as discussed in section 5 and 6 above. Information should be provided to indicate that a de-icing system should not be de-activated until the completion of an entire de-icing cycle after leaving icing conditions. An anti-icing system should not be de-activated before leaving icing conditions.

9. COMPLIANCE WITH § 25.1420

a. **Requirement of the Rule.** Section 25.1420 is applicable to aircraft equipped with reversible flight controls in either the pitch or roll axis. It requires that one of the following must be provided to alert the flight crew that they must exit icing conditions:

- Substantiated visual cues that enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or
- A system that alerts the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas

b. **Acceptable Means of Determining if Airplane is Operating in Large Droplet Icing Conditions.** There are several acceptable means for determining that the airplane is operating in large droplet conditions conducive to ice accumulation aft of the airframe's protected area. These include:

(1) Direct or Remote Measurement on a Monitored Surface:

(a) *Placement of Detectors.*

(i) For direct measurement, ice detectors are fitted directly onto the surface to be monitored. The detectors sense the presence and/or the thickness of ice that is accumulating aft of the protected area. They are usually flush-mounted (integrated on or within the skin). The monitored surface may vary from a spot of approximately 1 square inch to several square inches or larger.

(ii) For remote measurement, the sensing element is not directly fitted onto the surface to be monitored. An optical means (e.g., infrared or laser devices) may be one means of compliance. The surface extent monitored by this system is usually larger than with direct measurements.

(b) *Ability to Sense Ice.* The applicant should demonstrate that the detector will perform its intended function.

(i) For direct measurement, an icing wind tunnel and/or a laboratory chamber may be used to evaluate the ability of the ice detector to detect ice.

(ii) For remote measurement, laboratory tests may be used to demonstrate the ability of the detector to detect ice on the monitored surface.

(c) *Detector Position.* The detector should be positioned such that it performs its intended function with considerations given to the following factors:

(i) accretion characteristics of the monitored surface,

(ii) sensitivity of the airfoil to ice accretions,

(iii) thermal characteristic of the installation with respect to the generation of heat (direct measurement only),

(iv) physical damage from foreign objects,

(v) early detection (response time),

(vi) not intrusive relative to ice accretion on the monitored surface (direct measurement only),

(vii) field of view relative to the monitored surface (remote measurement only),

(viii) obscuration due to atmospheric conditions (e.g. snow, clouds) (remote measurement only), and

(ix) any other appropriate factors.

(d) *Analysis and icing wind tunnels* may provide information for location of the detector. In addition, laboratory tests may provide information for location of the remote detector.

(2) Remote Measurement Correlated to Ice Accumulation on a Monitored Surface. One method that could be used would be to provide indication of the conditions by discriminating droplet sizes. This method could provide an indication of conditions beyond those for which the airplane has been demonstrated.

(a) *Acceptable Settings.* Unless other acceptable criteria can be established, the device should be set to provide an indication when conditions exceed those specified in Appendix C, assuming a Langmuir E distribution for 50μm MED droplets. (The definition of a Langmuir E distribution can be found in the FAA Technical Report DOT/FAA/CT-88/8-1, "Aircraft Icing Handbook" published March 1991, updated September 1993.) When the device detects conditions that exceed the Appendix C conditions, the "exit icing" signal should be activated.
Note: this paragraph may need revision in light of further information to be developed during task 2.

(b) *Component Qualification.* The component level certification should verify that the uninstalled device is capable of providing a reliable and repeatable signal. One method would be to perform testing in an icing tunnel. The droplet size distribution should bracket the signal point, with droplet distributions slightly below and slightly above the signal point. The test should be repeated at sufficient conditions of liquid water content and ambient temperature to ensure operation throughout the icing conditions defined by Appendix C (of 14 CFR part 25) and with droplet sizes up to 500 microns, or identify limitations as to the conditions where performance is degraded. The applicant must substantiate the acceptability of any equipment limitations.

(3) Visual Means. This means can range from direct observation of ice accretions aft of the airplane's protected surfaces to observation of ice accretions on reference surfaces. Examples of visual means that could indicate to the flightcrew that the airplane is operating in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas include observations of:

- accretions forming on unheated portions of side windows,

- accretions forming on the aft portions of propeller spinners,
- accretions forming on aft portions of radomes, and
- water splashing on the windshields at static temperatures below freezing

(a) *Field of View.* The visual cue should be developed with the following considerations:

(i) Visual cues should be within the flightcrew's vision scan area while seated and performing their normal duties.

(ii) The visual cue should be visible during all modes of operation (day, night).

(b) *Verification.* During the certification process, the applicant should verify the ability of the crew to observe the visual cue and reference surface. The visual cue should not be dependent upon the location of the flightcrew's seats. The visual cue should be evaluated from the most adverse flightcrew seat locations in combination with the range of flightcrew heights, within the approved range of eye reference point locations, if available. The visual cues should be visible from both the left and right seats. Consideration should be given to the difficulty of observing clear ice. If a reference surface is used, the applicant should validate that it correlates with conditions conducive to ice accumulation aft of the airframe's protected areas. Validation of the visual cues may be accomplished by testing in measured natural icing or simulated large droplet icing behind a calibrated water tanker aircraft. However, the low probability of finding conditions conducive to ice accumulation aft of the protected areas may make natural icing flight tests impractical.

c. **System Safety Considerations.** The applicant should consult AC 25.1309-1A for guidance on compliance with §§ 25.1309.

(1) Hazard classification. The following is a qualitative analysis that may be used for determining the hazard classification for compliance with this part 25 regulation. Not all encounters with large droplet icing result in a catastrophic event. While definitive statistics are not available, given the volume of aircraft operations and reported incidents that did not result in a catastrophe, a factor of approximately 1 in 100 is a reasonable assumption of the probability of a catastrophic event, if an airplane encounters large droplet conditions conducive to ice accumulation aft of the airframe's protected areas. Based on the above assumption, the hazard classification of an unannunciated encounter with "large droplet conditions conducive to ice accumulation aft of the airframe's protected areas" may be considered as *severe major* in accordance with AC 25.1309-1A.

(2) Frequency of occurrence. The icing conditions described in Appendix C were designed to include 99 percent of the icing conditions. Evaluation of icing data has indicated that the probability of encountering icing outside of Appendix C droplet

conditions is on the order of 10^{-2}. The applicant may assume this probability for encountering the large droplet conditions conducive to ice accumulation aft of the airframe's protected areas. It should be considered as an average probability throughout the flight.

(3) Numerical safety analysis. For the purposes of a numerical safety analysis, the applicant may combine the probability of equipment failure with the probability, defined above, of encountering large droplet conditions conducive to ice accumulation aft of the airframe's protected areas. Therefore, if the applicant uses the above qualitative analysis for the hazard classification and the above probability of encountering the specified large droplet conditions (10^{-2}), it follows that the probability of an unannunciated equipment failure should be less than 10^{-5}.

d. **System Performance when Installed.**

(1) The ice detector system installed for compliance with § 25.1420 is intended to detect ice that forms due to large supercooled droplets that exceed Appendix C. Flight tests in measured natural icing conditions (required by § 25.1419) should be conducted to ensure that the system does not produce nuisance warnings when operating in conditions defined by Appendix C.

(2) The low probability of finding, for testing purposes, conditions conducive to ice accumulation aft of the protected areas, may make natural icing flight tests impractical as a means of demonstrating the system functions in conditions that exceed Appendix C. The applicant may use flight tests of the airplane under simulated icing conditions (icing tanker) or icing wind tunnel tests of a representative airfoil section to demonstrate the proper functioning of the system and to correlate the signals provided by the detectors and the actual ice accretion on the surface.

NOTE: The measured natural icing flight tests required by § 25.1419 are only applicable for conditions that are defined by Appendix C.

e. **Hardware and Software Qualification.** For guidance on hardware and software qualification, the applicant should consult RTCA/DO-178B, "Software Considerations in Airborne Systems and Equipment Certification," and RTCA/DO160D, "Environmental Conditions and Test Procedures for Airborne Equipment."

f. **Airplane Flight Manual**

(1) For ice detector systems, the AFM should address:

- operational use of the ice detection system and any limitations of the system; and
- failure indications and associated crew procedures.

(2) For visual means of compliance, the AFM should contain procedures that describe the visual means used to indicate that the airplane is operating in large droplet conditions that are conducive to ice accumulation aft of the airframe's protected areas.

(3) The following are acceptable AFM changes regarding actions the flightcrew should take after there is an indication of ice aft of the protected areas. Changes to the Limitations Section of the AFM must be approved by the FAA.

(a) Revise the Limitations Section of the FAA-approved AFM to require the pilot in command to immediately take action to exit the conditions where ice accretion is occurring, unless in the opinion of the pilot-in-command, it is necessary to delay such action in the interest of safety.

(b) Revise the Normal Procedures Section of the FAA-approved AFM to include the following:

- In order to avoid extended exposure to flight conditions that result in ice accumulations aft of the protected areas, the pilot in command must immediately take action to exit the conditions in which any ice accretion is occurring, unless in the opinion of the pilot in command, it is necessary to delay such action in the interest of safety.
- Avoid abrupt and excessive maneuvering that may exacerbate control difficulties.
- Do not engage the autopilot.
- If the autopilot is engaged, hold the control wheel firmly and disengage the autopilot.
- If an unusual roll response or uncommanded roll control movement is observed, smoothly but positively reduce the angle-of-attack.
- Do not extend flaps during extended operation in icing conditions. Operation with flaps extended can result in the possibility of ice forming on the upper surface further aft on the wing than normal, possibly aft of the protected area.
- If the flaps are extended, do not retract them until the airframe is clear of

ice.

- Report these weather conditions to Air Traffic Control.

- Maintain airspeed awareness and follow minimum speed guidelines per Airplane Flight Manual procedures, including a nose down attitude, if required, to maintain an acceptable airspeed.

Continue to follow these procedures until it can be determined that there are no ice accretions aft of the protected surface.

Transport Airplane Directorate
Aircraft Certification Service

TASK 1
PART 25 + 121 UPDATE

FEB 12 2002

Mr. Craig R. Bolt
Assistant Chair, Aviation Rulemaking
Advisory Committee
Pratt & Whitney
400 Main Street
East Hartford, CT 06108

Dear Mr. Bolt:

This letter further responds to your June 29, 2001, letter transmitting a report and options to a draft part 25 proposal concerning ice protection. In our September 17 interim letter, we indicated that we would work closely with the Joint Aviation Authorities and Transport Canada to review the report and options and to have a decision by October 2001. Although later than anticipated, the authorities agree with and fully endorse option C of the working group report. The authorities agree with the advisory committee to delay the release of any proposal to require certain airplanes to exit icing conditions, until the working group makes further progress on the definition of an icing environment that include supercooled large droplets.

The FAA is currently revising the draft part 25 rule based on the authorities' disposition of the comments contained in the working group report. Once we have finished, the final product will be provided to the working group for information only. In the meantime, we have enclosed the disposition of comments generated by the authorities while they were reviewing the June 29 report and options.

In our September 17, 2001, response to your May 21 letter, we provided the dates of November 30 and February 28, 2002, respectively, for completion of the regulatory and legal reviews of the draft operations rule and advisory circular on operations in icing conditions. We have since had to readjust that schedule. The regulatory review was completed on December 31, 2001; we now expect the legal review to be completed by the end of March. The draft will be returned to the Aviation Rulemaking Advisory Committee shortly thereafter.

In a separate letter, you requested that we delete reference to part 23 in several task statements assigned to the Ice Protection Harmonization Working Group. The FAA agrees that the working group's forthcoming recommendations may not be appropriate for part 23 category airplanes, and we have modified the statements to address only part 25.

Sincerely yours,

ORIGINAL SIGNED BY
ANTHONY F. FAZIO

Anthony F. Fazio
Director, Office of Rulemaking

Attachment

16 September 2002

IN REPLY, REFER TO
L374-44-02-22

Mr. Craig R. Bolt
Assistant Chair, Advisory Committee on Transport Aircraft Engines Issues
440 Main Street
East Hartford, CT 06108

Dear Mr. Bolt:

This letter is submitted as a transmittal cover for the Ice Protection Harmonization Working Group (IPHWG) products relative to Task 1 of the work plan. These products are ready for a final vote from TAEIG.

The submittal includes three separate documents: the proposed preamble materials with the proposed 14 CFR 121 rule, the proposed Advisory Circular, and the FAA Regulatory Evaluation.

These materials are recommended by the IPHWG for TAEIG final approval. However, some minority comments were accepted after the conclusion of the "final" FAA regulatory evaluation and legal review. Due to this timing, they were not included in the formal preamble materials but are included as attachments to this submittal letter. It is recommended that these minority comments be submitted to the FAA along with the following majority comments.

A majority of the IPHWG generally accepts the overall results of the Regulatory Evaluation. However, it is recognized that the analysis was performed using FAA established guidelines (APO 110 Statistical and Forecast Branch). The IPHWG believes that some aspects of these guidelines have significantly limited the applicability of the analysis.

The comments shown in the RAA, SAAB and Boeing comments (which are generally supported by BAE) reflect areas where these economic analysis methods do not adequately model the costs and benefits. The FAA economist has stated that the analysis was constrained to use one of three forecast models. A majority of the members of the IPHWG believes that these constraints do not fairly reflect the fleet under consideration for the proposed rule. The forecasts do not distinguish between:

- ✓ Retirement averages versus individual aircraft expectations.
- ✓ Reversible and irreversible flight controls.
- ✓ Cost benefit differences of pneumatic de-ice boots versus thermal ice protection systems.
- ✓ The forecast is limited to aircraft with no more than 60 seats (relative to seat growth).
- ✓ Weights above the 60,000 lbs discriminator in the proposed rule.
- ✓ Pre and Post economic conditions of 9/11/2001.

In addition, the working group acknowledges that there are uncertainties in the use of the airworthiness directive effectiveness factor of 50%. Even though a statistical analysis could not be performed, a rational review of the event record was performed to see which events could potential be affected by the airworthiness directives. This review indicated that approximately 50% of the events could have potentially been prevented by the AD's. Although an evaluation was performed, confidence in the evaluation results may be limited.

Relative to the ALPA comments, the airline pilots association (ALPA) generally supports the economic evaluation, however, they feel that one additional accident should be considered (Dec 14, 1987 accident at Joplin, Missouri [NTSB #MKC88FA027]). The working group does not believe this would significantly influence the regulatory evaluation, as there were no fatalities in this event.

While acknowledging the limitations of the regulatory evaluation process, the majority of the working group generally accepts the conclusion of the analysis and recommends submittal to the FAA with the above comments.

Sincerely,

(original signed by)

Jim Hoppins
Co-Chair Ice Protection Harmonization Working Group

U.S. Department
of Transportation

FEDERAL AVIATION ADMINISTRATION
Office of Aviation Policy and Plans
Washington, D.C. 20591

PROPOSED REGULATORY EVALUATION, PROPOSED REGULATORY FLEXIBILITY DETERMINATION, PROPOSED INTERNATIONAL TRADE IMPACT ASSESSMENT AND PROPOSED UNFUNDED MANDATE ASSESSMENT FOR THE ICE PROTECTION HARMONIZATION WORKING GROUP

ACTIVATION OF ICE PROTECTION SYSTEMS AND EXISTING ICING CONDITIONS PROPOSED OPERATING RULE (14 CFR Parts 121)

OFFICE OF AVIATION POLICY, PLANS AND MANAGEMENT ANALYSIS

AIRCRAFT REGULATORY ANALYSIS BRANCH, APO-320

GEORGE THURSTON

June 2002

TABLE OF CONTENTS

EXECUTIVE SUMMARY

This proposal would amend the regulations applicable to operators of airplanes with a Maximum Take-off Weight (MTOW) of less than 60,000 pounds, used in 14 CFR Part 121 air carrier service. The proposal would require either the installation of ice detection equipment or changes to the Airplane Flight Manual (AFM) to ensure timely activation of the ice protection system (IPS). This proposal also would specify when airplanes with reversible flight controls for the pitch and/or roll axis should exit conditions conducive to airframe icing. This proposed regulation is the result of information gathered from a review of icing accidents and incidents, and it is intended to improve the level of safety when airplanes are operated in icing conditions.

The rulemaking proposal contained in this notice is based on a recommendation developed by the Ice Protection Harmonization Working Group (IPHWG) of Aviation Rulemaking Advisory Committee (ARAC). There is ongoing ARAC activity on additional icing related rules, which the FAA anticipates would result in proposals for rulemaking.

The FAA estimates the present (2002$) value of the total quantifiable safety benefits from 2007 through 2026 to be about $106.6 million dollars. The FAA estimates that the present (2002$) value of the total costs from 2007 through 2026 to be about $70.2 million dollars. Viewed over 20-years, approximately $58.0 million, representing 82.6 percent of the total cost, would be incurred in the first year following the effective date of this proposed rule.

The FAA has determined that this rule: (1) has benefits which do justify its costs; (2) does not impose costs sufficient to be considered "significant" under the economic standards for significance under Executive Order 12866 or under DOT's Regulatory Policies and Procedures; due to public interest and safety, however, it is considered significant under the Executive Order and DOT policy; (3) would have a significant impact on a substantial number of small entities; (4) would primarily have a domestic impact, thus the trade impact is minimal and does not create obstacles to foreign commerce for the U.S.; and (5) does not impose an unfunded mandate on state, local, or tribal governments, or on the private sector.

I. INTRODUCTION

This proposed rule is responsive to National Transportation Safety Board (NTSB) recommendation A-96-56, which is on the NTSB's Most Wanted List. The proposed rule is also one of the items listed in the FAA's In-flight Aircraft Icing Plan, April 1997. The Icing Plan details the FAA's plans for improving the safety of airplanes when they are operated in icing conditions. Neither the operating regulations nor the certification regulations require a means for the pilot in command to specifically identify that hazardous icing conditions have been encountered.

II. BACKGROUND

On October 31, 1994, at 1559 Central Standard Time, an Avions de Transport Regional model 72-212 (Aerospatiale Model ATR 72) operated by Simmons Airlines, Incorporated, and doing business as American Eagle flight 4184, crashed during a rapid descent after an uncommanded roll excursion. The airplane was in a holding pattern and was descending to a newly assigned altitude of 8,000 feet when the initial roll excursion occurred. Impact forces destroyed the airplane; and the captain, first officer, 2 flight attendants and 64 passengers received fatal injuries. Flight 4184 was a regularly scheduled passenger flight being conducted under 14 Code of Federal Regulations (CFR), Part 121; and an instrument flight rules plan had been filed. Flight 4184 operated in icing conditions, believed to include freezing drizzle droplets, which were reported in the area. The FAA, Aerospatiale, the French Direction Générale de l'Aviation Civile, Bureau Enquete Accident, National Aeronautics and Space Administration (NASA), National Transportation Safety Board, and others have conducted an extensive investigation of this accident. This investigation concluded that freezing drizzle conditions created a ridge of ice aft of the deicing boots and forward of the ailerons, which resulted in uncommanded roll of the airplane.

NTSB Safety Recommendations

The NTSB issued various safety recommendations to the FAA following the Model ATR72 accident investigation. One of the recommendations, A-96-56, states in part that:

If safe operations in certain icing conditions cannot be demonstrated by the manufacturer, operational limitations should be imposed to prohibit flight in such conditions and flight crews should be provided with the means to positively determine when they are in icing conditions that exceed the limits for aircraft certification.

The rulemaking proposal addresses the NTSB safety recommendations by defining, to the pilot in command, when to exit icing conditions.

Industry Recommendation

Partially in response to the latter portion of this safety recommendation, the FAA tasked the Aviation Rulemaking Advisory Committee (ARAC), by notice published in the Federal Register on December 8, 1997 (62 FR 64621), to consider the need for a regulation that requires installation of ice detectors, aerodynamic performance monitors, or another acceptable means to warn flight crews of ice accumulation on critical surfaces requiring crew action (regardless of whether the icing conditions are inside or outside of Appendix C of 14 CFR Part 25).

The rulemaking proposal contained in this notice is based on a recommendation developed by the Ice Protection Harmonization Working Group (IPHWG) of ARAC that ARAC approved and presented to the FAA as a recommendation.

DISCUSSION

Review Process

To address the task, the IPHWG followed a process consisting of the following five elements:

1. Review of the airplane icing-related accident/incident history,
2. Identification of safety concerns,
3. Identification of the airplanes subject to the safety concerns (i.e., applicability),

4. Identification of various means to address the safety concerns, and
5. Review of the technology available to allow compliance with any proposed methods of addressing the safety concerns.

These five elements are discussed in more detail below.

1. Accident/Incident History Review

The IPHWG reviewed the airplane icing-related accident/incident history and developed a database of approximately 1,300 worldwide icing-related accidents and incidents. The IPHWG then refined the database by:

- Removing duplicate entries and reports with insufficient data.
- Removing elements that were not relevant to in-flight airframe icing problems, such as reports related to ground deicing and carburetor icing.
- Excluding single-engine piston airplanes, because most of these airplanes are not certificated for flight in icing. (Although a few of these airplanes may be certificated and equipped for flight in icing, the IPHWG considered that their exclusion would not affect the outcome of the review.)
- Removing reports involving multi-engine piston airplanes that were not certificated for flight in icing.
- Removing reports of events in which externally aggravating circumstances existed, such as operation of the airplane outside of its weight and balance limitations, descent below published minimums, or other reasons not related to airplane icing.

The IPHWG reviewed the remaining events and identified 96 events that contained adequate information to apply the following criteria:

- Was there ice accretion that was not known to the flight crew? and
- Would knowledge of this ice accretion have made a difference to the outcome of the accident or incident?

Based on these 96 events, the IPHWG concluded that in at least 61 events, there is substantive documented accident and incident history in which the level of flight crew cognizance of ice buildup on airframe surfaces was not adequate.

Once the group had concluded that flight crew cognizance of ice buildup on airframe surfaces was not adequate, an effort was undertaken to further analyze the evidence in order to identify factors which play a role in the flight crew's situational awareness as it pertains to icing. A parallel effort was undertaken to identify aerodynamic and system design factors which might play a role in the susceptibility of an airplane to icing effects, thus influencing the procedural vigilance required of the flight crew.

Both of these efforts required that the database be expanded. To do this, the same refinements described above were applied to the 1,300-event database, except that reports were included in which there was not sufficient information to positively determine whether flight crew knowledge of the ice accretion would have made a difference to the outcome of the accident or incident. This review yielded 234 events.

All 234 events were used to examine aerodynamic and system design factors. However, in order to look at issues regarding the flight crews situational awareness, single-pilot operations were not considered relevant to multi-pilot aircrew cognizance. Therefore, events, which were likely to have involved a single pilot, were removed from the 234 events for this purpose, leaving 119 events.

During the review of the original 96-event data set, certain factors became apparent and these were evaluated more closely using the 119-event data set. In particular, factors which affect crew workload were considered, such as phase of flight and crew complement.

Crew complement was estimated based on the number of pilots required by the type certificate and/or the type of operation being conducted. Phase of flight was extracted from the narratives of the events.

This part of the analysis revealed that 49 percent of the 119 events had taken place during the approach and landing phases of flight, 38 percent had taken place during the cruise phase, 8 percent during the climb phase, and 2 percent during the go-around phase.

The phase-of-flight analysis was conducted again using only accidents. The pattern remains similar: 73 percent of the accidents had taken place during approach and landing, 17 percent during cruise, 7 percent during climb, and 2 percent during go-around.

The approach and landing phases of flight involve considerably higher degrees of pilot workload than do the cruise and climb phases. Thus, there is less attention available to manage the ice accretion problem. Further, these phases involve continuous changes in flight parameters such as airspeed, altitude, and bank angle. In these phases of flight, indications of ice accretion other than visual cues, such as trim changes and drag increases are much less visible to the crew. Finally, research was considered which suggests that the drag effects of ice accreted at low angles of attack can become very significant when the angle of attack is increased. Ice accreted early in the approach phase may not manifest its effects until the angle of attack is increased later in the approach or landing. All of these factors influence the situation while the airplane is in close proximity to the ground.

The pilot workload required varies. In all cases, it requires that the ice accretion be detected. In some cases, it then requires that the ice accretion be evaluated prior to operation of the IPS.

With this data in hand, further work was undertaken to examine the crew response to knowledge of ice accretion. In 122 events out of 234, the narrative contained information that the flight crew knew that ice was accreting on the airframe. Yet in only 48 cases was there positive evidence that the crew had operated the IPS. This did not seem to be affected by crew complement, with 20 of the 48 cases involving a single pilot. In 16 of these cases, there was positive evidence that the crew had not operated the IPS; in the remainder, no information regarding IPS operation was available.

The IPHWG also considered extensively the significant air carrier accidents and incidents in recent years due to icing. These included the accidents at Roselawn, Indiana, in 1994 and at Monroe, Michigan, in 1997. Consideration also included incidents involving Fokker F-27s at East Midlands, UK, and Copenhagen, Denmark; the British Aerospace ATP at Cowley, UK; Embraer EMB-120s at Tallahassee, Elko, Fort Smith, and Klamath Falls, US, and several Aerospatiale/Alenia ATR events during the 1980s

2. Safety Concerns

Activation of Airframe IPS. The airplane icing-related accident/incident history review revealed accidents and incidents where the flight crew either:

- Was completely unaware of ice accumulation on the airframe, or
- Was aware of ice accumulation but judged that it was not significant enough to warrant operation of the IPS.

This led the IPHWG to conclude that flight crews must be provided with a clear means to know when to activate the IPS.

Exit Icing Conditions. The database contains accidents and incidents where the IPS was operated according to accepted procedures, yet the ice accretions still created degradations that led to an event. Therefore, the IPHWG concluded that the flight crew must be provided with a means to know if the airplane is in conditions conducive to ice accumulation that warrant the flight crew taking actions to exit icing conditions.

3. Applicability

The IPHWG examined the 234-event accident and incident history and found that discriminating factors exist that significantly reduce the risk of icing accidents and incidents. A wide range of factors was considered, including airplane size, type of flight control system, and wing chord length.

A limited analysis of the event database described above revealed that average wing chord length has a roughly inverse relationship to the event history. Of the data considered, the IPHWG noted that airplanes with average chord lengths in excess of ten feet had not experienced any accidents due to in-flight icing. Although some airplanes with shorter chords have no event history, many do.

Evidence is available to show that contamination on the upper wing surface results in an increasing deterioration in the wing's coefficient of lift and the coefficient of drag as the ratio of surface roughness height to wing chord length increases. This may sufficiently influence the contamination effects in a typical icing encounter such that a large chord length experiences minimal aerodynamic effect, while a small chord length may experience significant effects. Another contributing factor for the lack of accidents may be the fact that for any given icing encounter, droplets will impinge further aft and the resulting ice shape will be larger on a short-chord wing than on a longer-chord wing. Chord length, then, may be an appropriate discriminator for determining which airplanes have a higher risk of accidents and incidents without the flight crew having a clear means to know when to activate the IPS and when to exit icing conditions.

However, chord length is not a commonly known attribute of the airplane; therefore, the IPHWG sought a simple discriminator that could be readily understood by the aviation community. In the accident/incident database, those airplanes with a ten-foot average chord correspond quite well with airplanes with a weight of 60,000 pounds. Since the maximum certificated gross takeoff weight is simple and well understood, it was recommended as the discriminating parameter.

4. Possible Means of Addressing the Safety Concerns

The FAA has issued Airworthiness Directives (AD's) to require activation of pneumatic deicing boots at the first signs of ice accumulation on several types of airplanes operated under 14 CFR Part 121. These AD's relieve the pilot of determining whether the amount of ice accumulated on the wing warrants activation of the IPS. However, the flight crew's observation of ice accumulations can be difficult during times of high workload, operations at night, or when clear ice has accumulated. The difficulties of observing ice accumulations are applicable to any IPS which relies on pilot observation for activation of the system, not just pneumatic deicing boots.

The IPHWG concluded that an improved means to address these situations would be to require installation of a device that would alert the flight crew that the IPS should be activated. An advisory ice detection system in conjunction with substantiated visual cues will provide a much higher level of safety than visual cues alone. This device would mitigate the effects of high workload and of human sensory limitations in detecting ice and evaluating its thickness. When using such a device in conjunction with a manual IPS as required in 14 CFR 121.XXX (a)(2), the IPHWG considers it unacceptable to use crew assessment of depth of ice as a discriminator in deciding when to operate the de-icing system. The intent is to permit current certified manual systems to be used in such a way that they replicate the effectiveness of an automatic system without the dependency on the crew to establish ice depths. There are several types of airplanes currently in operation which have primary ice detection systems installed, and the IPHWG considers that these airplanes already meet the desired level of safety.

An alternative to requiring the installation of such an ice detector would be to require that the IPS be operated continuously when the airplane is operating in conditions conducive to airframe icing: reference 14 CFR 121.XXX (a)(3)(i). In this case, the flight crew would operate the IPS in response to a specific air temperature threshold and the presence of visible moisture. Temperature and visible moisture information is readily available and unambiguous. This approach has disadvantages with respect to increased maintenance due to increased time in operation. However, it presents large advantages with respect to flight crew workload and procedural reliability. It is consistent with systems used as anti-ice systems and is the procedure in use for many thermally anti-iced small jets. The IPHWG noted that small jets that used these procedures were absent from the incident database. When a manual de-icing system is required to be operated as defined above, the IPHWG considers it unacceptable to use crew assessment of depth of ice as a discriminator in deciding when to operate the de-icing system. The intent is to permit current certified manual systems to be used in such a way that they replicate the effectiveness of an automatic system without the dependency on the crew to establish ice depths. The IPHWG considered that this procedure could be used as an alternative to an ice detector.

The information in the database revealed that the phases of flight that presented the greatest risk due to airframe icing were those that were associated with low speed and relatively high angle-of-attack operation (i.e., approach, landing, go-around, and holding). Takeoff was excluded because the accidents related to that phase of flight were caused by improper ground deicing/anti-icing procedures; this has been adequately addressed by amendment 121-253 to 14 CFR [§ 121.629(b) and (c), "Operating in icing conditions"]. This conclusion was based primarily on the preponderance of icing accidents taking place during those phases, particularly approach and landing.

The IPHWG considered another requirement that would apply in any case where an ice detector was not operational and/or installed. This alternative would require that when the airplane is operating in conditions conducive to airframe icing, the IPS must be operated continuously. The group then considered how this procedure would apply to each phase of flight.

The database lists ten accidents worldwide as originating during cruise. In six of the ten accidents, the flight crew was aware of the ice accretion. In the remaining four accidents, very little relevant data was available. For the six accidents, IPHWG determined that the cruise accident history did not have enough information to draw meaningful conclusions regarding potential rulemaking.

The database also lists a number of incidents in the cruise phase, of which at least five were potential accidents. Further examination of the incidents where sufficient data was available led the IPHWG to conclude that the crews were aware that ice was accreting and that operation of the IPS at the first sign of ice accretion would have prevented the incidents. Examination of these incidents caused the IPHWG to conclude that the cruise phase should be included in the rule. However, the IPHWG did not believe that continuous operation of the IPS while in conditions conducive to icing was warranted. The IPHWG was reluctant to require continuous operation of manually cycled IPS's in conditions conducive to airframe icing due to considerations of crew workload and a concern that it would introduce a procedure possibly leading to substantial non-compliance. The IPHWG felt that continuous operation of the IPS at the first sign of ice accretion was more appropriate and alleviated the concern with procedural non-compliance.

With respect to the climb, approach, landing, holding and go-around phases of flight, the IPHWG determined that the following factors substantiated requiring the continuous operation of the IPS while in conditions conducive to icing:

- An overall majority of events which originated in these phases of flight;
- A sufficient number of events in which the flight crew was confirmed to be unaware of ice accretion, supplemented by a substantial number of events in which the flight crew awareness of ice accretion was unknown;
- High cockpit workload resulting in low residual flight crew attention;
- Frequent maneuvering, resulting in little opportunity for the flight crew to detect aerodynamic degradations due to icing;
- Maneuvering at relatively high angles of attack.

Exit Icing Conditions. The safety concern of when to exit icing conditions was partially addressed in 1996 by a series of AD's issued by the FAA. [Amendment 39-9698, AD 96-09-22 (61 FR 20674, May 7, 1996) is typical of these AD's.] The AD's require certain airplanes to exit icing when the conditions exceed the capabilities of the ice protection equipment. Generally, the visual cues for determining that the flight crew must act to exit icing conditions are subjective and can result in varying interpretations. Terms such as "unusually extensive ice," ice that is "not normally observed," and ice that is "farther aft than normally observed" are used in the AD's. These are all variable terms that are largely dependent on flight crew experience. The IPHWG concluded that less subjective means of determining when the flight crew should exit icing conditions are needed.

5. Technology

To ensure that viable means exist for compliance with any proposed methods of addressing the safety concerns, the IPHWG reviewed the current state of technology with regard to ice detectors and aerodynamic performance monitors.

Ice detector technology is sufficiently mature that there currently are available several methods that can reliably alert the flight crew as to when the IPS should be activated. This type of technology already has been certificated on various airplanes as either an advisory or a primary means of determining when the IPS should be activated. However, an ice detection system with the capability to alert the flight crew when to exit icing conditions would have to be able to detect when:

a. The icing conditions encountered exceed the criteria to which the airplane was certificated; or

b. Ice is accreting on surfaces of the airplane where it could prove hazardous and that were not addressed in the airplane's icing certification.

Some ice detection systems currently installed on airplanes have the capability to detect and alert the flight crew that ice is accreting on sensor elements of the detector. Depending upon the intended application of these detectors, ice accretions of approximately 0.1 mm to 1 mm and larger are detectable. However, these detectors have not been proven to operationally perform either of the functions identified in paragraphs a and b above.

Due to the unproven capabilities of ice detectors for the above application and the immature development of aerodynamic performance monitors, the IPHWG considered additional means for the flight crew to know when they should exit icing conditions.

It is feasible for the current ice detector technology to identify the existence of ice aft of the protected areas. Based on the accident and incident history and the current state of ice detector technology, the IPHWG recommended that the regulations be revised to address the known safety concern of ice accumulations aft of the airframe's protected areas on airplanes with reversible flight controls in the pitch or roll axis.

The IPHWG also acknowledged that, in lieu of an ice detector, it might be possible to use the flight crew's observation of ice accretion on reference surfaces, provided that the visual cues are substantiated for the specific airplane.

The relevant icing accidents and incidents occurred on airplanes equipped with pneumatic deicing boots. However, the accumulation of ice aft of the protected areas due to large droplet icing conditions can occur on any airplane, regardless of the type of IPS installed on it. Therefore, the IPHWG maintained that any revision to the current regulations should be applicable regardless of the type of IPS.

III. THE COSTS ESTIMATES

The proposed rule consists of two parts:

(1) Sections (a), (b), (e), and (f) which affect all 14 CFR Part 121 operated airplanes with a MTOW of less than 60,000 pounds. These sections would mandate when the pilot is to activate the IPS's.

(2) Sections (c), (d), (e), and (f), which affect all 14 CFR Part 121 operated airplanes with a MTOW of less than 60,000 pounds and equipped with reversible flight controls in the pitch and/or roll axis. These sections would mandate when the pilot is to exit icing conditions.

Sections (e) and (f) affect both parts of the proposed rule. Section (e) requires AFM procedures for compliance with the proposed rule. Section (f) requires approval of system installations and Airplane Flight Manual procedures through an amended or supplemental type certificate.

Three elements drive the overall cost estimate. They are:

(1) the costs per airplane to the operators required to implement sections (a), (b),(e), and (f) of this proposed rule;

(2) the costs per airplane to the operators required to implement sections (c), (d), (e), and (f) of this proposed rule;

(3) the estimate of the number of affected airplanes; including a snapshot of the current active fleet, a forecast of airplanes affected by the proposed rule entering the fleet, and a forecast of the retired affected airplanes during the 20-year analysis period.

The basis on which each element was estimated follows. All costs, discussed in the following estimates, are based in 2002 dollars and the discount factor is 7 percent as mandated by the Office of Management and Budget. The FAA analyzed the costs and benefits of this proposed rule over the 20-year period 2007 through 2026.

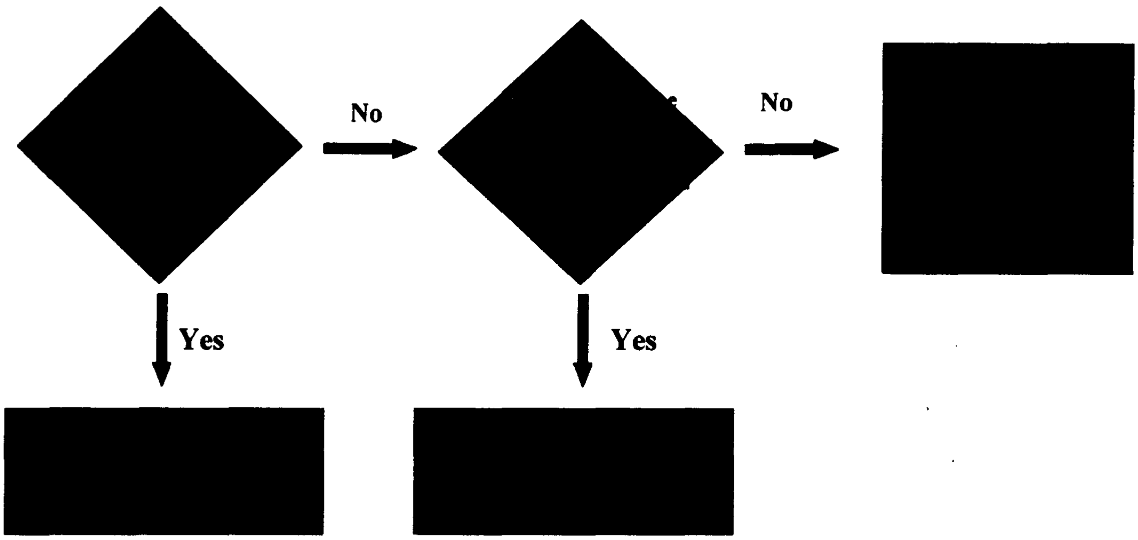
In order to estimate the potential costs and benefits of the proposed rule, the FAA has made the following assumptions:

(1) The proposed rule will become a final rule in 2005. The operators will have 24 months to comply. The first year the final rule imposes costs on the operators will be 2007.
(2) The FAA used $60.00 hourly rate for a mechanic/technician working for an airplane manufacturer or modifier and the $100.00 hourly rate for an engineer working for an airplane manufacturer or modifier.
(3) In this analysis, operators would pay for the indirect non-recurring costs that originally would be incurred first by manufacturers. These indirect non-recurring costs are distributed equally across each airplane in each airplane model group addressed by the proposed rule. The indirect non-recurring costs are one-time costs incurred within 24 months after the proposed rule becomes final.
(4) The FAA assumed whenever various compliance options are available to the operators, the minimal cost option will always be chosen.
(5) The proposed rule may result in airplane diversions from scheduled and non-scheduled operations, however, the costs of the diversions have not been included in the regulatory evaluation because reliable data is not available for predicting the number of diversions that would precipitate.

Costs Required to Implement Sections (a), (b),(e), and (f)

Exhibit 1 illustrates the chain of events leading up to the decision on whether an operator would incur the cost of a primary ice detection system, an advisory ice detection system, or activate the IPS's when entering conditions conducive to airframe icing.

Exhibit 1
Cost of (a), (b), (e), or (f) Compliance



To determine the direct costs to operators to implement sections (a), (b),(e), and (f) of the proposed rule, the analysis required distinguishing each airplane by having either one of two ice detection systems installed, one requiring substantiated visual cues as well, or having no ice detection system installed. To satisfy the intent of section (a) or (b), and (e) and (f) of the proposed rule, each of the airplanes was analyzed to determine if they currently had:

(1) a primary ice detection system (a)(1) or

(2) an advisory ice detection system installed, along with substantiated visual cues (a)(2).

If the airplane had either one of the two options, then the intent of section (a)or (b), and (e) and (f) has been satisfied and operators would not incur compliance costs for these sections. If an airplane does not have either one of the two options, then when the airplane is operating in conditions conducive to airframe icing, the IPS must be activated prior to and operated during all phases of flight except take-off and cruise (unless ice accretion is seen anywhere on the airplane, then it must also be operated during those phases unless prohibited by the AFM).

For section (a) of the proposed rule, if the operator decides to install a primary or advisory ice detection system, then the costs include:

(1) Indirect Non-recurring Airplane Group Costs
(2) Direct Operator Costs.

Section (a)(1) and (a)(2) - Indirect Non-recurring Airplane Group Costs

If the decision is made to install a primary or advisory ice detection system, non-recurring costs consist of the following:

(1) System Design – includes ice detector system architecture and integration, positioning, and updating the manufacturer's AFM procedures
(2) System Qualification/certification – includes ice detector qualification, certification, and flight test
(3) Tasks associated to the retrofit – includes service bulletin preparation, approval and a crew-training program.

As mentioned earlier, these non-recurring costs are manufacturer's costs and were distributed equally across each airplane in each major airplane group. Note the more airplanes in a major airplane group, the cheaper the non-recurring costs are to the operators of those airplanes. The converse is also true. Major airplane groups consisting of only a few airplanes have higher non-recurring costs per airplane.

Section (a)(1) and (a)(2) – Direct Operator Costs

Direct operator costs are defined herein as:

(1) The purchase of Primary or Advisory Ice Detection system
(2) The installation of the Primary or Advisory Ice Detection system

(3) Pilot Training costs

(4) Updating the operator's AFM.

The IPHWG provided the FAA with the costs of purchasing and installing primary or advisory ice detection systems for the airplanes affected by this proposed rule. As shown in Appendix C1, C2 and C3, the cost of installing a primary or advisory ice detection system was far more costly than complying with section (a)(3).

Section (a)(3) of the proposed rule states when operating in conditions conducive to airframe icing, the IPS must be activated prior to and operated during all phases of flight except takeoff and cruise. During takeoff and cruise ["any other phase of flight"], unless prohibited by the AFM, the IPS must be operated at either the first sign of ice formation anywhere on the airplane or when conditions conducive to airframe icing are present (visible moisture at or below a static air temperature of +2 deg. C).

The costs for Section (a)(3) include:

(1) Indirect Non-recurring Costs

(2) Direct Operator Costs.

Section (a)(3) - Indirect Non-recurring Costs

There are three non-recurring costs associated with continuously operating the IPS during all phases of flight except take off and cruise. They are:

(1) Updating the manufacturer's AFM for each major airplane group, and

(2) Updating the operators AFM for each major airplane group

(3) Flight tests.

The non-recurring costs, for updating the manufacturer's AFM for each major airplane group, were distributed equally across each airplane in each major airplane group. The non-recurring costs, for updating the operators AFM, were distributed equally across each of the operator's airplanes in each of the operator's major airplane groups (as shown in Appendix C3).

Section (a)(3) – Direct Operator Costs

Since (a)(3)(i) effectively would increase the usage of IPS's, then this proposed section would increase costs of maintenance and of replacement of the IPS's. In order to estimate the increased maintenance costs and the increased frequency of replacing the IPS's, the FAA reviewed the currently issued AD's concerning activation of the IPS and how the AD's differed from this proposed rule.

The AD's in Docket Number 99-NM-137-AD through 99-NM-145-AD, 99-NM-147-AD through 99-NM-154-AD, and AD 2001-06-18 require airplane operators of certain airplanes to activate the pneumatic wing and tail deicing boots **at the first sign of ice accumulation.** The proposed rule would require the operators to activate the pneumatic wing and tail deicing boots **when visible moisture is at or below a static air temperature of +2 degrees C.** When the IPS is operated based on visible moisture and a temperature there might not actually be ice accumulating on the airframe. Thus, the proposed rule is more conservative than the current AD's issued because the IPS's will be activated even though ice may not be accreting on the airframe.

IPHWG provided data from one operator claims that the increase use of the IPS mandated by the AD's in Docket Number 99-NM-137-AD through 99-NM-145-AD, 99-NM-147-AD through 99-NM-154-AD, and AD 2001-06-18, will drop the average service life of a pneumatic deicing boot from 4 years to 2.5 years to 2 years. The operator provided IPHWG with the following costs for operating the IPS's pre-AD and post-AD on their fleet of 89 affected airplane. The AD's added an additional $178 per month, per airplane in maintenance and replacement costs to operate the IPS's. The IPHWG estimates the further increase of boot usage, due to the proposed rule, will add about $198 per month, per airplane, for airplanes subject to the AD's.

For airplanes which are not subject to the AD's and are operating the deicing boots based on flight crew observation of a specific thickness of ice, the increased deicing boot usage will add $377 per airplane, per month (see Appendix C3). These additional costs are the only recurring costs estimated over the 20-year analysis period.

For airplanes which are not subject to the AD's and are operating the deicing boots based on flight-crew observation of a specific thickness of ice there will be costs to certificate the airplanes to operate the deicing boots based on visible moisture and temperature. Those costs are estimated to be $300,000.00/airplane group or type (See Appendix C3).

Each U.S. certificated operator would be required to provide training for pilots and copilots of airplane involved with new equipment or procedures mandated by the proposed rule. The FAA accepts the IPHWG's estimate of two hours of initial training per pilot or copilot and that ten pilots per airplane will need training. At $60.00 per hour training costs,[1] the FAA estimates that the initial cost of training would be $1,200 per affected airplane. The training costs estimated are one-time fees incurred in the first year the proposed rule becomes effective.

Section (b) – Direct Operator Costs

Section (b) of the proposed rule states that if the procedures in section (a)(3) are prohibited in the AFM, then compliance must be shown with the requirements of section (a)(1) or (a)(2). The FAA has found no case where the procedures in section (a)(3) are prohibited in the AFM for airplanes affected by the proposed rule. Therefore, section (b) adds no costs to the operators. Costs for section (e) and (f) of the proposed rule are embedded in the estimates for section (a)and (b).

<u>Costs Required to Implement Section (c), (d), (e), and (f)</u>

1 Ice Protection Harmonization Working Group (IPHWG) of the Aviation Rulemaking Advisory Committee (ARAC).

Sections (c), (d), (e), and (f) would require certain actions applicable to airplanes with reversible flight controls for the pitch and/or roll axis. Reversible flight controls are cockpit controls that are connected to the pitch, roll, or yaw control surfaces by direct mechanical linkages, cables, or push-pull rods such that pilot effort produces motion or force about the hinge line.

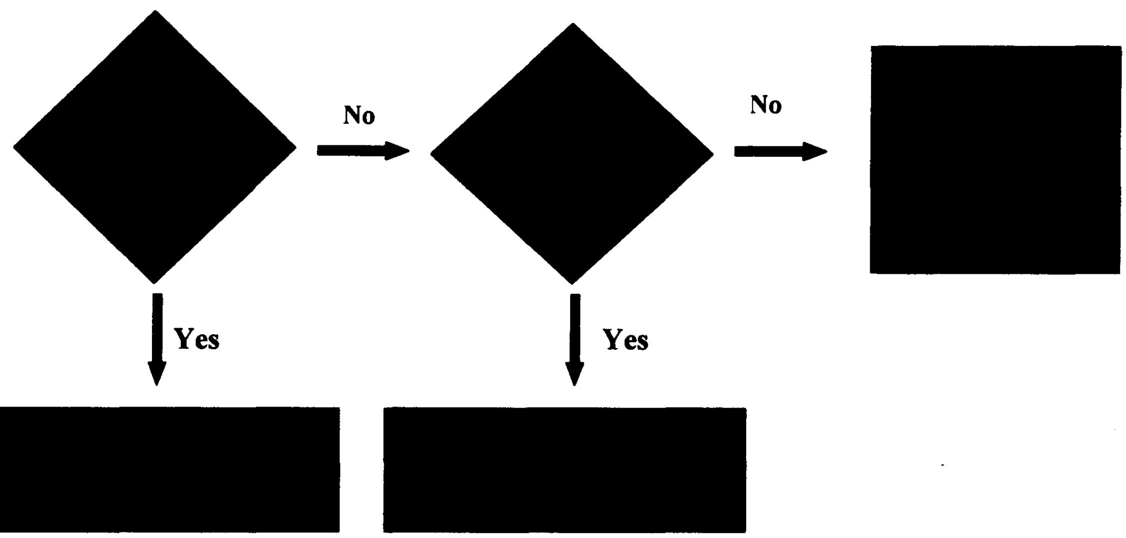
Irreversible flight controls are cockpit controls where all of the force required to move the pitch, roll, or yaw control surfaces is provided by hydraulic or electric actuators, the motion of which is controlled by signals from the cockpit controls.

There is a history of accidents and incidents caused by the uncommanded deflections of reversible flight controls in both pitch and roll axes in icing conditions. These uncommanded deflections were the result of ice accreting ahead of the control surfaces, either aft of the protected area or on the protected area when the IPS was not activated.

For irreversible flight controls, the control surface actuators are sized to maintain the control surface in its commanded position throughout the airplane's flight envelope, including high-speed dive. This results in the design loads for the actuators being larger than the loads induced by flow separation caused by ice accretions aft of the airplane's protected areas. Therefore, airplanes with irreversible flight controls are not subject to uncommanded control surface deflection caused by ice accretions.

Exhibit 2 illustrates the chain of events leading up to the decision on whether an operator would incur the cost of a tanker test to substantiate visual cues to determine that the airplane is in large-droplet conditions conducive to ice accumulation, (c)(1), or whether to incur the costs of equipping their airplanes with a caution-level alert system and its associated visual or aural means to alert the flight crew that the airplane is in large droplet conditions conducive to ice accumulation, (c)(2).

Exhibit 2
Cost of (c), (d), (e) and (f) Compliance



In December 1994, ATR, DGAC, and the FAA conducted a series of flight tests at Edwards Air Force Base in California. The flight tests utilized an Air Force NKC-135A tanker that was flown ahead of an ATR and other turboprop airplanes. The ATR airplane established a visual cue associated with large droplet icing conditions. It is likely that the visual cue can be substantiated as adequate for compliance with (c)(1). Two other turboprop airplanes were tested. The visual cues may or may not be considered as adequate for compliance with (c)(1). For the purposes of this economic evaluation it will be assumed that it will be possible to substantiate that no additional testing is required to demonstrate compliance with (c)(1) for the ATR. For the other two turboprop airplanes the FAA will conservatively assume, from an economic impact point of view, that it will not be possible to substantiate that these airplanes comply with (c)(1) without additional testing. Since the cost of a tanker test can approach $500,000 (See Appendix C4), and the probability of establishing visual cues is not 100% certain, the FAA did not consider Section (c)(1) as a minimal cost option.

For section (c)(2) of the proposed rule, if the operator decides to install a caution-level alert system, then the costs include:

(1) Indirect Non-recurring Airplane Group Costs and
(2) Direct Operator costs.

Section (c)(2) – Indirect Non-recurring Airplane Group Costs

If the decision is made to install a caution-level alert system, non-recurring costs consist of the following:

(1) System Design – includes caution-level alert system architecture and integration, positioning, and procedures for updating the manufacturer's AFM,
(2) System Qualification/certification – includes caution-level alert qualification, certification, and flight test,
(3) Tasks associated to the retrofit – includes service bulletin preparation, approval and a crew training program,
(4) Cost for Icing Tanker rental and AFM changes to substantiation that the caution alert system be certified.

As mentioned earlier, these non-recurring costs are manufacturer's costs and were distributed equally across each airplane in their major airplane group (see Appendix C-5).

Section (c)(2) – Direct Operator costs

Direct operator costs are defined herein as:

(1) The purchase of caution-level alert system
(2) The installation of the caution-level alert system
(3) Pilot Training costs
(4) Updating the operator's AFM.

Each U.S. certificated operator would be required to provide training for pilots and copilots of airplane involved with new equipment or procedures mandated by the proposed rule. The FAA accepts the IPHWG's estimate of two hours of initial training per pilot or copilot and ten pilots per airplane. At $60.00 per hour training costs,[2] the FAA estimates that the initial cost of training would be $1,200 per affected airplane. The training costs estimated are one-time fees incurred in the first year the proposed rule becomes effective.

The FAA considered the potential fuel burn cost from the added weight of the caution-level alert system. According to the IPHWG, the weight is minimal and would have limited impact on additional fuel burn and the cost of operating an airplane.

The FAA also considered whether the installation of the caution-level alert system could be accomplished during scheduled maintenance A and C checks. If not, then downtime costs for the airplane would need to be added. From the Fleet PC™[3] database, turboprop hours were analyzed. The average hours flown per year of the average affected turboprop is 2,278. IPHWG provided that C checks are performed on these turboprops every 4,000 hours. Since a typical turboprop would be ready for a C check every 1.75 years and it will take approximately 1 year to certificate the system, the installation of the caution-level alert system could not be accomplished during scheduled maintenance C checks before the end of the compliance time for the proposed rule. According to the IPHWG, the installation will take 3 days with an associated loss of profit of $5000.00/day/airplane.

Costs for section (d),(e), and (f) of the proposed rule are embedded in the estimates for the caution alert system and the tanker tests.

The breakdown of these costs can be found in Appendix C4 and C5.[4]

Estimating the Number of Affected Airplanes

[2] Ice Protection Harmonization Working Group (IPHWG) of the Aviation Rulemaking Advisory Committee (ARAC).

[3] BACK Aviation Solutions, Aviation Link: FleetPC, January 6, 2002.

[4] IPHWG

The cost estimates discussed above are per-airplane costs. To obtain a total cost estimate, these per airplane costs are multiplied by the number of airplanes, hence, the fleet of affected airplanes must be estimated. To estimate the number of affected airplanes; the FAA analyzed the current active fleet of airplanes, a forecast of airplanes affected by the proposed rule entering the fleet, and a forecast of the retired affected airplanes exiting the fleet during the 20-year analysis period.

A list of all U.S. operated civilian airplanes operating under 14 CFR Part 121 was generated by the FAA Flight Standards Group.[5]

Each listed airplane was matched with its current (as of January 6, 2002) MTOW and age through the use of the FleetPC™ database.

All airplanes with a MTOW greater than 60,000 pounds were then eliminated, leaving 1,735 airplanes in the active fleet to be subject to the proposed rule.

Fleet PC™ had numerous airplanes with no MTOW data available. For these airplanes, Janes *All the Worlds Aircraft Publication* was consulted.

Using industry sources, mostly from the manufacturers of airplanes affected by this proposed rule, airplanes with reversible flight controls were distinguished from airplanes with irreversible flight controls.[6] In addition, the FAA determined which airplanes currently had primary or advisory icing detection systems, visual cues, or caution-level alert systems installed.[7]

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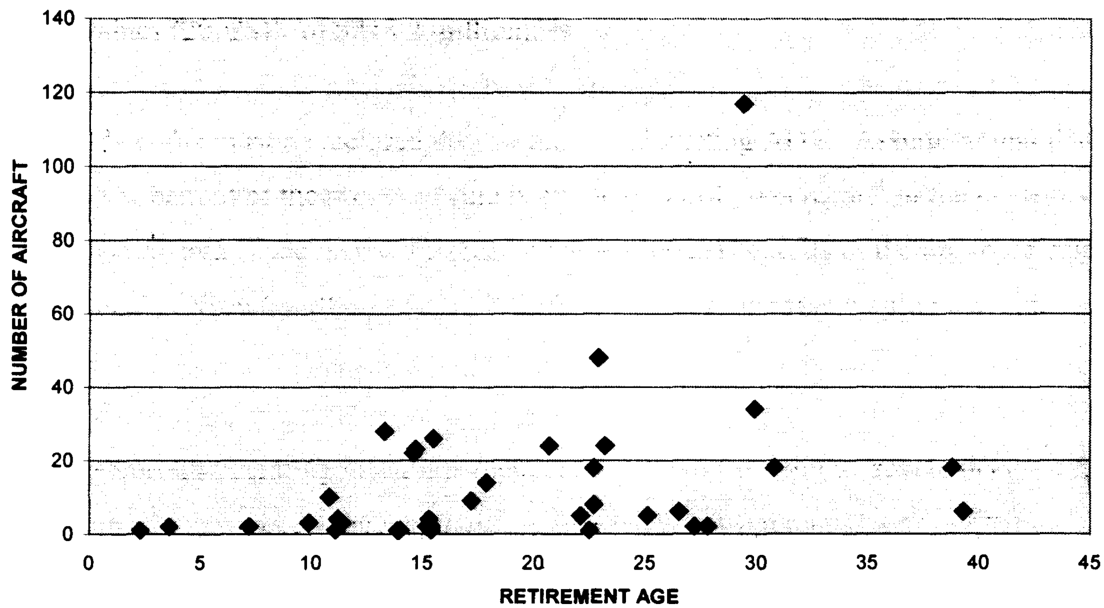
[5] AFS-260, March 7, 2002

[6] Ice Protection Harmonization Working Group (IPHWG) of the Aviation Rulemaking Advisory Committee (ARAC).

[7] ibid

The FAA used the FleetPC™ database and determined turboprops are retired from U.S. certificated service at an average age (mean) of 23.8 years with a standard deviation of 7.43 years. The age distribution of retired U.S. operated turboprops is shown in Graph 1.

GRAPH 1
AVERAGE AGE OF RETIRED TURBOPROPS
US Certificated Operators



When the FAA computed costs for airplanes affected by the proposed rule, turboprops were retired from the active fleet if their age exceeded 23.8 years. The FAA conservatively assumed that turboprop airplanes, close to 23.8 years old, would remain in active service and be retrofitted to comply with the proposed rule and then retired. The FAA assumed that all turbojet airplanes would stay active in the 20-year analysis period.

Table C1 details the turboprop airplanes, and their average age, retiring in 2007[8]:

Table C1

Retirements from Affected Fleet

2007

Table C1
Retirements From Affected Fleet
2007

Equipment Type	Average Retirement Age in 2007	Number
C46-D	63.0	1
C46-R	65.0	1
CE-402-B	34.0	1
CE-421-B	34.0	1
Convair 240	55.6	10
Convair 340	54.1	9
Convair 440	50.0	7
DC-3-C	63.5	2
DHC-6	36.2	36
DHC-7	26.6	6
Fokker 27	40.9	32
Metro	25.8	1
TOTAL		107

At the end of the 20-year analysis period, 2026, the FAA assumed a total of 1,131 turboprops have retired from Part 121 service.

Table C2 shows the number of airplanes affected, and whether the airplanes have reversible or irreversible flight controls, a primary or advisory ice detection system, visual icing cues, or a large droplet alert system:

[8] Sensitivity studies were conducted with regard to the average age of retirement. If the retirement age were 30 years, instead of the base case 23.8 years used to calculate costs, then the discounted costs (2002$) would increase by 3.2% or $2.4 million. If the retirement age were 60 years, instead of the base case 23.8 years, then the discounted costs would increase by 13.9% or $11.5 million dollars.

TABLE C2

U.S. Operated Airplanes with MTOW < 60,000 pounds

Affected by the Proposed Rule

Airplane Type	Number of Affected Airplanes	Reversible or Irreversible	Primary Ice Detector? (a)(1)	Advisory Ice Detector? (a)(2)	Visual Cues (c)(1)	Large Droplet Alert System (c)(2)
ATR 42	59	Reversible	No	Yes	Yes	No
ATR 72	64	Reversible	No	Yes	Yes	No
Bombardier CRJ	296	Irreversible	Yes	Yes	N/A	N/A
DHC-8-100 thru-300	189	Reversible	No	Yes	No	No
Dornier 328	48	Reversible	No	Yes	No	No
Dornier 328JET	32	Reversible	No	Yes	No	No
Embraer EMB-120	199	Reversible	No	Yes	No	No
Embraer EMB-135	67	Irreversible	Yes	No	N/A	N/A
Embraer EMB-145	203	Irreversible	Yes	No	N/A	N/A
Fokker/Fairchild F27C	6	Reversible	No	No	No	No
Jetstream 31/32	51	Reversible	No	No	No	No
Jetstream 4101	57	Reversible	No	Yes	No	No
Metro II/III	26	Reversible	No	No	No	No
Raytheon 1900C/D	172	Reversible	No	No	No	No
Saab 340	253	Reversible	No	No	No	No
Shorts 330/360	13	Reversible	No	No	No	No

The FAA conservatively assumed future deliveries, of new airplanes with a MTOW less than 60,000, will need to become compliant to the proposed rule. The FAA Statistical and Forecast Branch[9] provided the forecast for regional turbojet and turboprops. As with the active fleet, all airplanes with a MTOW greater than 60,000 pounds were eliminated from the forecast.

At the time of this writing, German plane maker Fairchild-Dornier filed for insolvency after running out of cash, but is currently looking for a strategic investor to continue production. The FAA retained future forecasted Fairchild-Dornier airplanes in its analysis of costs for this proposed rulemaking.

Table C3 shows the number of forecasted new airplanes, with a MTOW less than 60,000 pounds, delivered to U.S. certificated carriers from 2002-2026:

Table C3

Forecasted Fleet

US Operators

MTOW < 60,000 pounds

Year	New Deliveries
2002	87
2003	125
2004	136
2005	136
2006	146
2007	127
2008	119
2009	148
2010	203
2011	178
2012	178
2013	172
2014	166
2015	160
2016	154
2017	148
2018	142
2019	135
2020	128
2021	121
2022	114
2023	108
2024	103
2025	98
2026	93

The total undiscounted cost of making future deliveries compliant with the proposed 14 CFR Part 121 rulemaking, from 2002 through 2026, is estimated to be $14.7 million. The FAA, using IPHWG costs, estimates that the discounted present value (2002$) of this cost over the analysis period is $8.0 million.

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[9] APO-110

Table C4 shows the estimated average non-discounted initial costs by airplane type for each Section of the proposed rule:

Table C4

US Operated Commercial Airplanes

MTOW < 60,000 pounds

Average Initial Cost

Airplane Type	Number of Airplanes 2007	Cost = min[(a)(1), (a)(2), or (a)(3)]				Cost = min[(c)(1) or (c)(2)]		Average Initial Total Fleet Cost
		Reversible or Irreversible	Primary Ice Detector? (a)(1)	Advisory Ice Detector? (a)(2)	Visible Moisture and Temp. (a)(3)	Visible Cues (c)(1)	Large Droplet Alert System (c)(2)	
ATR 42	59	Reversible	No	Comply	$0	Comply	$0	$0
ATR 72	64	Reversible	No	Comply	$0	Comply	$0	$0
Bombardier CRJ	296	Irreversible	Comply	Comply	$0	N/A	N/A	$0
DHC-8-100 thru-300	189	Reversible	No	Comply	$0	No	$66,097	$12,492,333
Dornier 328	48	Reversible	No	Comply	$0	No	$83,244	$3,995,712
Dornier 328JET	32	Reversible	No	Comply	$0	No	$70,868	$2,267,776
Embraer EMB-120	199	Reversible	No	Comply	$0	No	$65,804	$13,094,996
Embraer EMB-135	67	Irreversible	Comply	No	$0	N/A	N/A	$0
Embraer EMB-145	203	Irreversible	Comply	No	$0	N/A	N/A	$0
Fokker/Fairchild F27C	6	Reversible	No	No	$4,593	No	$244,135	$1,492,368
Jetstream 31/32	51	Reversible	No	No	$4,223	No	$70,475	$3,809,598
Jetstream 4101	57	Reversible	No	Comply	$0	No	$70,945	$4,043,865
Metro II/III	26	Reversible	No	No	$2,029	No	$102,693	$2,722,772
Raytheon 1900C/D	172	Reversible	No	No	$3,120	No	$66,674	$12,004,568
Saab 340	253	Reversible	No	No	$1,339	No	$64,621	$16,687,880
Shorts 330/360	13	Reversible	No	No	$2,798	No	$145,125	$1,922,999

Summary of Costs

The FAA, using IPHWG costs, estimates that the total undiscounted cost of the proposed rule, from 2007 through 2026, is estimated to be $107.0 million. The discounted present value (2002$) of this cost over the 20-year analysis period is $70.2 million. Approximately $58.0 million, representing 82.6 percent of the total discounted present value (2002$) cost, occur in 2007. Appendix C6 shows the distribution of the costs throughout the 20-year analysis period.

The FAA solicits comments from affected entities with respect to these findings and determinations, and request that all comments be accompanied by clear documentation.

IV. THE BENEFITS ESTIMATE

The FAA expects the proposed rule to generate total potential safety benefits estimated at $572.6 million over the 2007 through 2026 analysis period and discounted at 7 percent annually to present values (2002$)[10] of $213.2 million.

The total benefits must be factored down because of existing AD's. Assuming that that the actual safety benefit of the proposed rule is on the order of 50 percent[11] of the present values due to the effectiveness of the AD's, the present value (2002$) benefits of the proposed rulemaking are estimated at $106.6 million. A key benefit of the proposed rule would be avoidance of these accidents.

Under the current operating rules, it is the responsibility of the flight crew to decide whether icing conditions have been encountered. Neither the operation regulations nor the certification regulations require a means for the pilot in command to identify that hazardous icing conditions have been encountered. An examination of the accident and incident history revealed that the flight crews must be provided with a clear means to know when to activate the IPS. This proposed rule will ensure timely activation of the IPS. This proposed rule will provide a means for the flight crew to determine that icing conditions must be exited.

Since 1985, 14 CFR Part 121 passenger-carrying air operators have had 7 accidents which may have been prevented if this rule had been in effect. Table B1 shows these accidents resulted in 99 fatalities, 2 serious injuries and 15 minor injuries. In addition, all of the airplanes involved in the accidents were either destroyed or received substantial damage.[12] These accidents all occurred in the small (under 60,000 pound MTOW) 14 CFR Part 121 airplanes addressed by this proposed rule. In addition, 8 icing-related incidents were found which the FAA notes had the

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[10] OMB

[11] Ice Protection Harmonization Working Group (IPHWG) of the Aviation Rulemaking Advisory Committee (ARAC).

potential of resulting in accidents; however, the FAA assigns no quantitative benefits to these icing-related incidents due to the lack of airplane-damage detail available. The data includes accidents and incidents that occurred under Part 135 operations. They are considered as relevant to this proposed part 121 rule because under today's regulations those Part 135 operations would be classified as Part 121.

Table B1						
Passenger Operator Icing Related Accidents						
1985 to 2001						
Year	**Operator Name**	**Accident/Incident**	**Aircraft Series**	**Fatalies**	**Serious Injuries**	**Minor Injuries**
1986	Sea Alaska	Accident	DHC-6	0	2	2
1989	Mid Pacific Airlines	Accident	YS-11A	2	0	0
1993	CO Express	Accident	EMB-120	0	0	13
1993	Express 1	Accident	SAAB 340	0	0	0
1994	Simmons Airlines	Accident	ATR 72	68	0	0
1997	Comair	Accident	EMB-120	29	0	0
2001	Comair	Accident	EMB-120	0	0	0
Total Casualtes:				**99**	**2**	**15**
Average Casualtes:				**14.1**	**0.3**	**2.1**

The FAA is aware of accidents and incidents in icing conditions occurring prior to 1985. Table B2 illustrates several examples of such accidents that were well documented. However, the quality of many accident reports and incident investigations from earlier years is not sufficient to determine whether this rule would have changed the outcome. In order to insure a dataset that

Table B2			
Passenger Operator Icing Related Accidents			
Prior to 1985			
Year	**Airplane**	**City**	**State**
1947	DC-3	North Platte	Nebraska
1954	DC-3	Near Kansas City	Missouri
1958	VC-VISCOUNT	Freeland	Michigan
1960	C-46	McGuire Air Force Base	New Jersey
1963	VC-VISCOUNT	Kansas City	Missouri
1963	CV-440	Midland	Texas
1964	DC-3	Boston	Massachusetts
1964	DC-4	Chicago	Illinois

was uniform and consistent in detail, the FAA did not include accidents which occurred prior to 1985[13].

[12] National Transportation Safety Board (NTSB) Accident Reports, FAA National Aviation Safety Data Analysis Center (NASDAC).

[13] Ice Protection Harmonization Working Group (IPHWG) of the Aviation Rulemaking Advisory Committee

Icing related accidents during the cruise, holding and landing phase of flight have also occurred in Australia, Canada, Greenland, Iceland, Italy, Kazakhstan, Russia, Sweden, and the United Kingdom.[14]

Table B3			
Average Benefit of Preventing One Accident Due to Icing			
Category	**Value**	**Number**	**Total**
Fatalities	$3,000,000	14.1	$42,300,000
Serious Injuries	$260,500	0.3	$78,150
Minor Injuries	$6,000	2.1	$12,600
Medical and Legal Costs - Fatality	$132,700	14.1	$1,871,070
Medical and Legal Costs - Serious Injury	$46,633	0.3	$13,990.00
Medical and Legal Costs - Minor Injury	$2,500	2.1	$5,250
NTSB Investigation	$1,411,700	1	$1,411,700
Airplane Replacement	$3,840,000	1	$3,840,000
Total			**$49,532,760**

In order to quantify future benefits, the FAA calculated the costs of a future averted accident as a result of this proposed rule. Table B1 lists the airplanes, fatalities, serious and minor injuries, as well as the average number of casualties per accident. There were 7 accidents, 99 fatalities, 2 serious injuries, and 15 minor injuries. The FAA sets the value of a statistical aviation fatality avoided at $3.0 million, that of a serious injury (assumed to be the average of a severe, serious, and moderate injury) at $260,500, and that of a minor injury at $6,000. The associated medical and legal costs for a fatality is $132,700, a serious injury (assumed to be the average of a severe, serious, and moderate injury) $46,633.33, and that of a minor injury, $2,500.[15] In addition, the average replacement costs of a destroyed airplane totaled $3.84 million and a NTSB accident investigation costs about $1.4 million. The FAA estimates the average value of avoiding an icing-related accident, where the airplane is destroyed, to be $49.5 million (Table B3).

(ARAC).

[14] ibid

[15] "Treatment of Value of Life and Injury In Economic Analysis" (FAA-APO-02-1), February 2002 and "Aviation Accident Investigation Costs" (FAA-APO-00-1), August 2000.

The FAA expects the seriousness of future accident to increase. Herein, the methodology is presented to substantiate the basis for increasing value of preventing icing related accidents that could occur over the 2007 through 2026 timeframe in the absence of the proposed rule:

1. Based on the casualty losses listed in Table B1, five separate accident and casualty rates were estimated. These accident and casualty rates were estimated by dividing the total losses per category over the 1985 through 2001 period by the number of air carrier operations over that same time period.[16] The results of this derivation are exhibited in Table B4.
2. These rates were adjusted for changes in airplane size[17] over the 2007 through 2026 analysis period. For example, the average number of seats on an air operator for the 1985 through 2001 period is 27.[18] In 2007, the FAA estimates the average number of seats will be is 39,[19] and therefore approximately a 44 ((39/27)-1) percent increase. Subsequently, the number of potential casualties will increase by 44 percent as well.
3. The historical accident and casualty rates per million operations were multiplied by the annual number of projected operations from 2007 through 2026,[20] and then adjusted by the percent change in the average number of seats in an air carrier for that year.
4. After totaling the number of accidents and casualties over the 2007 through 2026 period, the FAA applied the critical values in Table B3 to determine the total potential benefits of the proposed rule.

Table B4 and B5 shows these calculations.

[16] U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Plans and Management Analysis, March 2002 Operations and Seat Source: Statistical and Forecast Branch, FAA/APO, FAA Aviation Forecasts 1986-2013, 298c Commuters. The FAA used the 298c Commuter database because the data most closely matched the airplanes affected by this proposed rulemaking.
[17] ibid
[18] ibid
[19] ibid
[20] ibid

Table B4
Derivation of Accident and Casualty Rates for Part 121 Operated Airplanes

Year	Operations	Avg. No. of Seats on Airplane	Fatalities per Million Ops	Serious Injuries per million Ops	Minor Injuries per million Ops	Accident Investigations per Million ops	Destroyed Airplanes per Millions Ops
1985	4,734,066	20.29	The fatality rate is derived by dividing the total number of fatalities over the past 17 year period (99) by the total number of operations over the same period (96 million).	The serious injury rate is derived by dividing the total number of serious injuries over the past 17 year period (2) by the total number of operations over the same period (96 million).	The minor injury rate is derived by dividing the total number of minor injuries over the past 17 year period (15) by the total number of operations over the same period (96 million).	The accident investigation rate is derived by dividing the total number of investigations (7) over the past 17 years by the total number of operations over the same time period (96 million).	The destroyed airplane rate is derived by dividing the total number of airplanes destroyed over the past 17 year period (7) by the total number of operations over the same period (96 million).
1986	4,929,110	21.13					
1987	5,480,632	22.39					
1988	5,866,284	24.13					
1989	5,765,186	24.05					
1990	6,206,942	25.61					
1991	6,155,224	25.70					
1992	6,079,610	26.60					
1993	6,352,490	26.72					
1994	6,855,650	27.05					
1995	5,949,878	27.70					
1996	5,941,022	27.79					
1997	5,823,834	28.29					
1998	5,706,940	28.91					
1999	5,484,810	31.22					
2000	5,207,032	31.70					
2001	3,526,521	33.03					
	96,065,231 (Total)	26.61 (Average)	1.03	0.02	0.16	0.07	0.07

Source: U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Plans and Management Analysis, March 2002
Operations and Seats Source: Statistical and Forecast Branch, FAA/APO, FAA Aviation Forecasts, Fiscal Years 1986-2013, 298 Commuter.

Table B5
Derivation of Benefits for Part 121 Operated Airplanes

Year	Operations	Fatalities per Annual Million Operations	Serious Injuries per million Ops	Minor Injuries per million Ops	Avg. Number of Seats per Aircraft and % Increase from Past 16 year Avg. (27)		Estimated Fatalities	Estimated Serious Injuries	Estimated Minor Injuries	Estimated Investigations	Estimated Airplanes Replaced
2007	4,029,450	4.16	0.08	0.63	39.00	44.44%	6.00	0.12	0.91	0.31	0.31
2008	4,092,696	4.22	0.09	0.64	39.50	46.30%	6.17	0.12	0.94	0.31	0.31
2009	4,160,962	4.29	0.09	0.65	40.00	48.15%	6.36	0.13	0.96	0.32	0.32
2010	4,236,650	4.37	0.09	0.66	40.50	50.00%	6.55	0.13	0.99	0.33	0.33
2011	4,316,032	4.45	0.09	0.67	41.00	51.85%	6.76	0.14	1.02	0.33	0.33
2012	4,403,837	4.54	0.09	0.69	41.50	53.70%	6.98	0.14	1.06	0.34	0.34
2013	4,497,865	4.64	0.09	0.70	42.00	55.56%	7.22	0.15	1.09	0.35	0.35
2014	4,596,818	4.74	0.10	0.72	42.50	57.41%	7.46	0.15	1.13	0.35	0.35
2015	4,702,545	4.85	0.10	0.73	43.00	59.26%	7.72	0.16	1.17	0.36	0.36
2016	4,815,406	4.97	0.10	0.75	43.50	61.11%	8.00	0.16	1.21	0.37	0.37
2017	4,935,791	5.09	0.10	0.77	44.00	62.96%	8.29	0.17	1.26	0.38	0.38
2018	5,064,122	5.22	0.11	0.79	44.50	64.81%	8.61	0.17	1.30	0.39	0.39
2019	5,200,853	5.36	0.11	0.81	45.00	66.67%	8.94	0.18	1.35	0.40	0.40
2020	5,346,477	5.51	0.11	0.84	45.50	68.52%	9.29	0.19	1.41	0.41	0.41
2021	5,501,525	5.67	0.11	0.86	46.00	70.37%	9.67	0.20	1.46	0.42	0.42
2022	5,666,571	5.84	0.12	0.89	46.50	72.22%	10.06	0.20	1.52	0.44	0.44
2023	5,842,234	6.02	0.12	0.91	47.00	74.07%	10.49	0.21	1.59	0.45	0.45
2024	6,029,186	6.22	0.13	0.94	47.50	75.93%	10.94	0.22	1.66	0.46	0.46
2025	6,228,149	6.42	0.13	0.97	48.00	77.78%	11.42	0.23	1.73	0.48	0.48
2026	6,439,906	6.64	0.13	1.01	48.50	79.63%	11.93	0.24	1.81	0.50	0.50
Total		103	2	16			169	3	26	8	8

Source: U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Plans and Management Analysis, March 2002
Operations and Seats Source: Statistical and Forecast Branch, FAA/APO, FAA Aviation Forecasts, Fiscal Years 1986-2013, 298 Commuters.

In the absence of the proposed rule, and due to growth in operations, the FAA expects that over the 2007 through 2026 analysis period, approximately 8 accidents would occur. These accidents are expected to result in approximately 169 fatalities, 3 serious injuries, and 26 minor injuries.

The accident-rate assumptions must account for the effects of recent AD's against affected models, because the FAA does not accept that this icing rule, by itself, will prevent all 8 future accidents. In 1996 AD's were issued for airplanes with unpowered controls and pneumatic de-icing boots. In 1999 a second series of AD's were issued for airplanes with pneumatic de-icing boots to activate the systems at the first sign of ice accretion. These two ADs accomplish much the same objectives as the proposed 14 CFR Part 121 rule.

The 1996 severe-icing directives required that operating manuals provide pilots with instructions for operating in freezing rain and freezing drizzle, provided cues to identify such conditions, and offered instructions on how to exit the conditions. These requirements are similar to the proposed rule in sections (c) and (d). The major differences between the 1996 directives and the proposed rule are in the added requirement to substantiate the large droplet icing cues and the provision of an alternate option to install a caution-level alert to provide the required indication.

A second set of AD's were issued in 1999 requiring activation of the IPS at the first sign of ice accretion anywhere on the airplane or upon annunciation of an ice detection system. The system is to be operated on automatic mode if available or by manually cycling to minimize ice accretions on the airframe. This directive accomplishes much of what proposed sections (a) and (b) are proposed to achieve. The main difference is that the proposed rule would require a more conservative activation cue is required (temperature and visible moisture) and that the visual cues used in combination with an advisory ice detection would require validation (or re-validation).

The AD's were issued to establish an increased level of safety with respect to initiating activation of the IPS and providing cues to determine when large droplet icing conditions have been encountered. The benefits analysis considers accidents and incidents that occurred prior to the issuance of the AD's. In fact, it was the findings from the two major accidents listed in Table B1 (1994 & 1997) that prompted the AD's.

Due to the similarity of requirements, it appears reasonable to assume that the ADs have accomplished a substantial portion of the safety increase attributed to the proposed rule within the benefits analysis. The IPHWG, with FAA concurrence, believes it is reasonable to assume that the AD's have already accomplished 50 percent of the safety benefit attributed to the proposed rule in the analysis. This difference would indicate that the actual safety benefit of the proposed rule is on the order of 50 percent of the present values due to the effectiveness of the AD's. Therefore the benefits of preventing future accidents have been reduced by 50 percent.

Table B6
Accidents and Casualties Avoided Over the Next Twenty Years As a Result of Deicing NPRM

Year	Discount Factor	Fatalities Avoided	Present Value (millions)	Serious Injuries Avoided	Present Value (millions)	Minor Injuries Avoided	Present Value (millions)	Total Airplanes Replaced	Present Value (millions)	Investigations	Present Value (millions)	Total (millions)
2007	0.7130	6.00	$13.41	0.12	$0.03	0.91	$0.0055	0.31	$0.85	0.31	$0.31	$14.60
2008	0.6663	6.17	$12.89	0.12	$0.03	0.94	$0.0053	0.31	$0.81	0.31	$0.30	$14.02
2009	0.6227	6.36	$12.40	0.13	$0.02	0.96	$0.0051	0.32	$0.77	0.32	$0.28	$13.48
2010	0.5820	6.55	$11.95	0.13	$0.02	0.99	$0.0049	0.33	$0.73	0.33	$0.27	$12.97
2011	0.5439	6.76	$11.52	0.14	$0.02	1.02	$0.0047	0.33	$0.69	0.33	$0.25	$12.49
2012	0.5083	6.98	$11.12	0.14	$0.02	1.06	$0.0046	0.34	$0.66	0.34	$0.24	$12.05
2013	0.4751	7.22	$10.74	0.15	$0.02	1.09	$0.0044	0.35	$0.63	0.35	$0.23	$11.63
2014	0.4440	7.46	$10.38	0.15	$0.02	1.13	$0.0043	0.35	$0.60	0.35	$0.22	$11.23
2015	0.4150	7.72	$10.04	0.16	$0.02	1.17	$0.0041	0.36	$0.58	0.36	$0.21	$10.85
2016	0.3878	8.00	$9.72	0.16	$0.02	1.21	$0.0040	0.37	$0.55	0.37	$0.20	$10.50
2017	0.3624	8.29	$9.42	0.17	$0.02	1.26	$0.0039	0.38	$0.53	0.38	$0.19	$10.16
2018	0.3387	8.61	$9.13	0.17	$0.02	1.30	$0.0038	0.39	$0.51	0.39	$0.19	$9.85
2019	0.3166	8.94	$8.87	0.18	$0.02	1.35	$0.0036	0.40	$0.49	0.40	$0.18	$9.55
2020	0.2959	9.29	$8.61	0.19	$0.02	1.41	$0.0035	0.41	$0.47	0.41	$0.17	$9.27
2021	0.2765	9.67	$8.37	0.20	$0.02	1.46	$0.0034	0.42	$0.45	0.42	$0.17	$9.01
2022	0.2584	10.06	$8.15	0.20	$0.02	1.52	$0.0033	0.44	$0.43	0.44	$0.16	$8.76
2023	0.2415	10.49	$7.93	0.21	$0.02	1.59	$0.0033	0.45	$0.42	0.45	$0.15	$8.52
2024	0.2257	10.94	$7.73	0.22	$0.02	1.66	$0.0032	0.46	$0.40	0.46	$0.15	$8.30
2025	0.2109	11.42	$7.55	0.23	$0.01	1.73	$0.0031	0.48	$0.39	0.48	$0.14	$8.09
2026	0.1971	11.93	$7.37	0.24	$0.01	1.81	$0.0030	0.50	$0.38	0.50	$0.14	$7.90
Total		169	$197.29	3	$0.39	26	$0.0811	8	$11.32	8	$4.16	$213.24

Note: Fatalities, Serious Injuries, and Minor Injuries include "Willingness To Pay" (WTP) plus Medical and Legal Costs.

Source: U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Plans and Management Analysis, March 2002

Table B5 shows the present value (2002$) benefits of preventing these accidents and casualties are estimated at $213.2 million. Assuming that that the actual safety benefit of the proposed rule is on the order of 50 percent of the present values due to the effectiveness of the AD's, the present value (2002$) benefits of preventing these accidents and casualties are estimated at $106.6 million.

V. BENEFIT-COST ANALYSIS

Following the crash of American Eagle's flight 4184, the NTSB published recommendation A-96-56, which states in part that:

> *If safe operations in certain icing conditions cannot be demonstrated by the manufacturer, operational limitations should be imposed to prohibit flight in such conditions and flight crews should be provided with the means to positively determine when they are in icing conditions that exceed the limits for aircraft certification.*

Following this, the FAA issued the FAA's In-flight Aircraft Icing Plan, April, 1997, detailing the FAA's plans for improving the safety of airplanes operating in icing conditions.

In the absence of this proposed rule, it is highly likely that future icing-related accidents will occur. This industry group study expects on average 8 accidents, over the 20-year analysis period, could be prevented by the enactment of this proposed rule and AD's. The benefit of the proposed rule would be avoiding these accidents. The discounted present value (2002$) benefits of the proposed rule are estimated to be $106.6 million over the 20-year analysis period. These benefits are derived from preventing accidents due to reduced risk of airframe icing. The FAA seeks comment with supportive justification of these benefit estimates.

It is estimated that over the 20-year analysis period, the discounted present value (2002$) cost of the proposed rule is $70.2 million. This includes the cost of ice detection systems design, qualification, certification, crew training, equipment purchase and installation, and testing. The FAA seeks comment with supportive justification on these cost estimates.

The estimated $106.6 million benefits of this proposed rule exceeds the estimated $70.2 million costs.

Thus, accepting the IPHWG's recommendations, the FAA concludes that the benefits of the proposed rule do justify the costs of the proposed 14 CFR Part 121 rule.

VI. INITIAL REGULATORY FLEXIBILITY DETERMINATION

A. Introduction and Purpose of This Analysis

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) establishes "as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation." To achieve that principle, the Act requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The Act covers a wide-range of small entities, including small businesses, not-for-profit organizations and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule will have a significant economic impact on a substantial number of small entities. If the determination is that it will, the agency must prepare a regulatory flexibility analysis as described in the Act.

The FAA believes that this proposal will result in a significant economic impact on a substantial number of small entities. The purpose of this analysis is to provide the reasoning underlying the FAA determination.

Under Section 63(b) of the RFA, the analysis must address:

- Description of reasons the agency is considering the action
- Statement of the legal basis and objectives for the proposed rule
- Description of the record keeping and other compliance requirements of the proposed rule
- All federal rules that may duplicate, overlap, or conflict with the proposed rule
- Description and an estimated number of small entities to which the proposed rule will apply
- Analysis of small firms' ability to afford the proposed rule
- Conduct a disproportionality analysis
- Conduct a competitive analysis
- Estimation of the potential for business closures
- Describe the alternatives considered

B. Reasons Why the Rule Is Being Proposed

On October 31, 1994, an Avions de Transport Regional model 72-212 (Aerospatiale Model ATR 72), operated by American Eagle as flight 4184, crashed during a rapid descent after an uncommanded roll excursion. Flight 4184 was a regularly scheduled passenger flight being conducted under 14 CFR Part 121, and an instrument flight rules plan had been filed. The airplane was in a holding pattern and was descending to a newly assigned altitude of 8,000 feet when the initial roll excursion occurred. Impact forces destroyed the airplane; the captain, first officer, two flight attendants, and 64 passengers received fatal injuries. Flight 4184 operated in icing conditions, believed to include freezing drizzle droplets, which were reported in the area. The FAA, Aerospatiale, the French Direction Générale de l'Aviation Civile, Bureau Enquete Accident, National Aeronautics and Space Administration (NASA), National Transportation Safety Board (NTSB), and others have conducted an extensive investigation of this accident. The investigation concluded that freezing drizzle conditions created a ridge of ice aft of the deicing boots and forward of the ailerons, which resulted in uncommanded roll of the airplane.

An examination of the accident and incident history revealed that the flight crews must be provided with a clear means to know when to activate the IPS (Ice Protection System). This proposed rule would ensure timely activation of the IPS when the airplane is in icing conditions.

The proposed rule is responsive to NTSB recommendation A-96-56, which is on the NTSB's Most Wanted List. The proposed rule is also one of the items listed in the FAA's In-flight Aircraft Icing Plan, April, 1997. The Icing Plan details the FAA's plans for improving the safety of airplanes when they are operated in icing conditions. Neither the operating regulations nor the certification regulations require a means for the pilot in command to specifically identify that hazardous icing conditions have been met. The proposed rule will provide a means for the flight crew to determine that icing conditions must be exited.

The NPRM specifically applies to 14 CFR part 121 operators of airplanes that have MTOW of less than 60,000 pounds and are certificated for flight in icing. For this section of the analysis, those operators meeting the above criteria that have 1,500 or fewer employees are considered.[21]

C. Statement of the Legal Basis and Objectives

Under Title 49 of the United States Code, the FAA Administrator is required to consider the following matters, among others, as being in the public interest:

- Assigning, maintaining, and enhancing safety and security as the highest priorities in air commerce. [See 49 U.S.C. §40101(d)(1).]
- Additionally, it is the FAA Administrator's statutory duty to carry out his or her responsibilities "in a way that best tends to reduce or eliminate the possibility or recurrence of accidents in air transportation." [See 49 U.S.C. §44701(c).]

Accordingly, this proposed rule will amend Title 14 of the Code of Federal Regulations to require the operators of airplanes with a MTOW of less than 60,000 pounds that operate under 14 CFR part 121 regulations to either install ice detection equipment or change the AFM to ensure timely activation of the IPS. The proposed rule also will require certain actions applicable to airplanes with reversible flight controls for the pitch and/or roll axis.

D. Projected Reporting, Record Keeping and Other Requirements

The FAA expects no more than minimal new reporting and record-keeping compliant requirements would result from this proposed rule. The proposed rule will require additional entries in existing required maintenance records to account for either the additional maintenance requirements or the installation of ice detection system and/or caution-level alert systems.

[21] 13 CFR Part 121.201, Size Standards Used to Define Small Business Concerns, Sector 48-49 Transportation, Subsector 481 Air Transportation.

Additional reporting and record keeping for training also will be no more than minimal because, under 14 CFR 121.419, certificate holders already must provide pilot training that includes:

> . . . procedures for recognizing and avoiding severe weather situations; escaping from severe weather situations, and operating in or near thunderstorms (including best penetrating altitudes), turbulent air (including clear air turbulence), icing, hail, and other potentially hazardous meteorological conditions.

E. Overlapping, Duplicative, or Conflicting Federal Rules

The FAA is unaware that the proposed rule will conflict with existing Federal Rules. The requirements proposed in this NPRM to some extent overlap and duplicate existing requirements in certain ADs (Airworthiness Directives). Those ADs require revisions to AFM's (Aircraft Flight Manual) for certain airplanes to provide information and instructions to pilots for operating in icing conditions. The costs attributed to those AD's were the costs associated with revising the AFM's. Similarly, this proposed rule would require AFM revisions to provide information for operating in icing conditions for these same airplanes, among others. The information required by this proposal would be more detailed and specific to the individual airplane models than the information required by the AD's. Once this rule is adopted, the FAA will consider revising the AD's to eliminate requirements for information that is no longer needed.

F. Estimated Number of Small Firms Potentially Impacted

The FAA used the SBA guideline of 1,500 employees or less per firm as the criterion for the determination of a small business in commercial air service.[22]

[22] 13 CFR Part 121.201, Size Standards Used to Define Small Business Concerns,

A list of all U.S. operated civilian airplanes operating in 14 CFR Part 121 was generated by the FAA Flight Standards Group.[23]

Each listed airplane was matched with its current (as of January 6, 2002) MTOW and age through the use of the FleetPC™ database provided by BACK Aviation Solutions.

All airplanes with a MTOW greater than 60,000 pounds were eliminated from the fleet of 14 CFR Part 121 airplanes.

Fleet PC™ had numerous airplanes with no MTOW data. For these airplanes, Janes *All the Worlds Aircraft Publication* was consulted.

Using information provided by the World Aviation Directory Winter 2000, Dunn and Bradstreet's company databases, and SEC filings through the Internet, scheduled and non-scheduled commercial operators that are subsidiary businesses of larger businesses were eliminated from the database. An example of a subsidiary business is Continental Express, Inc., which is a subsidiary of Continental Airlines.

Using information provided by the U.S. Department of Transportation Form41 filings, the World Aviation Directory Winter 2000, and Dunn and Bradstreet's company databases, all businesses with more than 1,500 employees were eliminated. For the remaining business, the FAA obtained company revenue from these three sources, when the operator made revenue was public.

Sector 48-49 Transportation, Subsector 481 Air Transportation.
[23] AFS-260

The FAA was unable to obtain employment data for the following 14 CFR Part 121 commercial air operators:

Operator	Annual Revenue	Employment
Air Tahoma Inc	n/a	n/a
Aviation Services, Ltd.	n/a	n/a
Gulf and Caribbean Cargo, Inc.	n/a	n/a
PauMitch Corp	n/a	n/a
Royal Air Freight, Inc.	n/a	n/a

The FAA used the FleetPC™ database and determined turboprops are retired from U.S. certificated service at an average age (mean) of 23.8 years with a standard deviation of 7.43 years. The FAA assumed the following small business operator's airplanes would be retired by 2007.

Operator	Make Model	Number
COASTAL AIR TRANSPORT	CV-340	1
Eagle Canyon Airlines, Inc.	DHC-6	19
Eagle Jet Charter, Inc.	F-27	5
Empire Airlines, Inc.	F-27	13
ERA AVIATION INC	CV-340	3
ERA AVIATION INC	CV-440	2
ERA AVIATION INC	DC-3-C	2
ERA AVIATION INC	DHC-6	9
Farwest Airlines LLC	DHC-7	1
Gulfstream International Airlines	DHC-7	2
Lynx Air International, Inc.	SA-227	1
Mountain Air Cargo, Inc.	F-27	14
Samoa Aviation, Inc.	DHC-6	1
Seaborne Virgin Islands, Inc.	DHC-6	7
Tatonduk Outfitters, Ltd.	C46	2
Tol Air Services Inc.	CV-240	1
Trans Air Link Corp.	CV-440	1
Trans Florida Airlines, Inc.	CV-240	3

The FAA notes the above 87 small business operated 14 CFR Part 121 airplanes represent 81% of the total number of airplanes the FAA assumed would be retired by 2007.

The methodology discussed above resulted in the following list of 27 U.S. scheduled and nonscheduled commercial operators with less than 1,500 employees, operating a total of 548 airplanes:

Operator	Number
Air Midwest Inc.	26
BIG SKY TRANSPORTATION CO	16
Casino Airlines, Inc.	1
Champlain Enterprises, Inc.	31
CHAUTAUQUA AIRLINES INC	56
Colgan Air, Inc.	18
CORPORATE AIR	2
Corporate Airlines, Inc.	17
ERA AVIATION INC	3
Executive Airlines, Inc.	30
Express Airlines I, Inc	47
Farwest Airlines LLC	1
Frontier Flying Service, Inc.	5
Great Lakes Aviation, Ltd.	48
Gulfstream International Airlines Inc	34
Lynx Air International, Inc.	2
Merlin Airways, Inc.	1
MIDWAY AIRLINES CORPORATION	24
Mountain Air Cargo, Inc.	6
Ozark Air Lines, Inc.	2
Pacific Island Aviation, Inc.	3
PENINSULA AIRWAYS INC	10
Samoa Aviation, Inc.	1
Shuttle America Corporation	4
SkyWest Airlines, Inc.	117
Sunrise Airlines, Inc.	1
Trans States Airlines Inc.	42
TOTAL	548

G. Cost and Affordability for Small Entities

The FAA estimated the cost of compliance per airplane and multiplied this cost by the total fleet of affected airplanes per operator to obtain the total compliance cost by small entity.

The following table shows the non-discounted initial cost of compliance per airplane:

Airplane Type	Number of Airplanes 2007	Reversible or Irreversible	Cost = min[(a)(1), (a)(2), or (a)(3)]			Cost = min[(c)(1) or (c)(2)]		Additional Annual Costs to Maintain Ice Protection System
			Primary Ice Detector? (a)(1)	Advisory Ice Detector? (a)(2)	Visible Moisture and Temp. (a)(3)	Visible Cues (c)(1)	Large Droplet Alert System (c)(2)	
ATR 42	59	Reversible	No	Comply	$0	Comply	$0	$0
ATR 72	64	Reversible	No	Comply	$0	Comply	$0	$0
Bombardier CRJ	296	Irreversible	Comply	Comply	$0	N/A	N/A	$0
DHC-8-100 thru-300	189	Reversible	No	Comply	$0	No	$66,097	$0
Dornier 328	48	Reversible	No	Comply	$0	No	$83,244	$0
Dornier 328JET	32	Reversible	No	Comply	$0	No	$70,868	$0
Embraer EMB-120	199	Reversible	No	Comply	$0	No	$65,804	$0
Embraer EMB-135	67	Irreversible	Comply	No	$0	N/A	N/A	$0
Embraer EMB-145	203	Irreversible	Comply	No	$0	N/A	N/A	$0
Fokker/Fairchild F27C	6	Reversible	No	No	$4,593	No	$244,135	$2,378
Jetstream 31/32	51	Reversible	No	No	$4,223	No	$70,475	$4,521
Jetstream 4101	57	Reversible	No	Comply	$0	No	$70,945	$0
Metro II/III	26	Reversible	No	No	$2,029	No	$102,693	$2,378
Raytheon 1900C/D	172	Reversible	No	No	$3,120	No	$66,674	$4,521
Saab 340	253	Reversible	No	No	$1,339	No	$64,621	$2,378
Shorts 330/360	13	Reversible	No	No	$2,798	No	$145,125	$2,378

The degree to which small air operator entities can "afford" the cost of compliance is determined by the availability of financial resources. The initial implementation costs of the proposed rule may be financed, paid for using existing company assets, or borrowed. As a proxy for the firm's ability to afford the cost of compliance, the FAA calculated the ratio of the total present value cost of the proposed rule as a percentage of annual revenue. This ratio is a conservative measure as the present value of the 20-year total compliance cost is divided by one year of annual revenue. Twelve of the 27 small business operators potentially affected by this proposed rule incurred costs greater that 2 percent of their annual revenue. The following table shows the economic impact of the small entity air operators affected by this proposed rule.

Operator	Number of Airplanes	PVCost	Percent	Annual Revenue	Employment
MIDWAY AIRLINES CORPORATION	24	$0	0.00%	$164,783,000	336
Executive Airlines, Inc.	30	$769,683	0.44%	$174,571,133	1,490
ERA AVIATION INC	3	$141,379	0.60%	$23,468,175	500
Trans States Airlines Inc.	42	$1,256,197	0.64%	$196,861,728	1,473
Shuttle America Corporation	4	$188,506	0.67%	$27,930,988	350
Merlin Airways, Inc.	1	$95,632	0.74%	$12,956,433	35
SkyWest Airlines, Inc.	117	$4,269,476	0.82%	$522,058,773	15
Express Airlines I, Inc	47	$1,499,946	1.22%	$123,025,000	563
CORPORATE AIR	2	$247,233	1.37%	$18,000,000	180
Samoa Aviation, Inc.	1	$47,126	1.41%	$3,348,147	65
Casino Airlines, Inc.	1	$59,495	1.59%	$3,750,000	15
Mountain Air Cargo, Inc.	6	$1,297,301	1.65%	$78,757,000	472
Great Lakes Aviation, Ltd.	48	$3,535,803	1.77%	$199,507,753	1,250
Air Midwest Inc.	26	$2,059,135	1.79%	$115,345,307	375
Frontier Flying Service, Inc.	5	$353,289	2.14%	$16,496,102	95
PENINSULA AIRWAYS INC	10	$834,223	2.65%	$31,463,237	350
Gulfstream International Airlines Inc	34	$2,474,451	2.85%	$86,880,041	769
Champlain Enterprises, Inc.	31	$2,469,574	3.29%	$75,000,000	375
Sunrise Airlines, Inc.	1	$62,311	3.56%	$1,750,000	7
Ozark Air Lines, Inc.	2	$135,092	3.60%	$3,750,000	7
CHAUTAUQUA AIRLINES INC	56	$1,432,067	3.88%	$36,901,617	700
Lynx Air International, Inc.	2	$179,894	4.80%	$3,750,000	35
Colgan Air, Inc.	18	$1,169,986	6.16%	$19,000,000	200
BIG SKY TRANSPORTATION CO	16	$1,489,454	6.20%	$24,007,470	240
Pacific Island Aviation, Inc.	3	$384,195	7.01%	$5,484,131	small
Corporate Airlines, Inc.	17	$1,254,891	71.71%	$1,750,000	small
Farwest Airlines LLC	1	$47,538	n/a	n/a	35

A summary of the present value (2002$) discounted costs per annual revenue is presented in the following table.

Present Value Cost As a Percent of Annual Revenue	Number of Firms	Percent of Firms
Unknown Annual Revenue	1	3.70%
0 to 1%	7	25.93%
1.1 - 2%	7	25.93%
2.1 to 3%	3	11.11%
3.1 to 4%	4	14.81%
4.1 to 5%	1	3.70%
5.1 to 6%	0	0.00%
Over 6.1%	4	14.81%
Totals	27	100.00%

H. Disproportionality Analysis

In the first year of this proposed rule, 74 percent of U.S. passenger small business operators' and 54 percent of the large U.S. commercial passenger business operators' fleets would be affected by the proposed rule. This disproportionately higher impact of the proposed rule on the fleets of small operators result in disproportionately higher cost to small operators. In addition, these costs represent a larger percentage of annual revenue for the small operators than for the large operators. Further, due to the potential of fleet discounts, large operators may be able to negotiate better pricing from outside sources for inspections, installation, and ice protection hardware purchases.

Based on the percent of potentially affected current airplanes over the 20-year analysis period, small U.S. business operators are estimated to bear a disproportionate impact from the proposed rule.

I. Competitive Analysis

In order to determine the competitive impact of the rule on small entities, the FAA studied the routes the small business operators operated. The FAA determined that 15 of the 27 U.S. commercial passenger small business operators operated scheduled services.[24] The route structures and specific markets of these 15 operators were examined. The FAA determined that the 15 operators operated in 391 distinct U.S. markets. As small business operators are compensated by their major code-share partner for code-share routes, 198 of these markets were excluded. In only 20 of the 193 remaining markets, do large operators compete with the 15 small business operators. In 173 of the 193 markets served by the 15 operators, the operators could be considered local monopolies since the affected carriers are the only providers of service. Small business operators have a local monopoly by serving specific needs. As a result of operating in these niche markets, a carrier would be able to pass some of the cost to its passengers. Similarly, the remaining 12 of the 27 operators are likely to provide customized

[24] BACK Aviation Solutions, Aviation Schedules(OAG)

services and would be able to pass some costs to its customers. Thus, as a result of this rule, there is expected to be little change in competition and little change in market share within the industry.

Overall, in terms of competition, this proposed rule does not reduce the ability of small operators to compete.

Business Closure Analysis

For commercial operators, the ratio of present-value costs to annual revenue shows that 4 of the 27 U.S. scheduled and nonscheduled commercial small business air operator firms analyzed would have ratios in excess of 5 percent, and such a ratio may have a significant financial impact when this proposed rule becomes effective. To fully assess whether this proposed rule would force a small entity into bankruptcy requires more financial information than is readily available.

The FAA seeks comment with supportive justification to determine the degree of hardship the proposed rule will have on these businesses.

J. Analysis of Alternatives

Alternative One

The "baseline," "do nothing," or *status quo* alternative has no compliance costs but will not accomplish the intent of the NTSB recommendation A-96-56 and the FAA's In-flight Icing Plan. As it stands, the proposed rule is the reasoned result of the FAA Administrator carrying out the FAA's In-flight Aircraft Icing Plan. The FAA rejected this "do nothing" alternative because the proposed rule would enhance passenger safety and prevent ice-related accidents for airplanes with a MTOW less than 60,000 pounds.

Alternative Two

Alternative Two would be to issue AD's requiring a means to know when to exit icing conditions and when the IPS must be activated. AD's have been issued for certain airplanes requiring the activation of ice protection systems at the first sign of ice accretion and exiting icing conditions based on subjective visual cues.

The FAA has issued AD's to address the activation of IPS and when to exit icing conditions. The AD's regarding the activation of the IPS relieve the pilot of determining whether the amount of ice accumulated on the wing warrants activation of the IPS. The AD's mandate the activation of the IPS when the pilot becomes aware of ice accretions on the airplane. The AD's regarding exiting icing conditions generally rely on visual cues that are subjective and can result in varying interpretations.

An evaluation of accidents and incidents led to the conclusion that the AD's do not provide adequate assurance that the flightcrew will be made aware of when to activate the IPS or when to exit icing conditions. Because this problem is not unique to particular airplane designs, but exists for all airplanes that are susceptible to the icing hazards described previously, it is appropriate to address this problem through an operational rule, rather than by ADs.

Alternative Three

The working group considered installing an aerodynamic performance monitor to provide a warning to the crew when the aerodynamic performance of the airplane has degraded to the point where the flight crew should exit icing conditions. The immature development of aerodynamic performance monitors does not make this alternative a viable option.

Alternative Four

Alternative Four is the proposed rule. The FAA's judgement is that this is the most viable option since the proposed rule will increase the safety of the flying public by reducing icing-related accidents in the future in the least costly way.

VII. INTERNATIONAL TRADE IMPACT ASSESSMENT

The Trade Agreement Act of 1979 prohibits Federal agencies from engaging in any standards or related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards.

In accordance with the above statute, the FAA has assessed the potential effect of this proposed rule and has determined that the impact is primarily domestic, as these are operators of short-haul market airplanes, and that the purpose of the rule is safety. The FAA considers that this is consistent with the International Trade Act and therefore is not considered an obstacle to international trade.

VIII. UNFUNDED MANDATES ASSESSMENT

Title II of the Unfunded Mandates Reform Act of 1995 (the Act), enacted as Pub. L. 104-4 on March 22, 1995, requires each Federal agency, to the extent permitted by law, to prepare a written assessment of the effects of any Federal mandate in a final agency rule that may result in the expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more (adjusted annually for inflation) in any one year. Section 204(a) of the Act, 2 U.S.C. 1534(a), requires the Federal agency to develop an effective process to permit timely input by elected officers (or their designees) of State, local, and tribal governments on a final "significant intergovernmental mandate." A "significant intergovernmental mandate" under the Act is any provision in a Federal agency regulation that will impose an enforceable duty upon

State, local, and tribal governments, in the aggregate, of $100 million (adjusted annually for inflation) in any one year. Section 203 of the Act, 2 U.S.C. 1533, which supplements section 204(a), provides that before establishing any regulatory requirements that might significantly or uniquely affect small governments, the agency shall have developed a plan that, among other things, provides for notice to potentially affected small governments, if any, and for a meaningful and timely opportunity to provide input in the development of regulatory rules. Because this proposed rule does not include a private-sector mandate with a potential cost impact of more than $100 million annually, the analytical requirements of Title II of the Unfunded Mandates Reform Act of 1995 do not apply.

Appendix C1

Manufacture Non-recurring and Direct Operator Costs for Section (a)(1)

Manufacture Non-recurring Costs (per airplane group/type) 2002$		HOURS	HOURLY RATE	ADDITIONAL COST	COST
System Design					
	System architecture/integration	3,000	$100		$300,000
	Ice detector positioning	300	$100		$30,000
	Associated Procedure for AFM,FCOM and MMEL	200	$100		$20,000
System Qualification/ certification					
	Ice detector qualification	300	$100		$30,000
	Ice detection system certification	600	$100		$60,000
	Reports - Test Proposal and Results Flight test	400	$100	$460,000	$500,000
Tasks associated to the retrofit					
	Service Bulletin preparation/approval	500	$60		$30,000
	Crew Training program	500	$60		$30,000
TOTAL		**5,800**			**$1,000,000**
Operator Costs (per airplane)					
	Service Bulletin Kit (Primary Ice Detector)			$35,000	$35,000
	Kit Installation	300	$60		$18,000
	Training costs - 10 pilots	20	$60		$1,200
	Additional weight is 5-10 kg				$0
	Loss of Revenue (3 days downtime @ $5,000/day)				$15,000
	Update AFM	1	$60		$60
TOTAL					**$69,260**

Appendix C2

Manufacture Non-recurring and Direct Operator Costs for Section (a)(2)

Manufacture Non-recurring Costs (per airplane group/type) 2002$		HOURS	HOURLY RATE	ADDITIONAL COST	COST
System Design					
	System architecture/integration	2,500	$100		$250,000
	Ice detector positioning	200	$100		$20,000
	Visual cue determination	200	$100		$20,000
	Associated Procedure for AFM,FCOM and MMEL	200	$100		$20,000
System Qualification/ certification					
	Ice detector qualification	300	$100		$30,000
	Visual cue substantiation	200	$100		$20,000
	Ice detection system certification	300	$100		$30,000
	Reports - Test Proposal and Results				
	Flight test	400	$100	$330,000	$370,000
Tasks associated to the retrofit					
	Service Bulletin preparation/approval	500	$60		$30,000
	Crew Training program	500	$60		$30,000
TOTAL		**5,300**			**$820,000**
Operator Costs (per airplane)					
	Service Bulletin Kit (Advisory Ice Detector)			$19,500	$19,500
	Kit Installation	150	$60		$9,000
	Training costs - 10 pilots	20	$60		$1,200
	Additional weight is 5-10 kg				$0
	Loss of Revenue (3 days downtime @ $5,000/day)				$15,000
	Update AFM	1	$60		$60
TOTAL					**$44,760**

Appendix C3

Manufacture Non-recurring and Direct Operator Costs for Section (a)(3)

	ALL OTHER AIRPLANES			CESSNA 402/421. DC-3, C-46, JETSTREAM 3101/3201/41 B1900			
Manufacturer Non-recurring Costs (per airplane group/type) 2002$	**HOURS**	**HOURLY RATE**	**COST**	**HOURS**	**HOURLY RATE**	**ADDITIONAL COST**	**COST**
System Design							
Procedures for AFM, AOM/FCOM & MME	200	$100	$20,000	200	$100		$20,000
System Qualification / certification							
Flight tests			$0			$300,000	$300,000
Total	**200**		**$20,000**	**200**			**$320,000**
Operator costs (per airplane)							
Training costs - 10 pilots	20	$60	$1,200	20	$60		$1,200
Additional weight is 5 - 10 kg			$0				$0
Update AFM	1	$60	$60	1	$60		$60
Total			**$1,260**				**$1,260**
Increased Maintenance Costs (per airplane/Month)							
Increased use of a pneumatic boot will drop the average service life. The service life will decrease from originally 4 years to 2 to 2.5 years due to already introduced AD's. Further 25% increase of boots usage due to new regulated cue decreases the life to 2*0.75 = 1.5 years							
Pre AD			$416				$416
Post AD			$594				
Post IPHWG			$793				$793
Increase (post IPHWG-pre AD)							$377
Increase (post IPHWG-post AD)			$198				

Appendix C4

Costs for Section (c)(1)

Manufacturer Non-recurring Costs (per airplane group/type) 2002$	**HOURS**	**HOURLY RATE**	**ADDITIONAL COST**	**COST**
Icing Tanker			$240,000	$240,000
Flight test including airplane rental	300	$100	$220,000	$250,000
Associated procedures for AFM & AOM/FCOM	100	$100		$10,000
Total	**400**			**$500,000**

Appendix C5

Manufacture Non-recurring and Direct Operator Costs for Section (c)(2)

NRC - Non-recurring Costs (per a/p group) caution-level alert system		HOURS	HOURLY RATE	ADDITIONAL COST	COST
System Design					
	System architecture/integration	2500	$100		$250,000
	Caution Level Alert positioning	200	$100		$20,000
	Associated Procedure for AFM,FCOM and MMEL	200	$100		$20,000
System Qualification/ certification					
	Ice detector qualification	300	$100		$30,000
	Ice detection system certification	300	$100		$30,000
	Flight test including airplane rental			$453,250	$453,250
	Icing tanker			$240,000	$240,000
Tasks associated to the retrofit					
	Service Bulletin preparation/approval	500	$60		$30,000
	Crew Training program	500	$60		$30,000
TOTAL		**4500**			**$1,103,250**
Operator Cost (per airplane)					
	Service Bulletin Kit (Equipment purchase only)			$35,000	$35,000
	Kit Installation	150	$60		$9,000
	Training costs - 10 pilots	20	$60		$1,200
	Additional weight is 5-10 kg				$0
	Loss of Revenue (3 days downtime @ $5,000/day)				$15,000
	Update AFM	1	$60		$60
Total		**171**			**$60,260**

Appendix C6

Cost Summary

	YEAR	Undiscounted Costs	P.V.	Discounted Costs
	2002	$0.00	1.00	$0.00
	2003	$0.00	0.93	$0.00
	2004	$0.00	0.87	$0.00
	2005	$0.00	0.82	$0.00
	2006	$0.00	0.76	$0.00
1	2007	$81,327,527	0.71	$57,985,403
2	2008	$1,999,056	0.67	$1,332,055
3	2009	$2,272,059	0.62	$1,414,924
4	2010	$2,537,929	0.58	$1,477,098
5	2011	$2,485,623	0.54	$1,352,014
6	2012	$2,426,184	0.51	$1,233,349
7	2013	$2,390,520	0.48	$1,135,719
8	2014	$2,201,792	0.44	$977,622
9	2015	$1,907,670	0.41	$791,615
10	2016	$1,654,982	0.39	$641,830
11	2017	$1,515,053	0.36	$549,125
12	2018	$1,407,242	0.34	$476,682
13	2019	$1,263,220	0.32	$399,903
14	2020	$916,672	0.30	$271,210
15	2021	$386,892	0.28	$106,979
16	2022	$218,821	0.26	$56,547
17	2023	$60,260	0.24	$14,554
18	2024	$0	0.23	$0
19	2025	$0	0.21	$0
20	2026	$0	0.20	$0
TOTAL		$106,971,502.87		$70,216,629.76

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

January 3, 2003

Federal Aviation Administration
800 Independence Avenue, SW
Washington, D.C. 20591

Attention: Mr. Nicholas Sabatini, Associate Administrator for Regulation and Certification

Subject: ARAC Recommendation, Ice Protection Operating Rules

Reference: ARAC Tasking, December 8, 1997

Dear Nick,

The Transport Airplane and Engine Issues Group is pleased to submit the following as a recommendation to the FAA in accordance with the reference tasking. This information has been prepared by the Ice Protection Harmonization Working Group.

- Proposed NPRM – Part 121 – Operations in Icing Conditions
- Proposed Advisory Material – Compliance with Requirements of121.XXX
- Proposed Regulatory Evaluation

Also attached are a series of minority comments regarding the methodology and assumptions used in the economic analysis of the proposed rule. This subject generated significant discussion at our TAEIG meeting and it is recommended that the FAA consider these comments not only for this proposed rule but also as they may apply to the rulemaking process in general.

Sincerely yours,

Craig R. Bolt

C. R. Bolt
Assistant Chair, TAEIG

Copy: Dionne Krebs – FAA-NWR

Mike Kaszycki – FAA-NWR
Effie Upshaw – FAA-Washington, D.C.
Jim Hoppins - Cessna

Kathi Ishii

ANM-113 Susan Boylon

TASK 1

U.S. Department
of Transportation

**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, DC 20591

JUN 9 2003

Mr. Craig R. Bolt
Assistant Chair, Aviation Rulemaking
Advisory Committee
Pratt & Whitney
400 Main Street, Mail Stop 162-14
East Hartford, CT 06108

Dear Mr. Bolt:

This letter accepts your January 3 recommendation package from the Transport Airplanes and Engines issues group of the Aviation Rulemaking Advisory Committee (ARAC). The recommendation package and attached comments propose operating requirements for a means of knowing when to activate an ice protection system and when to exit icing conditions. This letter also provides feedback on an earlier recommendation package (presented in June 2001) that addressed the part 25 airworthiness standards for installing ice detection systems and recognizing ice accretion on critical surfaces.

As you are aware through ARAC meetings, the agency has decided to combine the part 25 and part 121 recommendation packages. Additionally, on March 27 the Rulemaking Management Council assigned resources to develop the regulatory analysis for the rule. We anticipate publishing a notice of proposed rulemaking sometime during 2004.

Since a recommendation package signals completion of a task, we are closing the task that had been assigned to the Ice Protection Harmonization Working Group. We shall keep the committee apprised of the agency's efforts through the Federal Aviation Administration (FAA) report at the ARAC working group meetings. Further, if the proposed rule generates substantive or controversial comments once the FAA publishes it in the *Federal Register*, we may task the ARAC to recommend disposition of the comments.

I would like to thank ARAC, particularly those members associated with Ice Protection Harmonization Working Group for their resources and efforts in completing this task.

Sincerely,

Original Signed By
Margaret Gilligan

Nicholas A. Sabatini
for Associate Administrator for Regulation
and Certification

ARM-209: EUpshaw:fs:4/12/03;PC DOCS #18892
cc: ARM-1/24/200/209; ANM-113/110
File # ANM-02-575-A
Control No. 20031282-0

[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. FAA-2001-________; Notice No.___________]

RIN 2120-___________

Operations in Icing Conditions

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: This proposal would amend the regulations applicable to transport category airplanes certificated for flight in icing. The proposal would require either the installation of a primary ice detection system; or the definition of visual cues for recognition of ice accretion on a specified surface, combined with an advisory ice detector that provides an alert. For airplanes with reversible flight controls in the pitch or roll axis, the proposal would also require a means to indicate to the flightcrew that the airplane is in conditions conducive to ice accumulation aft of the airframe's protected areas. This proposed regulation is the result of information gathered from a review of icing accidents and incidents, and it is intended to improve the level of safety when airplanes are operated in icing conditions.

DATES: Send your comments on or before [Insert date 90 days after date of publication in the Federal Register.].

ADDRESSES: Address your comments to the Docket Management System, U.S. Department of Transportation, Room Plaza 401, 400 Seventh Street, SW., Washington, DC 20590-0001. You must identify the docket number FAA-2001-__________ at the beginning of your comments, and you should submit two copies of your comments. If you wish to receive confirmation that FAA received your comments, include a self-addressed, stamped postcard.

You may also submit comments through the Internet to http://dms.dot.gov. You may review the public docket containing comments to these proposed regulations in person in the Dockets Office between 9:00 a.m. and 5:00 p.m., Monday through Friday, except Federal holidays. The Dockets Office is on the plaza level of the NASSIF Building at the Department of Transportation at the above address. Also, you may review public dockets on the Internet at http://dms.dot.gov.

FOR FURTHER INFORMATION CONTACT: Kathi Ishimaru, FAA, Propulsion/Mechanical Systems Branch, ANM-112, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue SW., Renton, WA 98055-4056; telephone (425) 227-2674; facsimile (425) 227-1320, e-mail kathi.ishimaru@faa.gov.

SUPPLEMENTARY INFORMATION:

Comments Invited

Interested persons are invited to participate in the making of the proposed action by submitting such written data, views, or arguments as they may desire. Comments relating to the environmental, energy, federalism, or economic impact that might result from adopting the proposals in this document also are invited. Substantive comments should be accompanied by cost estimates. Comments must identify the regulatory docket or notice number and be submitted in duplicate to the DOT Rules Docket address specified above.

All comments received, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking, will be filed in the docket. The docket is available for public inspection before and after the comment closing date.

All comments received on or before the closing date will be considered by the Administrator before taking action on this proposed rulemaking. Comments filed late will be considered as far as possible without incurring expense or delay. The proposals in this document may be changed in light of the comments received.

Commenters wishing the FAA to acknowledge receipt of their comments submitted in response to this document must include a pre-addressed, stamped postcard with those comments on which the following statement is made: "Comments to Docket No. FAA-2001-__________." The postcard will be date stamped and mailed to the commenter.

Availability of NPRM Documents

You can get an electronic copy using the Internet by taking the following steps:

(1) Go to the search function of the Department of Transportation's electronic Docket Management System (DMS) web page (http://dms.dot.gov/search).

(2) On the search page type in the last four digits of the Docket number shown at the beginning of this notice. Click on "search."

(3) On the next page, which contains the Docket summary information for the Docket you selected, click on the document number of the item you wish to view.

You can also get an electronic copy using the Internet through FAA's web page at http://www.faa.gov/avr/arm/nprm/nprm.htm or the Federal Register's web page at http://www.access.gpo.gov/su_docs/aces/aces140.html.

You can also get a copy by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue SW., Washington, DC 20591, or by calling (202) 267-9680. Make sure to identify the docket number, notice number, or amendment number of this rulemaking.

BACKGROUND

On October 31, 1994, an accident involving an Aerospatiale Model ATR72 series airplane occurred in which icing conditions, believed to include freezing drizzle droplets, were reported in the area. The FAA, Aerospatiale, the French Direction Générale de l'Aviation Civile, Bureau Enquète Accident, National Aeronautics and Space Administration (NASA), National Transportation Safety Board (NTSB), and others have conducted an extensive investigation of this accident. This investigation has led to the conclusion that freezing drizzle conditions created a ridge of ice aft of the deicing boots and forward of the ailerons, which resulted in uncommanded roll of the airplane.

Existing Regulations

Certification Regulations. The current regulations that are applicable to transport category airplanes for flight in icing conditions are contained in Title 14, Code of Federal Regulations (14 CFR) part 25 (§ 25.1419, "Ice protection"). This regulation requires that an airplane must be able to safely operate in the continuous maximum and intermittent maximum icing conditions of 14 CFR part 25, appendix C. Appendix C characterizes continuous maximum and intermittent maximum icing conditions within stratiform and cumuliform clouds. Freezing precipitation (freezing drizzle and freezing rain) is not included. Appendix C defines icing cloud characteristics (for both small and transport airplanes) in terms of mean effective drop diameters, liquid water content, temperature, horizontal extent, and altitude. Icing conditions containing freezing drizzle and freezing rain sometimes result in mean effective diameters that are larger than the mean effective drop diameters defined in appendix C. Consequently, these icing conditions containing freezing drizzle and freezing rain are not considered during the certification of the airplane's ice protection system, and exposure to these conditions could result in hazardous ice accumulations.

Operating Regulations. There also are relevant regulations that apply to airplane operations, which are found in 14 CFR part 121 ("Operating Requirements: Domestic, Flag, and Supplemental Operations"). Specifically, § 121.629(a) ("Operation in icing conditions") states:

> "No person may dispatch or release an aircraft, continue to operate an aircraft en route, or land an aircraft when in the opinion of the pilot in command or aircraft dispatcher (domestic and flag operations only), icing conditions are expected or met that might adversely affect the safety of the flight."

Also, § 121.341 ("Equipment for operations in icing conditions") requires the installation of certain types of ice protection equipment and wing illumination equipment.

Neither the operating regulations nor the certification regulations require a means for the pilot-in-command specifically to identify that hazardous icing conditions have been encountered.

NTSB Safety Recommendations

The NTSB issued various safety recommendations to the FAA following the Model ATR72 accident. One of the recommendations, A-96-56, states in part that:

> ". . . If safe operations in certain icing conditions cannot be demonstrated by the manufacturer, operational limitations should be imposed to prohibit flight in such conditions and flightcrews should be provided with the means to positively determine when they are in icing conditions that exceed the limits for aircraft certification."

In response to the latter portion of this safety recommendation, the FAA tasked the Aviation Rulemaking Advisory Committee (ARAC), by notice published in the Federal Register on December 8, 1997 (62 FR 64621), to do the following:

> ". . . consider the need for a regulation that requires installation of ice detectors, aerodynamic performance monitors, or another acceptable means to warn flightcrews of ice accumulation on critical surfaces requiring crew action (regardless of whether the icing conditions are inside or outside of appendix C of 14 CFR part 25)."

The Aviation Rulemaking Advisory Committee (ARAC)

The ARAC was formally established by the FAA on January 22, 1991 (56 FR 2190), to provide advice and recommendations concerning the full range of the FAA's safety-related rulemaking activity. The FAA sought this advice to develop better rules in less overall time, using fewer FAA resources than are currently needed. The committee provides the opportunity for the FAA to obtain firsthand information and insight from interested parties regarding proposed new rules or revisions of existing rules.

There are 64 member organizations on the committee, representing a wide range of interests within the aviation community. Meetings of the committee are open to the public, except as authorized by section 10(d) of the Federal Advisory Committee Act.

The ARAC establishes working groups to develop proposals to recommend to the FAA for resolving specific issues. Tasks assigned to working groups are published in the Federal Register. Although working group meetings are not generally open to the public, all interested parties are invited to participate as working group members. Working groups report directly to the ARAC, and the ARAC must accept a working group proposal before that proposal can be presented to the FAA as an advisory committee recommendation.

The activities of the ARAC will not, however, circumvent the public rulemaking procedures. After an ARAC recommendation is received and found acceptable by the FAA, the agency proceeds with the normal public rulemaking procedures. Any ARAC participation in a rulemaking package will be fully disclosed in the public docket.

In response to the FAA's tasking of December 8, 1997 (see above), ARAC's Ice Protection Harmonization Working Group (IPHWG) developed recommendations for

FAA rulemaking to address flight in icing conditions. The ARAC accepted those recommendations and presented them to the FAA. The FAA has reviewed and accepted those recommendations, and has based the rulemaking proposal contained in this NPRM on them.

DEVELOPMENT OF THE PROPOSAL

Review Process

To address the FAA's tasking, the IPHWG followed a process consisting of the following five elements:

1. Review of the airplane icing related accident/incident history,
2. Identification of safety concerns,
3. Identification of the airplanes subject to the safety concerns (i.e., applicability),
4. Identification of various means to address the safety concerns, and
5. Review of the technology available to allow compliance with any proposed methods of addressing the safety concerns.

These five elements are discussed in more detail below.

1. Accident/Incident History Review

The IPHWG reviewed the airplane icing related accident/incident history and developed a database of approximately 1,300 worldwide icing-related accident and incident reports. The IPHWG then refined the database by:

- Removing duplicate entries and reports with insufficient data.
- Removing elements that were not relevant to inflight airframe icing problems, such as reports related to ground deicing and carburetor icing.

- Excluding single-engine piston airplanes, because most of these airplanes are not certificated for flight in icing. (Although a few of these airplanes may be certificated and equipped for flight in icing, the IPHWG considered that their exclusion would not affect the outcome of the review.)
- Removing reports involving multi-engine piston airplanes that were not certificated for flight in icing.
- Removing reports of events in which externally aggravating circumstances existed, such as operation of the airplane outside of its weight and balance limitations, descent below published minimums, or other reasons not related to airplane icing.

The IPHWG reviewed the remaining events and identified 61 events that were relevant to the task of determining the need for an ice detector. The IPHWG applied the following criteria to make this determination:

- Was there ice accretion that was not known to the flightcrew?

and

- Would knowledge of this ice accretion have made a difference to the outcome of the accident or incident?

Based on these 61 events, the IPHWG concluded that there is substantive documented accident and incident history in which the existing level of flightcrew cognizance of ice buildup on airframe surfaces is not adequate.

2. Safety Concerns

Activation of Airframe Ice Protection Systems (IPS). The airplane icing-related accident/incident history review revealed accidents and incidents where the flightcrew either:

- was completely unaware of ice accumulation on the airframe, or
- was aware of ice accumulation, but judged that it was not significant enough to warrant operation of the IPS.

From this, the IPHWG concluded that flightcrews must be provided with a clear means to know when to activate the IPS.

Exit Icing Conditions. The database contains reports of accidents and incidents where the IPS was operated according to accepted procedures, yet the ice accretions still created degradations that led to an event. Therefore, the IPHWG concluded that the flightcrew must be provided with a means to know if the airplane is in conditions conducive to ice accumulation that warrant the flightcrew taking actions to exit those icing conditions.

3. Applicability

Activation of Airframe Ice Protection Systems (IPS). The IPHWG examined the accident and incident history and found that discriminating design factors exist, such as wing chord length or airplane weight, that significantly reduce the risk of icing accidents and incidents. These discriminators were applied to the IPHWG recommended Operation Rule proposals, which are retrospective and apply to airplane types currently in service. However, the IPHWG recommended that a certification rule dealing with ice detectors should not be limited to a specific group of airplanes because of past performance. Future airplane designs may change and a similar safety record may not be achieved. Therefore, reliance on past performance for future airplane designs would not be prudent.

Exit Icing Conditions.

There have been a number of accidents and incidents caused by the uncommanded deflections of reversible flight controls in both pitch and roll axes in icing conditions. These uncommanded deflections were the result of ice accreting ahead of the control surfaces, either aft of the protected area or on the protected area when the IPS was not activated. This resulted in airflow separation over a control surface. Such an airflow separation changes the pressure distribution on the control surface. The resulting control force change may be quite large, with significant difficulty for the flightcrew to manage. In some cases, the flightcrew may not be able to regain control of the airplane.

There is no history in the database of accidents or incidents due to uncommanded rudder deflections. Due to engine inoperative and crosswind landing requirements, the rudder is designed for operation at high deflection angles without force reversal. Normal airplane operation does not expose the vertical stabilizer to high sideslip angles (angle-of-attack), thereby leaving a large stall margin.

For irreversible flight controls, the control surface actuators are sized to maintain the control surface in its commanded position throughout the airplane's flight envelope, including high-speed dive. This results in the design loads for the actuators being larger than the loads induced by airflow separation caused by ice accretions aft of the airplane's protected areas. Therefore, airplanes with irreversible flight controls have not experienced uncommanded control surface deflection caused by ice accretions.

This caused the IPHWG to maintain unpowered flight controls as a discriminator in the proposed cert rule 25-1420 pertaining to exit of icing conditions.

4. Possible Means of Addressing the Safety Concerns

Activation of Airframe Ice Protection Systems (IPS). For some types of aircraft previously certified, the safety concern of when to activate the IPS has already been partially addressed by Airworthiness Directives (AD's). The FAA has issued AD's to require activation of pneumatic deicing boots at the first signs of ice accumulation on the airplane. These AD's relieve the pilot of determining if the amount of ice accumulated on the wing warrants activation of the IPS. However, activation of the deicing boots is still subject to the flightcrew's observation of ice accumulations, and such observations can be difficult during times of high workload, operations at night, or when clear ice has accumulated. Also, the difficulties of observing ice accumulations is applicable to any IPS that relies on the flightcrew's observations for activating the system, not just pneumatic deicing boots.

The IPHWG concluded that an improved means to address these situations for future aircraft would be to require installation of a device that would alert the flightcrew when it was appropriate to activate the IPS. A primary ice detection system would be one acceptable means to alert the flightcrew. It could either automatically activate the IPS, or provide an indication to the flightcrew when the system must be activated. An advisory ice detection system, in conjunction with substantiated visual cues, will provide a much higher level of safety than visual cues alone. These means would mitigate the effects of human sensory limitations and of inadequate attention.

An alternative to requiring the installation of an ice detector would be to require that the IPS be operated whenever the airplane is operating in conditions conducive to airframe icing. The IPS would be operated in these conditions during all phases of flight, unless it can be shown that the IPS need not be activated during certain phases of flight. In this case, the flightcrew would initiate the ice protection system in response to a specific air temperature threshold and the presence of visible moisture. Because temperature and visible moisture information is readily available and unambiguous, deciding when to initiate the system would require little increased effort by the flightcrew.

The IPS continuous operation approach has disadvantages with respect to increased maintenance due to increased time in operation. However, it presents great advantages with respect to flightcrew workload and procedural reliability. It is consistent with systems used as anti-ice systems and is the procedure in use for many thermally anti-iced small jets. The IPHWG noted that small jets that used these procedures were absent from the event data base. The IPHWG considered that this procedure could be used as an alternative to an ice detection system.

The flightcrew must be provided with a clear means to know when to activate the IPS both for the initial activation and on a continuing basis. The FAA is concerned with the flightcrew workload created if an IPS must be manually cycled. An IPS that is automatically cycled or operates on a continuous basis (for example, an anti-icing system) does not create this additional workload and, therefore, is not a concern. The workload can be alleviated by equipping airplanes with a system that automatically cycles the ice protection system or with an ice detection system that alerts the flightcrew each time the IPS must be cycled.

Exiting Icing Conditions. The safety concern of when to exit icing conditions was partially addressed for existing airplanes in 1996 by a series of AD's that the FAA issued and further addressed by the IPHWG Operating Rule proposals. [AD 96-09-22, amendment 39-9698, (61 FR 20674, May 7, 1996), is typical of these AD's.] The AD's require certain airplanes to exit icing when the conditions exceed the design conditions of the ice protection equipment. Generally, the visual cues for determining that the flightcrew must act to exit icing conditions are subjective and can result in varying interpretations. Terms such as, "unusually extensive ice," ice that is "not normally observed," and ice that is "farther aft than normally observed" are used in the AD's. These are all variable terms that are largely dependent on flightcrew experience. The IPHWG concluded that more definitive means of determining when the flightcrew should exit icing conditions are needed.

As previously discussed, NTSB recommendation A-96-56 states that if safe operations in certain icing conditions cannot be demonstrated by the manufacturer, operational limitations should be imposed to prohibit flight in such conditions. The current state of the art in "icing conditions that are conducive to ice accumulation aft of the airframe's protected areas" do not allow accurate investigation into the aircraft flying qualities with such accretions. The ability to determine flight characteristics with such conditions is dependent on the development of engineering definitions for these conditions and further developments in the engineering tools used to examine the ice accretions developed under these conditions.

It is recognized that the proposed rule does not permit an option that would allow continued flight in such conditions. This is due to the inability to demonstrate handling qualities given the existing state of knowledge on such conditions. The IPHWG is tasked with future work to define such conditions and has recommended future developments of the engineering tools in this respect. However, this work is ongoing and will not be available in the time frame of the proposed certification rule. The rule as proposed addresses the NTSB recommended safety concern by requiring the identification of such conditions with subsequent exit.

After the completion of the IPHWG tasking to define a supercooled large droplet environment and further maturity of the engineering tools, future rulemaking may be required to provide an option other than exiting the conditions. Much of the framework for criteria to be used in evaluating the effects of such accretions is already in the ARAC approval process. The Flight Test Harmonization Working Group (FTHWG) has recommended proposed rulemaking on defining acceptable flight characteristics in icing conditions. These proposals were drafted to accommodate possible modifications of Appendix C of 14 CFR Part 25 to account for large drop conditions. It is expected that these proposed rules will be used in defining acceptable criteria for handling quality evaluations to ensure that aircraft can either safely transition the conditions or safely exit them once the ability to define and simulate such conditions are available.

5. Technology

To ensure that viable means exist for compliance with any proposed methods of addressing the safety concerns, the IPHWG reviewed the current state of technology with regard to ice detectors and aerodynamic performance monitors.

Ice detector technology is sufficiently mature that there currently are available several methods that can reliably alert the flightcrew as to when the ice protection system should be activated. This type of technology already has been certificated on various airplanes as either an advisory or a primary means of determining when the ice protection systems should be activated.

One ice detection system to indicate when a de-icing ice protection system should be initially activated and subsequently cycled is commercially available. Sensors for such ice detection systems, installed on the protected surfaces, sense the accumulation of ice that is sufficient to warrant cycling of a deicing system. Other ice detection systems capable of sensing the rate of ice accumulation may be used to indicate when a deicing IPS should be cycled based on ice accumulation from the preceding cycling of the system. The IPHWG, therefore, considers that these existing technologies could be further developed to effectively indicate when the initial and subsequent cycling of a deicing IPS should occur.

However, an ice detection system with the capability to alert the flightcrew when to exit icing conditions would have to be able to detect when:

a. the icing conditions encountered exceed the criteria to which the airplane was certificated; or

b. ice is accreting on surfaces of the airplane where it could prove hazardous and that were not addressed in the airplane's icing certification.

Some ice detection systems currently installed on airplanes have the capability to detect and alert the flightcrew that ice is accreting on sensor elements of the detector. Depending upon the intended application of these detectors, ice accretions of approximately 0.5 mm or less are detectable. However, these detectors only measure ice accretions and are not able perform either of the functions identified as a. and b., above.

Due to the limitations of ice detector systems and the immature development of aerodynamic performance monitors, the IPHWG considered additional means for the flightcrew to know when they should exit icing conditions.

It is feasible for the current ice detector technology to identify the existence of ice aft of the protected areas. Based on the accident and incident history and the current state of ice detector technology, the IPHWG recommended that the regulations be revised to address the known safety concern of ice accumulations aft of the airframe's ice protection systems on airplanes with reversible flight controls in the pitch or roll axis. The FAA accepted that recommendation, and the subject of this NPRM is limited to addressing that known safety concern. The FAA will consider further rulemaking if improvements occur in the technology of the ice detectors or aerodynamic performance monitors.

The IPHWG also acknowledged that, instead of an ice detector, it might be possible to use the flightcrew's observation of ice accretion on reference surfaces, provided that the visual cues are substantiated for the specific airplane. This may appear to be inconsistent with the earlier determination that visual cues should not be relied upon for determining when the ice protection system should be activated. However, the visual cues would only be acceptable if the surface was close to the flightcrew and easily observable, such as icing on the side window of the flight deck.

The relevant icing accidents and incidents occurred on airplanes equipped with pneumatic deicing boots. However, the accumulation of ice aft of the protected areas due to large droplet icing conditions can occur on any airplane, regardless of the type of ice protection system installed on it. Therefore, the IPHWG recommended that any revision to the current regulations should be applicable regardless of the type of ice protection system installed.

DEFINITION OF TERMS

For the purposes of this proposed rule, the following definitions are applicable. These definitions of terms are intended for use only with this rule:

a. **Advisory ice detection system:** An advisory system annunciates the presence of ice accretion or icing conditions. The flightcrew is responsible for monitoring the icing conditions or ice accretion as defined in the Airplane Flight Manual (AFM), typically using total air temperature and visible moisture criteria, visible ice accretion, or specific airframe ice accretion thickness, and activation by the flightcrew of the anti-icing or de-icing system(s) remains a requirement. The advisory system provides information to advise the flightcrew of the presence of ice accretion or icing conditions, but it can only be used in conjunction with other means to determine the need for, or timing of, activating the anti-icing or de-icing system.

b. **Airframe icing:** Ice accretions on portions of the airplane, with the exception of the propulsion system, on which supercooled liquid droplets may impinge.

c. **Anti-Icing:** The prevention of ice formation or accumulation on a protected surface, either:

- by evaporating the impinging water; or
- by allowing it to run back and off the surface or freeze on non-critical areas.

d. **Automatic cycling mode:** A mode of operation of the airframe de-icing system that provides repetitive cycles of the system without the need for the pilot to select each cycle. This is generally done with a timer, and there may be more than one timing mode.

e. **Deicing:** Removal or the process of removal of an ice accretion after it has formed on a surface.

f. **Irreversible flight controls:** All of the force required to move the pitch, roll, or yaw control surfaces is provided by hydraulic or electric actuators, the motion of which is controlled by signals from the flight deck controls. Loads generated at the control surfaces themselves are reacted against the actuator and its mounting, and cannot be transmitted directly back to the flight deck controls.

g. **Large droplet conditions conducive to ice accumulation aft of the airframe's protected area:** Conditions containing a population of supercooled droplets sufficiently larger than those provided for in Appendix C (of 14 CFR part 25) to cause ice accretions aft of the protected areas. The accumulation mechanism aft of the protected surface may be by direct impingement and accretion, or delayed freezing of large droplets that impinge further forward. These conditions may be aircraft-dependent as a consequence of the geometry of the airfoil and the limits of protected areas.

h. **Monitored Surface:** The surface of concern regarding ice hazard (for example, the leading edge of the wing).

i. **Primary ice detection system:** The means used to determine when the IPS must be activated. The system annunciates the presence of ice accretion or icing conditions, and may also provide information to other aircraft systems. A <u>primary automatic system</u> automatically activates the anti-icing or de-icing systems. With a <u>primary manual system</u>, the flightcrew activates the IPS upon indication from the system.

j. **Reference Surface:** The surface where an ice detection sensor is located or where a visual cue is located remotely from the surface of concern regarding ice hazard (for example, a propeller spinner).

k. **Reversible flight controls:** The flight deck controls are connected to the pitch, roll, or yaw control surfaces by direct mechanical linkages, cables, or push-pull rods, such that pilot effort produces motion or force about the hinge line. Conversely, force or motion originating at the control surface (through aerodynamic loads, static imbalance, or trim tab inputs, for example) is transmitted back to flight deck controls.

- Aerodynamically boosted flight controls: Reversible flight control systems that employ a movable tab on the trailing edge of the main control surface linked to the pilot's controls or to the structure in such a way as to produce aerodynamic forces that move, or help to move, the surface. Among the various forms are flying tabs, geared or servo tabs, and spring tabs.

- Power-assisted flight controls: Reversible flight control systems in which some means is provided, usually a hydraulic actuator, to apply force to a control surface in addition to that supplied by the pilot to enable large surface deflections to be obtained at high speeds.

l. **Static air temperature:** The air temperature as would be measured by a temperature sensor not in motion with respect to that air. This temperature is also referred to in other documents as "outside air temperature," "true outside temperature," or "ambient temperature."

m. **Substantiated visual cues:** Ice accretion on a reference surface identified in the AFM that is observable by the flightcrew. (**NOTE**: Visual cues used to identify ice addressed in appendix C will differ from those used to identify large droplet ice.)

DISCUSSION OF THE PROPOSED RULE

The FAA has reviewed and accepted the recommendations that the IPHWG developed and ARAC approved. The FAA proposes to amend the current part 25 regulations in two areas:

1. Activation of the IPS

The first area addresses the possibility of the flightcrew failing to recognize that the airframe ice protection procedures should be initiated. The proposed rule would require a method of ice detection which enables activation of the airframe ice protection system (IPS) for the initial cycles and any subsequent cycles through:

- a primary ice detection system, automatic or manual; or
- visual cues for recognition of ice accretion on a specified surface, combined with an advisory ice detection system that alerts the flight crew; or
- identification of icing conditions, as defined by an appropriate static or total air temperature and visible moisture during all phases of flight, unless it can be substantiated that the ice protection system need not be operated during specific phases of flight;
- if the ice protection system operates in a cyclical manner: a system that automatically cycles the ice protection system, or an ice detection system that is effective for the initial activation of the ice protection system and subsequent cycles.

Each of these methods provides a clear means for addressing the safety concern of when the IPS must be activated.

2. Indication of Ice Accumulation Aft of the Airframe's Protected Areas

The second area of the proposed rule addresses the possibility of ice accumulations on the airplane that could lead to hazardous operating conditions if the airplane is allowed to stay in icing conditions. The rule would be limited to airplanes equipped with reversible flight controls in the pitch or roll axis, because these aircraft can be subject to uncommanded control surface deflections caused by ice accretions. The proposed rule would require a method to alert the crew that they should exit icing conditions. Two options would be:

- Visual cues must be defined that will enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas, Or
- The airplane must be equipped with a system that alerts the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.

These proposed requirements address the known problem of large droplet ice accretions aft of protected surfaces causing uncommanded pitch or roll control surface deflection that may result in loss of control of the airplane. The FAA will consider further rulemaking if improvements occur in ice detection system technologies.

The determination that the airplane is operating in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas could be based on:

- a measurement of ice accumulations on the airframe, or
- a measurement of supercooled liquid droplet diameters , or
- visual observation of ice accumulations on the airframe.

The intent of the proposed rule is to provide methods to detect when the airplane is experiencing these icing conditions. Therefore, forecast icing conditions are not to be considered when complying with this proposed rule.

FAA Advisory Material

In addition to the amendment proposed in this notice, the FAA has developed an Advisory Circular (AC) that provides guidance as to acceptable means of demonstrating compliance with this proposed rule. Comments on the proposed AC are requested by separate notice published elsewhere in this issue of the Federal Register.

Other Related Rulemaking

The FAA has proposed a new operations regulation that would revise 14 CFR part 121 and require actions similar to those in this proposed part 25 rule. The proposed operations rule would be applicable to airplanes with a maximum certificated takeoff weight less than 60,000 pounds. It would require either the installation of ice detection equipment, or changes to the Airplane Flight Manual to ensure timely activation of the ice protection system. For airplanes with reversible flight controls in the pitch and/or roll axis, the proposed operations rule would require that either :

- visual cues be defined that enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or

- the airplane be equipped with an alert to notify the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.

On being aware of ice accumulation aft of the airframe protected areas, the rule requires the pilot in command to take action to exit the conditions in which any ice accretion is occurring.

Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. We have determined that there are no new information collection requirements associated with this proposed rule.

International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to comply with International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA determined that there are no ICAO Standards and Recommended Practices that correspond to these proposed regulations.

Executive Order 12866 and DOT Regulatory Policies and Procedures

[APO is responsible for drafting the Regulatory Evaluation Summary.

***Summary of the economic evaluation prepared by APO will be inserted here.*]**

Economic Evaluation, Regulatory Flexibility Determination, International Trade Impact Assessment, and Unfunded Mandates Assessment

Proposed changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency propose or adopt a regulation only upon a determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (19 U.S.C. section 2531-2533) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, this Trade Act also requires agencies to consider international standards and, where appropriate, use them as the basis of U.S. standards. And fourth, the Unfunded Mandates Reform Act of 1995 requires agencies to prepare a written assessment of the costs, benefits and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local or tribal governments, in the aggregate, or by the private sector, of $100 million or more annually (adjusted for inflation.)

In conducting these analyses, FAA has determined this rule 1) has benefits which do justify its costs, is not a "significant regulatory action" as defined in the Executive Order and is "significant" as defined in DOT's Regulatory Policies and Procedures; 2) will not have a significant impact on a substantial number of small entities; 3) reduces barriers to international trade; and 4) does not impose an unfunded mandate on state, local, or tribal governments, or on the private sector. These analyses, available in the docket, are summarized below.

Regulatory Flexibility Act

The Regulatory Flexibility Act (RFA) of 1980, (5 U.S.C. 601 et seq.) directs the FAA to fit regulatory requirements to the scale of the business, organizations, and governmental jurisdictions subject to the regulation. We are required whether a proposed or final action will have a significant impact on a substantial number of "small entities" as defined by the Act. If we find that the action will have a significant impact, we must do a "regulatory flexibility analysis."

International Trade

The Trade Agreement Act of 1979 prohibits Federal agencies from engaging in any standards or related activity that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and where appropriate, that they be the basis for U.S. standards. In addition, consistent with the Administration's belief in the general superiority and desirability of free trade, it is the policy of the Administration to remove or diminish, to the extent feasible, barriers to international trade, including both barriers affecting the export of American goods and services to foreign countries and barriers affecting the import of foreign goods and services to into the U.S.

In accordance with the above statute and policy, the FAA has assessed the potential effect of this proposed and has determined that it would have only a domestic impact and therefore no affect on any trade-sensitive activity.

Regulations Affecting Interstate Aviation in Alaska

Section 1205 of the FAA Reauthorization Act of 1996 (110 Stat. 3213) requires the Administrator, when modifying regulations in title 14 of the CFR in manner affecting interstate aviation in Alaska, to consider the extent to which Alaska is not served by transportation modes other than aviation, and to establish such regulatory distinctions as he or she considers appropriate. Because this proposed rule would apply to the certification of future designs of transport category airplanes and their subsequent operation, it could, if adopted, affect interstate aviation in Alaska. The FAA therefore specifically requests comments on whether there is justification for applying the proposed rule differently in interstate operations in Alaska.

Unfunded Mandates Reform Act

[APO is responsible for developing this analysis.]

The Unfunded Mandates reform Act of 1995 (2 U.S.C. §§ 1532-1538) requires the FAA to assess the effects of Federal Regulatory actions on state, local, and tribal governments, and on the private sector of proposed rules that contain a Federal intergovernmental or private sector mandate that exceeds $100 million in any one year. This action *[does or does not]* contain such a mandate.

Executive Order 13132, Federalism

The FAA has analyzed this proposed rule under the principles and criteria of Executive Order 13132, Federalism. We determined that this action would not have a substantial direct effect on the States, on the relationship between the national Government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, we determined that this notice of proposed rulemaking would not have federalism implications.

Plain Language

In response to the June 1, 1998 Presidential memorandum regarding the use of plain language, the FAA re-examined the writing style currently used in the development of regulations. The memorandum requires federal agencies to communicate clearly with the public. We are interested in your comments on whether the style of this document is clear, and in any other suggestions you might have to improve the clarity of FAA communications that affect you. You can get more information about the Presidential memorandum and the plain language initiative at http://www.plainlanguage.gov.

Environmental Analysis

FAA Order 1050.1D defines FAA actions that may be categorically excluded from preparation of a National Environmental Policy Act (NEPA) environmental impact statement. In accordance with FAA Order 1050.1D, appendix 4, paragraph 4(j), this proposed rulemaking action qualifies for a categorical exclusion.

Energy Impact

The energy impact of the notice has been assessed in accordance with the Energy Policy and Conservation Act (EPCA) Pub. L. 94-163, as amended (42 U.S.C. 6362) and FAA Order 1053.1. It has been determined that the notice is not a major regulatory action under the provisions of the EPCA.

List of Subjects in 14 CFR Part 121

Aircraft, Aviation safety, Reporting and record keeping requirements, Safety, Transportation.

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend part 25 of Title 14, Code of Federal Regulations, as follows:

PART 25—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

1. The authority citation for part 25 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702 and 44704

2. Add new paragraphs (e), (f), and (g) to § 25.1419 to read as follows:

§ 25.1419 Ice Protection.

* * * * *

(e) One of the following methods of icing detection must be provided to indicate when the airframe ice protection system must be activated:

(1) A primary ice detection system that automatically activates or alerts the flightcrew to activate the airframe ice protection system; or

(2) A definition of visual cues for recognition of ice accretion on a specified surface combined with an advisory ice detection system that alerts the flightcrew to activate the airframe ice protection system; or

(3) Identification of conditions conducive to airframe icing as defined by an appropriate static or total air temperature and visible moisture during all phases of flight,

unless it can be shown that the ice protection system need not be operated during specific phases of flight.

(f) If the ice protection system requires repeated cycling after initial activation:

(1) the airplane must be equipped with a system that automatically cycles the ice protection system, or

(2) an ice detection system must be provided to alert the flight crew each time the ice protection system must be cycled.

(g) Procedures for operation of the ice protection system must be established.

3. Add a new § 25.1420 to read as follows:

§ 25.1420 Exit large droplet conditions.

(a) For airplanes with reversible roll or pitch controls: if certification for flight in icing conditions is desired, one of the following must be provided to alert the flightcrew that they must exit icing conditions

(1) Substantiated visual cues that enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or

(2) A system that alerts the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.

(b) Procedures for exiting icing conditions must be established.

Issued in Washington, D.C., on

Aircraft Certification Service

Attachment 1: ALPA comments submitted to C. Bolt on 5 Sept 2002
(w/copy to IPHWG)

September 5, 2002

Mr. Craig Bolt
Director - Validation and Certification
Pratt & Whitney
400 Main Street 162-14
East Hartford, Connecticut 06108

Dear Mr. Bolt,

This letter is to indicate that the Air Line Pilots Association generally supports the economic evaluation done for the Ice Protection Harmonization Working Group's proposed Part 121 Rule regarding the activation of ice protection systems and the detection of ice accretion. However, we believe that Table B1 of that economic analysis omitted one very pertinent accident.

The accident took place on December 14, 1987, at Joplin, Missouri. It involved a BAE-3100 (Jetstream) aircraft that experienced an ice contaminated tailplane stall event during landing. The NTSB Identification Number is MKC88FA027. The accident resulted in 7 injuries, 2 serious and 5 minor. Although the NTSB report does not cite "icing", this accident was included in data presented by the FAA at the 1993 International Tailplane Icing Workshop. ALPA strongly feels that that accident should be considered and added to the economic analysis report.

Thank you for your assistance in this matter. Please feel free to contact me if you have any questions or comments.

Sincerely,

(original signed by)

Joe Bracken
Senior Staff Engineer
Engineering & Air Safety Department

JB:ak

Attachment 2: RAA comments submitted to IPHWG on 4 Sept 2002

Subject: Comments on the revised Part 121 RegEval (ICE2)

RAA considers the proposed cost benefit analysis to be fundamentally flawed. The purpose of a cost-benefit analysis should support government decision-making in ensuring that adopted rules expend industry resources wisely. The FAA economist assigned to IPHWG, stipulated certain restraints that rendered the analysis incapable of performing its intended purpose.

The first restraint was to stipulate that all airplanes greater than 23.8 years were excluded from the cost benefit analysis but yet still be affected by the proposed rule. The basis was that 23.8 years is a "statistical" retirement age for this fleet so the cost of retrofit should not be included in the analysis since the aircraft would probably be retired by the operators regardless of the rule. RAA requested that at least the Twin Otter fleet (DHC-6) be included because there are no indications that this airplane will be retired in the foreseeable future. The Twin Otter is primarily used for tourist excursion flights in Alaska, Hawaii and in the Grand Canyon. The operators of this unique aircraft plan to structurally maintain its airframe indefinitely because there simply is no aircraft being manufactured or designs on any drawing board that could provide what the Twin Otter offers. One example given why this airplane should be counted in the future fleet is the relative ease of maintenance; it takes just two people to lift and replace a wing. RAA views the position of excluding the Twin Otter airplane from the cost benefit analysis but yet including it in the rule, as unrealistic.

The second and more significant restraint was that the cost benefit analysis be "constrained to using one of three forecasts provided by APO-110". The choices were Commuter 298C, Form41 Commuters and Total Commuters (sum of Commuter 298C and Form41), with "Commuter 298C" being the selected choice. This restraint was highlighted when RAA requested that the cost benefit analysis distinguish the costs and benefits of airplanes with reversible flight controls (airplanes with "booted" wing ice protection systems) from airplanes with irreversible flight controls (airplanes with internally heated wing ice protection systems; i.e "unbooted" airplanes). For reasons discussed below we thought it extremely beneficial to accomplish the analysis for the two airplane fleets (both fleets are readily identifiable). The simple response to our request was "No, we are constrained to only using one of APO-110's forecasts!

It is difficult to understand why a "Commuter 298C forecast" could be a reason to deny our request to separate the cost benefit analysis between the two fleet types.

"Commuter 298C" is defined as an air carrier that chooses to be "exempt" from obtaining DOT 4102 certificate authority. It is available only to air carriers or air taxi operators operating aircraft having no more than 60 passenger seats. It is optional and operators with such aircraft may file under DOT 4102 certificate authority, if they choose. The Commuter 298C fleet includes corporate jets (air taxi operators) operating under Part 135. Since the Commuter 298C fleet is limited to airplanes that have 60 passenger seats or less, it would by definition exclude the ATR 72 airplane. The Roselawn accident which occurred in an ATR 72 airplane, is of course the most significant accident and serves to justify the NPRM. The ATR 72 airplane is included in the cost benefit analysis but it is not a "Commuter 298C" airplane. The air taxi jets operating under Part 135 are not included in the cost benefit analysis but are "Commuter 298C" airplanes. What then is the relevance of a "Commuter 298C forecast" for preparing the cost benefit analysis for the NPRM?

There were several reasons why we requested that the benefit analysis distinguish the "booted" airplanes from the "unbooted" airplanes (the cost side for the "unbooted" airplanes is zero).

First, IPHWG reviewed principally only the "booted" airplane accidents and incidents. The initial data base contained only "booted" airplane accidents and incidents. While there may have been some discussion of icing problems associated with the "unbooted" airplanes, the group's meeting minutes and the preamble to the NPRM do not mention the relevance of including the "unbooted" airplanes in the NPRM. The primary reason why "unbooted" accidents/incidents are not mentioned is of course the lack of accidents and the relative newness of the regional jet fleet. The one "unbooted" accident that was mentioned in IPHWG conversation is the 1997 CRJ Fredericton, Canada approach and landing accident. If trace amounts of ice on the wings were a contributing factor however, the IPHWG has failed to distinguish the Fredericton accident from similar accidents that occurred in other jets such as the McDonnell Douglas DC-9-10 and the Fokker F-28. The DC-9's and F-28's are not affected by the proposal because their maximum takeoff weight exceeds 60,000 pounds. What then is the basis for excluding "unbooted" airplanes that are greater than 60,000 pounds, if the Fredericton accident is in fact relevant?

Second, by not distinguishing the "unbooted" airplanes from the "booted" airplanes in the benefit analysis, there is an implication that the benefits of accident reduction between the two airplane types are equal. Again there is nothing in any meeting minutes nor the preamble to the NPRM to suggest that any of the IPHWG members believe there are similar benefits. The RJ fleet is not equally susceptible to the adverse effect of in-flight icing. The proposed rule distinguishes the two airplane types in the rulemaking provisions (provisions (a) and (b) affect both airplane types, (c), (d) and (e) affect only the "booted" airplanes). We are simply requesting that the "benefits" analysis make a similar distinction.

Lastly, by combining the two groups, the benefit for the "booted" airplanes is greatly exaggerated because the fleet size of the "unbooted" airplanes (RJ's) is greatly increasing while the fleet size of the "booted" airplanes (turboprops) is significantly decreasing and the cost of compliance for the "unbooted" airplanes is negligible while the cost of compliance for the "booted" airplanes is huge.

The differences between the two future fleet types are significant both in number of operations and in the aircraft seating capacity:

U.S. operators currently operate 756 "unbooted" airplanes affected by this proposal (i.e. CRJ-100/-200 and ERJ-135/-140/-145 airplanes). There are 494 "unbooted" airplanes affected by this proposal on firm order. There are an additional 970 RJ's (i.e."unbooted" airplanes) on conditional order or option. For updated information, see the RJ Internet Site: http://www.regionalairservice.org In contrast there are no newly manufactured turboprops on order for U.S. operators; nor have there been any for the last several years

(The Q400 orders are not included since it has a MTOW of greater than 60,000 #). The majority of turboprop airplane types in service today are no longer being produced. The turboprop fleet will significantly decrease in the next 20 years. RAA estimates that annually, 8-10% of the new RJ fleet will replace the turboprop fleet. Five years out, it is fair assessment to predict that the turboprop fleet will have been reduced by at least 50%.

Using the "Commuter 298C forecast", the Cost Benefit Analysis forecasts the future fleet as simply a percentage increase of the entire fleet. No distinction is made to account for the projected differences between turboprop and turbojet fleets. Significant changes in the regional fleet size during the last 12 months (since 9/11/01) are also not accurately depicted in the Cost Benefit Analysis. For example, the Cost Benefit Analysis estimates the current "unbooted" fleet size at 566 (CRJ–100/–200 and ERJ–135/-140/-145) and the "booted" fleet size at 1169. RAA estimates the current fleet of "unbooted" airplanes at 756 and the "booted" fleet size at 863. For the year 2007, the Cost Benefit Analysis estimates no increase in the "unbooted" fleet size (566 for CRJ–100/–200 and ERJ–135/-140/-145) and no decrease in the "booted" fleet size at 1169 (Note: Table C4 doesn't reflect the projected fleet increase shown by Table C3). Using the above data on firm and conditional orders for RJ's, RAA conservatively estimates the 2007 fleet of "unbooted" airplanes at 1850 and the "booted" fleet size at 450.

Similarly the projected seating estimate is affected. The cost benefit analysis projects a 44% increase in the number of seats. This of course is solely attributed to the increased use of the RJ's. Since the turboprop fleet is significantly decreasing, the projected number of seats per airplane should remain about the same for the "booted" airplanes. The proposed applicability of limiting airplanes at 60,000 pounds maximum take-off weight will also impact the projected seating estimate since the "Commuter 298C forecast" is based upon an airplane at 60 passengers or less. The CRJ-200 at 53,000 pounds maximum take-off weight is the "heaviest" airplane; it can carry up to 50 passengers. There are no airplanes built or being built that will carry a maximum of 51-60 passengers.

Lastly, the cost of compliance for an "unbooted" airplane (i.e. irreversible flight controls) is negligible so the total cost of compliance is borne by the operators of the "booted" fleet types (i.e. reversible flight controls). The rule notes the distinction but the cost benefit analysis does not. This does not make sense. RAA believes that it is essential to distinguish the benefits between the "booted" and "unbooted" fleet because of the great disparity in costs and benefits. When combined with projected increase in the RJ fleet, this "apples to oranges" comparison completely distorts the actual benefit of the proposed operating rule.

RAA recommends that the cost benefit analysis either be totally revised or that it not be endorsed by the IPHWG membership.

Attachment 3: SAAB Aircraft AB comments submitted to IPHWG on 10 Sept 2002

Subject: Saab Aircraft AB comments on the economic analysis of the proposed Part 121 rule on in-flight icing (version 2002-08-14)

Saab Aircraft AB ("Saab") acknowledges that the proposed Part 121 rule will have a positive impact on flight safety. However, Saab has the following comments on the economic analysis.

Saab knows that the FAA economist has to use certain methodology (for instance, a 20-year analysis period to calculate the benefit) and certain forecast models (i.e., only FAA forecast models for growth of the concerned fleet can be used, even if the FAA's models do not accurately represent the impact of the proposed rule on the effected fleet). However, Saab has the opinion that the possible effect of the inaccuracy of some assumptions is not made clear enough in the proposed Regulatory Evaluation report. The difference between the cost and benefit is too marginal considering the inaccuracy of some important assumptions. Small changes in some of the assumptions can easily change the result of the cost-benefit analysis to the opposite of what is now contained in the Regulatory Evaluation. For instance, the safety-improvement effect of the recent AD's attributed to the proposed rule has been estimated to be a 50 percent reduction in the number of projected future icing accidents. It is Saab's opinion that 50 percent is conservative and has a very large uncertainty. Also, the growth forecast of the effected fleet is very important for the benefits and the growth forecast used for the effected fleet remains a controversial issue (see also RAA comments). Both of these examples are discussed in detail below.

1. Correction of accident rate for the effect of recent AD's.

The 1996 the FAA has issued severe-icing AD's for airplanes with unpowered controls and pneumatic de-icing boots. The AD's required that operating manuals provide pilots with instructions for operating in freezing rain and freezing drizzle, provided cues to identify such conditions, and offered instructions on how to exit the conditions. These requirements are similar to the proposed rule in sections (c) and (d). The differences between the 1996 directives and the proposed rule are the proposed new requirement to substantiate the large-droplet icing cues and the provision of an alternate option to install a caution-level alert to provide the required indication.

A second set of AD's was issued in 1999 for airplanes with pneumatic de-icing boots which required activation of the IPS at the first sign of ice accretion. These AD's accomplished much of what proposed sections (a) and (b) are intended to achieve. The differences are that the proposed rule requires a more conservative activation cue (temperature and visible moisture) and that the visual cues used in combination with an advisory ice detection would require validation (or re-validation).

The above-mentioned AD's were issued to establish an increased level of safety with respect to initiating activation of the ice protection systems and providing cues to determine when large droplet icing conditions have been encountered. The benefit analysis however, considers accidents that occurred prior to the issuance of these AD's. In fact, it was the findings from the two major accidents listed in Table B1 (1994 & 1997) that prompted the AD's.

Due to the similarity of requirements, the above-mentioned AD's have accomplished a substantial portion of the safety increase attributed to the proposed rule. In the benefit analysis it has been assumed that the AD's have accomplished 50 percent of the safety benefit attributed to the proposed rule, and therefore the proposed rule's benefit of preventing future accidents via the proposed rule has been reduced by 50 percent.

During the IPHWG meetings/teleconferences the 50 percent number was discussed at great length. Opinions of IPHWG members for an appropriate value varied from 10 percent to 90 percent. As it is not possible to accurately determine the future safety-benefit impact of the AD's, a compromise of 50 percent has been used for the benefit analysis.

It is Saab's opinion that 50 percent is conservative and, as discussed above, has a very large uncertainty. If the estimated effect of the AD's is increased slightly from 50 percent to 67 percent, then the cost would already be equal to the benefit. Therefore, Saab believes that it should be mentioned in the economic analysis that this percentage is very uncertain and that using a slightly different percentage can significantly change the outcome of the cost-benefit analysis.

2. Forecast model for growth of the effected fleet

A FAA's cost-benefit analysis has to be based on forecasts provided by APO-110. The "Commuter 298C" category has been used for the cost-benefit analysis as the basis for growth of the effected fleet.

Using the "Commuter 298C" category for forecasting, the cost-benefit analysis predicts the growth of the future fleet as a percentage increase of the entire fleet. No distinction is made to account for differences between airplanes with pneumatic de-icing systems ("booted" airplanes, mainly turboprops) and airplanes with thermal anti-icing systems ("non-booted" airplanes, turbojets). By not distinguishing the "non-booted" airplanes from the "booted" airplanes in the benefit analysis, there is the implication that the reducing effect on future icing accidents due to the recent AD's is equal for both the "booted" and "non-booted" airplanes types although the relevant AD's were only issued for airplanes with pneumatic de-icing boots.

The IPHWG concluded that airplanes of the same size, or maximum takeoff weight ("MTOW"), would in principle be equally susceptible to detrimental effects of ice accretion. Therefore "booted" airplanes and "non-booted" airplanes were treated in the same way in the operational rule. However, that does not and was not intended to imply that the proposed rule will have the same effect on reducing future icing accidents for both "booted" and "non-booted" airplanes. The historical database of icing accidents did not confirm that "non-booted" airplanes were equally susceptible to detrimental effects of ice accretion as "booted" airplanes. The database with relevant accidents contained only "booted" airplanes. The reason why "non-booted" accidents are not mentioned is the lack of accidents and the relative newness of the regional turbojet fleet. However, technical differences might well be the reason that "non-booted" airplanes do not appear in the icing accident database. One of the most important differences might be that "non-booted" airplanes in the effected fleet never had the disadvantage of having to wait for a certain amount of ice accretion to prevent ice bridging, as generally was the case for "booted" airplanes prior to issuing the AD's.

Combining the "booted" and "non-booted" airplane groups causes the benefit to be exaggerated because the fleet size of the "non-booted" airplanes is increasing while the fleet size of the "booted" airplanes is decreasing, and the cost of compliance for the "non-booted" airplanes is almost negligible while the cost of compliance for the "booted" airplanes is quite high.

Similarly, Saab does not agree with the use of the estimated average number of seats per airplane. The "Commuter 298C" forecast predicts an increase in average number of seats per airplane from 33.03 in year 2001 to 48.5 in the year 2026, i.e., an increment of 47 percent. Based on the reality of the industry market, this must be solely attributed to the increase of number of "non-booted" airplanes (regional jets). Since the turboprop fleet is decreasing, the number of seats per airplane should remain about the same for the "booted" airplanes. Moreover, the "Commuter 298C" forecast is based upon airplanes of 60 passengers or less and does not take into account the proposed limit in MTOW of 60,000 pounds. If the average number of seats per airplane increases by 47 percent, it then follows that the MTOW will also increase by roughly the same magnitude. Thus, a part of the growth is likely to result in airplanes above the 60,000 pound MTOW limit for the proposed rule.

Saab agrees with the RAA that it is essential to distinguish the benefits between the "booted" and "non-booted" fleet because of the disparity in costs and benefits. The number of prevented future icing accidents has to be predicted for the safety benefit of the "non-booted" fleet and it is expected to be significantly lower than for the "booted" airplanes. Also the growth prediction in number of airplanes, airplane operations, and average number of seats per airplane should consider the MTOW limit of 60,000 pounds. If it is not allowed or possible to perform the analysis with a more appropriate methodology because such an FAA forecast model does not exist, then Saab believes that the economic analysis must mention that the growth forecast used is actually not appropriate and therefore exaggerates the benefit in the outcome of the cost-benefit analysis, resulting in the benefits being greater than the costs.

Attachment 4: Boeing Company AB comments submitted to IPHWG on 10 Sept 2002

The Boeing Company ("Boeing") concurs in general with the opinions of the RAA and SAAB in that the economic analysis contains fundamental flaws. While Boeing supports the proposed rule, it is also Boeing's position that the economic evaluation must be based upon appropriate analytical data and methodology. As detailed in the RAA and SAAB comments, the FAA's requirements and policies prevent a valid analysis from being conducted, and therefore those requirements and policies should be revised so that there can be no question that the economic analyses of proposed regulations are appropriate.

Pratt & Whitney
400 Main Street
East Hartford, CT 06108

Pratt & Whitney
A United Technologies Company

January 2, 2007

Federal Aviation Administration
800 Independence Avenue, SW
Washington, D.C. 20591

Attention: Mr. Nicholas Sabatini, Associate Administrator for Regulation and Certification

Subject: ARAC Recommendation, Ice Detectors

Reference: ARAC Tasking, December 8, 1997

Dear Nick,

The Transport Airplane and Engine Issues Group and the Ice Protection Harmonization Working Group have evaluated the need for a TSO for ice detection devices per the reference tasking. The Ice Protection Harmonization Working Group has does not recommend a TSO for ice detectors or aerodynamic performance monitors as described in the attached letter. TAEIG concurs with this position.

Sincerely yours,

Craig R. Bolt

C. R. Bolt
Assistant Chair, TAEIG

Copy: Mike Kaszycki – FAA-NWR
Nic Davidson – FAA-Washington, D.C. – Office of Rulemaking
Jim Hoppins - Cessna

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

FEB 22 2007

Mr. Craig R. Bolt
Assistant Chair, Aviation Rulemaking
Advisory Committee
Pratt & Whitney
400 Main Street, Mail Stop 162-14
East Hartford, CT 06108

Dear Mr. Bolt:

This is in reply to your January 2, 2007 letter. The letter sends the recommendations of the Ice Protection Harmonization Working Group (IPHWG) and the Aviation Rulemaking Advisory Committee (ARAC), regarding the Technical Standard Order (TSO) aspect of Task 1. We acknowledge the IPHWG consensus and concurrence by ARAC, that a TSO for an ice detector or aerodynamic performance monitors is not recommended.

I wish to thank the Aviation Rulemaking Advisory Committee, particularly the members associated with Transport Airplane and Engines Issues, and its IPHWG that provided resources to develop the report and recommendation. The report will be placed on the ARAC website at: http://www.faa.gov/regulations_policies/rulemaking/committees/arac/.

We consider your submittal of the IPHWG report as completion of Task 1 of our December 8, 1997, tasking statement. We will keep the committee apprised of the agency's efforts on this recommendation through the FAA report at future ARAC meetings.

Sincerely,

Nick Sabatini

Nicholas A. Sabatini
Associate Administrator
for Aviation Safety

Recommendation

27 October 2006

IN REPLY, REFER TO
L374-44-06-231

Cessna
A Textron Company

Mr. Craig R. Bolt
Assistant Chair
Advisory Committee on Transport Airplane and Engine Issues
400 Main Street
East Hartford, CT 06108

Re: 1) Letter - C. Bolt to N. Sabatini, IPHWG Task 1 Part 121 rule proposal; 3 Jan 2003
2) Letter - C. Bolt to A. Fazio, IPHWG Task 1 Part 25 rule review; 29 Jun 2001

Dear Mr. Bolt:

This letter is provided for submittal of the Ice Protection Harmonization Working Group (IPHWG) recommendation on the TSO aspect Task 1. For reference IPHWG Task 1 is as follows:

> "As a short-term project, consider the need for a regulation that requires installation of ice detectors, aerodynamic performance monitors, or another acceptable means to warn flight crews of ice accumulation on critical surfaces requiring crew action (regardless of whether the icing conditions are inside or outside of Appendix C of 14 CFR Part 25). Also consider the need for a Technical Standard Order for design and/or minimum performance specifications for an ice detector and aerodynamic performance monitors. Develop the appropriate regulation and applicable standards and advisory material if a consensus on the need for such devices is reached".

The majority of the tasking was addressed via references 1 & 2. The remaining open aspect of this tasking is the statement: "Also consider the need for a Technical Standard Order for design and/or minimum performance specifications for an ice detector and aerodynamic performance monitors. Develop the appropriate ... applicable standards ... if a consensus on the need for such devices is reached".

The IPHWG deferred discussion of the TSO aspect of this tasking until completion of the Task 2 package. The IPHWG has completed deliberations on this topic.

The IPHWG has reviewed the available technical standard (SAE AS5498/EUROCAE ED-103) with the intent of determining what guidance should be provided to the FAA for the drafting of a TSO. The review identified concerns about the usefulness of a TSO due to the complexity of the interface between the ice detector equipment or aerodynamic performance monitors and the system level certification. The installation criticality and other installation effects drive the requirements for the equipment level qualification and can change for different aircraft. TSOs typically define minimum performance standards as well as interface requirements. Consequently, the utility of a TSO would be minimal, but advisory material would be appropriate. A revision to AC 20-73A has been released and has extensive guidance on ice detector certification and qualification.

EASA

EASA is currently considering an ETSO for in-flight ice detectors, based on the SAE/Eurocae specifications. The current draft of the ETSO references SAE AS 5498/ED-103 for ice detector performance, environment test conditions such as RTCA DO-160/Eurocae ED-14 for qualification of hardware, and qualification to RTCA DO-178/Eurocae ED-12 to demonstrate software compliance. The FAA already has released AC materials such as AC 21-16 and AC 20-115 which discuss the applicability RTCA DO-160 and DO-178 in the qualification of airborne hardware and software. AC 20-73A discusses ice detector installation and performance issues and refers to SAE AS 5498/ED-103. As such, the FAA has provided equivalent guidance to the proposed ETSO standards.

CONCLUSION

As discussed above, the consensus of the IPHWG is that a TSO for an ice detector or aerodynamic performance monitors is not recommended.

Sincerely,

Jim Hoppins
Co-Chair Ice Protection
Harmonization Working Group

[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 121

[Docket No. FAA-2002-__________________; Notice No.__________________]

RIN 2120-___________

Operations in Icing Conditions

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: This proposal would amend the regulations applicable to operators of certain airplanes used in air carrier service and certificated for flight in icing. The proposal would require either the installation of ice detection equipment or changes to the Airplane Flight Manual to ensure timely activation of the ice protection system. This proposal also would require certain actions applicable to airplanes with reversible flight controls for the pitch and/or roll axis. This proposed regulation is the result of information gathered from a review of icing accidents and incidents, and it is intended to improve the level of safety when airplanes are operated in icing conditions.

DATES: Send your comments on or before [*90 days after date of publication in the* *Federal Register*.]

ADDRESSES: Address your comments to the Docket Management System, U.S. Department of Transportation, Room Plaza 401, 400 Seventh Street, SW., Washington, DC 20590-0001. You must identify the docket number FAA-2002-__________ at the beginning of your comments, and you should submit two copies of your comments. If you wish to receive confirmation that FAA received your comments, include a self-addressed, stamped postcard.

You may also submit comments through the Internet to http://dms.dot.gov. You may review the public docket containing comments to these proposed regulations in person in the Dockets Office between 9:00 a.m. and 5:00 p.m., Monday through Friday, except Federal holidays. The Dockets Office is on the plaza level of the NASSIF Building at the Department of Transportation at the above address. Also, you may review public dockets on the Internet at http://dms.dot.gov.

FOR FURTHER INFORMATION CONTACT:

For operational issues contact: Daniel Meier, FAA, Air Carrier Operations Branch, AFS-220, Flight Standards Service, 800 Independence Ave., SW, Washington, DC 20591; telephone (202) 267-3749; fascimile (202) 267-5229, e-mail Daniel.Meier@faa.gov.

For certification issues contact: Kathi Ishimaru, FAA, Propulsion/Mechanical Systems Branch, ANM-112, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue SW., Renton, WA 98055-4056; telephone (425) 227-2674; facsimile (425) 227-1320, e-mail kathi.ishimaru@faa.gov.

SUPPLEMENTARY INFORMATION:

Comments Invited

The FAA invites interested persons to participate in this rulemaking by submitting written comments, data, or views. We also invite comments relating to the economic, environmental, energy, or federalism impacts that might result from adopting the proposals in this document. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, and include supporting data. We ask that you send us two copies of written comments.

We will file in the docket all comments we receive, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking. The docket is available for public inspection before and after the comment closing date. If you wish to review the docket in person, go to the address in the ADDRESSES section of this preamble between 9:00 a.m. and 5:00 p.m., Monday through Friday, except Federal holidays. You may also review the docket using the Internet at the web address in the ADDRESSES section.

Before acting on this proposal, we will consider all comments we receive on or before the closing date for comments. We will consider comments filed late if it is possible to do so without incurring expense or delay. We may change this proposal in light of the comments we receive.

If you want the FAA to acknowledge receipt of your comments on this proposal, include with your comments a pre-addressed, stamped postcard on which the docket number appears. We will stamp the date on the postcard and mail it to you.

Availability of NPRMs

You can get an electronic copy using the Internet by taking the following steps:

(1) Go to the search function of the Department of Transportation's electronic Docket Management System (DMS) web page (http://dms.dot.gov/search).

(2) On the search page type in the last four digits of the Docket number shown at the beginning of this notice. Click on "search."

(3) On the next page, which contains the Docket summary information for the Docket you selected, click on the document number of the item you wish to view.

You can also get an electronic copy using the Internet through the Office of Rulemaking's web page at http://www.faa.gov/avr/armhome.htm or the Federal Register's web page at http://www.access.gpo.gov/su_docs/aces/aces140.html.

You can also get a copy by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue SW, Washington, DC 20591, or by calling (202) 267-9680. Make sure to identify the docket number, notice number, or amendment number of this rulemaking.

BACKGROUND

On October 31, 1994, an accident involving an Aerospatiale Model ATR72 series airplane occurred in which icing conditions, believed to include freezing drizzle droplets, were reported in the area. The FAA, Aerospatiale, the French Direction Générale de l'Aviation Civile, Bureau Enquete Accident, National Aeronautics and Space Administration (NASA), National Transportation Safety Board (NTSB), and others have conducted an extensive investigation of this accident. This investigation concluded that freezing drizzle conditions created a ridge of ice aft of the deicing boots and forward of the ailerons, which resulted in uncommanded deflection of the aileron and consequent roll of the airplane.

Existing Regulations

Certification Regulations. The current regulations applicable to flight in icing conditions are contained in Title 14, Code of Federal Regulations (CFR) part 23 (§ 23.1419, "Ice protection") for small airplanes, and part 25 (§ 25.1419, "Ice protection") for transport category airplanes. Both of these regulations require that an airplane must be able to safely operate in the continuous maximum and intermittent maximum icing conditions of 14 CFR part 25, appendix C. Appendix C characterizes continuous maximum and intermittent maximum icing conditions within stratiform and cumuliform clouds. Freezing precipitation (freezing drizzle and freezing rain) is not included. Appendix C defines icing cloud characteristics (for both small and transport airplanes) in terms of mean effective drop diameters, liquid water content, temperature, horizontal extent, and altitude. Icing conditions containing freezing drizzle and freezing rain sometimes result in mean effective diameters that are larger than the mean effective drop diameters defined in appendix C. Consequently, these icing conditions containing freezing drizzle and freezing rain are not considered during the certification of the airplane's ice protection system, and exposure to these conditions could result in hazardous ice accumulations.

Operating Regulations. 14 CFR part 121.629(a) states:

> No person may dispatch or release an aircraft, continue to operate an aircraft enroute, or land an aircraft when in the opinion of the pilot in command or aircraft dispatcher (domestic and flag operations only), icing conditions are expected or met that might adversely affect the safety of the flight.

Also, 14 CFR part 121.341 requires certain types of ice protection equipment and wing illumination equipment to be installed.

Neither the operating regulations nor the certification regulations require a means for the pilot in command to specifically identify that hazardous icing conditions have been met.

NTSB Safety Recommendations

The NTSB issued various safety recommendations to the FAA following the Model ATR72 accident. One of the recommendations, A-96-56, states in part that:

> If safe operations in certain icing conditions cannot be demonstrated by the manufacturer, operational limitations should be imposed to prohibit flight in such conditions and flightcrews should be provided with the means to positively determine when they are in icing conditions that exceed the limits for aircraft certification.

In response to the latter portion of this safety recommendation, the FAA tasked the Aviation Rulemaking Advisory Committee (ARAC), by notice published in the Federal Register on December 8, 1997 (62 FR 64621), to:

> . . . consider the need for a regulation that requires installation of ice detectors, aerodynamic performance monitors, or another acceptable means to warn flightcrews of ice accumulation on critical surfaces requiring crew action (regardless of whether the icing conditions are inside or outside of Appendix C of 14 CFR

part 25).

The Aviation Rulemaking Advisory Committee (ARAC)

The ARAC was formally established by the FAA on January 22, 1991 (56 FR 2190), to provide advice and recommendations concerning the full range of FAA safety-related rulemaking activity. The FAA sought this advice to develop better rules in less overall time, using fewer FAA resources than are currently needed. The committee provides the opportunity for the FAA to obtain firsthand information and insight from interested parties regarding proposed new rules or revisions of existing rules.

There are 64 member organizations on the committee, representing a wide range of interests within the aviation community. Meetings of the committee are open to the public, except as authorized by section 10(d) of the Federal Advisory Committee Act.

The ARAC establishes working groups to develop proposals to recommend to the FAA for resolving specific issues. Tasks assigned to working groups are published in the Federal Register. Although working group meetings are not generally open to the public, all interested parties are invited to participate as working group members. Working groups report directly to the ARAC, and the ARAC must accept a working group proposal before that proposal can be presented to the FAA as an advisory committee recommendation.

The activities of the ARAC will not, however, circumvent the public rulemaking procedures. After an ARAC recommendation is received and found acceptable by the FAA, the agency proceeds with the normal public rulemaking procedures. Any ARAC participation in a rulemaking package will be fully disclosed in the public docket.

The rulemaking proposal contained in this notice is based on a recommendation developed by the ARAC Ice Protection Harmonization Working Group (IPHWG). The ARAC approved and presented the proposed rulemaking to the FAA as a recommendation.

DISCUSSION

Review Process

To address the task, the ARAC IPHWG followed a process consisting of the following five elements:

1. Review of the airplane icing related accident/incident history,
2. Identification of safety concerns,
3. Identification of the airplanes subject to the safety concerns (i.e., applicability),
4. Identification of various means to address the safety concerns, and
5. Review of the technology available to allow compliance with any proposed methods of addressing the safety concerns.

These five elements are discussed in more detail below.

1. Accident/Incident History Review

The ARAC IPHWG reviewed the airplane icing-related accident/incident history and developed a database of approximately 1,300 worldwide icing-related accidents and incidents. The ARAC IPHWG then refined the database by:

- Removing duplicate entries and reports with insufficient data.
- Removing elements that were not relevant to inflight airframe icing problems,

such as reports related to ground deicing and carburetor icing.

- Excluding single-engine piston airplanes, because most of these airplanes are not certificated for flight in icing. (Although a few of these airplanes may be certificated and equipped for flight in icing, the ARAC IPHWG considered that their exclusion would not affect the outcome of the review.)
- Removing reports involving multi-engine piston airplanes that were not certificated for flight in icing.
- Removing reports of events in which externally aggravating circumstances existed, such as operation of the airplane outside of its weight and balance limitations, descent below published minimums, or other reasons not related to airplane icing.

The ARAC IPHWG reviewed the remaining events and identified 96 events that contained adequate information to apply the following criteria:

- Was there ice accretion that was not known to the flightcrew, and
- Would knowledge of this ice accretion have made a difference to the outcome of the accident or incident.

Based on these 96 events, the ARAC IPHWG concluded that in at least 61 events, there is substantive documented accident and incident history in which the existing level of flightcrew cognizance of ice buildup on airframe surfaces was not adequate.

Once the group had concluded that flightcrew cognizance of ice buildup on airframe surfaces was not adequate, an effort was undertaken to further analyze the data in order to identify factors that play a role in the flightcrew's situational awareness as it pertains to icing. A parallel effort was undertaken to identify aerodynamic and system design factors that might play a role in the susceptibility of the airplane to icing effects, thus influencing the procedural vigilance required of the flightcrew.

Both of these efforts required that the database be expanded. The same refinements described above were applied to the 1,300-event database, except that reports were included in which there was not sufficient information to positively determine whether flightcrew knowledge of the ice accretion would have made a difference to the outcome of the accident or incident. This review yielded 234 events.

All 234 events were used to examine aerodynamic and system design factors. However, in order to look at issues regarding the flightcrew's situational awareness, single pilot operations were not considered relevant to multi-pilot aircrew cognizance. Therefore, events that were likely to have involved a single pilot were removed from the 234 events for this purpose. This left 119 events.

During the review of the 96-event data set, certain factors became apparent and these were evaluated more closely using the 119-event data set. In particular, factors that affect crew workload were considered, such as phase of flight and crew complement.

Crew complement was estimated based on the number of pilots required by the type certificate and/or the type of operation being conducted. Phase of flight was extracted from the narratives of the events.

This part of the analysis revealed that 49 percent of the 119 events had taken place during the approach and landing phases of flight, 38 percent had taken place during the cruise phase, 8 percent during the climb phase, and 2 percent during the go-around phase.

The phase-of-flight analysis was conducted again using only accidents. The pattern remains similar: 73 percent of the accidents had taken place during approach and landing, 17 percent during cruise, 7 percent during climb, and 2 percent during go-around.

Reported incidents represent a smaller portion of total incidents than reported accidents do of total accidents. However, if the proportion of reported incidents to total incidents is assumed to remain the same across all phases of flight, the relationship of accidents to incidents in each phase becomes of interest. It was found that in the case of approach and landing, there occurred just over 3 accidents for every reported incident. In the case of the cruise phase, there occurred 0.3 accidents for every reported incident; in the case of climb, 0.4 accidents for every reported incident.

This led the ARAC IPHWG to consider why the approach and landing phases were apparently much more likely to result in an event than the cruise and climb phases, and why that event was much more likely to be an accident.

The approach and landing phases of flight involve considerably higher degrees of pilot workload than do the cruise and climb phases, consequently, there is less attention available to manage the ice accretion problem. These phases involve continuous changes in flight parameters such as airspeed, altitude, and bank angle. Therefore, indications of ice accretion other than visual cues, such as trim changes and drag increases, are much less visible to the crew. Research suggests that the drag effects of ice accreted at low angles of attack can become very significant when the angle of attack is increased. Ice accreted early in the approach phase may not manifest its effects until the angle of attack is increased later in the approach or landing phase. All of these factors influence the situation while the airplane is in close proximity to the ground.

For all airplanes the pilot workload includes detection of ice accretion and for some airplanes the ice accretion must also be evaluated before operation of the ice protection system (IPS).

With this data the ARAC IPHWG examined the crew response to the knowledge of ice accretion. In 122 events out of 234, the flightcrew knew that ice was accreting on the airframe. Yet in only 48 cases was there positive evidence that the crew had operated the IPS. This did not seem to be affected by crew complement, with 20 of the 48 cases involving a single pilot. In 16 of these cases, there was positive evidence that the crew had not operated the IPS; in the remainder, no information regarding IPS operation was available.

The ARAC IPHWG also considered the significant air carrier accidents and incidents in recent years due to icing. These included the accidents at Roselawn, Indiana, in 1994, and at Monroe, Michigan, in 1997. It also included incidents involving Fokker F-27s at East Midlands, UK, and Copenhagen, Denmark; the British Aerospace ATP at Cowley, UK; Embraer EMB-120s at Tallahassee, Elko, Fort Smith, and Klamath Falls, US, and several Aerospatiale/Alenia ATR events during the 1980s.

2. Safety Concerns

Activation of Airframe IPS. The airplane icing-related accident/incident history review revealed accidents and incidents where the flightcrew either:

- Was completely unaware of ice accumulation on the airframe, or
- Was aware of ice accumulation but judged that it was not significant enough to warrant operation of the IPS.

This led the ARAC IPHWG to conclude that flightcrews must be provided with a clear means to know when to activate the IPS.

Exit Icing Conditions. The database contains accidents and incidents where the IPS was operated according to accepted procedures, yet the ice accretions still created degradations that led to an event. Therefore, the ARAC IPHWG concluded that the flightcrew must be provided with a means to know if the airplane is in conditions conducive to ice accumulation that warrant the flightcrew taking actions to exit icing conditions.

3. Applicability

The ARAC IPHWG examined the 234-event accident and incident history and found that discriminating factors exist that significantly reduce the risk of icing accidents and incidents. A wide range of factors was considered, including airplane size, type of flight control system, and wing chord length.

A limited analysis of the event database described above revealed that average wing chord length has a roughly inverse relationship to the event history. Of the data considered, the ARAC IPHWG noted that airplanes with average chord lengths in excess of ten feet had not experienced any accidents due to in-flight icing. Although some airplanes with shorter chords have no event history, many do.

Evidence is available to show that as the ratio of surface roughness height to chord length increases contamination on the upper wing surface results in an increasing deterioration in the wing's coefficient of lift and the coefficient of drag. This may sufficiently influence the contamination effects in a typical icing encounter such that a large chord experiences minimal aerodynamic effect, while a small chord may experience significant effects. Another contributing factor for the lack of accidents may be the fact that for any given icing encounter, droplets will impinge further aft and the resulting ice shape will be larger on a short chord wing than on a long chord wing. Chord length, then, may be an appropriate discriminator for determining which airplanes have a higher risk of accidents and incidents without the flightcrew having a clear means to know when to activate the IPS and when to exit icing conditions.

However, chord length is not a commonly known attribute of the airplane; therefore, the ARAC IPHWG sought a simple discriminator that could be readily understood by the aviation community. In the accident/incident database, those airplanes with a ten-foot average chord correspond quite well with airplanes with a weight of 60,000 pounds. Since the maximum certificated gross takeoff weight is simple and well understood, it was recommended as the discriminating parameter.

4. Possible Means of Addressing the Safety Concerns

The FAA has issued Airworthiness Directives (ADs) to require activation of pneumatic deicing boots at the first signs of ice accumulation on several types of airplanes operated under 14 CFR part 121. These ADs relieve the pilot of determining whether the amount of ice accumulated on the wing warrants activation of the IPS. However, the flightcrew's observation of ice accumulations can be difficult during times of high workload, operations at night, or when clear ice has accumulated. Also, the difficulties of observing ice accumulations is applicable to any IPS which relies on this observation for activation of the system, not just pneumatic deicing boots.

The ARAC IPHWG concluded that an improved means to address these situations would be to require installation of a device that would alert the flightcrew that the IPS should be activated. An advisory ice detection system in conjunction with substantiated visual cues will provide a much higher level of safety than visual cues alone. This device would mitigate the effects of high workload and of human sensory limitations in detecting ice and evaluating its thickness. When using such a device in conjunction with a manual ice protection system as proposed in 121.XXX (a)(2), the ARAC IPHWG considers it is not acceptable to use crew assessment of depth of ice as a discriminator in deciding when to operate the de-icing system. The intent is to permit current certified manual systems to be used in such a way that they replicate the effectiveness of an automatic system without the dependency on the crew to establish ice depths. There are several types of airplanes currently in operation which have primary ice detection systems installed, and the ARAC IPHWG considers that these airplanes already meet the desired level of safety.

An alternative to requiring the installation of such an ice detector would be to require that the IPS be operated continuously when the airplane is operating in conditions conducive to airframe icing: reference proposed 121.XXX (a)(3). In this case, the flightcrew would operate the ice protection system in response to a specific air temperature threshold and the presence of visible moisture. Temperature and visible moisture information is readily available and unambiguous. This approach has disadvantages with respect to increased maintenance due to increased time in operation. However, it presents large advantages with respect to flightcrew workload and procedural reliability. It is consistent with systems used as anti-ice systems and is the procedure in use for many thermally anti-iced small jets. The ARAC IPHWG noted that incidents involving small jets that used these procedures were absent from the incident database. When a manual de-icing system is required to be operated as defined above, the ARAC IPHWG considers it is not acceptable to use crew assessment of depth of ice as a discriminator in deciding when to operate the de-icing system. The intent is to permit current certified manual systems to be used in such a way that they replicate the effectiveness of an automatic system without the dependency on the crew to establish ice depths. The ARAC IPHWG considered that this procedure could be used as an alternative to an ice detector.

The information in the database revealed that the phases of flight that presented the greatest risk due to airframe icing were those that were associated with low speed and relatively high angle-of-attack operation (i.e., approach, landing, go-around, and holding). Takeoff was excluded because the accidents related to that phase of flight were caused by improper ground deicing/anti-icing procedures; this has been adequately addressed by amendment 121-253 to 14 CFR (§ 121.629(b) and (c), "Operating in icing conditions"). This conclusion was based primarily on the preponderance of icing accidents taking place during those phases, particularly approach and landing.

The ARAC IPHWG considered an alternative requirement that would apply in any case where an ice detector was not operational and/or installed. This alternative would require that, when the airplane is operating in conditions conducive to airframe icing, the IPS must be operated continuously. The group then considered how this procedure would apply to each phase of flight.

The database lists ten accidents as originating during cruise. In six of the ten accidents, the flightcrew was aware of the ice accretion. In the remaining four accidents, very little relevant data was available. These data were insufficient to draw meaningful conclusions and the ARAC IPHWG determined that the cruise accident history did not substantiate rulemaking.

The database also lists a number of incidents in the cruise phase, of which at least five were potential accidents. Further examination of the incidents where sufficient data was available led the ARAC IPHWG to conclude that the crews were aware that ice was accreting and that operation of the IPS at the first sign of ice accretion would have prevented the incidents. Examination of these incidents caused the ARAC IPHWG to conclude that the cruise phase should be included in the rule. However, the ARAC IPHWG did not believe that continuous operation of the IPS while in conditions conducive to icing was warranted. The ARAC IPHWG was reluctant to require continuous operation of manually cycled ice protection systems in conditions conducive to airframe icing due to considerations of crew workload and a concern that it would introduce a procedure possibly leading to substantial non-compliance. The ARAC IPHWG felt that continuous operation of the IPS at the first sign of ice accretion was more appropriate and alleviated the concern with procedural non-compliance.

With respect to the climb, approach, landing, holding and go-around phases of flight, the ARAC IPHWG determined that the following factors substantiated the need for requiring the continuous operation of the IPS while in conditions conducive to icing:

- An overall majority of events which originated in these phases of flight;
- A sufficient number of events in which the flightcrew was confirmed to be unaware of ice accretion, supplemented by a substantial number of events in which the flightcrew awareness of ice accretion was unknown;
- High cockpit workload resulting in low residual flightcrew attention;
- Frequent maneuvering, resulting in little opportunity for the flightcrew to detect aerodynamic degradations due to icing;
- Maneuvering at relatively high angles of attack.

In some cases, airframe manufacturers have specified definitions of icing conditions relative to given airplane types. In the absence of type-specific information, conditions conducive to airframe icing may be considered to exist in flight at an outside air temperature at or below +2? C in clouds or precipitation.

The safety concern of when to exit icing conditions was partially addressed in 1996 by a series of ADs issued by the FAA. (Amendment 39-9698, AD 96-09-22 (61 FR 20674, May 7, 1996) is typical of these ADs.) The ADs require certain airplanes to exit icing when the conditions exceed the capabilities of the ice protection equipment. Generally, the visual cues for determining that the flightcrew must act to exit icing conditions are subjective and can result in varying interpretations. Terms such as "unusually extensive ice," ice that is "not normally observed," and ice that is "farther aft than normally observed" are used in the ADs. These are all variable terms that are largely dependent on flightcrew experience. The ARAC IPHWG concluded that less subjective means of determining when the flightcrew should exit icing conditions are needed.

5. Minority Positions and Majority Responses

Minority Position - British Aerospace Public Limited Company (BAe Systems) (Supported by Cessna Aircraft Company)

The ARAC IPHWG proposed rule has three options for demonstrating compliance with paragraph (a) when flying in conditions conducive to airframe icing as follows:

1. The airplane must be equipped with a primary ice detection system or,
2. The substantiated visual cues and an advisory ice detection system or,
3. Paragraph (a) (3)(i) and (ii) mandate continuous operation of the ice protection system at various phases of flight.

BAe Systems cannot support the proposed rule paragraph (a) due to the inability of a part 121 rule to recognize compliance by an equivalent level of safety. The proposed rule has been developed to recognize that some aircraft types demonstrate unacceptable performance or handling characteristics in icing conditions. The incident and accident database was analyzed to determine a potential configuration that is susceptible to unsafe characteristics. The result of that analysis is that any aircraft of less than 60,000 pounds would be affected by the introduction of this rule. There are a number of aircraft types within this criterion that have a good safety record which would now have to revise the operation procedures in icing from those developed during certification.

Prior to completion of this ARAC IPHWG proposed rulemaking, the FAA issued NPRMs proposing ADs to modify the procedures for operation of the airframe de-icing systems of the affected airplanes. The proposed ADs would require activation of the airframe ice protection system at the first sign of ice formation anywhere on the aircraft, and thereafter operate continuously to minimize ice accretions on the airframe. This requirement was not supported by BAe Systems and some other manufacturers since the recommended and approved use of the de-icing systems was as established during certification and currently presented in the Airplane Flight Manual (AFM). The certified system operation requires the crew to establish when approximately one-half inch of ice has accreted prior to operation of the manually cycled de-icing system. This procedure was developed and agreed with the authorities. There appears to be no safety concern on the BAe Systems aircraft affected (or indeed some other aircraft) that would require such a change to system operating procedures, as evidenced by the withdrawal of the ADs.

The FAA decision to withdraw the proposed ADs on some aircraft types was based on evidence supplied by the respective manufacturers. Typically this included information on the certification testing, margin to stall warning, the susceptibility to adverse handling characteristics and the information presented in the AFM. On BAe Systems aircraft types this included information on ice accretions appropriate to normal de-icing system operation and to delayed activation or system failure. The FAA has thereby accepted that some aircraft can continue to operate the de-icing system as certified and have recognized that the crew have adequate means to determine the required level of ice has accreted and then cycle the boots accordingly. On these aircraft there is no justification to require the de-icing system operation to be amended by the introduction of the ARAC IPHWG proposed rule.

The intent of paragraph (a)(1), (2), and (3) of the proposed rule was not to require the current fleet to have primary ice detection systems fitted, but to allow installed systems to be able to demonstrate compliance. Compliance with option (a)(2) or (a)(3) would require changes to the certification of the ice protection system on some part 23 and part 25 aircraft which the FAA have previously agreed, by withdrawing the proposed ADs, are not required. The withdrawal of the ADs was not dependent on the aircraft having an ice detector fitted.

A list of aircraft that have had the de-icing ADs withdrawn is detailed below. As can be seen there is potential for a considerable number of aircraft types to be affected by the introduction of the proposed rule.

It is BAe Systems' contention that some aircraft that fall within the applicable criteria do not have a flight safety issue in icing, and as such should be allowed to operate as certified. BAe Systems propose that, since the proposed rule does not have a mechanism for accepting equivalent level of safety, the most effective way to accommodate this position is to revise the ARAC IPHWG proposed rule such that it would not be applicable to any aircraft type that has had the proposed de-icing AD withdrawn. This will recognize that the FAA has already determined the operation of these specific aircraft types in icing conditions meets the required safety levels, and therefore removes the need for amending system operation by the proposed rule.

<u>List of Aircraft Eligible for Part 121 Operations with AD withdrawal</u>

Part 25 Airplane models	**Docket No.**
Cessna Aircraft Company, Models 550, and 560 Series Airplanes.	**99-NM**-136-**AD**
Jetstream, Model 4101 Airplanes	**99-NM**-146-**AD**

Part 23 Airplane Models	**Docket No.**
LET, a.s., Model L-420 Airplanes	99-CE-39-AD
British Aerospace, Jetstream Models 3101 and 3201 Airplanes	**99-CE**-40-**AD**
Raytheon Aircraft Company, 90, **99**, 100, 200, 300, 1900 Series Airplanes	**99-CE**-46-**AD**
Short Brothers & Harland Ltd., Models SC-7 Series 2 and SC-7 Series 3 Airplanes	**99-CE**-48-**AD**

Majority Response

As described in the minority position, the FAA withdrew several notices of proposed rulemaking (NPRMs) which proposed that the airframe pneumatic deicing boots be activated at the first sign of ice accretion. Some of these withdrawals were based upon data that substantiated the airplanes could safely operate if the IPS was operated as certificated. However, the FAA states that during the evaluation of the data the FAA did not consider whether the flightcrew has a clear means to determine when the IPS should be activated. For example, if the certificated method of IPS operation is manual activation when one-half inch of ice has accumulated, the FAA did not evaluate whether the flightcrew could determine the one-half inch was present. The FAA evaluated whether the data substantiated that the airplane could safely operate with the one-half inch of ice. If the substantiation was found to be acceptable the FAA withdrew the NPRM. Consequently, an NPRM withdrawal does not equate to a determination by the FAA that there is a clear means to know when to activate the IPS. The visual cues to operate the ice protection systems are accepted during the initial known icing certification of aircraft. However, the ARAC IPHWG review of the accident and incident data indicates that the flightcrew's observation of these visual cues may be difficult on some models during times of high workload, operations at night, or when clear ice has accumulated.

The Jetstream Model 4101 is one case where the NPRM was withdrawn and is described in the AD Final Rule. Handling and performance flight tests were accomplished which substantiated that the airplane could be safely operated with certain ice accretions on the airplane. The tests included:

- Normal Operation of the Deicing Boots, one-half to three-quarters-inch of ice on the protected wing leading edges and up to three inches of ice on unprotected leading edges;
- Simulated Failure of the Deicing Boots, approximately one to one-and-one-half inches of ice on all leading edges; and
- Ice Accreted During the Take-off Phase, a thin rough layer of ice accreted during the initial take-off phase to 400 feet, prior to operation of deicing boots.

It might appear from this information that there is a factor of safety due to the tests with one to one-and-one-half inches of ice, which would compensate for not having a clear means to know when the IPS should be activated. However, for the normal condition of activating the boots with one-half to three-quarters-inch of ice the handling and performance criteria are more stringent than for the failure condition with one to one-and-one-half inches quarters inches. It cannot be concluded that the tests conducted with large ice accretions justifies a clear means to know when to operate the deicing boots during normal operations is not needed.

There are many events in the accident/incident database in which the ice protection system was operated either late or not at all. This led the ARAC

IPHWG to conclude that the flightcrew need a clear means to know when to activate the IPS. The proposed rule is intended to address that need. It is possible to have an aircraft that can safely operate in icing conditions provided the IPS is operated as certificated, however the certificated means to know when to operate the IPS may not be clear. Therefore, the proposed rule should not exclude aircraft that had the proposed deicing NPRMs withdrawn.

The majority of the ARAC IPHWG requests that the FAA further consider the airplanes for which the proposed ADs were withdrawn prior to publication of the NPRM for this proposed operating rule. Further consideration would assure the industry that operating these airplanes, as required by the NPRM, would not degrade their performance or adversely affect the safety of their operation. This consideration may need to include a review of the visual means used to determine when the IPS should be activated to evaluate whether they are in fact inadequate under some circumstances.

Minority Position The Regional Airlines Association (RAA)

"The RAA partially concurs with the Minority Position that states that since the proposed rule does not have a mechanism for accepting equivalent level of safety, the most effective way to accommodate this position is to revise the ARAC IPHWG proposed rule such that it would not be applicable to any aircraft type that has had the proposed de-icing AD withdrawn. The Minority Position was provided by BAe Systems and supported by Cessna Aircraft. The RAA believes however that original equipment manufacturers of several other aircraft types would similarly satisfy the criteria for AD withdrawal but simply did not petition the FAA for AD withdrawal. The Majority response to the BAe position is that the criteria used by the FAA for AD withdrawal was not sufficiently stringent since it did not address the events in the accident/incident database in which the ice protection system was operated either late or not at all. The Majority concludes that the flight crewmembers need a clear means to know when to activate the IPS and that the rule should apply as well, for the airplane types in which the ADs were withdrawn. RAA's response to the Majority position is that while it may be desirable to add additional automatic or alerting devices to assist the crewmembers in activating the IPS (or to exit SLD conditions), the Majority position is not supported by service data to conclude that a past accident/incident in a specific airplane type will duplicate itself in another airplane type, should the flightcrew respond in a similar manner. A crewmember's reaction to an inflight icing event can be viewed as independent of the airplane type being operated. However, the service data indicates that many airplane types have been safely operated for many years in icing conditions with no known accident/incidents and the frequency of operation is much greater than the operations in the airplane types in which the accidents/incidents occurred. How can this be? The RAA believes that ability of a crew to successfully react to an inflight icing event depends to a large degree upon the flight characteristics of a particular airplane type. The major flaw with the Majority's conclusion then is that a part 91/121/135 accident/incident database is equally relevant for all (part 121) airplanes with a maximum certificated takeoff weight less than 60,000 pounds. The RAA believes that any safety concerns expressed by the ARAC IPHWG can be more effectively addressed by issuance of ADs against the airplanes that have had past significant accidents/incidents. These ADs have in fact already been issued mandating extensive changes for the affected airplanes. A part 121 operating rule is therefore unnecessary."

Majority Response

The RAA position contains several issues to support their position that that the proposed 121 rule is unnecessary:

RAA Issue - Particular Airplane Types

Majority Response:

The Majority does not concur that an airplane without a history of icing events should be excluded from the proposed rule. The flightcrews of airplanes both with and without icing events typically use the visual observation of ice accretions to determine when the ice protection system should be activated. Observation of ice accretions can be difficult during times of high workload, operations at night, or when clear ice has accumulated. Consequently, the airplanes with and without icing events are all susceptible to an icing event where the ice protection system is not activated because the flightcrew is completely unaware of ice accretions on the airframe. This type of event can occur to any flightcrew and is not airplane specific.

The Minority position is based solely on the fact that certain airplane models are not identified in the accident/incident data base. The Minority position provides no other factual or analytical basis to support the conclusion that the hazards identified by the ARAC IPHWG do not exist for these airplanes.

No evidence has been found to indicate that there are specific airplane designs that keep these airplanes inherently safe from the hazard addressed by the proposed rule. The scientific literature, such as *Theory of Wing Sections* by Ira H. Abbot and Albert E. Von Doenhoff, clearly indicate that aerodynamic performance of the wing and horizontal stabilizer sections is degraded by leading edge surface roughness such as that resulting from the accretion of ice. The airplanes affected by the proposed rule will exhibit degraded performance and handling qualities, such as increased drag and stall speeds, with ice contaminated wings and empennage control surfaces.

Ice contaminated wings may result in airplane stall at an angle-of-attack that is less than the angle used in the design of the airplane's stall protection system. The in-service history of icing accidents and incidents revealed that degraded airplane performance and handling qualities resulting from inattention to proper operation of the ice protection system often resulted in airplane stall, loss-of-control, and airplane attitudes from which safe recovery of control was not achieved by the flightcrew. Attitudes exceeding the limits of the stall protection system were recorded in several events.

In some cases, safe recovery from such attitudes and loss of control is not demonstrated during airplane certification. During certification the airplane's stall recovery is demonstrated within the limits of the airplane's stall protection system for a normally operating ice protection system, and to stall warning for ice protection failure cases.

In an airplane type that has had no history of inflight icing accidents or events, the ability of an average airline crew to successfully react to the inflight icing events described in the in-service history (regardless of aircraft) is questionable. This is further aggravated by the inadequacy of the FAA operations training to minimize altitude losses through the use of power to recover from ice contamination induced stalls. Therefore, it is prudent that the proposed rule cover airplanes less than 60,000 pounds without a history of icing events to increase the level of safety for these aircraft.

RAA Issue - ADs

Majority Response:

The majority concur that unsafe conditions should be addressed by the Airworthiness Directive process. For certain airplanes, ADs have been issued requiring the activation of ice protection systems at the first sign of ice accretion and exiting icing conditions based on subjective visual cues.

The majority concurs that no additional ADs are needed at this time, but does not concur that the proposed part 121 rule is unnecessary. The FAA has issued ADs to address the activation of IPS and when to exit icing conditions. The ADs regarding the activation of the IPS relieve the pilot of determining whether the amount of ice accumulated on the wing warrants activation of the IPS. The ADs mandate the activation of the IPS when the pilot becomes aware of ice accretions on the airplane. The ADs regarding exiting icing conditions generally rely on visual cues that are subjective and can result in varying interpretations.

An evaluation of accidents and incidents led to the conclusion that the ADs do not provide adequate assurance that the flightcrew will be made aware of when to activate the IPS or when to exit icing conditions. Because this problem is not unique to particular airplane designs, but exists for all airplanes that are susceptible to the icing hazards described previously, it is appropriate to address this problem through an operational rule, rather than by ADs.

RAA Issue – Part 91 and 135 accidents and incidents.

Majority response:

The working group concluded that in at least 61 events, there is substantive documented accident and incident history in which the existing level of flightcrew cognizance of ice buildup on the airframe surfaces was not adequate. Of these 61 events more than half of these occurred on airplanes that could be operated in 121 service. If the working group limited their review to part 121 operations the conclusion on the need for a rule would not have changed.

Minority position: Airline Pilots' Association (ALPA)

The flightcrew must be provided with a clear means to know when to activate the IPS both for the initial activation and on a continuing basis. It is ALPA's position that the preamble does not adequately justify the acceptability of using the flightcrew's observation of airframe ice accretions as the sole means of knowing when to activate the ice protection system during the cruise phase.

Section 4 of the preamble states that the flightcrew's observation of ice accumulations can be difficult during times of high workload, operations at night, or when clear ice has accumulated. The preamble does not discuss the acceptability of flightcrew observation of airframe ice accretions during cruise if the operations are at night or if clear ice has accumulated.

The preamble states in section 2 that there were accidents and incidents where the flightcrew was completely unaware of ice accumulation on the airframe. It is ALPA's position that the flightcrew must have a clear means to know when to activate the ice protection system and that reliance on visual observation of ice accretions on the airframe during the cruise phase is not acceptable when consideration is given to operations at night and if clear ice has accumulated.

An IPS that must be manually cycled increases the flightcrew workload during the cruise phase. An IPS that is automatically cycled or operates on a continuous basis (e.g. an anti-icing system) does not create this additional workload and is not a concern. It is ALPA's position that the following factors result in an unacceptable burden on the flightcrew during the cruise phase:

- The additional flightcrew workload if the IPS is cycled manually,

- The additional flightcrew workload if it becomes necessary to operate the IPS during all of this phase,
- The longest phase of flight occurs during this phase, and
- The workload can be high when operating in congested areas.

Therefore, ALPA proposes the following:

1. When the airplane is operated in airframe icing conditions, the rule should require activation of the ice protection system during all phases of flight except first and second segment climb (0 to 400 feet). Takeoff climb prior to the completion of second segment climb is exempted because the accidents during this phase of flight are attributed to improper ground deicing/anti-icing procedures and not to inactivation of the IPS.

2. The rule should require that the airplanes be equipped with a system which automatically cycles the ice protection system or the ice detection system must be effective for the initial activation of the IPS and subsequent cycles if the IPS operates in a cyclical manner.

Majority Response

During the cruise phase, the ARAC IPHWG proposed rule as written would allow the use of visual observation of ice formation anywhere on the aircraft as the means of knowing when to activate the ice protection system during cruise in icing conditions. The ALPA minority position would require continuous operation of the system during cruise.

The cruise phase of flight typically has limited exposure to actual airframe icing due to the limited horizontal extent of icing clouds. In the FAA Technical Report DOT/FAA/CT-88/8-1 "Aircraft Icing Handbook" (March 1991), Figure 1-32, 90 percent of all icing clouds will have a horizontal extent of less than 50 statute miles. Typical part 121 turboprop aircraft have cruise speeds on the order of 275 to 300 KTAS. Based on these figures, 90 percent of the icing clouds will be transited on the order of 9 minutes. Based on the proposed guidance of a 3-minute maximum time interval, the crew workload would typically consist of four manual activation cycles during the cruise phase of flight.

For most phases of flight, the proposed rule requires the use of conditions conducive to airframe icing as a means to determine when to operate the ice protection systems. However, the probability of encountering the appropriate temperature and visible moisture conditions far exceeds the probability of actually accreting ice. In the FAA Technical Report DOT/FAA/CT-88/8-1 "Aircraft Icing Handbook" (March 1991), Figure 1-37, icing will occur a maximum of approximately 40 percent of the time spent in clouds with temperatures below freezing. This implies that if the system is required to be operated during the cruise phase in conditions conducive to airframe icing, there will be no actual airframe ice accretions greater than 60 percent of the time the system is required to be operated. If the ALPA proposal of operating the ice protection system continuously during the cruise phase based on clouds and temperature is adopted, then the increase in the amount of time that the flightcrew would be required to operate the ice protection systems could lead to increased workload concerns, particularly with aircraft certified with manual pneumatic de-ice systems.

Manually operating a pneumatic de-ice system on temperature and moisture cues is considered acceptable for short durations or for periods of increased risk. The vertical climb and descent phases of flight are typically of limited duration with respect to the proposed guidance of a 3-minute maximum time interval for ice protection system operation. These flight phases also tend to transition clouds vertically, which also limits the duration of the exposure. The additional flightcrew workload for aircraft with manual pneumatic de-ice systems during these relatively limited exposures was accepted by the majority of the ARAC IPHWG as compensating. However, directing flightcrews to operate a manual pneumatic de-ice system in such a manner over prolonged periods of cruise in benign cloud conditions would create a situation where the motivation to comply would be greatly reduced due to the requirement to expend effort to remove airframe ice that is not present.

In addition, the FAA proposed ADs in 1999 and 2000 to require the operation of the de-ice boots on certain airplane types at the first sign of formation anywhere on the aircraft with continued operation to minimize ice accretions. The appropriateness of this method of operation is still a controversial issue (See BAe/Cessna minority position on the topic). However, the requirements of the ADs are similar to the requirements of the ARAC IPHWG proposal as written, and no known issues regarding crew workload have surfaced. The issues raised in this document in the BAe/Cessna minority position are not workload related.

Based on the above considerations, the alternative of manually operating the boots during the cruise phase of flight based on temperature and moisture conditions was not considered by the ARAC IPHWG to be warranted (based on examination of the accident and incident history) or practical (based on frequent operation of the system with no actual ice accretions and the longer exposure of the cruise phase of flight). As stated in the preamble and generally acknowledged by the ARAC IPHWG, flightcrew observation of ice accumulations can be difficult under some circumstances. The majority of the ARAC IPHWG feels that allowing this, as written in the proposal, for the cruise phase is mitigated by the guidance provided in the proposed advisory circular for AFM language, as follows:

If an automatic cycling mode is <u>not</u> available, the system must be operated at short intervals (not to exceed three minutes) to minimize ice accretions. In addition, the system must be operated for at least one complete cycle immediately prior to:

a. Decreasing airspeed for holding or for maneuvering for approach and landing;

b. Commencing a holding turn;

c. Commencing the turn intended to intercept the final approach course inbound, including the procedure turn; and

d. Selecting landing flaps.

These actions will remove any ice accumulated during cruise without the crew's knowledge.

With respect to the second part of the ALPA proposal, the majority of the ARAC IPHWG believe that adoption of the ALPA minority position requiring automatic cycling of the ice protection system or an ice detection system effective for each cycle of the ice protection system would, in effect, disallow the use of manually operated ice protection systems in part 121 operations due to the complexity of the certification issues which would ensue.

It has never been the intention of the ARAC IPHWG to challenge the basic icing certification of any airplane to which this retrospective operating rule would apply. The proposal to require all aircraft to be equipped with a system that automatically cycles, or the use of an ice detection system that is effective for the initial activation of the IPS and subsequent cycles, would require the modification of aircraft with pneumatic manual de-ice systems.

For automatic cycles, the design change entails more than the addition of a timed control function to actuate the boots. The effectiveness of an existing manual pneumatic de-ice system to operate in an automatic cycle mode would need to be evaluated. The de-ice system effectiveness with thin ice accretions is largely dependent on whether the pneumatic system design can supply sufficient air to rapidly inflate the boots in an automatic cycle. An evaluation of the pneumatic characteristics of the system would be necessary. The failure monitoring strategy would likely require redesign and evaluation. The system reliability would need to be reassessed based on the increased number of operation cycles that typically occur with automatic systems. In addition, the residual and intercycle ice accretions handling qualities effects would need to be evaluated, typically both with simulated ice shapes and in natural icing conditions.

The alternate suggestion of using an ice detection system that is effective for the initial activation of the IPS and subsequent cycles if the IPS operates in a cyclic manner also would require reopening basic icing certification. While technology exists to operate a manual ice detection system in this manner, no part 121 aircraft has been certificated with this technology. The technology that does exist is advisory only and has not been certified as a primary ice protection system activation means with the associated system safety implications. Certification of such technology would likely require an extensive program to mature the technology, design a system around it including both control architecture and failure monitoring. Extensive flight-testing to verify system function and any effects on the aircraft handling qualities with residual or intercycle ice accretions would be required. The magnitude of these types of design changes is believed to be beyond the scope of an operating rule.

The majority of the ARAC IPHWG believe that if a retrospective re-certification of an individual airplane type's ice protection system should be found necessary, it should be required through the AD process, not in an operating rule. The majority also believes that the adoption of the rule language as proposed would not result in unacceptable increase in crew workload and is the most feasible means to address this issue.

Minority Response: FAA

The FAA concurs with many of the points in the majority response. However, this FAA response provides additional information to more fully respond to the ALPA position.

ALPA Issue: – Difficulty of flightcrew observations of airframe ice accretions during cruise if the operations are at night or if clear ice has accumulated.

FAA Response: The FAA does not concur that during cruise the IPS should be activated based on operation in icing conditions as opposed to observation of ice accretions. As described in the preamble, the accident and incident database lists ten accidents as originating during cruise. In six of the ten accidents, the flightcrew was aware of the ice accretion. In the remaining four accidents the data were insufficient to draw meaningful conclusions. Since the flightcrew was aware of ice accretion during these accidents, a rule that requires the activation of the IPS based on ice accretions would be an adequate means for the flightcrew to know when the IPS should be activated.

The FAA concurs with ALPA's concern that there may be difficulties observing ice accretions that are clear or that occur during night operations. However, the accident database indicates that the flightcrews were aware of ice accretions during cruise, so the accident history does not support that these difficulties have led to accidents. The difficulties observing ice accretions that are clear or that occur during night operations may be mitigated during cruise because the pilot workload is low during this phase of flight so there is more attention available to observe the aircraft. Also, there are indications of ice accretion during cruise other than visual cues, such as trim changes and drag increases.

Due to the absence of accidents where the flightcrew is unaware of ice accretions during cruise and because of factors which mitigate the difficulties of observing ice accretions that are clear or during night operations, the FAA does not concur that operation of the IPS during cruise based on icing conditions is warranted.

ALPA ISSUE: Flightcrew workload relief during cruise

FAA Response: It is the FAA's position that the proposed requirement to operate the IPS during cruise based on the observation of ice accretions does not create an unacceptable burden on the flightcrew. The FAA concurs with the ALPA position that their proposed change to require activation of the IPS during cruise based on operation in icing conditions would create a additional workload and automatic cycling to relieve the flightcrew workload would be necessary. The FAA has previously explained why it is not warranted to require activation based on icing conditions. Therefore, this response will only address the issue of workload associated with the activation of the IPS based on the first sign of ice accretion.

The Majority response, above, addresses the acceptability of the workload. The FAA concurs with the following Majority statements, "The cruise phase of flight typically has limited exposure to actual airframe icing due to the limited horizontal extent of icing clouds. In the FAA Technical Report DOT/FAA/CT-88/8-1 Aircraft Icing Handbook (March 1991), Figure 1-32, 90 percent of all icing clouds will have a horizontal extent of less than 50 statute miles. Typical part 121 turboprop aircraft have cruise speeds on the order of 275 to 300 KTAS. Based on these figures, 90 percent of the icing clouds will be transited on the order of 9 minutes. Based on the proposed guidance of a 3-minute maximum time interval, the crew workload would typically consist of four manual activation cycles during the cruise phase of flight." Four cycles would not be considered an undue burden on the flightcrew.

Flightcrews may be required to hold in icing for periods up to 45 minutes. In this case the flightcrew would have to operate the deicing boots numerous times. However, the operators of many airplanes that would be affected by this proposed rule are already operating the deicing boots based on the first sign of ice accretions and cycling the boots to minimize ice accretions. This method of operation was mandated through ADs in 1999 and 2000. The FAA is unaware of any crew workload issues related to these ADs, so we would not anticipate workload issues to arise from similar requirements contained in this proposed rule.

6. Technology

To ensure that viable means exist for compliance with any proposed methods of addressing the safety concerns, the ARAC IPHWG reviewed the current state of technology with regard to ice detectors and aerodynamic performance monitors.

Ice detector technology is sufficiently mature that there currently are available several methods that can reliably alert the flightcrew as to when the IPS should be activated. This type of technology already has been certificated on various airplanes as either an advisory or a primary means of determining when the IPS should be activated. However, an ice detection system with the capability to alert the flightcrew when to exit icing conditions would have to be able to detect when:

a. The icing conditions encountered exceed the criteria to which the airplane was certificated; or

b. The ice is accreting on surfaces of the airplane where it could prove hazardous and that were not addressed in the airplane's icing certification.

Some ice detection systems currently installed on airplanes have the capability to detect and alert the flightcrew that ice is accreting on sensor elements of the detector. Depending upon the intended application of these detectors, ice accretions of approximately 0.1 mm to 1 mm and larger are detectable. However, these detectors have not been proven to operationally perform either of the functions identified in paragraphs a. and b. above.

Due to the unproven capabilities of ice detectors for the above application and the immature development of aerodynamic performance monitors, the ARAC IPHWG considered additional means for the flightcrew to know when they should exit icing conditions.

There is an accident and incident history caused by the uncommanded deflections of reversible flight controls in both pitch and roll axes in icing conditions. These uncommanded deflections were the result of ice accreting ahead of the control surfaces, either aft of the protected area or on the protected area when the IPS was not activated. This resulted in airflow separation over a control surface. Such a flow separation changes the pressure distribution on the control surface. The resulting control force change may be quite large, with significant difficulty for the flightcrew to manage. In some cases, control of the airplane may not be regained.

In the database there is no history of accidents or incidents due to uncommanded rudder deflections caused by icing. Normal operation of the airplane does not expose the vertical stabilizer to high sideslip angles (angles of attack) that could cause the vertical tail to stall and result in uncommanded movement of the rudder; there is a large stall margin for the vertical tail. Due to engine inoperative and crosswind landing requirements, the rudder is designed for operation at high sideslip angles without force reversal. The ARAC IPHWG found no grounds for including the yaw axis in the proposed rule.

For irreversible flight controls, the control surface actuators are sized to maintain the control surface in its commanded position throughout the airplane's flight envelope, including high-speed dive. This results in the design loads for the actuators being larger than the loads induced by flow separation caused by ice accretions aft of the airplane's protected areas. Therefore, airplanes with irreversible flight controls are not subject to uncommanded control surface deflection caused by ice accretions.

It is feasible for the current ice detector technology to identify the existence of ice aft of the protected areas. Based on the accident and incident history and the current state of ice detector technology, the ARAC IPHWG recommends that the regulations be revised. The revised regulations would address the known safety concern of ice accumulations aft of the airframe's protected areas on airplanes with reversible flight controls in the pitch or roll axis.

The ARAC IPHWG also acknowledged that, in lieu of an ice detector, it might be possible to use the flightcrew's observation of ice accretion on reference surfaces, provided that the visual cues are substantiated for the specific airplane.

The relevant icing accidents and incidents occurred on airplanes equipped with pneumatic deicing boots. However, the accumulation of ice aft of the protected areas due to large droplet icing conditions can occur on any airplane, regardless of the type of IPS installed on it. Therefore, the ARAC IPHWG maintained that any revision to the current regulations should be applicable regardless of the type of IPS.

Definition of Terms

For the purposes of this proposed rule, the following definitions are applicable. These definitions of terms are intended for use only with this rule.

a. Advisory ice detection system: An advisory system annunciates the presence of ice accretion or icing conditions. The flightcrew is responsible for monitoring the ice accretion or icing conditions as defined in the AFM, typically using total air temperature and visible moisture criteria, visible ice accretion, or specific airframe ice accretion thickness, and activation by the flightcrew of the anti-icing or de-icing system(s) is necessary. The advisory system provides information to advise the flightcrew of the presence of ice accretion or icing conditions but it can only be used in conjunction with other means to determine the need for, or timing of, anti-icing or de-icing system activation.

b. Airframe icing: Ice accretions on portions of the airplane on which supercooled liquid droplets may impinge, with the exception of the propulsion system.

c. Anti-Icing: The prevention of ice formation or accumulation on a protected surface, by:

- evaporating the impinging water, or
- allowing it to run back and off the surface, or
- allowing it to run back and freeze on non-critical areas.

d. Automatic cycling mode: A mode of airframe de-icing system operation that provides repetitive cycles of the system without pilot selection of each cycle. This is generally done with a timer and there may be more than one timing mode.

e. Conditions conducive to airframe icing: Visible moisture at or below a static air temperature of +2? C, unless otherwise substantiated.

f. Deicing: Removal or the process of removal of an ice accretion after it has formed on a surface.

g. Irreversible flight controls: All of the force required to move the pitch, roll, or yaw control surfaces is provided by hydraulic or electric actuators, the motion of which is controlled by signals from the flight deck controls. Loads generated at the control surfaces themselves are reacted against the actuator and its mounting and cannot be transmitted directly back to the flight deck controls.

h. Large dropletconditions conducive to ice accumulation aft of the airframe's protected area: Conditions containing a population of supercooled droplets sufficiently larger than those provided for in 14 CFR part 25 appendix C to cause ice accretions aft of the protected areas. The accumulation mechanism aft of the protected surface may be by direct impingement and accretion or delayed freezing of large droplets that impinge further forward. These conditions may be aircraft dependent as a consequence of airfoil geometry and limits of protected areas.

i. Monitored Surface: The surface of concern regarding ice hazard (for example, the leading edge of the wing).

j.Primary ice detection system: The means used to determine when the IPS must be activated. The system annunciates the presence of ice accretion or icing conditions and may also provide information to other aircraft systems. A primary automatic system automatically activates anti-icing or de-icing systems. With a primary manual system, the flightcrew activates the IPS upon indication from the system.

k. Reference Surface: The surface where an ice detection sensor is located or where a visual cue is located remotely from the surface of concern regarding ice hazard (for example, a propeller spinner).

l. Reversible flight controls: The flight deck controls are connected to the pitch, roll, or yaw control surfaces by direct mechanical linkages, cables, or push-pull rods, such that pilot effort produces motion or force about the hinge line. Conversely, force or motion originating at the control surface (through aerodynamic loads, static imbalance, or trim tab inputs, for example) is transmitted back to flight deck controls.

1. Aerodynamically boosted flight controls: Reversible flight control systems that employ a movable tab on the trailing edge of the main control surface linked to the pilot's controls or to the structure in such a way as to produce aerodynamic forces that move, or help to move, the surface. Among the various forms are flying tabs, geared or servo tabs, and spring tabs.

2. Power-assisted flight controls: Reversible flight control systems in which some means is provided, usually a hydraulic actuator, to apply force to a control surface

in addition to that supplied by the pilot to enable large surface deflections to be obtained at high speeds.

m. Static air temperature: The air temperature as would be measured by a temperature sensor not in motion with respect to that air. This temperature is also referred to in other documents as "outside air temperature," "true outside temperature," or "ambient temperature."

n. Substantiated visual cues: Ice accretion on a reference surface identified in the AFM, which is observable by the flightcrew. Visual cues used to identify appendix C ice will differ from those used to identify large droplet ice.

Discussion of the Proposed Rule

The FAA has reviewed and accepted the recommendations that were developed by the IPHWG and were approved by ARAC. The FAA proposes to amend the current part 121 regulations in the following two areas:

1. Activation of IPS

The proposed rule addresses the possibility of the flightcrew failing to recognize that the airframe ice protection procedures should be initiated. The proposed rule would be applicable to airplanes that have a maximum certified takeoff weight less than 60,000 pounds. As discussed previously in the Discussion section of this preamble, airplanes with takeoff weights less than 60,000 pounds typically have wing chord lengths of the size that have been involved in relevant icing-related accidents and incidents. The proposed rule would require:

- A primary ice detection system and initiation of any other procedures for operating in icing conditions specified in the AFM; or

- Both substantiated visual cues and an advisory ice detection system, either of which enable the flightcrew to determine that the ice protection system must be activated, and initiation of any other procedures for operating in icing conditions specified in the AFM; or
- That during climb, holding, maneuvering for approach and landing, and any other operation at approach or holding airspeeds, when in conditions conducive to airframe icing, the IPS must be activated and the approved procedures for operating in airframe icing conditions must be initiated, and
- That during any other phase of flight, the IPS must be activated and operated at the first sign of ice formation anywhere on the aircraft, except where the AFM specifies that the IPS should not be used.

Each of these methods provides a clear means for addressing the safety concern of when the IPS must be activated.

2. <u>Indication of Ice Accumulation Aft of the Airframe's Protected Areas</u>

The proposed rule addresses the possibility of ice accumulations on the airplane that could lead to hazardous operating conditions if the airplane is allowed to stay in icing conditions. For the same reason stated above, the proposed rule would be applicable to airplanes that have a maximum certified take-off weight less than 60,000 pounds. Further, the rule would be limited to airplanes equipped with reversible flight controls in the pitch or roll axis because these aircraft can be subject to uncommanded control surface deflections caused by ice accretions. The proposed rule would require that:

- Visual cues must be substantiated that enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or
- The airplane must be equipped with a caution level alert and its associated visual or aural means to alert the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.

These proposed requirements address the known problem of large droplet ice accretions aft of protected surfaces causing uncommanded pitch or roll control surface deflection that may result in loss of control of the airplane.

The determination that the airplane is operating in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas could be based on:

- A <u>direct</u> measurement of ice accumulations on the airframe, or
- An <u>indirect</u> measurement of supercooled liquid droplet diameters, or
- Visual observation of ice accumulations on the airframe.

The intent of the proposed rule is to detect when the airplane is experiencing these icing conditions. Therefore, "forecast icing conditions" are not to be considered when complying with this proposed rule.

Direct measurement could be a surface-mounted ice detector located aft of the protected areas that detects the presence of ice. Indirect measurement could be a device that is remotely located and the detection of icing conditions at the device's location can be correlated to the presence of ice on the airfoil surface. Direct observation of ice accretion on substantiated locations on the airframe can be an acceptable means of compliance.

The proposed rule would require that the pilot in command must take action to immediately exit the conditions upon determining that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas unless, in the opinion of the pilot in command, it is necessary to delay such action in the interest of safety.

Airworthiness Directives: The requirements proposed in this NPRM to some extent overlap and duplicate existing requirements in certain ADs. Those ADs require revisions to AFMs for certain airplanes to provide information and instructions to pilots for operating in icing conditions. Similarly, this proposed rule would require AFM revisions to provide information for operating in icing conditions for these same airplanes, among others. The information required by this proposal would be more detailed and specific to the individual airplane models than the information required by the ADs. Once this rule is adopted, the FAA will consider revising the ADs to eliminate requirements for information that is no longer needed.

Level of Approval

The modifications to airplanes that would be necessary to comply with the proposed rule would likely be complex and would require thorough testing and analysis to ensure that they perform their intended function when installed on the airplane. Therefore, the FAA proposes that the modifications and AFM procedures used to comply with this regulation would be required to be approved through an amended or supplemental type certificate in accordance with 14 CFR part 21. As discussed in FAA Order 8110.4B ("Type Certification"), an amended type certificate might not involve a physical alteration to the type certificate for some type design changes.

The proposed rule is not intended to disapprove an existing icing certification. Therefore, it is not necessary to re-certificate an airplane for flight in icing.

In the process of obtaining the amended or supplemental type certificate, the pertinent rules that apply to any modification are contained in § 23.1301 and § 25.1301 ("Equipment -- Function and installation"). Paragraph (a) of these rules requires that the equipment, "Be of a kind and design appropriate to its intended function." The applicant would be required to show that the modifications necessary for compliance with this proposed rule meet the "intended function" of the part 121 rule. This is consistent with the FAA's practice of compliance findings for the digital flight data recorder requirements of § 121.343 (Amendment No. 121-238).

Compliance

The notice proposes a two-year compliance time from the effective date of the final rule. The compliance time is based on the time required to certificate and install new equipment. For some airplanes it may be possible to comply with the rule through AFM revisions which could be accomplished quickly. However, it may be necessary for some airplanes to go through a more involved certification process so the longer compliance time of two years was chosen.

Reasons for Proposing a Part 121 Operations Rule

Part 121 covers all scheduled operations of airplanes with ten or more passenger seats and scheduled operations of all turbojets regardless of size. In addition, the "hub and spoke" route network of the U.S. air traffic system can concentrate large numbers of part 121 operations within a single weather system. With occasional exceptions under § 121.590, part 121 operators are constrained to use only airports certificated under 14 CFR part 139. A given part 121 operator is generally further constrained to only those part 139 airports listed in its Operations Specifications. The flightcrews of part 121 operators generally do not carry approach charts for airports not listed in their Operations Specifications. During busy traffic periods, lengthy vectoring or holding for landing sequencing is common at these airports. When this vectoring results in exposure to undesirable conditions such as icing, the flightcrews' options (except in case of emergency) are generally limited to tolerating the exposure or diverting to a pre-planned part 139 alternate airport listed in their Operations Specifications.

Consideration was also given to 14 CFR part 91 and part 135 operations. Most aircraft operated under part 91 and part 135 have been subjected to ADs discussed above regarding activation of their de-icing boots at first signs of accretion and also regarding exiting icing in severe icing environments. These ADs were proposed for all aircraft with pneumatic de-icing boots that are certified for known icing operations. The proposed ADs regarding boot activation resulted in an FAA review of operating procedures and certification basis on the affected aircraft. The severe icing ADs provide generic visual cues that can provide a means to identify conditions conducive to ice accumulations aft of protected areas and require exiting the conditions upon detection. As a result of this aircraft review and/or application of ADs, a level of safety relative to initial ice accretions and severe icing environments has been established. These procedures are relatively recent and the full impact of these safety improvements is not reflected in the reviewed event database.

In addition, part 91 and part 135 operators are not constrained to part 139 airports, and in fact, often avoid them in the first place due to the factors discussed above. Even when they plan to use them, they are free to divert to any suitable airport in the given terminal area, of which there are often several. Consequently, part 91 and part 135 operators often operate in lower air traffic density that results in fewer holding delays and significantly more routing options in icing conditions. Under part 91 the tactical flexibility increases even more due to the inclusion of many small-scale general aviation aircraft.

Moreover, part 91 and part 135 aircraft are typically smaller-scale aircraft than those operated under part 121. This smaller scale provides easier monitoring of ice accretions, estimation of ice thickness, and identification of severe icing cues.

The level of safety provided by the combination of the ADs, the recent review of the operating procedures, the ability to more readily evaluate ice accretions, and tactical flexibility provide a comparable level of safety to other part 91 and part 135 operational requirements. The proposed part 121 rule change will enhance the level of safety to the segment of the traveling public that has the greatest exposure and subsequent risk associated with flight in icing. Therefore, the ARAC IPHWG believes that a part 91 and part 135 rule is not required.

Applicability to Part 23 and Part 25 Airplanes

The icing accident and incident database developed by the ARAC IPHWG showed that all the relevant accidents and incidents occurred on aircraft with wing chord lengths less than 10 feet. Based on this finding, the FAA has proposed a part 121 rule that is applicable to airplanes with a maximum certified takeoff weight of less than 60,000 pounds. Since the proposed rule addresses the safety concerns of flight in icing for smaller aircraft (i.e., maximum takeoff weight less than 60,000 pounds), the FAA proposes that the rule be applicable to both part 23 and part 25 airplanes that are operated under part 121.

Applicable Airplane Models Eligible for Operation under 14 CFR Part 121

The following is a list of currently certificated part 23 and part 25 airplanes under 60,000 pounds, equipped with reversible flight controls in the pitch or roll axis. Inclusion in this list does not necessarily mean the airplane is used in part 121 operations, however.

- Aerospace Technologies of Australia Models N22B and N24A.
- Aerospatiale ModelsATR-42 and ATR-72 series.
- Beech Model 99, 200, and 1900 series.
- British Aerospace Model HS 748 series.
- CASA Models C-212 and CN-235 series.
- Cessna Models 500, 501, 550/560 series, and 650 series.
- de Havilland Models DHC-6, DHC-7, and DHC-8 series.
- Dornier Models 228, 328-100 and 328-300.
- EMBRAER Models EMB-110O1, EMB-110P2, and EMB-120 series.
- Fairchild Models F27 and FH227 series.
- Fairchild Aircraft Models SA226 and SA227 series.
- Fokker Model F27 Mark 100, 200, 300, 400, 500, 600, 700, and 050 series.
- Frakes Aviation Model G-73 (Mallard) and G-73T series.
- Gulfstream Aerospace Model G-159 series.
- Harbin Aircraft Mfg. Corporation Model Y12 IV.
- Jetstream Models 3101/3201, BAe ATP, and 4101.
- Lear models

- Lockheed Models L-14 and L-18 series.
- McDonnell Douglas Models DC-3 and DC-4 series.
- Mitsubishi Heavy Industires Model YS-11 and YS-11A series.
- Pilatus Britten-Norman Ltd. Models BN-2A, BN-2B, and BN-2T.
- Raytheon Aircraft Company (formerly known as Beech Aircraft Corporation) Models 100 series, 200 series, 300 series, B300 series, 400A, Hawker 800 and 1000.
- Reims F406
- Saab 340 series and SAAB 2000.
- Sabreliner Corporation Models 40, 60, 70, and 80 series.
- Short Brothers Models SD3-30, SD3-60, and SD3-SHERPA series.
- SIAI-Marchetti S.r.I (Augusta) Models SF600 and SF600A.

FAA Advisory Material

In addition to the amendment proposed in this notice, the FAA has developed an Advisory Circular (AC) that provides guidance as to acceptable means of demonstrating compliance with this proposed rule. Comments on the proposed AC are requested by separate notice published elsewhere in this issue of the Federal Register.

Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. We have determined that there are no new information collection requirements associated with this proposed rule.

International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to comply with International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA determined that there are no ICAO Standards and Recommended Practices that correspond to these proposed regulations.

Economic Evaluation, Regulatory Flexibility Determination, Trade Impact Assessment, and Unfunded Mandates Assessment

Proposed changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency propose or adopt a regulation only upon a determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (19 U.S.C. section 2531-2533) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, this Trade Act requires agencies to consider international standards and, where appropriate, use them as the basis of U.S. standards. And fourth, the Unfunded Mandates Reform Act of 1995 (Public Law 104-4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local or tribal governments, in the aggregate, or by the private sector, of $100 million or more annually (adjusted for inflation). In conducting these analyses, FAA has determined that this proposed rulemaking: (1) would generate benefits that justify its costs and would not impose costs sufficient to be considered "significant" under the economic standards for significance under Executive Order 12866 or under DOT's Regulatory Policies and Procedures, however, due to public interest and safety, it is considered significant under the Executive Order and DOT policy; (2) would have a significant impact on a substantial number of small entities; (3) would not create obstacles to foreign commerce for the U.S.; and (4) would not impose an unfunded mandate on State, local, or tribal governments, or on the private sector. These analyses, available in the docket, are summarized as follows.

Analyses Summaries

This proposal would amend the regulations applicable to operators of airplanes, with a maximum take-off weight (MTOW) of less than 60,000 pounds, used in 14 CFR part 121 air carrier service. The proposal would require either the installation of ice detection equipment or changes to the Airplane Flight Manual to ensure timely activation of the ice protection system. This proposal also would specify when airplanes with reversible flight controls for the pitch and/or roll axis should exit conditions conducive to airframe icing. This proposed regulation is the result of information gathered from a review of icing accidents and incidents, and it is intended to improve the level of safety when airplanes are operated in icing conditions.

The rulemaking proposal contained in this notice is based on a recommendation developed by the Ice Protection Harmonization Working Group (IPHWG) of the Aviation Rulemaking Advisory Committee (ARAC). There is ongoing ARAC activity on additional icing related rules, which the FAA anticipates would result in proposals for rulemaking.

In addition, this proposed rule is responsive to NTSB recommendation A-96-56, which is on the NTSB's Most Wanted List. The proposed rule is also one of the items listed in the FAA's In-flight Icing Plan, April 1997. The Icing Plan details the FAA's plans for improving the safety of airplanes when they are operating in icing conditions. Neither the operating nor the certification regulations require a means for the pilot in command to specifically identify when hazardous icing conditions are encountered.

In the absence of a new rule, it is likely that future, ice accretion related incidents on airplanes with a MTOW under 60,000 pounds, operating during the cruise, holding or landing phase of flight, would occur. A key benefit of the proposed rule would be avoidance of these accidents.

A. Benefit Summary

Since 1985, 14 CFR part 121 passenger-carrying air operators have had 7 accidents which may have been prevented if this proposed rule had been in effect. These accidents resulted in 99 fatalities, 2 serious injuries, and 15 minor injuries. In addition, all of the airplanes involved in the accidents were either destroyed or received substantial damage. These accidents all occurred in small (under 60,000 pound MTOW) 14 CFR part 121 airplanes addressed by this proposed rule. In addition, 8 icing-related incidents were found that the FAA notes had the potential of resulting in accidents; however, the FAA assigns no quantitative benefits to these icing-related incidents due to the lack of airplane-damage detail available. The data includes accidents and incidents that occurred under part 135 operations. They are considered as relevant to this proposed part 121 rule because under today's regulations those part 135 operations would be classified as part 121 operations.

The FAA is aware of accidents and incidents in icing conditions occurring prior to 1985, but due to the unavailability of detailed information reported, the FAA did not include these in the analysis.

Icing related accidents during the cruise, holding and landing phase of flight have also occurred in Australia, Canada, Greenland, Iceland, Italy, Kazakhstan, Russia, Sweden and the United Kingdom.

In order to quantify future benefits, the FAA calculated the costs of a future averted accident as a result of this proposed rule. The economic value assigned to these losses is now specified. The FAA sets the value of a statistical aviation fatality avoided at $3.0 million, that of a serious injury (assumed to be the average of a severe, serious, and moderate injury) at $260,500, and that of a minor injury at $6,000. The associated medical and legal costs for a fatality is $132,700, a serious injury (assumed to be the average of a severe, serious, and moderate injury) $46,633, and that of a minor injury, $2,500. In addition, the average replacement costs of a destroyed airplane totaled $3.84 million and an NTSB accident investigation costs about $1.4 million. The number of fatalities, serious injuries and minor injuries represents the average number of such casualties in the 7 accidents. The FAA estimates the average value for avoiding an icing related accident is $49.5 million.

The following methodology is presented to substantiate the basis for increasing value of preventing icing related accidents that could occur over the 2007 through 2026 timeframe in the absence of the proposed rule:

Based on the casualty losses, five separate accident and casualty rates were estimated. These accident and casualty rates were estimated by dividing the total losses per category over the 1985 through 2001 period by the number of air carrier operations over that same time period.

These rates were adjusted for changes in airplane size over the 2007 through 2026 analysis period. For example, the average number of seats on an air operator for the 1985 through 2001 period is 27 (U.S. DOT 298c Commuter). In 2007, the FAA estimates the average number of seats will be 39, approximately a 44 [(39/27)-1] percent increase. Subsequently, the number of potential casualties will increase by 44 percent as well.

The historical accident and casualty rates per million operations were multiplied by the annual number of projected operations from 2007 through 2026, and then adjusted by the percent change in the average number of seats in an air carrier for that year.

After totaling the number of accidents and casualties over the 2007 through 2026 period, the FAA applied the critical analysis values from steps one through four to determine the total potential benefits of the proposed rule.

In the absence of the proposed rule, and due to growth in airplane operations, the FAA expects that over the 2007 through 2026 analysis period, approximately 8 accidents would occur. These accidents are expected to result in approximately 169 fatalities, 3 serious injuries, and 26 minor injuries.

The accident-rate assumptions must account for the effects of recent Airworthiness Directives (AD) against affected models, because the FAA does not accept that this icing rule, by itself, will prevent all 8 future accidents. In 1996, ADs were issued for airplanes with unpowered controls and pneumatic de-icing boots. In 1999, a second series of ADs were issued for airplanes with pneumatic de-icing boots to activate the systems at the first sign of ice accretion. These two ADs accomplish much the same objectives as the proposed 14 CFR part 121 rule.

The 1996 severe-icing directives require that operating manuals provide pilots with instructions for operating in freezing rain and freezing drizzle, provide cues to identify such conditions, and offer instructions on how to exit the conditions. These requirements are similar to the proposed rule in sections (c) and (d). The major differences between the 1996 directives and the proposed rule are in the added requirement to substantiate the large droplet icing cues, and the provision of an alternate option to install a caution-level alert to provide the required indication.

A second set of ADs were issued in 1999 requiring activation of the IPS at the first sign of ice accretion anywhere on the airplane or upon annunciation of an ice detection system. The system is to operate on automatic mode if available or by manually cycling to minimize ice accretions on the airframe. This directive accomplishes much of what the proposed rule sections (a) and (b) would achieve. The main difference between the 1999 ADs and the proposed rule is that the proposed rule would require a more conservative activation cue(temperature and visible moisture) and that the visual cues used in combination with an advisory ice detection would require validation (or re-validation).

The ADs were issued to establish an increased level of safety with respect to initiating activation of the IPS and providing cues to determine when large droplet icing conditions have been encountered. The benefits analysis considers accidents and incidents that occurred prior to the issuance of the ADs. In fact, it was the findings from the two major accidents (1994 Simmons Airlines ATR-72 and 1997 Comair EMB-120) that prompted the ADs.

Due to the similarity of requirements, it appears reasonable to assume that the ADs have accomplished a substantial portion of the safety increase attributed to the proposed rule within the benefits analysis. The ARAC IPHWG, with FAA concurrence, finds that it is reasonable to assume that the ADs have already accomplished 50 percent of the safety benefit attributed to the proposed rule in the analysis. This difference would indicate that the actual safety benefit of the proposed rule is on the order of 50 percent of the present values due to the effectiveness of the ADs. Therefore the benefits of preventing future accidents have been reduced by 50 percent.

The present value (2002 dollars) benefits of preventing these 8 future accidents and casualties are estimated at $213.24 million. Assuming that that the actual safety benefit of the proposed rule is on the order of 50 percent of the present values due to the effectiveness of the ADs, the present value (2002 dollars) benefits of preventing these accidents and casualties are estimated at $106.6 million.

B. <u>Cost Summary</u>

1. The proposed rule consists of two parts:

(a) Sections (a), (b), (e) and (f) that affect all 14 CFR part 121 operated airplanes with a MTOW of less than 60,000 pounds. These sections will mandate when the pilot is to activate the IPSs.

(b) Sections (c), (d), (e), and (f) that affect all 14 CFR part 121 operated airplanes with a MTOW of less than 60,000 pounds and equipped with reversible flight controls in the pitch and/or roll axis. These sections will mandate when the pilot is to exit icing conditions.

2. Three elements drive the overall cost estimate. They are:

(a) the costs per airplane to the operators required to implement sections (a), (b),(e), and (f) of this proposed rule;

(b) the costs per airplane to the operators required to implement sections (c), (d), (e), and (f) of this proposed rule;

(c) the estimate of the number of affected airplanes; including a snapshot of the current active fleet, a forecast of airplanes affected by the proposed rule entering the fleet, and a forecast of the retired affected airplanes during the 20-year analysis period.

3. The basis on which each element was estimated follows. All costs, discussed in the following estimates, are based in 2002 dollars and the discount factor is 7 percent, as mandated by the Office of Management and Budget. The FAA analyzed the costs and benefits of this proposed rule over the 20-year period from 2007 through 2026.

In order to estimate the potential costs of the proposed rule, the FAA has made the following assumptions:

(a) The proposed rule will become a final rule in 2005 allowing the operators 24 months to comply. The first year the final rule imposes costs on the operators will be

2007.

(b) The FAA used a $60.00 hourly rate for a mechanic/technician working for an airplane manufacturer or modifier and a $100.00 hourly rate for an engineer working for an airplane manufacturer or modifier.

(c) In this analysis, operators would pay for the indirect non-recurring costs that would be incurred first by manufacturers. These indirect non-recurring costs are distributed equally across each airplane in each airplane model group addressed by the proposed rule. The indirect non-recurring costs are one-time costs incurred within 24 months after the proposed rule becomes final.

(d) The FAA assumed whenever various compliance options are available to the operators, the minimal cost option would always be chosen.

(e) The proposed rule may result in airplane diversions from scheduled and non-scheduled operations, however, the costs of the diversions have not been included in the regulatory evaluation because reliable data is not available for predicting the number of diversions that would precipitate.

Each U.S. certificated operator would be required to provide training for pilots and copilots of airplanes involved with new equipment or procedures mandated by the proposed rule. The training costs estimated are one time fees incurred in the first year the proposed rule becomes effective.

The FAA considered the potential fuel burn cost from the added weight of the caution level alert system. According to the ARAC IPHWG, the weight is minimal and will have limited impact on additional fuel burn and the cost of operating an airplane.

The FAA also considered whether the installation of the caution-level alert system could be accomplished during scheduled maintenance A and C checks. If not, then downtime costs for the airplane would need to be added. From the Fleet PC™ database, turboprop hours were analyzed. The average hours flown per year of the average affected turboprop is 2,278. The ARAC IPHWG provided that C checks are performed on these turboprops every 4,000 hours. Since a typical turboprop would be ready for a C check every 1.75 years and it will take approximately 1 year to certificate the system, the installation of the caution-level alert system could not be accomplished during scheduled maintenance C checks before the end of the compliance time for the proposed rule. According to the ARAC IPHWG, the installation will take 3 days with an associated loss of profit of $5000.00/day/airplane.

To estimate the number of affected airplanes, the FAA analyzed the following information: the current active fleet of airplanes, a forecast of airplanes affected by the proposed rule entering the fleet, and a forecast of the affected airplanes to be retired from the existing fleet during the 20-year analysis period.

A list of all U.S. operated civilian airplanes operating under 14 CFR part 121 was generated by the FAA office of Flight Standards. Each listed airplane was matched with its current (as of January 6, 2002) MTOW and age through the use of the FleetPC™ database.

All airplanes with a MTOW greater than 60,000 pounds were eliminated, leaving 1,735 airplanes in the active fleet to be subject to the proposed rule.

The FAA used the Fleet PC™ database to determine that turboprops are retired from U.S. certificated 14 CFR part 121 service at an average age (mean) of 23.8 years with a standard deviation of 7.43 years. When the FAA computed costs for airplanes affected by the proposed rule, turboprops were retired from the active fleet if their age exceeded 23.8 years. The FAA conservatively assumed that turboprop airplanes close to 23.8 years old would be retrofitted to comply with the proposed rule and remain in active service. The FAA assumed that all the commercial and corporate turbojet airplanes would stay active during the 20-year analysis period.

At the end of the 20-year analysis period, 2026, the FAA assumed a total of 1,131 turboprops would be retired from part 121 service. Sensitivity studies were conducted with regard to the average age of retirement. If the retirement age were 30 years, instead of the base case 23.8 years used to calculate costs, then the discounted costs (2002 dollars) would increase by 3.2 percent or $2.4 million. If the retirement age were 60 years, instead of the base case 23.8 years, then the discounted costs would increase by 13.9 percent or $11.5 million dollars.

The ARAC IPHWG is working on a 14 CFR part 25 rulemaking where the costs would be incurred by the manufacturers. However, until that rulemaking is complete the operator is responsible for new airplane deliveries to be compliant with this proposed 14 CFR part 121 rule. The costs for making these new airplane deliveries compliant with the proposed rule were incorporated into the operators cost in this analysis.

At the time of this writing, German airplane maker Fairchild-Dornier filed for insolvency but is currently looking for a strategic investor to continue production. The FAA retained future forecasted Fairchild-Dornier airplanes in its analysis of costs for this proposed rulemaking.

The FAA, using ARAC IPHWG costs, estimates that the total undiscounted cost of making future airplane deliveries compliant with the proposed 14 CFR part 121 rulemaking, from 2002 through 2026, is estimated to be $14.7 million. The discounted present value (2002 dollars) of this cost over the analysis period is $8.0 million.

In order to comply with the proposed rule, the FAA needed the following details, provided by the ARAC IPHWG, for the benefit/cost analysis of the proposed rule. The information provided was used to determine if an airplane has reversible or irreversible flight controls, a primary or advisory ice detection system installed, substantiated visual cues when entering large-droplet-icing conditions, or a caution level alert (Large Droplet Alert) system installed. The FAA, using ARAC IPHWG costs, estimates that the total non-discounted cost of the proposed rule, from 2007 through 2026, is estimated to be $107.0 million. The discounted present value (2002 dollars) of this cost over the 20-year analysis period is $70.2 million. Approximately $58.0 million, representing 82.6 percent of the total discounted present value (2002 dollars) cost, would occur in 2007.

C. Cost Benefit Summary

The crash of American Eagle's Flight 4184 resulted in the deaths of the captain, first office, 2 flight attendants and 64 passengers. In two other icing related accidents from 1985 to 2001, 31 people died. As recently as March 2001, an Embraer-120 operating as Comair Flight 5054 from Nassau, Bahamas, to Orlando, Florida, experienced an upset event after encountering icing conditions.

In the absence of this proposed rule, it is highly likely that future icing-related accidents will occur. This industry group study expects on average 8 accidents over the 20-year analysis period could be prevented by the enactment of this proposed rule and ADs. The benefit of the proposed rule would be avoiding these accidents. The discounted present value (2002 dollars) benefits of the proposed rule are estimated to be $113.02 million over the 20-year analysis period. These benefits are derived from preventing accidents due to reduced risk of airframe icing. The FAA seeks comment with supportive justification of these benefit estimates.

It is estimated that over the 20-year analysis period, the discounted present value (2002 dollars) cost of the proposed rule is $70.2 million. This includes the cost of ice detection systems design, qualification, certification, crew training, equipment purchase and installation, and testing. The FAA seeks comment with supportive justification on these cost estimates.

The estimated $113.02 million benefits of this proposed rule exceeds the estimated $70.2 million costs. The FAA accepts the ARAC IPHWG's recommendations and concludes that the benefits of the proposed rule do justify the costs of the proposed 14 CFR part 121 rule.

Regulatory Flexibility Determination

A. Introduction and Purpose of This Analysis

The Regulatory Flexibility Act (RFA) of 1980 establishes "...as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation." To achieve that principle, the RFA requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The RFA covers a wide range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule will have a "significant economic impact on a substantial number of small entities." If the determination finds that it will, the agency must prepare a regulatory flexibility analysis, as described in the RFA.

The FAA finds that this proposal would result in a significant economic impact on a substantial number of small entities. This analysis provides the reasoning underlying the FAA determination.

Under Section 63(b) of the RFA, the analysis must include:

(1) A description of the reasons why action by the agency is being proposed.

(2) A statement of the legal basis and objectives for the proposed rule.

(3) A description of the projected recordkeeping and other compliance requirements of the proposed rule.

(4) An identification, to the extent practicable, of all federal rules that may duplicate, overlap, or conflict with the proposed rule.

(5) A description and an estimate of the number of small entities to which the proposed rule would apply

(6) An analysis of the small firms' ability to afford the proposed rule.

(7) A disproportionality analysis.

(8) A competitive analysis.

(9) An estimate of the potential for business closures.

(10) A description of the alternatives considered.

B. Reasons Why the Rule Is Being Proposed

On October 31, 1994, an Avions de Transport Regional, Model 72-212 (Aerospatiale Model ATR 72), operated by American Eagle flight 4184, crashed following a rapid descent after an uncommanded roll excursion. Flight 4184 was a regularly scheduled passenger flight operating under 14 CFR part 121; with an instrument flight rules plan on file. The airplane was in a holding pattern and descending to a newly assigned altitude of 8,000 feet when the initial roll excursion occurred. Impact forces destroyed the airplane; the captain, first officer, 2 flight attendants, and 64 passengers received fatal injuries. Flight 4184 was operating in icing conditions, believed to include freezing drizzle droplets, which were reported in the area. The FAA, Aerospatiale, the French Direction Générale de l'Aviation Civile, Bureau Enquete Accident, National Aeronautics and Space Administration (NASA), National Transportation Safety Board (NTSB), and others have conducted an extensive investigation of this accident. The investigators concluded that freezing drizzle conditions created a ridge of ice aft of the deicing boots and forward of the ailerons that resulted in uncommanded roll of the airplane.

An examination of the accident and incident history revealed that the flightcrews must be provided with a clear means to know when to activate the IPS (Ice Protection System). This proposed rule would ensure timely activation of the IPS when the airplane is in icing conditions.

This proposed rule is responsive to NTSB recommendation A-96-56, which is on the NTSB's Most Wanted List. The proposed rule is also one of the items listed in the FAA's Inflight Icing Plan, April 1997. The Icing Plan details the FAA's plans for improving the safety of airplanes when they are operated in icing conditions. Neither the operating regulations, nor the certification regulations require a means for the pilot in command to specifically identify that hazardous icing conditions have been met. The proposed rule would provide a means for the flightcrew to determine that icing conditions must be exited.

The proposed rule specifically applies to 14 CFR part 121 operators of airplanes that have MTOW of less than 60,000 pounds and are certificated for flight in icing. For this section of the analysis, those operators meeting the above criteria that have 1,500 or fewer employees are considered.

C. Statement of the Legal Basis and Objectives

Under Title 49 of the United States Code, the FAA Administrator is required to consider the following matters, among others, as being in the public interest:

Assigning, maintaining, and enhancing safety and security as the highest priorities in air commerce. (See 49 U.S.C. §40101(d)(1).).

Additionally, it is the FAA Administrator's statutory duty to carry out his or her responsibilities 'in a way that best tends to reduce or eliminate the possibility or recurrence of accidents in air transportation.' (See 49 U.S.C. §44701(c).).

Accordingly, this proposed rule will amend Title 14 of the Code of Federal

Regulations to require the operators of airplanes with a MTOW of less than 60,000 pounds, that operate under 14 CFR part 121 regulations, to either install ice detection equipment or change the Airplane Flight Manual to ensure timely activation of the ice protection system. This proposed rule also would require certain actions applicable to airplanes with reversible flight controls for the pitch and/or roll axis.

D. Projected Reporting, Record Keeping and Other Requirements

The FAA expects no more than minimal new reporting and recordkeeping compliant requirements would result from this proposed rule. The proposed rule will require additional entries in existing required maintenance records to account for either the additional maintenance requirements, or the installation of ice detection system and/or caution level alert systems.

Additional reporting and recordkeeping for training also will be no more than minimal because, under 14 CFR 121.419, certificate holders already must provide "training for pilots must include procedures for recognizing and avoiding severe weather situations; escaping from severe weather situations, and operating in or near thunderstorms (including best penetrating altitudes), turbulent air (including clear air turbulence), icing, hail, and other potentially hazardous meteorological conditions."

E. Overlapping, Duplicative, or Conflicting Federal Rules

The FAA is unaware that the proposed rule would conflict with existing regulations. The proposed requirements to some extent overlap and duplicate existing requirements in certain ADs. Those ADs require revisions to Airplane Flight Manuals (AFM) for certain airplanes to provide information and instructions to pilots for operating in icing conditions. The costs attributed to those ADs were the costs associated with revising the AFMs. Similarly, this proposed rule would require AFM revisions to provide information for operating in icing conditions for these same airplanes, among others. The information required by this proposal would be more detailed and specific to the individual airplane models than the information required by the ADs. Once this rule is adopted, the FAA may consider revising the ADs to eliminate requirements for information that is no longer needed.

F. Estimated Number of Small Firms Potentially Impacted

The FAA used the Small Business Association (SBA) guideline of 1,500 employees or less per firm as the criterion for the determination of a small business in commercial air service.

A list of all U.S. operated civilian airplanes operating in 14 CFR part 121 was generated by the FAA office of Flight Standards.

Each listed airplane was matched with its current (as of January 6, 2002) MTOW and age through the use of the FleetPC™ database provided by BACK Aviation Solutions.

All airplanes with a MTOW greater than 60,000 pounds were eliminated from the fleet of 14 CFR part 121 airplanes.

Fleet PC™ had numerous airplanes with no MTOW data. For these airplanes, Janes *All the Worlds Aircraft Publication* was consulted.

Using information provided by the World Aviation Directory Winter 2000, Dunn and Bradstreet's company databases, and SEC filings through the Internet, scheduled and non-scheduled commercial operators that are subsidiary businesses of larger businesses were eliminated from the database. An example of a subsidiary business is Continental Express, Inc., which is a subsidiary of Continental Airlines.

Using information provided by the U.S. Department of Transportation Form 41 filings, the World Aviation Directory Winter 2000, and Dunn and Bradstreet's company databases, all businesses with more than 1,500 employees were eliminated. For the remaining business, the FAA obtained company revenue from these three sources, when the operator-made revenue was public.

The FAA used the FleetPC™ database and determined turboprops are retired from U.S. certificated service at an average age (mean) of 23.8 years with a standard deviation of 7.43 years. The FAA notes the above 87 small business operated 14 CFR part 121 airplanes represent 81 percent of the total number of airplanes the FAA assumed would be retired by 2007.

The methodology discussed above was used to develop a list of 27 U.S. scheduled and nonscheduled commercial operators with less than 1,500 employees, operating a total of 548 airplanes.

G. Cost and affordability for Small Entities

The FAA estimates the cost of compliance per airplane and multiplies this cost by the total fleet of affected airplanes per operator to obtain the total compliance cost by a small entity.

The degree to which small air operator entities can "afford" the cost of compliance is determined by the availability of financial resources. The initial implementation costs of the proposed rule may be financed, paid for using existing company assets, or borrowed. As a proxy for the firm's ability to afford the cost of compliance, the FAA calculated the ratio of the total present value cost of the rule as a percentage of annual revenue. This ratio is a conservative measure as the present value of the 20-year total compliance cost is divided by one year of annual revenue. Twelve of the 27 small business operators potentially affected by this proposed rule would incur costs greater that 2 percent of their annual revenue.

H. Disproportionality Analysis

In the first year of this proposed rule, 74 percent of U.S. passenger small business operators' and 54 percent of the large U.S. commercial passenger business operators' fleets would be affected by the proposed rule. This disproportionately higher impact of the proposed rule on the fleets of small operators result in disproportionately higher cost to small operators. In addition, these costs represent a larger percentage of annual revenue for the small operators than for the large operators. Further, due to the potential of fleet discounts, large operators may be able to negotiate better pricing from outside sources for inspections, installation, and ice protection hardware purchases.

Based on the percent of potentially affected current airplanes over the 20-year analysis period, small U.S. business operators are estimated to bear a disproportionate impact from the proposed rule.

I. Competitive Analysis

In order to determine the competitive impact of the proposed rule on small entities, the FAA studied the routes operated by small business operators. The FAA determined that 15 of the 27 U.S. commercial passenger small business operators operated scheduled services.[1] The route structures and specific markets of these 15 operators were examined. The FAA determined that the 15 operators operated in 391 distinct U.S. markets. As small business operators are compensated by their major code-share partner for code-share routes, 198 of these markets were excluded. In only 20 of the 193 remaining markets, do large operators compete with the 15 small business operators. In 173 of the 193 markets served by the 15 operators, the operators could be considered local monopolies since the affected carriers are the only providers of service. Small business operators have a local monopoly by serving specific needs. As a result of operating in these niche markets, a carrier would be able to pass some of the cost to its passengers. Similarly, the remaining 12 of the 27 operators are likely to provide customized services and would be able to pass some costs to its customers. Thus, as a result of this proposed rule, there is expected to be little change in competition and little change in market share within the industry.

Overall, in terms of competition, this proposed rule does not reduce the ability of small operators to compete.

J. Business Closure Analysis

For commercial operators, the ratio of present-value costs to annual revenue shows that 4 of the 27 U.S. scheduled and nonscheduled commercial small business air operator firms analyzed would have ratios in excess of 5 percent, and such a ratio may have a significant financial impact when this proposed rule becomes effective. To fully assess whether this proposed rule would force a small entity into bankruptcy requires more financial information than is readily available. The FAA seeks comment with supportive justification to determine the degree of hardship the proposed rule will have on these businesses.

K. Analysis of Alternatives

Alternative One

The "baseline," "do nothing," or *status quo* alternativehas no compliance costs but would not accomplish the intent of the NTSB recommendation A-96-56 and the FAA's In-flight Icing Plan. The FAA rejected this "do nothing" alternative because the proposed rule would enhance passenger safety and prevent ice-related accidents for airplanes with a MTOW less than 60,000 pounds. As it stands, the proposed rule is the reasoned result of the FAA Administrator carrying out the FAA's In-flight Aircraft Icing Plan.

Alternative Two

This alternative would issue ADs requiring a means to know when to exit icing conditions and when the IPS must be activated. Airworthiness Directives have been issued for certain airplanes requiring the activation of ice protection systems at the first sign of ice accretion and exiting icing conditions based on subjective visual cues.

The FAA has issued ADs to address the activation of IPS and when to exit icing conditions. The ADs regarding the activation of the IPS relieve the pilot of determining whether the amount of ice accumulated on the wing warrants activation of the IPS. The ADs mandate the activation of the IPS when the pilot becomes aware of ice accretions on the airplane. The ADs regarding exiting icing conditions generally rely on visual cues that are subjective and can result in varying interpretations.

An evaluation of accidents and incidents led to the conclusion that the ADs do not provide adequate assurance that the flightcrew will be made aware of when to activate the IPS or when to exit icing conditions. Because this problem is not unique to particular airplane designs, but exists for all airplanes that are susceptible to the icing hazards described previously, it is appropriate to address this problem through an operational rule, rather than by ADs.

Alternative Three

The working group considered installing an aerodynamic performance monitor to provide a warning to the crew when the aerodynamic performance of the airplane has degraded to the point where the flightcrew should exit icing conditions. The immature development of aerodynamic performance monitors does not make this alternative a viable option.

Alternative Four

Alternative Four is the most viable option. The FAA finds that the proposed rule would increase the safety of the flying public by reducing icing-related accidents in the future in the least costly way.

Trade Impact Assessment

The Trade Agreement Act of 1979 prohibits Federal agencies from engaging in any standards or related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards.

In accordance with the above statute, the FAA has assessed the potential effect of this proposed rule and has determined that the impact is primarily domestic, as these are operators of short-haul market airplanes, and that the purpose of the rule is safety. The FAA considers that this is consistent with the International Trade Act and therefore is not considered an obstacle to international trade.

Unfunded Mandates Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (the Act), enacted as Pub. L. 104-4 on March 22, 1995, requires each Federal agency, to the extent permitted by law, to prepare a written assessment of the effects of any Federal mandate in a final agency rule that may result in the expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more (adjusted annually for inflation) in any one year. Section 204(a) of the Act, 2 U.S.C. 1534(a), requires the Federal agency to develop an effective process to permit timely input by elected officers (or their designees) of State, local, and tribal governments on a proposed "significant intergovernmental mandate." A "significant intergovernmental mandate" under the Act is any provision in a Federal agency regulation that will impose an enforceable duty upon State, local, and tribal governments, in the aggregate, of $100 million (adjusted annually for inflation) in any one year. Section 203 of the Act, 2 U.S.C. 1533, which supplements section 204(a), provides that before establishing any regulatory requirements that might significantly or uniquely affect small governments, the agency shall have developed a plan that, among other things, provides for notice to potentially affected small governments, if any, and for a meaningful and timely opportunity to provide input in the development of regulatory rules. Because this proposed rule does not include a private-sector mandate with a potential cost impact of more than $100 million annually, the analytical requirements of Title II of the Unfunded Mandates Reform Act of 1995 do not apply.

Regulations Affecting Interstate Aviation in Alaska

Section 1205 of the FAA Reauthorization Act of 1996 (110 Stat. 3213) requires the Administrator, when modifying regulations in title 14 of the CFR in manner affecting interstate aviation in Alaska, to consider the extent to which Alaska is not served by transportation modes other than aviation, and to establish such regulatory distinctions as he or she considers appropriate. Because this proposed rule would apply to the certification of future designs of transport category airplanes and their subsequent operation, it could, if adopted, affect interstate aviation in Alaska. The FAA therefore specifically requests comments on whether there is justification for applying the proposed rule differently in interstate operations in Alaska.

Executive Order 13132, Federalism

The FAA has analyzed this proposed rule under the principles and criteria of Executive Order 13132, Federalism. We determined that this action would not have a substantial direct effect on the States, on the relationship between the national Government and the States, or on the distribution of power and responsibilities among the various levels of government. Therefore, we determined that this notice of proposed rulemaking would not have federalism implications.**ARAC Comments on the**

Regulatory Evaluation

Comment by the Regional Airlines Association (RAA)

The regulatory analysis assumes the airplanes affected by this proposed rule will retire at 23.8 years. There are airplanes operating today which are already older than this retirement age. The regulatory analysis should include the cost for these airplanes to comply with the proposed rule.

FAA Response:

The FAA is mandated by law to provide sound economic and statistical analysis on proposed rules. Economists and statisticians accept the airplane retirement methodology used in the regulatory evaluation.

The retirement methodology is based on the central limit theorem and normal distributions. The central limit theorem states that the population will follow a normal distribution if the population is large. The population of airplanes, approximately 2,000, affected by this proposed rule is large enough to apply the central limit theorem.

In a normal distribution one would expect observations that are two and three standard deviations away from the mean. In fact, 95 percent of the observations will be between two standard deviations from the mean in a normal distribution.

Therefore, the existence of some aircraft with operating lives longer than the mean is expected. However, these airplanes are the exception rather than the rule.

Plain Language

In response to the June 1, 1998, Presidential memorandum regarding the use of plain language, the FAA re-examined the writing style currently used in the development of regulations. The memorandum requires federal agencies to communicate clearly with the public. We are interested in your comments on whether the style of this document is clear, and in any other suggestions you might have to improve the clarity of FAA communications that affect you. You can get more information about the Presidential memorandum and the plain language initiative at http://www.plainlanguage.gov.

Environmental Analysis

FAA Order 1050.1D defines FAA actions that may be categorically excluded from preparation of a National Environmental Policy Act (NEPA) environmental impact statement. In accordance with FAA Order 1050.1D, appendix 4, paragraph 4(j), this proposed rulemaking action qualifies for a categorical exclusion.

Energy Impact

The energy impact of the notice has been assessed in accordance with the Energy Policy and Conservation Act (EPCA) Pub. L. 94-163, as amended (42 U.S.C. 6362) and FAA Order 1053.1. It has been determined that the notice is not a major regulatory action under the provisions of the EPCA.

List of Subjects in 14 CFR Part 121

Air carriers, Aircraft, Aviation safety, Reporting and record keeping requirements, Safety, Transportation.

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend part 121 of Title 14, Code of Federal Regulations, as follows:

PART 121—OPERATING REQUIREMENTS: DOMESTIC, FLAG, AND

SUPPLEMENTAL OPERATIONS

1. The authority citation for part 121 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 40119, 44101, 44701-44702, 44705, 44709-44711, 44713, 44716-44717, 44722, 44901, 44903-44904, 44912, 46105.

2. Add § 121.XXX to subpart ____ to read as follows:

§ 121.XXX [Title].

After [a date 24 months after the effective date of the final rule], no person may operate an airplane with a maximum certified takeoff weight less than 60,000 pounds in conditions conducive to airframe icing unless it complies with this section. Conditions conducive to airframe icing are considered as visible moisture at or below a static air temperature of +2? C., unless the approved Airplane Flight Manual provides another definition.

(a) When operating in conditions conducive to airframe icing:

(1) The airplane must be equipped with a primary ice detection system and all necessary procedures for activation of the ice protection system and operation in icing conditions specified in the Airplane Flight Manual must be initiated; or

(2) Both substantiated visual cues and an advisory ice detection system must be provided, either of which enable the flightcrew to determine that the ice protection system must be activated; when the ice protection system is activated, any other procedures for operation in icing conditions specified in the Airplane Flight Manual must be initiated; or

(3) If the airplane is not equipped to comply with the provisions of paragraph (a)(1) or (a)(2), then the following will apply:

(i) When operating in conditions conducive to airframe icing, the ice protection system must be activated prior to and operated during the following phases of flight, and any additional procedures for operation in icing conditions specified in the Airplane Flight Manual must be initiated: take off climb after second segment, en route climb, go-around climb, holding, maneuvering for approach and landing, and any other operation at approach or holding airspeeds.

(ii) During any other phase of flight, the ice protection system must be activated and operated at the first sign of ice formation anywhere on the aircraft, except where the Airplane Flight Manual specifies that the ice protection system should not be used.

(b) If the procedures specified in paragraph (a)(3)(i) of this section are specifically prohibited in the Airplane Flight Manual, compliance must be shown with the requirements of paragraph (a)(1) or (a)(2).

(c) For airplanes with reversible flight controls for the pitch and/or roll axis:

(1) Visual cues must be substantiated that enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or

(2) The airplane must be equipped with a caution level alert and its associated visual or aural means to alert the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.

(d) For airplanes with reversible flight controls for the pitch and/or roll axis, the pilot in command must take action to immediately exit the conditions in which any ice accretion is occurring, upon:

(1) Determining that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or

(2) Activation of the caution level alert required by (c)(2);

unless, in the opinion of the pilot in command, it is necessary to delay such action in the interest of safety.

(e) All procedures necessary for compliance with this section must be set forth in the Airplane Flight Manual.

(f) System installations and Airplane Flight Manual procedures used to comply with this section must be approved through an amended or supplemental type certificate in accordance with part 21 of this subchapter.

Issued in Washington, DC, on

[1] BACK Aviation Solutions, Aviation Schedules(OAG)

U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

DRAFT

Subject: COMPLIANCE WITH REQUIREMENTS OF § 121.XXX, ______________	**Date:** Draft 8/27/02	**AC No: 121-XX**
	Initiated By: ANM-110	**Change:**

1. PURPOSE.

a. This Advisory Circular (AC)describes an acceptable means for showing compliance with the requirements of § 121.XXX, "______________," of Title 14, Code of Federal Regulations (14 CFR) part 121, commonly referred to as part 121 of the Federal Aviation Regulations (FAR). Part 121 contains the applicable aircraft operating requirements (for domestic, flag, and supplemental operations). The means of compliance described in this document is intended to provide guidance to supplement the engineering and operational judgment that must form the basis of any compliance findings relative to the requirements of § 121.XXX. Guidance includes considerations for:

- Installing a primary ice detection system; or
- Developing a method to alert the flight crew that the airframe ice protection system (IPS) must be activated, and revising the Airplane Flight Manual (AFM) concerning procedures for activating the airframe IPS; and
- A means for the flight crew to determine that they must exit icing conditions.

b. The guidance provided in this document is directed to airplane and engine manufacturers, modifiers, foreign regulatory authorities, and Federal Aviation Administration airplane type certification engineers and their designees.

c. Like all advisory circular material, this AC is not, in itself, mandatory, and does not constitute a regulation. It is issued to describe an acceptable means, but not the only means, for demonstrating compliance with the requirements for transport category airplanes. Terms such as "shall" and "must" are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described in this document is used. While these guidelines are not mandatory, they are derived from extensive Federal Aviation Administration and industry experience in determining compliance with the pertinent regulations.

d. This advisory circular does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements.

2. APPLICABILITY. The guidance provided in this AC applies to the operation, in conditions conducive to inflight airframe icing, of part 23 (small) and part 25 (transport category) airplanes with a maximum certified take-off weight less than 60,000 pounds and used in part 121 operations.

3. RELATED DOCUMENTS.

a. **Regulations contained in Title 14, Code of Federal Regulations (14 CFR).**

§ 23.1301	Equipment - Function and installation
§ 23.1309	Equipment, systems, and installations
§ 23.1322	Warning, caution, and advisory lights
§ 23.1419	Ice protection
§ 23.1585(a)	Operating procedures

§ 25.1301	Equipment - Function and installation
§ 25.1309	Equipment, systems, and installations
§ 25.1316(b)	System lightning protection
§ 25.1321	Instruments Installation - Arrangement and visibility
§ 25.1322	Warning, caution, and advisory lights
§ 25.1333	Instrument systems
§ 25.1419	Ice protection
§ 25.1585(a)(6)	Operating procedures

Appendix C to Part 25

b. **Advisory Circulars (AC).** The ACs listed below may be obtained from the U.S. Department of Transportation, Subsequent Distribution Office, SVC-121.23, Ardmore East Business Center, 3341 Q 75th Avenue, Landover, MD 20785:

AC 20-73	Aircraft Ice Protection, dated April 21, 1971.
AC 20-117A	Hazards Following Ground Deicing and Ground Operations in Conditions Conducive to Aircraft Icing, dated December 17, 1982.
AC 20-115B	Radio Technical Commission for Aeronautics, Inc. (RTCA) Document RTCA/DO-178B, dated January 11, 1993.
AC 23.1309-1C	Equipment, Systems, and Installations in Part 23 Airplanes, dated March 12, 1999.

AC 23.1419-2A	Certification of Part 23 Airplanes for Flight in Icing Conditions, dated August 19, 1998.

AC 25-7A	Flight Test Guide for Certification of Transport Category Airplanes, dated March 31, 1998.
AC 25-11	Transport Category Airplane Electronic Display Systems, dated July 16, 1987
AC 25.1309-1A	System Design Analysis, dated June 21, 1988.
AC 25.1419-1	Certification of Transport Category Airplanes for Flight in Icing Conditions, dated August 18, 1999.

4. **DEFINITION OF TERMS.**For the purposes of this AC, the following definitions should be used. These definitions of terms are intended for use only with respect to § 121.XXX.

a. **Advisory ice detection system**: An advisory system annunciates the presence of ice accretion or icing conditions. The flightcrew is responsible for monitoring the ice accretion or icing conditions as defined in the AFM, typically using total air temperature and visible moisture criteria, visible ice accretion, or specific airframe ice accretion thickness, and activation by the flightcrew of the anti-icing or de-icing system(s) is necessary. The advisory system provides information to advise the flightcrew of the presence of ice accretion or icing conditions but it can only be used in conjunction with other means to determine the need for, or timing of, anti-icing or de-icing system activation.

b. **Airframe icing:** Ice accretions on portions of the airplane on which supercooled liquid droplets may impinge, with the exception of the propulsion system.

c. **Anti-Icing**: The prevention of ice formation or accumulation on a protected surface, by evaporating the impinging water, or by allowing it to run back and off the surface, or allowing it to run back and freeze on non-critical areas.

d. **Automatic cycling mode:** A mode of airframe de-icing system operation that provides repetitive cycles of the system without pilot selection of each cycle. This is generally done with a timer and there may be more than one timing mode.

e. **Conditions conducive to airframe icing:** Visible moisture at or below a static air temperature of +2° C, unless otherwise substantiated.

f. **Deicing**: Removal or the process of removal of an ice accretion after it has formed on a surface.

g. **Irreversible flight controls:** All of the force required to move the pitch, roll, or yaw control surfaces is provided by hydraulic or electric actuators, the motion of which is controlled by signals from the cockpit controls. Loads generated at the control surfaces themselves are reacted against the actuator and its mounting and cannot be transmitted directly back to the cockpit controls.

h. **Large dropletconditions conducive to ice accumulation aft of the airframe's protected area:** Conditions containing a population of supercooled droplets sufficiently larger than those provided for in 14 CFR part 25 appendix C to cause ice accretions aft of the protected areas. The accumulation mechanism aft of the protected surface may be by direct impingement and accretion or delayed freezing of large droplets that impinge further forward. These conditions may be aircraft dependent as a consequence of airfoil geometry and limits of protected areas.

i. **Monitored Surface**: The surface of concern regarding ice hazard (for example, the leading edge of the wing).

j. **Primary ice detection system**: The means used to determine when the IPS must be activated. The system annunciates the presence of ice accretion or icing conditions and may also provide information to other aircraft systems. A primary <u>automatic</u> system automatically activates anti-icing or de-icing systems. With a primary <u>manual</u> system, the flightcrew activates the IPS upon indication from the system.

k. **Reference Surface**: The surface where an ice detection sensor is located or where a visual cue is located remotely from the surface of concern regarding ice hazard (for example, a propeller spinner).

l. **Reversible flight controls:** The flight deck controls are connected to the pitch, roll, or yaw control surfaces by direct mechanical linkages, cables, or push-pull rods such that pilot effort produces motion or force about the hinge line. Conversely, force or motion originating at the control surface (through aerodynamic loads, static imbalance, or trim tab inputs, for example) is transmitted back to flight deck controls.

(1) <u>Aerodynamically boosted flight controls</u>: Reversible flight control systems that employ a movable tab on the trailing edge of the main control surface linked to the pilot's controls or to the structure in such a way as to produce aerodynamic forces that move, or help to move, the surface. Among the various forms are flying tabs, geared or servo tabs, and spring tabs.

(2) <u>Power-assisted flight controls</u>: Reversible flight control systems in which some means is provided, usually a hydraulic actuator, to apply force to a control surface in addition to that supplied by the pilot to enable large surface deflections to be obtained at high speeds.

m. **Static air temperature:** The air temperature as would be measured by a temperature sensor not in motion with respect to that air. This temperature is also referred to in other documents as "outside air temperature," "true outside temperature," or "ambient temperature."

n. **Substantiated visual cues**: Ice accretion on a reference surface identified in the AFM, which is observable by the flightcrew. Visual cues used to identify appendix C ice will differ from those used to identify large droplet ice.

5. COMPLIANCE WITH § 121.XXX: Determining static air temperature.

a. In the absence of more specific guidance provided by the manufacturer and approved by the FAA, § 121.XXX allows for the use of visible moisture and static air temperature at or below +2° C for determination of conditions conducive to airframe icing. If this provision is used, the flightcrew should be able to easily determine the static air temperature.

b. The FAA anticipates that most types of airplanes to which § 121.XXX applies already incorporate a display of static air temperature available to the pilot. Existing displays that have been previously certificated need not be re-certificated. If the display is a new installation, the cognizant Aircraft Certification Office must approve the modification. If there is no such display, a placard can be provided showing corrections for temperature versus air speed to the nearest degree Centigrade in the region of interest (for example, around 0 degrees).

c. Requiring the pilots to access hand-held charts or calculators in lieu of a placard is not an acceptable means.

6. COMPLIANCE WITH § 121.XXX(a)(1) and (2).

a. This section of the rule requires as an acceptable means of compliance:

(1) For § 121.xxx(a)(1), either a primary automatic or primary manual ice detection system.

(2) For § 121.xxx(a)(2), substantiated visual cues and an advisory ice detection system.

(3) The applicant should present an ice detection system certification plan to the cognizant Aircraft Certification Office for an amended or supplemental type certificate. For part 25 airplanes, the certification plan should cover compliance with §§ 25.1301, 25.1309, 25.1419, and any other applicable sections. For part 23 airplanes, the certification plan should cover §§ 23.1301, 23.1309, 23.1419, and any other applicable sections.

b. **System Performance when Installed.** The applicant should accomplish a droplet impingement analysis and/or tests to ensure that the ice detector is properly located. The detector and its installation should minimize nuisance warnings, in accordance with §§ 23.1301 or 25.1301. The applicant must show that the modifications necessary for compliance with this proposed rule meet the "intended function" of the system required by this part 121 rule.

c. **System Safety Considerations.** The applicant should consult AC 23.1309-1C or AC 25.1309-1A for guidance on compliance with §§ 23.1309 and 25.1309, respectively. In accordance with those ACs, the applicant should accomplish a functional hazard assessment to determine the hazard level associated with failure of the ice detection system. The unannunciated failure of a primary ice detection system is assumed to be a catastrophic failure condition, unless the characteristics of the airplane in icing conditions without activation of the IPS are demonstrated to result in a less severe hazard category. The annunciated failure of a primary ice detection system is considered to be minor. The annunciated failure requires the flightcrew to:

(1) avoid conditions considered to be conducive to icing, or

(2) conduct operations in accordance with § 121.XXX(a)(2), if substantiated visual cues and an advisory ice detector are available for the airplane; or

(3) conduct operations in accordance with § 121.XXX(a)(3).

Failure of an advisory ice detection system is considered to be minor.

d. **Safe Operations in Icing Conditions.**

(1) Both §§ 23.1419 and 25.1419 require that the applicant demonstrate that the airplane is able to operate safely in the icing conditions defined in part 25 appendix C. It is not necessary to re-certificate the airplane for flight in icing to comply with § 121.XXX. However, the ice detection system should be shown to operate in the range of conditions defined by appendix C.

(2) Both §§ 23.1419 and 25.1419 also require a combination of tests and analyses to demonstrate the performance of the ice detector and the system as installed on the airplane. This could include icing tunnel and icing tanker tests to evaluate the ice detector performance. Also required are analysis and flight tests in measured natural atmospheric conditions to demonstrate satisfactory performance of the system as installed on the airplane. The approach used should result in activation of the IPS with the same amount of ice or less than would result from application of the approved existing AFM procedures. If this is not the case, the system may not be acceptable as a primary ice detection system for the purposes of § 121.XXX. Additional substantiation may be required to demonstrate that the airplane can safely operate with these larger ice accretions.

e. **Airplane Flight Manual (AFM).** The AFM should address the following:

(1) Operational use of the inflight ice detection system and any limitations; and

(2) Failure indications and appropriate crew procedures.

7. OPERATING PROCEDURES FOR § 121.XXX(a).

a. This section provides operating procedures to show compliance using various types of icing protection systems. Section 121.XXX (a)(3) provides an option to the means defined in paragraphs 121.XXX(a)(1) and (a)(2). This alternative requires the operation of the IPS when the airplane is in conditions conducive to airframe icing during the following phases of flight:

(1) Takeoff climb after second segment, en route climb, and go-around climb;

(2) Holding;

(3) Maneuvering for approach and landing;

(4) Any other operation at approach and holding airspeeds.

b. In addition, during any other phase of flight, the IPS must be activated and operated at the first sign of ice formation anywhere on the aircraft, unless the AFM specifies that IPS should not be used.

c. It is not acceptable to use crew assessment of depth of ice as a discriminator in deciding when to operate a de-icing system. The intent is to permit current certified manual systems to be used in such a way that they replicate the effectiveness of an automatic system without the dependency on the crew to establish ice depths.

d. Refer to Appendix 1, Airplane Flight Manual, for an acceptable AFM change for compliance with paragraph 121.XXX(a)(2).

e. Refer to Appendix 2, Airplane Flight Manual, for an acceptable AFM change for compliance with paragraph 121.XXX(a)(3).

8. COMPLIANCE WITH § 121.XXX(c).

a. Requirement of the Rule. Paragraph (c) of § 121.XXX is applicable to aircraft with a maximum certified takeoff weight less than 60,000 pounds and equipped with reversible flight controls in either the pitch or roll axis. The paragraph requires that:

(1) Visual cues must be substantiated to enable the flightcrew to determine that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas; or

(2) The airplane must be equipped with a caution level alert and its associated visual or aural means to alert the flightcrew that the airplane is in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas.

b. Applicable Airplanes. The applicable part 23 and part 25 airplanes have a maximum certified takeoff weight of less than 60,000 pounds with reversible flight controls in the pitch and/or roll axis and are used in part 121 operations. Consult with the aircraft manufacturer, cognizant certification office, and type data certificate to determine which model aircraft meet these criteria.

c. Acceptable Means of Determining if Airplane is Operating in Large Droplet Icing Conditions Conducive to Ice Accumulation Aft of the Airframe's Protected Area. There are several acceptable means for determining that the airplane is operating in large droplet conditions conducive to ice accumulation aft of the airframe's protected area. These include:

(1) Direct or Remote Measurement on a Monitored Surface:

(a) Placement of Detectors.

1. For direct measurement, ice detectors are fitted directly onto the surface to be monitored. The detectors sense the presence and/or the thickness of ice that is accumulating aft of the protected area. They are usually flush-mounted (integrated on or within the skin). The monitored surface may vary from a spot of approximately one square inch to several square inches or larger.

2. For remote measurement, the sensing element is not directly fitted onto the surface to be monitored. An optical means (e.g., infrared or laser device) may be one means of compliance. The surface extent monitored by this system is usually larger than with direct measurements.

(b) Ability to Sense Ice. The applicant should demonstrate that the detector is able to detect ice accumulation aft of the protected area that requires crew action to exit icing conditions. (See paragraph 8.d. of this AC for an acceptable means of determining when the flightcrew should exit icing conditions.)

1. For direct measurement, an icing wind tunnel, icing tanker and/or a laboratory chamber may be used to evaluate the ability of the ice detector to detect ice.

2. For remote measurement, laboratory tests may be used to demonstrate the ability of the detector to detect ice on the monitored surface.

(c) Detector Position. The detector should be positioned such that it performs its intended function with considerations given to the following factors:

1. Accretion characteristics of the monitored surface,

2. Sensitivity of the airfoil to ice accretions,

3. Thermal characteristic of the installation with respect to the generation of heat (direct measurement only),

4. Physical damage from foreign objects,

5. Early detection (response time),

6. Not intrusive relative to ice accretion on the monitored surface (direct measurement only),

7. Field of view relative to the monitored surface (remote measurement only),

8. Obscuration due to atmospheric conditions (for example snow, clouds) (remote measurement only), and

9. Any other appropriate factors.

(d) Analysis, icing tankers, and icing wind tunnels may provide information for location of the detector. In addition, laboratory tests may provide information for location of the remote detector.

(2) Remote Measurement Correlated to Ice Accumulation on a Monitored Surface. One method that could be used to determine if the airplane is operating in large droplet icing conditions conducive to ice accumulation aft of the airframe's protected area would be to provide indication of the conditions by discriminating droplet sizes. This method could provide an indication of conditions beyond those for which the airplane has been demonstrated.

(a) Acceptable Settings. Unless other acceptable means can be established, the device should be set to provide an indication when conditions exceed those specified in appendix C, assuming a Langmuir E distribution for 50μm Median Volumetric Diameter (MVD) droplets. The definition of a Langmuir E distribution may be found in the FAA Technical report DOT/FAA/CT-88/8-1, "Aircraft Icing Handbook" published March 1991, updated September 1993. The applicant should determine what droplet sizes might result in impingement aft of the protected surfaces. When the device detects conditions that exceed the appendix C conditions, the "exit icing" signal should be activated.

(b) Component Qualification. The component level certification should verify that the device is capable of providing a reliable and repeatable signal. One method would be to perform testing in an icing tunnel. The droplet size distribution should bracket the signal point, with droplet distributions slightly below and slightly above the signal point. The test should be repeated at sufficient conditions of liquid water content and ambient temperature to ensure operation throughout the icing conditions defined by appendix C and with droplet sizes up to 500 microns, or identify limitations as to the conditions where performance is degraded.

(3) Visual Means. This means can range from direct observation of ice accretions aft of the airplane's protected surfaces to observation of ice accretions on reference surfaces. Examples of visual means that could indicate to the flightcrew that the airplane is operating in large droplet conditions conducive to ice accumulation aft of the airframe's protected areas include observations of:

(a) Accretions forming on unheated portions of side windows,

(b) Accretions forming on the aft portions of propeller spinners,

(c) Accretions forming on aft portions of radomes, and

(d) Water splashing on the windshields at static temperatures below freezing.

(4) Multiple cues may be required to meet the requirements of this rule.

(a) Field of View. Visual cues should be developed with the following considerations:

1. Visual cues should be within the flightcrew's vision scan area while seated and performing their normal duties.

2. Visual cues should be observable during all modes of operation (day, night, Instrument Meteorological Conditions (IMC).

(b) Verification. The applicant should verify the ability of the crew to observe the visual cues and reference surface. The visual cues should be evaluated from the most adverse flightcrew seat locations during normal duties in combination with the range of flightcrew heights. Consideration should be given to the difficulty of observing clear ice on the monitored or reference surface. If a reference surface is used, the applicant should verify that it correlates with conditions conducive to ice accumulation aft of the airframe's protected areas. Verification of the visual cues may be accomplished by testing in measured natural icing or simulated large droplet icing behind a calibrated water tanker aircraft.

d. Acceptable Means of Determining When Flightcrew Should Exit Icing Conditions. The flightcrew should exit the icing conditions in which ice accretion is occurring if any amount of ice is detected, or correlated to ice accumulation, aft of the protected areas.

e. System Safety Considerations. The applicant should consult either AC 25.1309-1A or AC 23.1309-1C, as appropriate, for guidance on compliance with §§ 25.1309 or 23.1309, respectively.

(1) Hazard classification. The following is a qualitative analysis that may be used for determining the hazard classification for compliance with this part 121 regulation. Not all encounters with large droplet icing result in a catastrophic event. While definitive statistics are not available, given the volume of aircraft operations, and reported incidents that did not result in a catastrophe, a factor of around 1 in 100 is a

reasonable assumption of the probability of a catastrophic event, if an airplane encounters large droplet conditions conducive to ice accumulation aft of the airframe's protected areas. Based on the above assumption, the hazard classification of an unannunciated encounter with "large droplet conditions conducive to ice accumulation aft of the airframe's protected areas" may be considered as severe major or hazardous in accordance with AC 25.1309-1A or AC 23.1309-1C, respectively.

(2) Frequency of occurrence. The appendix C conditions were designed to include 99 percent of icing conditions. Evaluation of icing data has indicated that the probability of encountering icing outside of appendix C droplet conditions is on the order of 10^{-2}. The applicant may assume this probability for encountering the large droplet conditions conducive to ice accumulation aft of the airframe's protected areas. It should be considered as an average probability throughout the flight.

(3) Numerical safety analysis. For the purposes of a numerical safety analysis, the applicant may combine the probability of equipment failure with the probability, defined above, of encountering large droplet conditions conducive to ice accumulation aft of the airframe's protected areas. Therefore on a transport category airplane, if the applicant uses the above analysis for the hazard classification and the above probability of encountering the specified large droplet conditions (10^{-2}), it follows that the probability of an unannunciated equipment failure should be less than 10^{-5}.

f. System Performance When Installed.

(1) The ice detector system installed for compliance with § 121.XXX(c) is intended to detect ice that forms due to large supercooled droplets that exceed those specified in Appendix C. Flight tests in measured natural icing conditions (required by §§ 23.1419 and 25.1419) should be conducted to ensure that the system does not produce nuisance warnings when operating in conditions defined by appendix C.

(2) The low probability of finding conditions conducive to ice accumulation aft of the protected areas makes natural icing flight tests impractical as a means of demonstrating that the system functions in conditions exceeding appendix C. The applicant may use flight tests of the airplane under simulated icing conditions (icing tanker) or icing wind tunnel tests of a representative airfoil section to demonstrate the proper functioning of the system and to correlate the signals provided by the detectors and the actual ice accretion on the surface.

NOTE: The measured natural icing flight tests required by § 25.1419 are only applicable for conditions that are defined by appendix C.

g. Software and Hardware Qualification. For guidance on software and hardware qualification, the applicant should consult RTCA/DO-178, "Software Considerations in Airborne Systems and Equipment Certification," and RTCA/DO160D, "Environmental

Conditions and Test Procedures for Airborne Equipment."

h. Airplane Flight Manual. For any changes to the limitations and normal procedures section of the AFM, the aircraft type certificate holder should be consulted to ensure compatibility with the flight characteristics of the particular model aircraft.

(1) For ice detection systems, the AFM should address:

(a) Operational use of the ice detection systems and any limitations of the system; and

(b) Failure indications and associated crew procedures.

(2) For visual means of compliance, the AFM should contain procedures that describe the visual means used to indicate that the airplane is operating in large droplet conditions that are conducive to ice accumulation aft of the airframe's protected areas.

(3) The following are acceptable AFM changes regarding actions the flightcrew should take after there is an indication of ice aft of the protected areas. Changes to the Limitations Section of the AFM must be approved by the FAA.

(a) Revise the Limitations Section of the FAA-approved AFM to require the pilot in command to immediately take action to exit the conditions in which any ice accretion is occurring, unless in the opinion of the pilot in command, it is necessary to delay such action in the interest of safety.

(b) Revise the Normal Procedures Section of the FAA-approved AFM to include the following:

1. In order to avoid extended exposure to flight conditions that result in ice accumulations aft of the protected areas, the pilot in command must immediately take action to exit the conditions in which any ice accretion is occurring, unless in the opinion of the pilot in command, it is necessary to delay such action in the interest of safety.

2. Avoid abrupt and excessive maneuvering that may exacerbate control difficulties.

3. Do not engage the autopilot.

4. If the autopilot is engaged, hold the control wheel firmly and disengage the autopilot.

5. If an unusual roll response or uncommanded roll control movement is observed, smoothly but positively reduce the angle-of-attack.

6. Do not extend flaps during extended operation in icing conditions. Operation with flaps extended can result in a reduced wing angle-of-attack, with the possibility of ice forming on the upper surface further aft on the wing than normal, possibly aft of the protected area.

7. If the flaps are extended, do not retract them until the airframe is clear of ice.

8. Report these weather conditions to Air Traffic Control.

9. Maintain airspeed awareness and follow minimum speed guidelines per AFM procedures.

10. Continue to follow these procedures until it can be determined that there are no ice accretions aft of the protected surface.

9. FLIGHT CREW TRAINING. Training in the use and procedures for the equipment required by § 121.XXX should be included in an operator's approved training program. Additionally, all pilots employed in operations under part 121 should be given annual training in accordance with the approved methods in the operator's training program.

APPENDIX 1 - AIRPLANE FLIGHT MANUAL

The following is an acceptable Airplane Flight Manual (AFM) change for compliance with paragraph 121.XXX (a)(2): With the approval of the FAA, the applicant may revise the Limitations Section of the FAA-approved AFM to include the following requirements for activation of the Icing Protection system (IPS):

When the flight crew determines from either the substantiated visual cues or the advisory ice detection system that the ice protection system must be activated:

- *For anti-icing systems:* The system must be operated continuously.
- *For de-icing systems:*
    - ? If an automatic cycling mode is available, it must be operated continuously at the available cycle rate most appropriate for the ice accretion rate.
    - ? If an automatic cycling mode is not available, the system must be operated at short intervals (not to exceed three minutes) to minimize ice accretions. In addition, the system must be operated for at least one complete cycle immediately prior to:
        a. Decreasing airspeed for holding or for maneuvering for approach and landing;
        b. Commencing a holding turn;
        c. Commencing the turn intended to intercept the final approach course inbound, including the procedure turn; and
        d. Selecting landing flaps.
        e. After gear and flap retraction on a go-around climb.

The airframe ice protection system may be selected off:

- *For anti-icing systems:* After the substantiated visual cues and the advisory ice detection system no longer indicate ice accretion or after leaving conditions conducive to airframe icing.
- *For deicing systems:* After completion of an entire deicing cycle after the substantiated visual cues and the advisory ice detection system no longer indicate ice accretion or after leaving conditions conducive to airframe icing.

NOTE: This guidance may be reproduced and placed in the AFM.

APPENDIX 2 - AIRPLANE FLIGHT MANUAL

The following is an acceptable Airplane Flight Manual (AFM) change for compliance with paragraph 121.XXX (b): With the approval of the FAA, the applicant may revise the Limitations Section of the FAA-approved AFM to include the following requirements for activation of the Icing Protection System (IPS):

When operating in visible moisture at or below a static air temperature of +2° C. unless a different condition is substantiated by test data.

During take off climb after second segment, en route climb, and go-around climb, holding, maneuvering for approach and landing, and any other operation at approach or holding speeds, the airframe ice protection system must be activated.

During any other phase of flight the ice protection system must be activated and operated at the first sign of ice formation anywhere on the aircraft except where the AFM specifies that the ice protection should not be used.

- *For anti-icing systems:* The system must be operated continuously.
- *For de-icing systems:*
  - ? If an automatic cycling mode is available, it must be operated continuously at the available cycle rate most appropriate for the ice accretion rate.
  - ? If an automatic cycling mode is not available, the system must be operated at short intervals (not to exceed three minutes) to minimize ice accretions. In addition, the system must be operated for at least one complete cycle immediately prior to:
    a. Decreasing airspeed for holding or for maneuvering for approach and landing;
    b. Commencing a holding turn;
    c. Commencing the turn intended to intercept the final approach course inbound, including the procedure turn; and
    d. Selecting landing flaps.
    e. After gear and flap retraction on a go-around climb.

The airframe ice protection system may be selected off:

- *For anti-icing systems:* After leaving conditions conducive to airframe icing.
- *For deicing systems:* Following completion of an entire deicing cycle after leaving conditions conducive to airframe icing.

NOTE: This guidance may be reproduced and placed in the AFM.

U.S. Department
of Transportation

**FEDERAL AVIATION
ADMINISTRATION**
Office of Aviation Policy and Plans
Washington, D.C. 20591

PROPOSED REGULATORY EVALUATION,
PROPOSED REGULATORY FLEXIBILITY DETERMINATION,
PROPOSED INTERNATIONAL TRADE IMPACT ASSESSMENT
AND
PROPOSED UNFUNDED MANDATE ASSESSMENT
FOR THE
ICE PROTECTION HARMONIZATION WORKING GROUP

ACTIVATION OF ICE PROTECTION SYSTEMS
AND EXISTING ICING CONDITIONS
PROPOSED OPERATING RULE
(14 CFR Parts 121)

OFFICE OF AVIATION POLICY, PLANS AND MANAGEMENT ANALYSIS

AIRCRAFT REGULATORY ANALYSIS BRANCH, APO-320

GEORGE THURSTON

June 2002

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EXECUTIVE SUMMARY

This proposal would amend the regulations applicable to operators of airplanes with a Maximum Take-off Weight (MTOW) of less than 60,000 pounds, used in 14 CFR Part 121 air carrier service. The proposal would require either the installation of ice detection equipment or changes to the Airplane Flight Manual (AFM) to ensure timely activation of the ice protection system (IPS). This proposal also would specify when airplanes with reversible flight controls for the pitch and/or roll axis should exit conditions conducive to airframe icing. This proposed regulation is the result of information gathered from a review of icing accidents and incidents, and it is intended to improve the level of safety when airplanes are operated in icing conditions.

The rulemaking proposal contained in this notice is based on a recommendation developed by the Ice Protection Harmonization Working Group (IPHWG) of Aviation Rulemaking Advisory Committee (ARAC). There is ongoing ARAC activity on additional icing related rules, which the FAA anticipates would result in proposals for rulemaking.

The FAA estimates the present (2002$) value of the total quantifiable safety benefits from 2007 through 2026 to be about $106.6 million dollars. The FAA estimates that the present (2002$) value of the total costs from 2007 through 2026 to be about $70.2 million dollars. Viewed over 20-years, approximately $58.0 million, representing 82.6 percent of the total cost, would be incurred in the first year following the effective date of this proposed rule.

The FAA has determined that this rule: (1) has benefits which do justify its costs; (2) does not impose costs sufficient to be considered "significant" under the economic standards for significance under Executive Order 12866 or under DOT's Regulatory Policies and Procedures; due to public interest and safety, however, it is considered significant under the Executive Order and DOT policy; (3) would have a significant impact on a substantial number of small entities; (4) would primarily have a domestic impact, thus the trade impact is minimal and does not create obstacles to foreign commerce for the U.S.; and (5) does not impose an unfunded mandate on state, local, or tribal governments, or on the private sector.

I. INTRODUCTION

This proposed rule is responsive to National Transportation Safety Board (NTSB) recommendation A-96-56, which is on the NTSB's Most Wanted List. The proposed rule is also one of the items listed in the FAA's In-flight Aircraft Icing Plan, April 1997. The Icing Plan details the FAA's plans for improving the safety of airplanes when they are operated in icing conditions. Neither the operating regulations nor the certification regulations require a means for the pilot in command to specifically identify that hazardous icing conditions have been encountered.

II. BACKGROUND

On October 31, 1994, at 1559 Central Standard Time, an Avions de Transport Regional model 72-212 (Aerospatiale Model ATR 72) operated by Simmons Airlines, Incorporated, and doing business as American Eagle flight 4184, crashed during a rapid descent after an uncommanded roll excursion. The airplane was in a holding pattern and was descending to a newly assigned altitude of 8,000 feet when the initial roll excursion occurred. Impact forces destroyed the airplane; and the captain, first officer, 2 flight attendants and 64 passengers received fatal injuries. Flight 4184 was a regularly scheduled passenger flight being conducted under 14 Code of Federal Regulations (CFR), Part 121; and an instrument flight rules plan had been filed. Flight 4184 operated in icing conditions, believed to include freezing drizzle droplets, which were reported in the area. The FAA, Aerospatiale, the French Direction Générale de l'Aviation Civile, Bureau Enquete Accident, National Aeronautics and Space Administration (NASA), National Transportation Safety Board, and others have conducted an extensive investigation of this accident. This investigation concluded that freezing drizzle conditions created a ridge of ice aft of the deicing boots and forward of the ailerons, which resulted in uncommanded roll of the airplane.

NTSB Safety Recommendations

The NTSB issued various safety recommendations to the FAA following the Model ATR72 accident investigation. One of the recommendations, A-96-56, states in part that:

If safe operations in certain icing conditions cannot be demonstrated by the manufacturer, operational limitations should be imposed to prohibit flight in such conditions and flight crews should be provided with the means to positively determine when they are in icing conditions that exceed the limits for aircraft certification.

The rulemaking proposal addresses the NTSB safety recommendations by defining, to the pilot in command, when to exit icing conditions.

Industry Recommendation

Partially in response to the latter portion of this safety recommendation, the FAA tasked the Aviation Rulemaking Advisory Committee (ARAC), by notice published in the Federal Register on December 8, 1997 (62 FR 64621), to consider the need for a regulation that requires installation of ice detectors, aerodynamic performance monitors, or another acceptable means to warn flight crews of ice accumulation on critical surfaces requiring crew action (regardless of whether the icing conditions are inside or outside of Appendix C of 14 CFR Part 25).

The rulemaking proposal contained in this notice is based on a recommendation developed by the Ice Protection Harmonization Working Group (IPHWG) of ARAC that ARAC approved and presented to the FAA as a recommendation.

DISCUSSION

Review Process

To address the task, the IPHWG followed a process consisting of the following five elements:

1. Review of the airplane icing-related accident/incident history,
2. Identification of safety concerns,
3. Identification of the airplanes subject to the safety concerns (i.e., applicability),

4. Identification of various means to address the safety concerns, and

5. Review of the technology available to allow compliance with any proposed methods of addressing the safety concerns.

These five elements are discussed in more detail below.

1. Accident/Incident History Review

The IPHWG reviewed the airplane icing-related accident/incident history and developed a database of approximately 1,300 worldwide icing-related accidents and incidents. The IPHWG then refined the database by:

- Removing duplicate entries and reports with insufficient data.
- Removing elements that were not relevant to in-flight airframe icing problems, such as reports related to ground deicing and carburetor icing.
- Excluding single-engine piston airplanes, because most of these airplanes are not certificated for flight in icing. (Although a few of these airplanes may be certificated and equipped for flight in icing, the IPHWG considered that their exclusion would not affect the outcome of the review.)
- Removing reports involving multi-engine piston airplanes that were not certificated for flight in icing.
- Removing reports of events in which externally aggravating circumstances existed, such as operation of the airplane outside of its weight and balance limitations, descent below published minimums, or other reasons not related to airplane icing.

The IPHWG reviewed the remaining events and identified 96 events that contained adequate information to apply the following criteria:

- Was there ice accretion that was not known to the flight crew? and
- Would knowledge of this ice accretion have made a difference to the outcome of the accident or incident?

Based on these 96 events, the IPHWG concluded that in at least 61 events, there is substantive documented accident and incident history in which the level of flight crew cognizance of ice buildup on airframe surfaces was not adequate.

Once the group had concluded that flight crew cognizance of ice buildup on airframe surfaces was not adequate, an effort was undertaken to further analyze the evidence in order to identify factors which play a role in the flight crew's situational awareness as it pertains to icing. A parallel effort was undertaken to identify aerodynamic and system design factors which might play a role in the susceptibility of an airplane to icing effects, thus influencing the procedural vigilance required of the flight crew.

Both of these efforts required that the database be expanded. To do this, the same refinements described above were applied to the 1,300-event database, except that reports were included in which there was not sufficient information to positively determine whether flight crew knowledge of the ice accretion would have made a difference to the outcome of the accident or incident. This review yielded 234 events.

All 234 events were used to examine aerodynamic and system design factors. However, in order to look at issues regarding the flight crews situational awareness, single-pilot operations were not considered relevant to multi-pilot aircrew cognizance. Therefore, events, which were likely to have involved a single pilot, were removed from the 234 events for this purpose, leaving 119 events.

During the review of the original 96-event data set, certain factors became apparent and these were evaluated more closely using the 119-event data set. In particular, factors which affect crew workload were considered, such as phase of flight and crew complement.

Crew complement was estimated based on the number of pilots required by the type certificate and/or the type of operation being conducted. Phase of flight was extracted from the narratives of the events.

This part of the analysis revealed that 49 percent of the 119 events had taken place during the approach and landing phases of flight, 38 percent had taken place during the cruise phase, 8 percent during the climb phase, and 2 percent during the go-around phase.

The phase-of-flight analysis was conducted again using only accidents. The pattern remains similar: 73 percent of the accidents had taken place during approach and landing, 17 percent during cruise, 7 percent during climb, and 2 percent during go-around.

The approach and landing phases of flight involve considerably higher degrees of pilot workload than do the cruise and climb phases. Thus, there is less attention available to manage the ice accretion problem. Further, these phases involve continuous changes in flight parameters such as airspeed, altitude, and bank angle. In these phases of flight, indications of ice accretion other than visual cues, such as trim changes and drag increases are much less visible to the crew. Finally, research was considered which suggests that the drag effects of ice accreted at low angles of attack can become very significant when the angle of attack is increased. Ice accreted early in the approach phase may not manifest its effects until the angle of attack is increased later in the approach or landing. All of these factors influence the situation while the airplane is in close proximity to the ground.

The pilot workload required varies. In all cases, it requires that the ice accretion be detected. In some cases, it then requires that the ice accretion be evaluated prior to operation of the IPS.

With this data in hand, further work was undertaken to examine the crew response to knowledge of ice accretion. In 122 events out of 234, the narrative contained information that the flight crew knew that ice was accreting on the airframe. Yet in only 48 cases was there positive evidence that the crew had operated the IPS. This did not seem to be affected by crew complement, with 20 of the 48 cases involving a single pilot. In 16 of these cases, there was positive evidence that the crew had not operated the IPS; in the remainder, no information regarding IPS operation was available.

The IPHWG also considered extensively the significant air carrier accidents and incidents in recent years due to icing. These included the accidents at Roselawn, Indiana, in 1994 and at Monroe, Michigan, in 1997. Consideration also included incidents involving Fokker F-27s at East Midlands, UK, and Copenhagen, Denmark; the British Aerospace ATP at Cowley, UK; Embraer EMB-120s at Tallahassee, Elko, Fort Smith, and Klamath Falls, US, and several Aerospatiale/Alenia ATR events during the 1980s

2. Safety Concerns

Activation of Airframe IPS. The airplane icing-related accident/incident history review revealed accidents and incidents where the flight crew either:

- Was completely unaware of ice accumulation on the airframe, or
- Was aware of ice accumulation but judged that it was not significant enough to warrant operation of the IPS.

This led the IPHWG to conclude that flight crews must be provided with a clear means to know when to activate the IPS.

Exit Icing Conditions. The database contains accidents and incidents where the IPS was operated according to accepted procedures, yet the ice accretions still created degradations that led to an event. Therefore, the IPHWG concluded that the flight crew must be provided with a means to know if the airplane is in conditions conducive to ice accumulation that warrant the flight crew taking actions to exit icing conditions.

3. Applicability

The IPHWG examined the 234-event accident and incident history and found that discriminating factors exist that significantly reduce the risk of icing accidents and incidents. A wide range of factors was considered, including airplane size, type of flight control system, and wing chord length.

A limited analysis of the event database described above revealed that average wing chord length has a roughly inverse relationship to the event history. Of the data considered, the IPHWG noted that airplanes with average chord lengths in excess of ten feet had not experienced any accidents due to in-flight icing. Although some airplanes with shorter chords have no event history, many do.

Evidence is available to show that contamination on the upper wing surface results in an increasing deterioration in the wing's coefficient of lift and the coefficient of drag as the ratio of surface roughness height to wing chord length increases. This may sufficiently influence the contamination effects in a typical icing encounter such that a large chord length experiences minimal aerodynamic effect, while a small chord length may experience significant effects. Another contributing factor for the lack of accidents may be the fact that for any given icing encounter, droplets will impinge further aft and the resulting ice shape will be larger on a short-chord wing than on a longer-chord wing. Chord length, then, may be an appropriate discriminator for determining which airplanes have a higher risk of accidents and incidents without the flight crew having a clear means to know when to activate the IPS and when to exit icing conditions.

However, chord length is not a commonly known attribute of the airplane; therefore, the IPHWG sought a simple discriminator that could be readily understood by the aviation community. In the accident/incident database, those airplanes with a ten-foot average chord correspond quite well with airplanes with a weight of 60,000 pounds. Since the maximum certificated gross takeoff weight is simple and well understood, it was recommended as the discriminating parameter.

4. Possible Means of Addressing the Safety Concerns

The FAA has issued Airworthiness Directives (AD's) to require activation of pneumatic deicing boots at the first signs of ice accumulation on several types of airplanes operated under 14 CFR Part 121. These AD's relieve the pilot of determining whether the amount of ice accumulated on the wing warrants activation of the IPS. However, the flight crew's observation of ice accumulations can be difficult during times of high workload, operations at night, or when clear ice has accumulated. The difficulties of observing ice accumulations are applicable to any IPS which relies on pilot observation for activation of the system, not just pneumatic deicing boots.

The IPHWG concluded that an improved means to address these situations would be to require installation of a device that would alert the flight crew that the IPS should be activated. An advisory ice detection system in conjunction with substantiated visual cues will provide a much higher level of safety than visual cues alone. This device would mitigate the effects of high workload and of human sensory limitations in detecting ice and evaluating its thickness. When using such a device in conjunction with a manual IPS as required in 14 CFR 121.XXX (a)(2), the IPHWG considers it unacceptable to use crew assessment of depth of ice as a discriminator in deciding when to operate the de-icing system. The intent is to permit current certified manual systems to be used in such a way that they replicate the effectiveness of an automatic system without the dependency on the crew to establish ice depths. There are several types of airplanes currently in operation which have primary ice detection systems installed, and the IPHWG considers that these airplanes already meet the desired level of safety.

An alternative to requiring the installation of such an ice detector would be to require that the IPS be operated continuously when the airplane is operating in conditions conducive to airframe icing: reference 14 CFR 121.XXX (a)(3)(i). In this case, the flight crew would operate the IPS in response to a specific air temperature threshold and the presence of visible moisture. Temperature and visible moisture information is readily available and unambiguous. This approach has disadvantages with respect to increased maintenance due to increased time in operation. However, it presents large advantages with respect to flight crew workload and procedural reliability. It is consistent with systems used as anti-ice systems and is the procedure in use for many thermally anti-iced small jets. The IPHWG noted that small jets that used these procedures were absent from the incident database. When a manual de-icing system is required to be operated as defined above, the IPHWG considers it unacceptable to use crew assessment of depth of ice as a discriminator in deciding when to operate the de-icing system. The intent is to permit current certified manual systems to be used in such a way that they replicate the effectiveness of an automatic system without the dependency on the crew to establish ice depths. The IPHWG considered that this procedure could be used as an alternative to an ice detector.

The information in the database revealed that the phases of flight that presented the greatest risk due to airframe icing were those that were associated with low speed and relatively high angle-of-attack operation (i.e., approach, landing, go-around, and holding). Takeoff was excluded because the accidents related to that phase of flight were caused by improper ground deicing/anti-icing procedures; this has been adequately addressed by amendment 121-253 to 14 CFR [§ 121.629(b) and (c), "Operating in icing conditions"]. This conclusion was based primarily on the preponderance of icing accidents taking place during those phases, particularly approach and landing.

The IPHWG considered another requirement that would apply in any case where an ice detector was not operational and/or installed. This alternative would require that when the airplane is operating in conditions conducive to airframe icing, the IPS must be operated continuously. The group then considered how this procedure would apply to each phase of flight.

The database lists ten accidents worldwide as originating during cruise. In six of the ten accidents, the flight crew was aware of the ice accretion. In the remaining four accidents, very little relevant data was available. For the six accidents, IPHWG determined that the cruise accident history did not have enough information to draw meaningful conclusions regarding potential rulemaking.

The database also lists a number of incidents in the cruise phase, of which at least five were potential accidents. Further examination of the incidents where sufficient data was available led the IPHWG to conclude that the crews were aware that ice was accreting and that operation of the IPS at the first sign of ice accretion would have prevented the incidents. Examination of these incidents caused the IPHWG to conclude that the cruise phase should be included in the rule. However, the IPHWG did not believe that continuous operation of the IPS while in conditions conducive to icing was warranted. The IPHWG was reluctant to require continuous operation of manually cycled IPS's in conditions conducive to airframe icing due to considerations of crew workload and a concern that it would introduce a procedure possibly leading to substantial non-compliance. The IPHWG felt that continuous operation of the IPS at the first sign of ice accretion was more appropriate and alleviated the concern with procedural non-compliance.

With respect to the climb, approach, landing, holding and go-around phases of flight, the IPHWG determined that the following factors substantiated requiring the continuous operation of the IPS while in conditions conducive to icing:

- An overall majority of events which originated in these phases of flight;
- A sufficient number of events in which the flight crew was confirmed to be unaware of ice accretion, supplemented by a substantial number of events in which the flight crew awareness of ice accretion was unknown;
- High cockpit workload resulting in low residual flight crew attention;
- Frequent maneuvering, resulting in little opportunity for the flight crew to detect aerodynamic degradations due to icing;
- Maneuvering at relatively high angles of attack.

<u>*Exit Icing Conditions*</u>. The safety concern of when to exit icing conditions was partially addressed in 1996 by a series of AD's issued by the FAA. [Amendment 39-9698, AD 96-09-22 (61 FR 20674, May 7, 1996) is typical of these AD's.] The AD's require certain airplanes to exit icing when the conditions exceed the capabilities of the ice protection equipment. Generally, the visual cues for determining that the flight crew must act to exit icing conditions are subjective and can result in varying interpretations. Terms such as "unusually extensive ice," ice that is "not normally observed," and ice that is "farther aft than normally observed" are used in the AD's. These are all variable terms that are largely dependent on flight crew experience. The IPHWG concluded that less subjective means of determining when the flight crew should exit icing conditions are needed.

5. Technology

To ensure that viable means exist for compliance with any proposed methods of addressing the safety concerns, the IPHWG reviewed the current state of technology with regard to ice detectors and aerodynamic performance monitors.

Ice detector technology is sufficiently mature that there currently are available several methods that can reliably alert the flight crew as to when the IPS should be activated. This type of technology already has been certificated on various airplanes as either an advisory or a primary means of determining when the IPS should be activated. However, an ice detection system with the capability to alert the flight crew when to exit icing conditions would have to be able to detect when:

a. The icing conditions encountered exceed the criteria to which the airplane was certificated; or

b. Ice is accreting on surfaces of the airplane where it could prove hazardous and that were not addressed in the airplane's icing certification.

Some ice detection systems currently installed on airplanes have the capability to detect and alert the flight crew that ice is accreting on sensor elements of the detector. Depending upon the intended application of these detectors, ice accretions of approximately 0.1 mm to 1 mm and larger are detectable. However, these detectors have not been proven to operationally perform either of the functions identified in paragraphs a and b above.

Due to the unproven capabilities of ice detectors for the above application and the immature development of aerodynamic performance monitors, the IPHWG considered additional means for the flight crew to know when they should exit icing conditions.

It is feasible for the current ice detector technology to identify the existence of ice aft of the protected areas. Based on the accident and incident history and the current state of ice detector technology, the IPHWG recommended that the regulations be revised to address the known safety concern of ice accumulations aft of the airframe's protected areas on airplanes with reversible flight controls in the pitch or roll axis.

The IPHWG also acknowledged that, in lieu of an ice detector, it might be possible to use the flight crew's observation of ice accretion on reference surfaces, provided that the visual cues are substantiated for the specific airplane.

The relevant icing accidents and incidents occurred on airplanes equipped with pneumatic deicing boots. However, the accumulation of ice aft of the protected areas due to large droplet icing conditions can occur on any airplane, regardless of the type of IPS installed on it. Therefore, the IPHWG maintained that any revision to the current regulations should be applicable regardless of the type of IPS.

III. THE COSTS ESTIMATES

The proposed rule consists of two parts:

(1) Sections (a), (b), (e), and (f) which affect all 14 CFR Part 121 operated airplanes with a MTOW of less than 60,000 pounds. These sections would mandate when the pilot is to activate the IPS's.

(2) Sections (c), (d), (e), and (f), which affect all 14 CFR Part 121 operated airplanes with a MTOW of less than 60,000 pounds and equipped with reversible flight controls in the pitch and/or roll axis. These sections would mandate when the pilot is to exit icing conditions.

Sections (e) and (f) affect both parts of the proposed rule. Section (e) requires AFM procedures for compliance with the proposed rule. Section (f) requires approval of system installations and Airplane Flight Manual procedures through an amended or supplemental type certificate.

Three elements drive the overall cost estimate. They are:

(1) the costs per airplane to the operators required to implement sections (a), (b),(e), and (f) of this proposed rule;

(2) the costs per airplane to the operators required to implement sections (c), (d), (e), and (f) of this proposed rule;

(3) the estimate of the number of affected airplanes; including a snapshot of the current active fleet, a forecast of airplanes affected by the proposed rule entering the fleet, and a forecast of the retired affected airplanes during the 20-year analysis period.

The basis on which each element was estimated follows. All costs, discussed in the following estimates, are based in 2002 dollars and the discount factor is 7 percent as mandated by the Office of Management and Budget. The FAA analyzed the costs and benefits of this proposed rule over the 20-year period 2007 through 2026.

In order to estimate the potential costs and benefits of the proposed rule, the FAA has made the following assumptions:

(1) The proposed rule will become a final rule in 2005. The operators will have 24 months to comply. The first year the final rule imposes costs on the operators will be 2007.

(2) The FAA used $60.00 hourly rate for a mechanic/technician working for an airplane manufacturer or modifier and the $100.00 hourly rate for an engineer working for an airplane manufacturer or modifier.

(3) In this analysis, operators would pay for the indirect non-recurring costs that originally would be incurred first by manufacturers. These indirect non-recurring costs are distributed equally across each airplane in each airplane model group addressed by the proposed rule. The indirect non-recurring costs are one-time costs incurred within 24 months after the proposed rule becomes final.

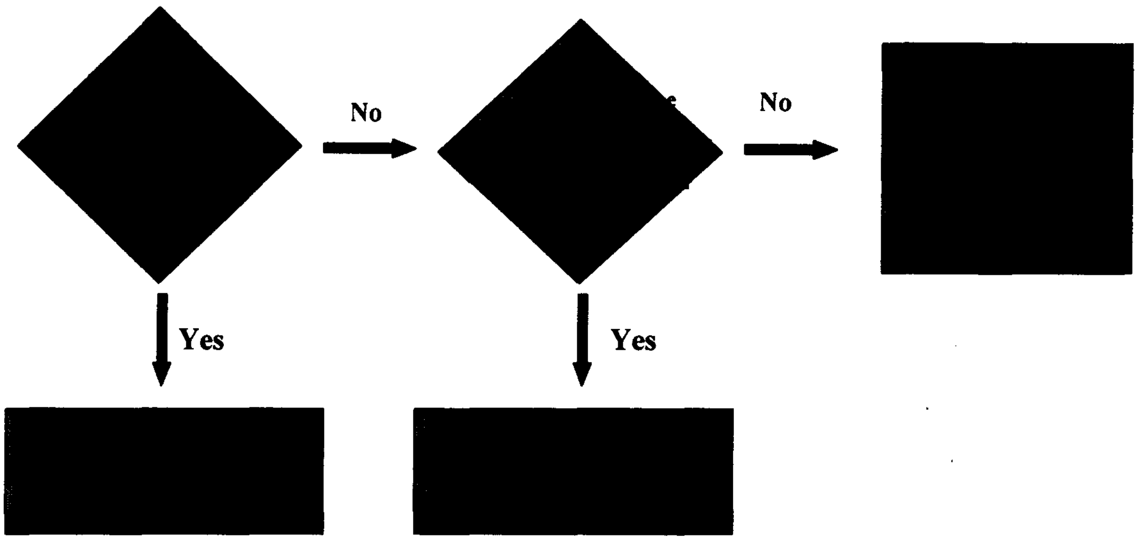
(4) The FAA assumed whenever various compliance options are available to the operators, the minimal cost option will always be chosen.

(5) The proposed rule may result in airplane diversions from scheduled and non-scheduled operations, however, the costs of the diversions have not been included in the regulatory evaluation because reliable data is not available for predicting the number of diversions that would precipitate.

Costs Required to Implement Sections (a), (b),(e), and (f)

Exhibit 1 illustrates the chain of events leading up to the decision on whether an operator would incur the cost of a primary ice detection system, an advisory ice detection system, or activate the IPS's when entering conditions conducive to airframe icing.

Exhibit 1
Cost of (a), (b), (e), or (f) Compliance



To determine the direct costs to operators to implement sections (a), (b),(e), and (f) of the proposed rule, the analysis required distinguishing each airplane by having either one of two ice detection systems installed, one requiring substantiated visual cues as well, or having no ice detection system installed. To satisfy the intent of section (a) or (b), and (e) and (f) of the proposed rule, each of the airplanes was analyzed to determine if they currently had:

(1) a primary ice detection system (a)(1) or

(2) an advisory ice detection system installed, along with substantiated visual cues (a)(2).

If the airplane had either one of the two options, then the intent of section (a)or (b), and (e) and (f) has been satisfied and operators would not incur compliance costs for these sections. If an airplane does not have either one of the two options, then when the airplane is operating in conditions conducive to airframe icing, the IPS must be activated prior to and operated during all phases of flight except take-off and cruise (unless ice accretion is seen anywhere on the airplane, then it must also be operated during those phases unless prohibited by the AFM).

For section (a) of the proposed rule, if the operator decides to install a primary or advisory ice detection system, then the costs include:

(1) Indirect Non-recurring Airplane Group Costs
(2) Direct Operator Costs.

Section (a)(1) and (a)(2) - Indirect Non-recurring Airplane Group Costs

If the decision is made to install a primary or advisory ice detection system, non-recurring costs consist of the following:

(1) System Design – includes ice detector system architecture and integration, positioning, and updating the manufacturer's AFM procedures
(2) System Qualification/certification – includes ice detector qualification, certification, and flight test
(3) Tasks associated to the retrofit – includes service bulletin preparation, approval and a crew-training program.

As mentioned earlier, these non-recurring costs are manufacturer's costs and were distributed equally across each airplane in each major airplane group. Note the more airplanes in a major airplane group, the cheaper the non-recurring costs are to the operators of those airplanes. The converse is also true. Major airplane groups consisting of only a few airplanes have higher non-recurring costs per airplane.

Section (a)(1) and (a)(2) – Direct Operator Costs

Direct operator costs are defined herein as:

(1) The purchase of Primary or Advisory Ice Detection system
(2) The installation of the Primary or Advisory Ice Detection system

(3) Pilot Training costs

(4) Updating the operator's AFM.

The IPHWG provided the FAA with the costs of purchasing and installing primary or advisory ice detection systems for the airplanes affected by this proposed rule. As shown in Appendix C1, C2 and C3, the cost of installing a primary or advisory ice detection system was far more costly than complying with section (a)(3).

Section (a)(3) of the proposed rule states when operating in conditions conducive to airframe icing, the IPS must be activated prior to and operated during all phases of flight except takeoff and cruise. During takeoff and cruise ["any other phase of flight"], unless prohibited by the AFM, the IPS must be operated at either the first sign of ice formation anywhere on the airplane or when conditions conducive to airframe icing are present (visible moisture at or below a static air temperature of +2 deg. C).

The costs for Section (a)(3) include:

(1) Indirect Non-recurring Costs

(2) Direct Operator Costs.

Section (a)(3) - Indirect Non-recurring Costs

There are three non-recurring costs associated with continuously operating the IPS during all phases of flight except take off and cruise. They are:

(1) Updating the manufacturer's AFM for each major airplane group, and

(2) Updating the operators AFM for each major airplane group

(3) Flight tests.

The non-recurring costs, for updating the manufacturer's AFM for each major airplane group, were distributed equally across each airplane in each major airplane group. The non-recurring costs, for updating the operators AFM, were distributed equally across each of the operator's airplanes in each of the operator's major airplane groups (as shown in Appendix C3).

Section (a)(3) – Direct Operator Costs

Since (a)(3)(i) effectively would increase the usage of IPS's, then this proposed section would increase costs of maintenance and of replacement of the IPS's. In order to estimate the increased maintenance costs and the increased frequency of replacing the IPS's, the FAA reviewed the currently issued AD's concerning activation of the IPS and how the AD's differed from this proposed rule.

The AD's in Docket Number 99-NM-137-AD through 99-NM-145-AD, 99-NM-147-AD through 99-NM-154-AD, and AD 2001-06-18 require airplane operators of certain airplanes to activate the pneumatic wing and tail deicing boots **at the first sign of ice accumulation.** The proposed rule would require the operators to activate the pneumatic wing and tail deicing boots **when visible moisture is at or below a static air temperature of +2 degrees C.** When the IPS is operated based on visible moisture and a temperature there might not actually be ice accumulating on the airframe. Thus, the proposed rule is more conservative than the current AD's issued because the IPS's will be activated even though ice may not be accreting on the airframe.

IPHWG provided data from one operator claims that the increase use of the IPS mandated by the AD's in Docket Number 99-NM-137-AD through 99-NM-145-AD, 99-NM-147-AD through 99-NM-154-AD, and AD 2001-06-18, will drop the average service life of a pneumatic deicing boot from 4 years to 2.5 years to 2 years. The operator provided IPHWG with the following costs for operating the IPS's pre-AD and post-AD on their fleet of 89 affected airplane. The AD's added an additional $178 per month, per airplane in maintenance and replacement costs to operate the IPS's. The IPHWG estimates the further increase of boot usage, due to the proposed rule, will add about $198 per month, per airplane, for airplanes subject to the AD's.

For airplanes which are not subject to the AD's and are operating the deicing boots based on flight crew observation of a specific thickness of ice, the increased deicing boot usage will add $377 per airplane, per month (see Appendix C3). These additional costs are the only recurring costs estimated over the 20-year analysis period.

For airplanes which are not subject to the AD's and are operating the deicing boots based on flight-crew observation of a specific thickness of ice there will be costs to certificate the airplanes to operate the deicing boots based on visible moisture and temperature. Those costs are estimated to be $300,000.00/airplane group or type (See Appendix C3).

Each U.S. certificated operator would be required to provide training for pilots and copilots of airplane involved with new equipment or procedures mandated by the proposed rule. The FAA accepts the IPHWG's estimate of two hours of initial training per pilot or copilot and that ten pilots per airplane will need training. At $60.00 per hour training costs,[1] the FAA estimates that the initial cost of training would be $1,200 per affected airplane. The training costs estimated are one-time fees incurred in the first year the proposed rule becomes effective.

Section (b) – Direct Operator Costs

Section (b) of the proposed rule states that if the procedures in section (a)(3) are prohibited in the AFM, then compliance must be shown with the requirements of section (a)(1) or (a)(2). The FAA has found no case where the procedures in section (a)(3) are prohibited in the AFM for airplanes affected by the proposed rule. Therefore, section (b) adds no costs to the operators. Costs for section (e) and (f) of the proposed rule are embedded in the estimates for section (a)and (b).

<u>Costs Required to Implement Section (c), (d), (e), and (f)</u>

[1] Ice Protection Harmonization Working Group (IPHWG) of the Aviation Rulemaking Advisory Committee (ARAC).

Sections (c), (d), (e), and (f) would require certain actions applicable to airplanes with reversible flight controls for the pitch and/or roll axis. Reversible flight controls are cockpit controls that are connected to the pitch, roll, or yaw control surfaces by direct mechanical linkages, cables, or push-pull rods such that pilot effort produces motion or force about the hinge line.

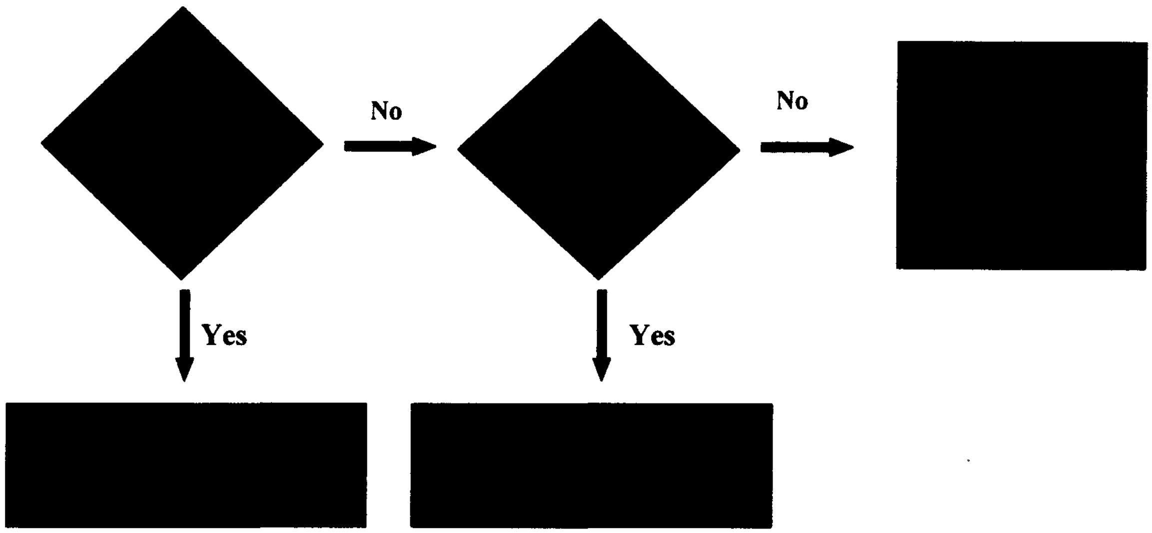
Irreversible flight controls are cockpit controls where all of the force required to move the pitch, roll, or yaw control surfaces is provided by hydraulic or electric actuators, the motion of which is controlled by signals from the cockpit controls.

There is a history of accidents and incidents caused by the uncommanded deflections of reversible flight controls in both pitch and roll axes in icing conditions. These uncommanded deflections were the result of ice accreting ahead of the control surfaces, either aft of the protected area or on the protected area when the IPS was not activated.

For irreversible flight controls, the control surface actuators are sized to maintain the control surface in its commanded position throughout the airplane's flight envelope, including high-speed dive. This results in the design loads for the actuators being larger than the loads induced by flow separation caused by ice accretions aft of the airplane's protected areas. Therefore, airplanes with irreversible flight controls are not subject to uncommanded control surface deflection caused by ice accretions.

Exhibit 2 illustrates the chain of events leading up to the decision on whether an operator would incur the cost of a tanker test to substantiate visual cues to determine that the airplane is in large-droplet conditions conducive to ice accumulation, (c)(1), or whether to incur the costs of equipping their airplanes with a caution-level alert system and its associated visual or aural means to alert the flight crew that the airplane is in large droplet conditions conducive to ice accumulation, (c)(2).

Exhibit 2
Cost of (c), (d), (e) and (f) Compliance



In December 1994, ATR, DGAC, and the FAA conducted a series of flight tests at Edwards Air Force Base in California. The flight tests utilized an Air Force NKC-135A tanker that was flown ahead of an ATR and other turboprop airplanes. The ATR airplane established a visual cue associated with large droplet icing conditions. It is likely that the visual cue can be substantiated as adequate for compliance with (c)(1). Two other turboprop airplanes were tested. The visual cues may or may not be considered as adequate for compliance with (c)(1). For the purposes of this economic evaluation it will be assumed that it will be possible to substantiate that no additional testing is required to demonstrate compliance with (c)(1) for the ATR. For the other two turboprop airplanes the FAA will conservatively assume, from an economic impact point of view, that it will not be possible to substantiate that these airplanes comply with (c)(1) without additional testing. Since the cost of a tanker test can approach $500,000 (See Appendix C4), and the probability of establishing visual cues is not 100% certain, the FAA did not consider Section (c)(1) as a minimal cost option.

For section (c)(2) of the proposed rule, if the operator decides to install a caution-level alert system, then the costs include:

(1) Indirect Non-recurring Airplane Group Costs and
(2) Direct Operator costs.

Section (c)(2) – Indirect Non-recurring Airplane Group Costs

If the decision is made to install a caution-level alert system, non-recurring costs consist of the following:

(1) System Design – includes caution-level alert system architecture and integration, positioning, and procedures for updating the manufacturer's AFM,
(2) System Qualification/certification – includes caution-level alert qualification, certification, and flight test,
(3) Tasks associated to the retrofit – includes service bulletin preparation, approval and a crew training program,
(4) Cost for Icing Tanker rental and AFM changes to substantiation that the caution alert system be certified.

As mentioned earlier, these non-recurring costs are manufacturer's costs and were distributed equally across each airplane in their major airplane group (see Appendix C-5).

Section (c)(2) – Direct Operator costs

Direct operator costs are defined herein as:

(1) The purchase of caution-level alert system
(2) The installation of the caution-level alert system
(3) Pilot Training costs
(4) Updating the operator's AFM.

Each U.S. certificated operator would be required to provide training for pilots and copilots of airplane involved with new equipment or procedures mandated by the proposed rule. The FAA accepts the IPHWG's estimate of two hours of initial training per pilot or copilot and ten pilots per airplane. At $60.00 per hour training costs,[2] the FAA estimates that the initial cost of training would be $1,200 per affected airplane. The training costs estimated are one-time fees incurred in the first year the proposed rule becomes effective.

The FAA considered the potential fuel burn cost from the added weight of the caution-level alert system. According to the IPHWG, the weight is minimal and would have limited impact on additional fuel burn and the cost of operating an airplane.

The FAA also considered whether the installation of the caution-level alert system could be accomplished during scheduled maintenance A and C checks. If not, then downtime costs for the airplane would need to be added. From the Fleet PC™[3] database, turboprop hours were analyzed. The average hours flown per year of the average affected turboprop is 2,278. IPHWG provided that C checks are performed on these turboprops every 4,000 hours. Since a typical turboprop would be ready for a C check every 1.75 years and it will take approximately 1 year to certificate the system, the installation of the caution-level alert system could not be accomplished during scheduled maintenance C checks before the end of the compliance time for the proposed rule. According to the IPHWG, the installation will take 3 days with an associated loss of profit of $5000.00/day/airplane.

Costs for section (d),(e), and (f) of the proposed rule are embedded in the estimates for the caution alert system and the tanker tests.

The breakdown of these costs can be found in Appendix C4 and C5.[4]

<u>Estimating the Number of Affected Airplanes</u>

[2] Ice Protection Harmonization Working Group (IPHWG) of the Aviation Rulemaking Advisory Committee (ARAC).
[3] BACK Aviation Solutions, Aviation Link: FleetPC, January 6, 2002.
[4] IPHWG

The cost estimates discussed above are per-airplane costs. To obtain a total cost estimate, these per airplane costs are multiplied by the number of airplanes, hence, the fleet of affected airplanes must be estimated. To estimate the number of affected airplanes; the FAA analyzed the current active fleet of airplanes, a forecast of airplanes affected by the proposed rule entering the fleet, and a forecast of the retired affected airplanes exiting the fleet during the 20-year analysis period.

A list of all U.S. operated civilian airplanes operating under 14 CFR Part 121 was generated by the FAA Flight Standards Group.[5]

Each listed airplane was matched with its current (as of January 6, 2002) MTOW and age through the use of the FleetPC™ database.

All airplanes with a MTOW greater than 60,000 pounds were then eliminated, leaving 1,735 airplanes in the active fleet to be subject to the proposed rule.

Fleet PC™ had numerous airplanes with no MTOW data available. For these airplanes, Janes *All the Worlds Aircraft Publication* was consulted.

Using industry sources, mostly from the manufacturers of airplanes affected by this proposed rule, airplanes with reversible flight controls were distinguished from airplanes with irreversible flight controls.[6] In addition, the FAA determined which airplanes currently had primary or advisory icing detection systems, visual cues, or caution-level alert systems installed.[7]

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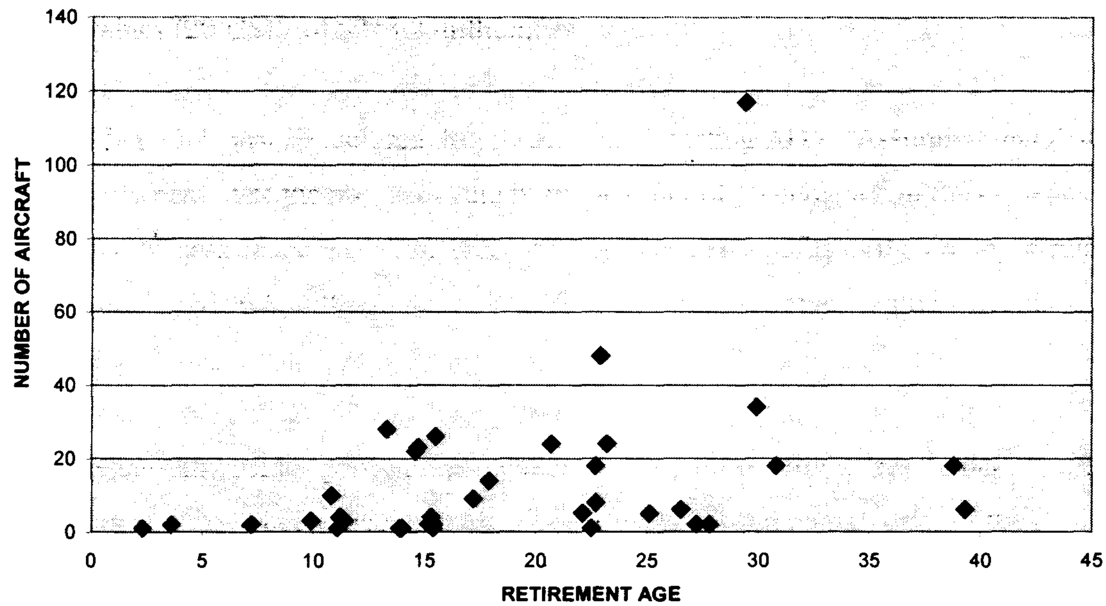
[5] AFS-260, March 7, 2002

[6] Ice Protection Harmonization Working Group (IPHWG) of the Aviation Rulemaking Advisory Committee (ARAC).

[7] ibid

The FAA used the FleetPC™ database and determined turboprops are retired from U.S. certificated service at an average age (mean) of 23.8 years with a standard deviation of 7.43 years. The age distribution of retired U.S. operated turboprops is shown in Graph 1.

GRAPH 1
AVERAGE AGE OF RETIRED TURBOPROPS
US Certificated Operators



When the FAA computed costs for airplanes affected by the proposed rule, turboprops were retired from the active fleet if their age exceeded 23.8 years. The FAA conservatively assumed that turboprop airplanes, close to 23.8 years old, would remain in active service and be retrofitted to comply with the proposed rule and then retired. The FAA assumed that all turbojet airplanes would stay active in the 20-year analysis period.

Table C1 details the turboprop airplanes, and their average age, retiring in 2007[8]:

Table C1

Retirements from Affected Fleet

2007

Table C1 Retirements From Affected Fleet 2007		
Equipment Type	**Average Retirement Age in 2007**	**Number**
C46-D	63.0	1
C46-R	65.0	1
CE-402-B	34.0	1
CE-421-B	34.0	1
Convair 240	55.6	10
Convair 340	54.1	9
Convair 440	50.0	7
DC-3-C	63.5	2
DHC-6	36.2	36
DHC-7	26.6	6
Fokker 27	40.9	32
Metro	25.8	1
TOTAL		**107**

At the end of the 20-year analysis period, 2026, the FAA assumed a total of 1,131 turboprops have retired from Part 121 service.

Table C2 shows the number of airplanes affected, and whether the airplanes have reversible or irreversible flight controls, a primary or advisory ice detection system, visual icing cues, or a large droplet alert system:

[8] Sensitivity studies were conducted with regard to the average age of retirement. If the retirement age were 30 years, instead of the base case 23.8 years used to calculate costs, then the discounted costs (2002$) would increase by 3.2% or $2.4 million. If the retirement age were 60 years, instead of the base case 23.8 years, then the discounted costs would increase by 13.9% or $11.5 million dollars.

TABLE C2

U.S. Operated Airplanes with MTOW < 60,000 pounds

Affected by the Proposed Rule

Airplane Type	Number of Affected Airplanes	Reversible or Irreversible	Primary Ice Detector? (a)(1)	Advisory Ice Detector? (a)(2)	Visual Cues (c)(1)	Large Droplet Alert System (c)(2)
ATR 42	59	Reversible	No	Yes	Yes	No
ATR 72	64	Reversible	No	Yes	Yes	No
Bombardier CRJ	296	Irreversible	Yes	Yes	N/A	N/A
DHC-8-100 thru-300	189	Reversible	No	Yes	No	No
Dornier 328	48	Reversible	No	Yes	No	No
Dornier 328JET	32	Reversible	No	Yes	No	No
Embraer EMB-120	199	Reversible	No	Yes	No	No
Embraer EMB-135	67	Irreversible	Yes	No	N/A	N/A
Embraer EMB-145	203	Irreversible	Yes	No	N/A	N/A
Fokker/Fairchild F27C	6	Reversible	No	No	No	No
Jetstream 31/32	51	Reversible	No	No	No	No
Jetstream 4101	57	Reversible	No	Yes	No	No
Metro II/III	26	Reversible	No	No	No	No
Raytheon 1900C/D	172	Reversible	No	No	No	No
Saab 340	253	Reversible	No	No	No	No
Shorts 330/360	13	Reversible	No	No	No	No

The FAA conservatively assumed future deliveries, of new airplanes with a MTOW less than 60,000, will need to become compliant to the proposed rule. The FAA Statistical and Forecast Branch[9] provided the forecast for regional turbojet and turboprops. As with the active fleet, all airplanes with a MTOW greater than 60,000 pounds were eliminated from the forecast.

At the time of this writing, German plane maker Fairchild-Dornier filed for insolvency after running out of cash, but is currently looking for a strategic investor to continue production. The FAA retained future forecasted Fairchild-Dornier airplanes in its analysis of costs for this proposed rulemaking.

Table C3 shows the number of forecasted new airplanes, with a MTOW less than 60,000 pounds, delivered to U.S. certificated carriers from 2002-2026:

Table C3

Forecasted Fleet

US Operators

MTOW < 60,000 pounds

Year	New Deliveries
2002	87
2003	125
2004	136
2005	136
2006	146
2007	127
2008	119
2009	148
2010	203
2011	178
2012	178
2013	172
2014	166
2015	160
2016	154
2017	148
2018	142
2019	135
2020	128
2021	121
2022	114
2023	108
2024	103
2025	98
2026	93

The total undiscounted cost of making future deliveries compliant with the proposed 14 CFR Part 121 rulemaking, from 2002 through 2026, is estimated to be $14.7 million. The FAA, using IPHWG costs, estimates that the discounted present value (2002$) of this cost over the analysis period is $8.0 million.

[9] APO-110

Table C4 shows the estimated average non-discounted initial costs by airplane type for each Section of the proposed rule:

Table C4

US Operated Commercial Airplanes

MTOW < 60,000 pounds

Average Initial Cost

Airplane Type	Number of Airplanes 2007	Cost = min[(a)(1), (a)(2), or (a)(3)]				Cost = min[(c)(1) or (c)(2)]		Average Initial Total Fleet Cost
		Reversible or Irreversible	Primary Ice Detector? (a)(1)	Advisory Ice Detector? (a)(2)	Visible Moisture and Temp. (a)(3)	Visible Cues (c)(1)	Large Droplet Alert System (c)(2)	
ATR 42	59	Reversible	No	Comply	$0	Comply	$0	$0
ATR 72	64	Reversible	No	Comply	$0	Comply	$0	$0
Bombardier CRJ	296	Irreversible	Comply	Comply	$0	N/A	N/A	$0
DHC-8-100 thru-300	189	Reversible	No	Comply	$0	No	$66,097	$12,492,333
Dornier 328	48	Reversible	No	Comply	$0	No	$83,244	$3,995,712
Dornier 328JET	32	Reversible	No	Comply	$0	No	$70,868	$2,267,776
Embraer EMB-120	199	Reversible	No	Comply	$0	No	$65,804	$13,094,996
Embraer EMB-135	67	Irreversible	Comply	No	$0	N/A	N/A	$0
Embraer EMB-145	203	Irreversible	Comply	No	$0	N/A	N/A	$0
Fokker/Fairchild F27C	6	Reversible	No	No	$4,593	No	$244,135	$1,492,368
Jetstream 31/32	51	Reversible	No	No	$4,223	No	$70,475	$3,809,598
Jetstream 4101	57	Reversible	No	Comply	$0	No	$70,945	$4,043,865
Metro II/III	26	Reversible	No	No	$2,029	No	$102,693	$2,722,772
Raytheon 1900C/D	172	Reversible	No	No	$3,120	No	$66,674	$12,004,568
Saab 340	253	Reversible	No	No	$1,339	No	$64,621	$16,687,880
Shorts 330/360	13	Reversible	No	No	$2,798	No	$145,125	$1,922,999

Summary of Costs

The FAA, using IPHWG costs, estimates that the total undiscounted cost of the proposed rule, from 2007 through 2026, is estimated to be $107.0 million. The discounted present value (2002$) of this cost over the 20-year analysis period is $70.2 million. Approximately $58.0 million, representing 82.6 percent of the total discounted present value (2002$) cost, occur in 2007. Appendix C6 shows the distribution of the costs throughout the 20-year analysis period.

The FAA solicits comments from affected entities with respect to these findings and determinations, and request that all comments be accompanied by clear documentation.

IV. THE BENEFITS ESTIMATE

The FAA expects the proposed rule to generate total potential safety benefits estimated at $572.6 million over the 2007 through 2026 analysis period and discounted at 7 percent annually to present values (2002$)[10] of $213.2 million.

The total benefits must be factored down because of existing AD's. Assuming that that the actual safety benefit of the proposed rule is on the order of 50 percent[11] of the present values due to the effectiveness of the AD's, the present value (2002$) benefits of the proposed rulemaking are estimated at $106.6 million. A key benefit of the proposed rule would be avoidance of these accidents.

Under the current operating rules, it is the responsibility of the flight crew to decide whether icing conditions have been encountered. Neither the operation regulations nor the certification regulations require a means for the pilot in command to identify that hazardous icing conditions have been encountered. An examination of the accident and incident history revealed that the flight crews must be provided with a clear means to know when to activate the IPS. This proposed rule will ensure timely activation of the IPS. This proposed rule will provide a means for the flight crew to determine that icing conditions must be exited.

Since 1985, 14 CFR Part 121 passenger-carrying air operators have had 7 accidents which may have been prevented if this rule had been in effect. Table B1 shows these accidents resulted in 99 fatalities, 2 serious injuries and 15 minor injuries. In addition, all of the airplanes involved in the accidents were either destroyed or received substantial damage.[12] These accidents all occurred in the small (under 60,000 pound MTOW) 14 CFR Part 121 airplanes addressed by this proposed rule. In addition, 8 icing-related incidents were found which the FAA notes had the

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10 OMB

11 Ice Protection Harmonization Working Group (IPHWG) of the Aviation Rulemaking Advisory Committee (ARAC).

potential of resulting in accidents; however, the FAA assigns no quantitative benefits to these icing-related incidents due to the lack of airplane-damage detail available. The data includes accidents and incidents that occurred under Part 135 operations. They are considered as relevant to this proposed part 121 rule because under today's regulations those Part 135 operations would be classified as Part 121.

Table B1
Passenger Operator Icing Related Accidents
1985 to 2001

Year	Operator Name	Accident/Incident	Aircraft Series	Fatalies	Serious Injuries	Minor Injuries
1986	Sea Alaska	Accident	DHC-6	0	2	2
1989	Mid Pacific Airlines	Accident	YS-11A	2	0	0
1993	CO Express	Accident	EMB-120	0	0	13
1993	Express 1	Accident	SAAB 340	0	0	0
1994	Simmons Airlines	Accident	ATR 72	68	0	0
1997	Comair	Accident	EMB-120	29	0	0
2001	Comair	Accident	EMB-120	0	0	0
Total Casualtes:				**99**	**2**	**15**
Average Casualtes:				**14.1**	**0.3**	**2.1**

The FAA is aware of accidents and incidents in icing conditions occurring prior to 1985. Table B2 illustrates several examples of such accidents that were well documented. However, the quality of many accident reports and incident investigations from earlier years is not sufficient to determine whether this rule would have changed the outcome. In order to insure a dataset that

Table B2
Passenger Operator Icing Related Accidents
Prior to 1985

Year	Airplane	City	State
1947	DC-3	North Platte	Nebraska
1954	DC-3	Near Kansas City	Missouri
1958	VC-VISCOUNT	Freeland	Michigan
1960	C-46	McGuire Air Force Base	New Jersey
1963	VC-VISCOUNT	Kansas City	Missouri
1963	CV-440	Midland	Texas
1964	DC-3	Boston	Massachusetts
1964	DC-4	Chicago	Illinois

was uniform and consistent in detail, the FAA did not include accidents which occurred prior to 1985[13].

[12] National Transportation Safety Board (NTSB) Accident Reports, FAA National Aviation Safety Data Analysis Center (NASDAC).
[13] Ice Protection Harmonization Working Group (IPHWG) of the Aviation Rulemaking Advisory Committee

Icing related accidents during the cruise, holding and landing phase of flight have also occurred in Australia, Canada, Greenland, Iceland, Italy, Kazakhstan, Russia, Sweden, and the United Kingdom.[14]

Table B3			
Average Benefit of Preventing One Accident Due to Icing			
Category	**Value**	**Number**	**Total**
Fatalities	$3,000,000	14.1	$42,300,000
Serious Injuries	$260,500	0.3	$78,150
Minor Injuries	$6,000	2.1	$12,600
Medical and Legal Costs - Fatality	$132,700	14.1	$1,871,070
Medical and Legal Costs - Serious Injury	$46,633	0.3	$13,990.00
Medical and Legal Costs - Minor Injury	$2,500	2.1	$5,250
NTSB Investigation	$1,411,700	1	$1,411,700
Airplane Replacement	$3,840,000	1	$3,840,000
Total			**$49,532,760**

In order to quantify future benefits, the FAA calculated the costs of a future averted accident as a result of this proposed rule. Table B1 lists the airplanes, fatalities, serious and minor injuries, as well as the average number of casualties per accident. There were 7 accidents, 99 fatalities, 2 serious injuries, and 15 minor injuries. The FAA sets the value of a statistical aviation fatality avoided at $3.0 million, that of a serious injury (assumed to be the average of a severe, serious, and moderate injury) at $260,500, and that of a minor injury at $6,000. The associated medical and legal costs for a fatality is $132,700, a serious injury (assumed to be the average of a severe, serious, and moderate injury) $46,633.33, and that of a minor injury, $2,500.[15] In addition, the average replacement costs of a destroyed airplane totaled $3.84 million and a NTSB accident investigation costs about $1.4 million. The FAA estimates the average value of avoiding an icing-related accident, where the airplane is destroyed, to be $49.5 million (Table B3).

(ARAC).

[14] ibid

[15] "Treatment of Value of Life and Injury In Economic Analysis" (FAA-APO-02-1), February 2002 and "Aviation Accident Investigation Costs" (FAA-APO-00-1), August 2000.

The FAA expects the seriousness of future accident to increase. Herein, the methodology is presented to substantiate the basis for increasing value of preventing icing related accidents that could occur over the 2007 through 2026 timeframe in the absence of the proposed rule:

1. Based on the casualty losses listed in Table B1, five separate accident and casualty rates were estimated. These accident and casualty rates were estimated by dividing the total losses per category over the 1985 through 2001 period by the number of air carrier operations over that same time period.[16] The results of this derivation are exhibited in Table B4.
2. These rates were adjusted for changes in airplane size[17] over the 2007 through 2026 analysis period. For example, the average number of seats on an air operator for the 1985 through 2001 period is 27.[18] In 2007, the FAA estimates the average number of seats will be is 39,[19] and therefore approximately a 44 ((39/27)-1) percent increase. Subsequently, the number of potential casualties will increase by 44 percent as well.
3. The historical accident and casualty rates per million operations were multiplied by the annual number of projected operations from 2007 through 2026,[20] and then adjusted by the percent change in the average number of seats in an air carrier for that year.
4. After totaling the number of accidents and casualties over the 2007 through 2026 period, the FAA applied the critical values in Table B3 to determine the total potential benefits of the proposed rule.

Table B4 and B5 shows these calculations.

[16] U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Plans and Management Analysis, March 2002 Operations and Seat Source: Statistical and Forecast Branch, FAA/APO, FAA Aviation Forecasts 1986-2013, 298c Commuters. The FAA used the 298c Commuter database because the data most closely matched the airplanes affected by this proposed rulemaking.
[17] ibid
[18] ibid
[19] ibid
[20] ibid

Table B4 Derivation of Accident and Casualty Rates for Part 121 Operated Airplanes								
Year	Operations	Avg. No. of Seats on Airplane	Fatalities per Million Ops	Serious Injuries per million Ops	Minor Injuries per million Ops	Accident Investigations per Million ops	Destroyed Airplanes per Millions Ops
1985	4,734,066	20.29	The fatality rate is derived by dividing the total number of fatalities over the past 17 year period (99) by the total number of operations over the same period (96 million).	The serious injury rate is derived by dividing the total number of serious injuries over the past 17 year period (2) by the total number of operations over the same period (96 million).	The minor injury rate is derived by dividing the total number of minor injuries over the past 17 year period (15) by the total number of operations over the same period (96 million).	The accident investigation rate is derived by dividing the total number of investigations (7) over the past 17 years by the total number of operations over the same time period (96 million).	The destroyed airplane rate is derived by dividing the total number of airplanes destroyed over the past 17 year period (7) by the total number of operations over the same period (96 million).
1986	4,929,110	21.13					
1987	5,480,632	22.39					
1988	5,866,284	24.13					
1989	5,765,186	24.05					
1990	6,206,942	25.61					
1991	6,155,224	25.70					
1992	6,079,610	26.60					
1993	6,352,490	26.72					
1994	6,855,650	27.05					
1995	5,949,878	27.70					
1996	5,941,022	27.79					
1997	5,823,634	28.29					
1998	5,706,940	28.91					
1999	5,484,810	31.22					
2000	5,207,032	31.70					
2001	3,526,521	33.03					
	96,065,231 (Total)	26.61 (Average)	1.03	0.02	0.16	0.07	0.07

Source: U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Plans and Management Analysis, March 2002
Operations and Seats Source: Statistical and Forecast Branch, FAA/APO, FAA Aviation Forecasts, Fiscal Years 1986-2013, 298 Commuter.

Table B5 Derivation of Benefits for Part 121 Operated Airplanes											
Year	Operations	Fatalities per Annual Million Operations	Serious Injuries per million Ops	Minor Injuries per million Ops	Avg. Number of Seats per Aircraft and % Increase from Past 16 year Avg. (27)		Estimated Fatalities	Estimated Serious Injuries	Estimated Minor Injuries	Estimated Investigations	Estimated Airplanes Replaced
2007	4,029,450	4.16	0.08	0.63	39.00	44.44%	6.00	0.12	0.91	0.31	0.31
2008	4,092,696	4.22	0.09	0.64	39.50	46.30%	6.17	0.12	0.94	0.31	0.31
2009	4,160,962	4.29	0.09	0.65	40.00	48.15%	6.36	0.13	0.96	0.32	0.32
2010	4,236,650	4.37	0.09	0.66	40.50	50.00%	6.55	0.13	0.99	0.33	0.33
2011	4,316,032	4.45	0.09	0.67	41.00	51.85%	6.76	0.14	1.02	0.33	0.33
2012	4,403,837	4.54	0.09	0.69	41.50	53.70%	6.98	0.14	1.06	0.34	0.34
2013	4,497,865	4.64	0.09	0.70	42.00	55.56%	7.22	0.15	1.09	0.35	0.35
2014	4,596,818	4.74	0.10	0.72	42.50	57.41%	7.46	0.15	1.13	0.35	0.35
2015	4,702,545	4.85	0.10	0.73	43.00	59.26%	7.72	0.16	1.17	0.36	0.36
2016	4,815,406	4.97	0.10	0.75	43.50	61.11%	8.00	0.16	1.21	0.37	0.37
2017	4,935,791	5.09	0.10	0.77	44.00	62.96%	8.29	0.17	1.26	0.38	0.38
2018	5,064,122	5.22	0.11	0.79	44.50	64.81%	8.61	0.17	1.30	0.39	0.39
2019	5,200,853	5.36	0.11	0.81	45.00	66.67%	8.94	0.18	1.35	0.40	0.40
2020	5,346,477	5.51	0.11	0.84	45.50	68.52%	9.29	0.19	1.41	0.41	0.41
2021	5,501,525	5.67	0.11	0.86	46.00	70.37%	9.67	0.20	1.46	0.42	0.42
2022	5,666,571	5.84	0.12	0.89	46.50	72.22%	10.06	0.20	1.52	0.44	0.44
2023	5,842,234	6.02	0.12	0.91	47.00	74.07%	10.49	0.21	1.59	0.45	0.45
2024	6,029,186	6.22	0.13	0.94	47.50	75.93%	10.94	0.22	1.66	0.46	0.46
2025	6,228,149	6.42	0.13	0.97	48.00	77.78%	11.42	0.23	1.73	0.48	0.48
2026	6,439,906	6.64	0.13	1.01	48.50	79.63%	11.93	0.24	1.81	0.50	0.50
Total		103	2	16			169	3	26	8	8

Source: U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Plans and Management Analysis, March 2002
Operations and Seats Source: Statistical and Forecast Branch, FAA/APO, FAA Aviation Forecasts, Fiscal Years 1986-2013, 298 Commuters.

In the absence of the proposed rule, and due to growth in operations, the FAA expects that over the 2007 through 2026 analysis period, approximately 8 accidents would occur. These accidents are expected to result in approximately 169 fatalities, 3 serious injuries, and 26 minor injuries.

The accident-rate assumptions must account for the effects of recent AD's against affected models, because the FAA does not accept that this icing rule, by itself, will prevent all 8 future accidents. In 1996 AD's were issued for airplanes with unpowered controls and pneumatic de-icing boots. In 1999 a second series of AD's were issued for airplanes with pneumatic de-icing boots to activate the systems at the first sign of ice accretion. These two ADs accomplish much the same objectives as the proposed 14 CFR Part 121 rule.

The 1996 severe-icing directives required that operating manuals provide pilots with instructions for operating in freezing rain and freezing drizzle, provided cues to identify such conditions, and offered instructions on how to exit the conditions. These requirements are similar to the proposed rule in sections (c) and (d). The major differences between the 1996 directives and the proposed rule are in the added requirement to substantiate the large droplet icing cues and the provision of an alternate option to install a caution-level alert to provide the required indication.

A second set of AD's were issued in 1999 requiring activation of the IPS at the first sign of ice accretion anywhere on the airplane or upon annunciation of an ice detection system. The system is to be operated on automatic mode if available or by manually cycling to minimize ice accretions on the airframe. This directive accomplishes much of what proposed sections (a) and (b) are proposed to achieve. The main difference is that the proposed rule would require a more conservative activation cue is required (temperature and visible moisture) and that the visual cues used in combination with an advisory ice detection would require validation (or re-validation).

The AD's were issued to establish an increased level of safety with respect to initiating activation of the IPS and providing cues to determine when large droplet icing conditions have been encountered. The benefits analysis considers accidents and incidents that occurred prior to the issuance of the AD's. In fact, it was the findings from the two major accidents listed in Table B1 (1994 & 1997) that prompted the AD's.

Due to the similarity of requirements, it appears reasonable to assume that the ADs have accomplished a substantial portion of the safety increase attributed to the proposed rule within the benefits analysis. The IPHWG, with FAA concurrence, believes it is reasonable to assume that the AD's have already accomplished 50 percent of the safety benefit attributed to the proposed rule in the analysis. This difference would indicate that the actual safety benefit of the proposed rule is on the order of 50 percent of the present values due to the effectiveness of the AD's. Therefore the benefits of preventing future accidents have been reduced by 50 percent.

Table B6
Accidents and Casualties Avoided Over the Next Twenty Years As a Result of Deicing NPRM

Year	Discount Factor	Fatalities Avoided	Present Value (millions)	Serious Injuries Avoided	Present Value (millions)	Minor Injuries Avoided	Present Value (millions)	Total Airplanes Replaced	Present Value (millions)	Investigations	Present Value (millions)	Total (millions)
2007	0.7130	6.00	$13.41	0.12	$0.03	0.91	$0.0055	0.31	$0.85	0.31	$0.31	$14.60
2008	0.6663	6.17	$12.89	0.12	$0.03	0.94	$0.0053	0.31	$0.81	0.31	$0.30	$14.02
2009	0.6227	6.36	$12.40	0.13	$0.02	0.96	$0.0051	0.32	$0.77	0.32	$0.28	$13.48
2010	0.5820	6.55	$11.95	0.13	$0.02	0.99	$0.0049	0.33	$0.73	0.33	$0.27	$12.97
2011	0.5439	6.76	$11.52	0.14	$0.02	1.02	$0.0047	0.33	$0.69	0.33	$0.25	$12.49
2012	0.5083	6.98	$11.12	0.14	$0.02	1.06	$0.0046	0.34	$0.66	0.34	$0.24	$12.05
2013	0.4751	7.22	$10.74	0.15	$0.02	1.09	$0.0044	0.35	$0.63	0.35	$0.23	$11.63
2014	0.4440	7.46	$10.38	0.15	$0.02	1.13	$0.0043	0.35	$0.60	0.35	$0.22	$11.23
2015	0.4150	7.72	$10.04	0.16	$0.02	1.17	$0.0041	0.36	$0.58	0.36	$0.21	$10.85
2016	0.3878	8.00	$9.72	0.16	$0.02	1.21	$0.0040	0.37	$0.55	0.37	$0.20	$10.50
2017	0.3624	8.29	$9.42	0.17	$0.02	1.26	$0.0039	0.38	$0.53	0.38	$0.19	$10.16
2018	0.3387	8.61	$9.13	0.17	$0.02	1.30	$0.0038	0.39	$0.51	0.39	$0.19	$9.85
2019	0.3166	8.94	$8.87	0.18	$0.02	1.35	$0.0036	0.40	$0.49	0.40	$0.18	$9.55
2020	0.2959	9.29	$8.61	0.19	$0.02	1.41	$0.0035	0.41	$0.47	0.41	$0.17	$9.27
2021	0.2765	9.67	$8.37	0.20	$0.02	1.46	$0.0034	0.42	$0.45	0.42	$0.17	$9.01
2022	0.2584	10.06	$8.15	0.20	$0.02	1.52	$0.0033	0.44	$0.43	0.44	$0.16	$8.76
2023	0.2415	10.49	$7.93	0.21	$0.02	1.59	$0.0033	0.45	$0.42	0.45	$0.15	$8.52
2024	0.2257	10.94	$7.73	0.22	$0.02	1.66	$0.0032	0.46	$0.40	0.48	$0.15	$8.30
2025	0.2109	11.42	$7.55	0.23	$0.01	1.73	$0.0031	0.48	$0.39	0.48	$0.14	$8.09
2026	0.1971	11.93	$7.37	0.24	$0.01	1.81	$0.0030	0.50	$0.38	0.50	$0.14	$7.90
Total		169	$197.29	3	$0.39	26	$0.0811	8	$11.32	8	$4.16	$213.24

Note: Fatalities, Serious Injuries, and Minor Injuries include "Willingness To Pay" (WTP) plus Medical and Legal Costs.

Source: U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Plans and Management Analysis, March 2002

Table B5 shows the present value (2002$) benefits of preventing these accidents and casualties are estimated at $213.2 million. Assuming that that the actual safety benefit of the proposed rule is on the order of 50 percent of the present values due to the effectiveness of the AD's, the present value (2002$) benefits of preventing these accidents and casualties are estimated at $106.6 million.

V. BENEFIT-COST ANALYSIS

Following the crash of American Eagle's flight 4184, the NTSB published recommendation A-96-56, which states in part that:

> *If safe operations in certain icing conditions cannot be demonstrated by the manufacturer, operational limitations should be imposed to prohibit flight in such conditions and flight crews should be provided with the means to positively determine when they are in icing conditions that exceed the limits for aircraft certification.*

Following this, the FAA issued the FAA's In-flight Aircraft Icing Plan, April, 1997, detailing the FAA's plans for improving the safety of airplanes operating in icing conditions.

In the absence of this proposed rule, it is highly likely that future icing-related accidents will occur. This industry group study expects on average 8 accidents, over the 20-year analysis period, could be prevented by the enactment of this proposed rule and AD's. The benefit of the proposed rule would be avoiding these accidents. The discounted present value (2002$) benefits of the proposed rule are estimated to be $106.6 million over the 20-year analysis period. These benefits are derived from preventing accidents due to reduced risk of airframe icing. The FAA seeks comment with supportive justification of these benefit estimates.

It is estimated that over the 20-year analysis period, the discounted present value (2002$) cost of the proposed rule is $70.2 million. This includes the cost of ice detection systems design, qualification, certification, crew training, equipment purchase and installation, and testing. The FAA seeks comment with supportive justification on these cost estimates.

The estimated $106.6 million benefits of this proposed rule exceeds the estimated $70.2 million costs.

Thus, accepting the IPHWG's recommendations, the FAA concludes that the benefits of the proposed rule do justify the costs of the proposed 14 CFR Part 121 rule.

VI. INITIAL REGULATORY FLEXIBILITY DETERMINATION

A. Introduction and Purpose of This Analysis

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) establishes "as a principle of regulatory issuance that agencies shall endeavor, consistent with the objective of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the business, organizations, and governmental jurisdictions subject to regulation." To achieve that principle, the Act requires agencies to solicit and consider flexible regulatory proposals and to explain the rationale for their actions. The Act covers a wide-range of small entities, including small businesses, not-for-profit organizations and small governmental jurisdictions.

Agencies must perform a review to determine whether a proposed or final rule will have a significant economic impact on a substantial number of small entities. If the determination is that it will, the agency must prepare a regulatory flexibility analysis as described in the Act.

The FAA believes that this proposal will result in a significant economic impact on a substantial number of small entities. The purpose of this analysis is to provide the reasoning underlying the FAA determination.

Under Section 63(b) of the RFA, the analysis must address:

- Description of reasons the agency is considering the action
- Statement of the legal basis and objectives for the proposed rule
- Description of the record keeping and other compliance requirements of the proposed rule
- All federal rules that may duplicate, overlap, or conflict with the proposed rule
- Description and an estimated number of small entities to which the proposed rule will apply
- Analysis of small firms' ability to afford the proposed rule
- Conduct a disproportionality analysis
- Conduct a competitive analysis
- Estimation of the potential for business closures
- Describe the alternatives considered

B. Reasons Why the Rule Is Being Proposed

On October 31, 1994, an Avions de Transport Regional model 72-212 (Aerospatiale Model ATR 72), operated by American Eagle as flight 4184, crashed during a rapid descent after an uncommanded roll excursion. Flight 4184 was a regularly scheduled passenger flight being conducted under 14 CFR Part 121, and an instrument flight rules plan had been filed. The airplane was in a holding pattern and was descending to a newly assigned altitude of 8,000 feet when the initial roll excursion occurred. Impact forces destroyed the airplane; the captain, first officer, two flight attendants, and 64 passengers received fatal injuries. Flight 4184 operated in icing conditions, believed to include freezing drizzle droplets, which were reported in the area. The FAA, Aerospatiale, the French Direction Générale de l'Aviation Civile, Bureau Enquete Accident, National Aeronautics and Space Administration (NASA), National Transportation Safety Board (NTSB), and others have conducted an extensive investigation of this accident. The investigation concluded that freezing drizzle conditions created a ridge of ice aft of the deicing boots and forward of the ailerons, which resulted in uncommanded roll of the airplane.

An examination of the accident and incident history revealed that the flight crews must be provided with a clear means to know when to activate the IPS (Ice Protection System). This proposed rule would ensure timely activation of the IPS when the airplane is in icing conditions.

The proposed rule is responsive to NTSB recommendation A-96-56, which is on the NTSB's Most Wanted List. The proposed rule is also one of the items listed in the FAA's In-flight Aircraft Icing Plan, April, 1997. The Icing Plan details the FAA's plans for improving the safety of airplanes when they are operated in icing conditions. Neither the operating regulations nor the certification regulations require a means for the pilot in command to specifically identify that hazardous icing conditions have been met. The proposed rule will provide a means for the flight crew to determine that icing conditions must be exited.

The NPRM specifically applies to 14 CFR part 121 operators of airplanes that have MTOW of less than 60,000 pounds and are certificated for flight in icing. For this section of the analysis, those operators meeting the above criteria that have 1,500 or fewer employees are considered.[21]

C. Statement of the Legal Basis and Objectives

Under Title 49 of the United States Code, the FAA Administrator is required to consider the following matters, among others, as being in the public interest:

- Assigning, maintaining, and enhancing safety and security as the highest priorities in air commerce. [See 49 U.S.C. §40101(d)(1).]
- Additionally, it is the FAA Administrator's statutory duty to carry out his or her responsibilities "in a way that best tends to reduce or eliminate the possibility or recurrence of accidents in air transportation." [See 49 U.S.C. §44701(c).]

Accordingly, this proposed rule will amend Title 14 of the Code of Federal Regulations to require the operators of airplanes with a MTOW of less than 60,000 pounds that operate under 14 CFR part 121 regulations to either install ice detection equipment or change the AFM to ensure timely activation of the IPS. The proposed rule also will require certain actions applicable to airplanes with reversible flight controls for the pitch and/or roll axis.

D. Projected Reporting, Record Keeping and Other Requirements

The FAA expects no more than minimal new reporting and record-keeping compliant requirements would result from this proposed rule. The proposed rule will require additional entries in existing required maintenance records to account for either the additional maintenance requirements or the installation of ice detection system and/or caution-level alert systems.

[21] 13 CFR Part 121.201, Size Standards Used to Define Small Business Concerns, Sector 48-49 Transportation, Subsector 481 Air Transportation.

Additional reporting and record keeping for training also will be no more than minimal because, under 14 CFR 121.419, certificate holders already must provide pilot training that includes:

> . . . procedures for recognizing and avoiding severe weather situations; escaping from severe weather situations, and operating in or near thunderstorms (including best penetrating altitudes), turbulent air (including clear air turbulence), icing, hail, and other potentially hazardous meteorological conditions.

E. <u>Overlapping, Duplicative, or Conflicting Federal Rules</u>

The FAA is unaware that the proposed rule will conflict with existing Federal Rules. The requirements proposed in this NPRM to some extent overlap and duplicate existing requirements in certain ADs (Airworthiness Directives). Those ADs require revisions to AFM's (Aircraft Flight Manual) for certain airplanes to provide information and instructions to pilots for operating in icing conditions. The costs attributed to those AD's were the costs associated with revising the AFM's. Similarly, this proposed rule would require AFM revisions to provide information for operating in icing conditions for these same airplanes, among others. The information required by this proposal would be more detailed and specific to the individual airplane models than the information required by the AD's. Once this rule is adopted, the FAA will consider revising the AD's to eliminate requirements for information that is no longer needed.

F. <u>Estimated Number of Small Firms Potentially Impacted</u>

The FAA used the SBA guideline of 1,500 employees or less per firm as the criterion for the determination of a small business in commercial air service.[22]

[22] 13 CFR Part 121.201, Size Standards Used to Define Small Business Concerns,

A list of all U.S. operated civilian airplanes operating in 14 CFR Part 121 was generated by the FAA Flight Standards Group.[23]

Each listed airplane was matched with its current (as of January 6, 2002) MTOW and age through the use of the FleetPC™ database provided by BACK Aviation Solutions.

All airplanes with a MTOW greater than 60,000 pounds were eliminated from the fleet of 14 CFR Part 121 airplanes.

Fleet PC™ had numerous airplanes with no MTOW data. For these airplanes, Janes *All the Worlds Aircraft Publication* was consulted.

Using information provided by the World Aviation Directory Winter 2000, Dunn and Bradstreet's company databases, and SEC filings through the Internet, scheduled and non-scheduled commercial operators that are subsidiary businesses of larger businesses were eliminated from the database. An example of a subsidiary business is Continental Express, Inc., which is a subsidiary of Continental Airlines.

Using information provided by the U.S. Department of Transportation Form41 filings, the World Aviation Directory Winter 2000, and Dunn and Bradstreet's company databases, all businesses with more than 1,500 employees were eliminated. For the remaining business, the FAA obtained company revenue from these three sources, when the operator made revenue was public.

Sector 48-49 Transportation, Subsector 481 Air Transportation.
[23] AFS-260

The FAA was unable to obtain employment data for the following 14 CFR Part 121 commercial air operators:

Operator	Annual Revenue	Employment
Air Tahoma Inc	n/a	n/a
Aviation Services, Ltd.	n/a	n/a
Gulf and Caribbean Cargo, Inc.	n/a	n/a
PauMitch Corp	n/a	n/a
Royal Air Freight, Inc.	n/a	n/a

The FAA used the FleetPC™ database and determined turboprops are retired from U.S. certificated service at an average age (mean) of 23.8 years with a standard deviation of 7.43 years. The FAA assumed the following small business operator's airplanes would be retired by 2007.

Operator	Make Model	Number
COASTAL AIR TRANSPORT	CV-340	1
Eagle Canyon Airlines, Inc.	DHC-6	19
Eagle Jet Charter, Inc.	F-27	5
Empire Airlines, Inc.	F-27	13
ERA AVIATION INC	CV-340	3
ERA AVIATION INC	CV-440	2
ERA AVIATION INC	DC-3-C	2
ERA AVIATION INC	DHC-6	9
Farwest Airlines LLC	DHC-7	1
Gulfstream International Airlines	DHC-7	2
Lynx Air International, Inc.	SA-227	1
Mountain Air Cargo, Inc.	F-27	14
Samoa Aviation, Inc.	DHC-6	1
Seaborne Virgin Islands, Inc.	DHC-6	7
Tatonduk Outfitters, Ltd.	C46	2
Tol Air Services Inc.	CV-240	1
Trans Air Link Corp.	CV-440	1
Trans Florida Airlines, Inc.	CV-240	3

The FAA notes the above 87 small business operated 14 CFR Part 121 airplanes represent 81% of the total number of airplanes the FAA assumed would be retired by 2007.

The methodology discussed above resulted in the following list of 27 U.S. scheduled and nonscheduled commercial operators with less than 1,500 employees, operating a total of 548 airplanes:

Operator	Number
Air Midwest Inc.	26
BIG SKY TRANSPORTATION CO	16
Casino Airlines, Inc.	1
Champlain Enterprises, Inc.	31
CHAUTAUQUA AIRLINES INC	56
Colgan Air, Inc.	18
CORPORATE AIR	2
Corporate Airlines, Inc.	17
ERA AVIATION INC	3
Executive Airlines, Inc.	30
Express Airlines I, Inc	47
Farwest Airlines LLC	1
Frontier Flying Service, Inc.	5
Great Lakes Aviation, Ltd.	48
Gulfstream International Airlines Inc	34
Lynx Air International, Inc.	2
Merlin Airways, Inc.	1
MIDWAY AIRLINES CORPORATION	24
Mountain Air Cargo, Inc.	6
Ozark Air Lines, Inc.	2
Pacific Island Aviation, Inc.	3
PENINSULA AIRWAYS INC	10
Samoa Aviation, Inc.	1
Shuttle America Corporation	4
SkyWest Airlines, Inc.	117
Sunrise Airlines, Inc.	1
Trans States Airlines Inc.	42
TOTAL	548

G. Cost and Affordability for Small Entities

The FAA estimated the cost of compliance per airplane and multiplied this cost by the total fleet of affected airplanes per operator to obtain the total compliance cost by small entity.

The following table shows the non-discounted initial cost of compliance per airplane:

Airplane Type	Number of Airplanes 2007	Reversible or Irreversible	Cost = min[(a)(1), (a)(2), or (a)(3)]			Cost = min[(c)(1) or (c)(2)]		Additional Annual Costs to Maintain Ice Protection System
			Primary Ice Detector? (a)(1)	Advisory Ice Detector? (a)(2)	Visible Moisture and Temp. (a)(3)	Visible Cues (c)(1)	Large Droplet Alert System (c)(2)	
ATR 42	59	Reversible	No	Comply	$0	Comply	$0	$0
ATR 72	64	Reversible	No	Comply	$0	Comply	$0	$0
Bombardier CRJ	296	Irreversible	Comply	Comply	$0	N/A	N/A	$0
DHC-8-100 thru-300	189	Reversible	No	Comply	$0	No	$66,097	$0
Dornier 328	48	Reversible	No	Comply	$0	No	$83,244	$0
Dornier 328JET	32	Reversible	No	Comply	$0	No	$70,868	$0
Embraer EMB-120	199	Reversible	No	Comply	$0	No	$65,804	$0
Embraer EMB-135	67	Irreversible	Comply	No	$0	N/A	N/A	$0
Embraer EMB-145	203	Irreversible	Comply	No	$0	N/A	N/A	$0
Fokker/Fairchild F27C	6	Reversible	No	No	$4,593	No	$244,135	$2,378
Jetstream 31/32	51	Reversible	No	No	$4,223	No	$70,475	$4,521
Jetstream 4101	57	Reversible	No	Comply	$0	No	$70,945	$0
Metro II/III	26	Reversible	No	No	$2,029	No	$102,693	$2,378
Raytheon 1900C/D	172	Reversible	No	No	$3,120	No	$66,674	$4,521
Saab 340	253	Reversible	No	No	$1,339	No	$64,621	$2,378
Shorts 330/360	13	Reversible	No	No	$2,798	No	$145,125	$2,378

The degree to which small air operator entities can "afford" the cost of compliance is determined by the availability of financial resources. The initial implementation costs of the proposed rule may be financed, paid for using existing company assets, or borrowed. As a proxy for the firm's ability to afford the cost of compliance, the FAA calculated the ratio of the total present value cost of the proposed rule as a percentage of annual revenue. This ratio is a conservative measure as the present value of the 20-year total compliance cost is divided by one year of annual revenue. Twelve of the 27 small business operators potentially affected by this proposed rule incurred costs greater that 2 percent of their annual revenue. The following table shows the economic impact of the small entity air operators affected by this proposed rule.

Operator	Number of Airplanes	PVCost	Percent	Annual Revenue	Employment
MIDWAY AIRLINES CORPORATION	24	$0	0.00%	$164,783,000	336
Executive Airlines, Inc.	30	$769,683	0.44%	$174,571,133	1,490
ERA AVIATION INC	3	$141,379	0.60%	$23,468,175	500
Trans States Airlines Inc.	42	$1,256,197	0.64%	$196,861,728	1,473
Shuttle America Corporation	4	$188,506	0.67%	$27,930,988	350
Merlin Airways, Inc.	1	$95,632	0.74%	$12,956,433	35
SkyWest Airlines, Inc.	117	$4,269,476	0.82%	$522,058,773	15
Express Airlines I, Inc	47	$1,499,946	1.22%	$123,025,000	563
CORPORATE AIR	2	$247,233	1.37%	$18,000,000	180
Samoa Aviation, Inc.	1	$47,126	1.41%	$3,348,147	65
Casino Airlines, Inc.	1	$59,495	1.59%	$3,750,000	15
Mountain Air Cargo, Inc.	6	$1,297,301	1.65%	$78,757,000	472
Great Lakes Aviation, Ltd.	48	$3,535,803	1.77%	$199,507,753	1,250
Air Midwest Inc.	26	$2,059,135	1.79%	$115,345,307	375
Frontier Flying Service, Inc.	5	$353,289	2.14%	$16,496,102	95
PENINSULA AIRWAYS INC	10	$834,223	2.65%	$31,463,237	350
Gulfstream International Airlines Inc	34	$2,474,451	2.85%	$86,880,041	769
Champlain Enterprises, Inc.	31	$2,469,574	3.29%	$75,000,000	375
Sunrise Airlines, Inc.	1	$62,311	3.56%	$1,750,000	7
Ozark Air Lines, Inc.	2	$135,092	3.60%	$3,750,000	7
CHAUTAUQUA AIRLINES INC	56	$1,432,067	3.88%	$36,901,617	700
Lynx Air International, Inc.	2	$179,894	4.80%	$3,750,000	35
Colgan Air, Inc.	18	$1,169,986	6.16%	$19,000,000	200
BIG SKY TRANSPORTATION CO	16	$1,489,454	6.20%	$24,007,470	240
Pacific Island Aviation, Inc.	3	$384,195	7.01%	$5,484,131	small
Corporate Airlines, Inc.	17	$1,254,891	71.71%	$1,750,000	small
Farwest Airlines LLC	1	$47,538	n/a	n/a	35

A summary of the present value (2002$) discounted costs per annual revenue is presented in the following table.

Present Value Cost As a Percent of Annual Revenue	Number of Firms	Percent of Firms
Unknown Annual Revenue	1	3.70%
0 to 1%	7	25.93%
1.1 - 2%	7	25.93%
2.1 to 3%	3	11.11%
3.1 to 4%	4	14.81%
4.1 to 5%	1	3.70%
5.1 to 6%	0	0.00%
Over 6.1%	4	14.81%
Totals	27	100.00%

H. <u>Disproportionality Analysis</u>

In the first year of this proposed rule, 74 percent of U.S. passenger small business operators' and 54 percent of the large U.S. commercial passenger business operators' fleets would be affected by the proposed rule. This disproportionately higher impact of the proposed rule on the fleets of small operators result in disproportionately higher cost to small operators. In addition, these costs represent a larger percentage of annual revenue for the small operators than for the large operators. Further, due to the potential of fleet discounts, large operators may be able to negotiate better pricing from outside sources for inspections, installation, and ice protection hardware purchases.

Based on the percent of potentially affected current airplanes over the 20-year analysis period, small U.S. business operators are estimated to bear a disproportionate impact from the proposed rule.

I. Competitive Analysis

In order to determine the competitive impact of the rule on small entities, the FAA studied the routes the small business operators operated. The FAA determined that 15 of the 27 U.S. commercial passenger small business operators operated scheduled services.[24] The route structures and specific markets of these 15 operators were examined. The FAA determined that the 15 operators operated in 391 distinct U.S. markets. As small business operators are compensated by their major code-share partner for code-share routes, 198 of these markets were excluded. In only 20 of the 193 remaining markets, do large operators compete with the 15 small business operators. In 173 of the 193 markets served by the 15 operators, the operators could be considered local monopolies since the affected carriers are the only providers of service. Small business operators have a local monopoly by serving specific needs. As a result of operating in these niche markets, a carrier would be able to pass some of the cost to its passengers. Similarly, the remaining 12 of the 27 operators are likely to provide customized

[24] BACK Aviation Solutions, Aviation Schedules(OAG)

services and would be able to pass some costs to its customers. Thus, as a result of this rule, there is expected to be little change in competition and little change in market share within the industry.

Overall, in terms of competition, this proposed rule does not reduce the ability of small operators to compete.

<u>Business Closure Analysis</u>

For commercial operators, the ratio of present-value costs to annual revenue shows that 4 of the 27 U.S. scheduled and nonscheduled commercial small business air operator firms analyzed would have ratios in excess of 5 percent, and such a ratio may have a significant financial impact when this proposed rule becomes effective. To fully assess whether this proposed rule would force a small entity into bankruptcy requires more financial information than is readily available.

The FAA seeks comment with supportive justification to determine the degree of hardship the proposed rule will have on these businesses.

J. <u>Analysis of Alternatives</u>

Alternative One

The "baseline," "do nothing," or *status quo* alternative has no compliance costs but will not accomplish the intent of the NTSB recommendation A-96-56 and the FAA's In-flight Icing Plan. As it stands, the proposed rule is the reasoned result of the FAA Administrator carrying out the FAA's In-flight Aircraft Icing Plan. The FAA rejected this "do nothing" alternative because the proposed rule would enhance passenger safety and prevent ice-related accidents for airplanes with a MTOW less than 60,000 pounds.

Alternative Two

Alternative Two would be to issue AD's requiring a means to know when to exit icing conditions and when the IPS must be activated. AD's have been issued for certain airplanes requiring the activation of ice protection systems at the first sign of ice accretion and exiting icing conditions based on subjective visual cues.

The FAA has issued AD's to address the activation of IPS and when to exit icing conditions. The AD's regarding the activation of the IPS relieve the pilot of determining whether the amount of ice accumulated on the wing warrants activation of the IPS. The AD's mandate the activation of the IPS when the pilot becomes aware of ice accretions on the airplane. The AD's regarding exiting icing conditions generally rely on visual cues that are subjective and can result in varying interpretations.

An evaluation of accidents and incidents led to the conclusion that the AD's do not provide adequate assurance that the flightcrew will be made aware of when to activate the IPS or when to exit icing conditions. Because this problem is not unique to particular airplane designs, but exists for all airplanes that are susceptible to the icing hazards described previously, it is appropriate to address this problem through an operational rule, rather than by ADs.

Alternative Three

The working group considered installing an aerodynamic performance monitor to provide a warning to the crew when the aerodynamic performance of the airplane has degraded to the point where the flight crew should exit icing conditions. The immature development of aerodynamic performance monitors does not make this alternative a viable option.

Alternative Four

Alternative Four is the proposed rule. The FAA's judgement is that this is the most viable option since the proposed rule will increase the safety of the flying public by reducing icing-related accidents in the future in the least costly way.

VII. INTERNATIONAL TRADE IMPACT ASSESSMENT

The Trade Agreement Act of 1979 prohibits Federal agencies from engaging in any standards or related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards.

In accordance with the above statute, the FAA has assessed the potential effect of this proposed rule and has determined that the impact is primarily domestic, as these are operators of short-haul market airplanes, and that the purpose of the rule is safety. The FAA considers that this is consistent with the International Trade Act and therefore is not considered an obstacle to international trade.

VIII. UNFUNDED MANDATES ASSESSMENT

Title II of the Unfunded Mandates Reform Act of 1995 (the Act), enacted as Pub. L. 104-4 on March 22, 1995, requires each Federal agency, to the extent permitted by law, to prepare a written assessment of the effects of any Federal mandate in a final agency rule that may result in the expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of $100 million or more (adjusted annually for inflation) in any one year. Section 204(a) of the Act, 2 U.S.C. 1534(a), requires the Federal agency to develop an effective process to permit timely input by elected officers (or their designees) of State, local, and tribal governments on a final "significant intergovernmental mandate." A "significant intergovernmental mandate" under the Act is any provision in a Federal agency regulation that will impose an enforceable duty upon

State, local, and tribal governments, in the aggregate, of $100 million (adjusted annually for inflation) in any one year. Section 203 of the Act, 2 U.S.C. 1533, which supplements section 204(a), provides that before establishing any regulatory requirements that might significantly or uniquely affect small governments, the agency shall have developed a plan that, among other things, provides for notice to potentially affected small governments, if any, and for a meaningful and timely opportunity to provide input in the development of regulatory rules. Because this proposed rule does not include a private-sector mandate with a potential cost impact of more than $100 million annually, the analytical requirements of Title II of the Unfunded Mandates Reform Act of 1995 do not apply.

Appendix C1

Manufacture Non-recurring and Direct Operator Costs for Section (a)(1)

Manufacture Non-recurring Costs (per airplane group/type) 2002$		HOURS	HOURLY RATE	ADDITIONAL COST	COST
System Design					
	System architecture/integration	3,000	$100		$300,000
	Ice detector positioning	300	$100		$30,000
	Associated Procedure for AFM,FCOM and MMEL	200	$100		$20,000
System Qualification/ certification					
	Ice detector qualification	300	$100		$30,000
	Ice detection system certification	600	$100		$60,000
	Reports - Test Proposal and Results Flight test	400	$100	$460,000	$500,000
Tasks associated to the retrofit					
	Service Bulletin preparation/approval	500	$60		$30,000
	Crew Training program	500	$60		$30,000
TOTAL		5,800			$1,000,000
Operator Costs (per airplane)					
	Service Bulletin Kit (Primary Ice Detector)			$35,000	$35,000
	Kit Installation	300	$60		$18,000
	Training costs - 10 pilots	20	$60		$1,200
	Additional weight is 5-10 kg				$0
	Loss of Revenue (3 days downtime @ $5,000/day)				$15,000
	Update AFM	1	$60		$60
TOTAL					$69,260

Appendix C2

Manufacture Non-recurring and Direct Operator Costs for Section (a)(2)

Manufacture Non-recurring Costs (per airplane group/type) 2002$		HOURS	HOURLY RATE	ADDITIONAL COST	COST
System Design					
	System architecture/integration	2,500	$100		$250,000
	Ice detector positioning	200	$100		$20,000
	Visual cue determination	200	$100		$20,000
	Associated Procedure for AFM,FCOM and MMEL	200	$100		$20,000
System Qualification/ certification					
	Ice detector qualification	300	$100		$30,000
	Visual cue substantiation	200	$100		$20,000
	Ice detection system certification	300	$100		$30,000
	Reports - Test Proposal and Results				
	Flight test	400	$100	$330,000	$370,000
Tasks associated to the retrofit					
	Service Bulletin preparation/approval	500	$60		$30,000
	Crew Training program	500	$60		$30,000
TOTAL		5,300			$820,000
Operator Costs (per airplane)					
	Service Bulletin Kit (Advisory Ice Detector)			$19,500	$19,500
	Kit Installation	150	$60		$9,000
	Training costs - 10 pilots	20	$60		$1,200
	Additional weight is 5-10 kg				$0
	Loss of Revenue (3 days downtime @ $5,000/day)				$15,000
	Update AFM	1	$60		$60
TOTAL					$44,760

Appendix C3

Manufacture Non-recurring and Direct Operator Costs for Section (a)(3)

	ALL OTHER AIRPLANES			CESSNA 402/421. DC-3, C-46, JETSTREAM 3101/3201/41 B1900			
Manufacturer Non-recurring Costs (per airplane group/type) 2002$	**HOURS**	**HOURLY RATE**	**COST**	**HOURS**	**HOURLY RATE**	**ADDITIONAL COST**	**COST**
System Design							
Procedures for AFM, AOM/FCOM & MME	200	$100	$20,000	200	$100		$20,000
System Qualification / certification							
Flight tests			$0			$300,000	$300,000
Total	**200**		**$20,000**	**200**			**$320,000**
Operator costs (per airplane)							
Training costs - 10 pilots	20	$60	$1,200	20	$60		$1,200
Additional weight is 5 - 10 kg			$0				$0
Update AFM	1	$60	$60	1	$60		$60
Total			**$1,260**				**$1,260**
Increased Maintenance Costs (per airplane/Month)							
Increased use of a pneumatic boot will drop the average service life. The service life will decrease from originally 4 years to 2 to 2.5 years due to already introduced AD's. Further 25% increase of boots usage due to new regulated cue decreases the life to 2*0.75 = 1.5 years							
Pre AD			$416				$416
Post AD			$594				
Post IPHWG			$793				$793
Increase (post IPHWG-pre AD)							$377
Increase (post IPHWG-post AD)			$198				

Appendix C4

Costs for Section (c)(1)

Manufacturer Non-recurring Costs (per airplane group/type) 2002$	HOURS	HOURLY RATE	ADDITIONAL COST	COST
Icing Tanker			$240,000	$240,000
Flight test including airplane rental	300	$100	$220,000	$250,000
Associated procedures for AFM & AOM/FCOM	100	$100		$10,000
Total	**400**			**$500,000**

Appendix C5

Manufacture Non-recurring and Direct Operator Costs for Section (c)(2)

NRC - Non-recurring Costs (per a/p group) caution-level alert system		HOURS	HOURLY RATE	ADDITIONAL COST	COST
System Design					
	System architecture/integration	2500	$100		$250,000
	Caution Level Alert positioning	200	$100		$20,000
	Associated Procedure for AFM,FCOM and MMEL	200	$100		$20,000
System Qualification/ certification					
	Ice detector qualification	300	$100		$30,000
	Ice detection system certification	300	$100		$30,000
	Flight test including airplane rental			$453,250	$453,250
	Icing tanker			$240,000	$240,000
Tasks associated to the retrofit					
	Service Bulletin preparation/approval	500	$60		$30,000
	Crew Training program	500	$60		$30,000
TOTAL		4500			$1,103,250
Operator Cost (per airplane)					
	Service Bulletin Kit (Equipment purchase only)			$35,000	$35,000
	Kit Installation	150	$60		$9,000
	Training costs - 10 pilots	20	$60		$1,200
	Additional weight is 5-10 kg				$0
	Loss of Revenue (3 days downtime @ $5,000/day)				$15,000
	Update AFM	1	$60		$60
Total		171			$60,260

Appendix C6

Cost Summary

	YEAR	Undiscounted Costs	P.V.	Discounted Costs
	2002	$0.00	1.00	$0.00
	2003	$0.00	0.93	$0.00
	2004	$0.00	0.87	$0.00
	2005	$0.00	0.82	$0.00
	2006	$0.00	0.76	$0.00
1	2007	$81,327,527	0.71	$57,985,403
2	2008	$1,999,056	0.67	$1,332,055
3	2009	$2,272,059	0.62	$1,414,924
4	2010	$2,537,929	0.58	$1,477,098
5	2011	$2,485,623	0.54	$1,352,014
6	2012	$2,426,184	0.51	$1,233,349
7	2013	$2,390,520	0.48	$1,135,719
8	2014	$2,201,792	0.44	$977,622
9	2015	$1,907,670	0.41	$791,615
10	2016	$1,654,982	0.39	$641,830
11	2017	$1,515,053	0.36	$549,125
12	2018	$1,407,242	0.34	$476,682
13	2019	$1,263,220	0.32	$399,903
14	2020	$916,672	0.30	$271,210
15	2021	$386,892	0.28	$106,979
16	2022	$218,821	0.26	$56,547
17	2023	$60,260	0.24	$14,554
18	2024	$0	0.23	$0
19	2025	$0	0.21	$0
20	2026	$0	0.20	$0
TOTAL		**$106,971,502.87**		**$70,216,629.76**

§ 26.41 Audits and corrective action.

* * * * *

(d) * * *

(1) The contracts of licensees and other entities with C/Vs and HHS-certified laboratories must reserve the right to audit the C/V, the C/V's subcontractors providing FFD program services, and the HHS-certified laboratories at any time, including at unannounced times, as well as to review all information and documentation that is reasonably relevant to the audits.

* * * * *

■ 4. In § 26.69, paragraphs (c)(3) and (d)(2) are revised to read as follows:

§ 26.69 Authorization with potentially disqualifying fitness-for-duty information.

* * * * *

(c) * * *

(3) If the designated reviewing official determines that a determination of fitness is required, verify that a professional with the appropriate qualifications, as specified in § 26.189(a), has indicated that the individual is fit to safely and competently perform his or her duties;

* * * * *

(d) * * *

(2) If the designated reviewing official concludes that a determination of fitness is required, verify that a professional with the appropriate qualifications, as specified in § 26.189(a), has indicated that the individual is fit to safely and competently perform his or her duties; and

* * * * *

■ 5. In § 26.137, paragraphs (d)(2)(i), (d)(5), and (e)(6)(v) are revised to read as follows:

§ 26.137 Quality assurance and quality control.

* * * * *

(d) * * *

(2) * * *

(i) Colorimetric pH tests must have a dynamic range of 2 to 12 and pH meters must be capable of measuring pH to one decimal place.

* * * * *

(5) Each analytical run performed to conduct initial validity testing shall include at least one quality control sample that appears to be a donor specimen to the licensee testing facility technicians.

* * * * *

(e) * * *

(6) * * *

(v) At least one positive control, certified to be positive by an HHS-certified laboratory, which appears to be a donor specimen to the licensee testing facility technicians.

* * * * *

■ 6. In § 26.153, paragraph (f)(3) is revised to read as follows:

§ 26.153 Using certified laboratories for testing urine specimens.

* * * * *

(f) * * *

(3) The laboratory shall maintain test records in confidence, consistent with the requirements of § 26.37, and use them with the highest regard for individual privacy.

* * * * *

Dated at Rockville, Maryland, this 27th day of July 2009.

For the Nuclear Regulatory Commission.

Annette L. Vietti-Cook,

Secretary of the Commission.

[FR Doc. E9–18364 Filed 7–31–09; 8:45 am]

BILLING CODE 7590–01–P

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No.: FAA–2007–27654; Amendment No. 25–129]

RIN 2120–AI90

Activation of Ice Protection

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: The Federal Aviation Administration amends the airworthiness standards applicable to transport category airplanes certificated for flight in icing conditions. The rule requires a means to ensure timely activation of the airframe ice protection system. This rule is the result of information gathered from a review of icing accidents and incidents, and will improve the level of safety for new airplane designs for operations in icing conditions.

DATES: This amendment becomes effective September 2, 2009.

FOR FURTHER INFORMATION CONTACT: For technical questions concerning this final rule contact Kathi Ishimaru, FAA, Propulsion and Mechanical Systems Branch, ANM–112, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Ave., SW., Renton, Washington 98057–3356; telephone (425) 227–2674; fax: (425) 227–1320, e-mail: *kathi.ishimaru@faa.gov.* For legal questions concerning this final rule contact Douglas Anderson, FAA, Office of Regional Counsel, Federal Aviation Administration, 1601 Lind Ave., SW., Renton, Washington 98057–3356; telephone (425) 227–2166; fax: (425) 227–1007, e-mail: *Douglas.Anderson@faa.gov.*

SUPPLEMENTARY INFORMATION:

Authority for This Rulemaking

The FAA's authority to issue rules on aviation safety is found in Title 49 of the United States Code. Subtitle I, Section 106 describes the authority of the FAA Administrator. Subtitle VII, Aviation Programs, describes in more detail the scope of the agency's authority.

This rulemaking is promulgated under the authority described in Subtitle VII, Part A, Subpart III, Section 44701, ''General requirements.'' Under that section, the FAA is charged with promoting safe flight of civil aircraft in air commerce by prescribing minimum standards required in the interest of safety for the design and performance of aircraft. This regulation is within the scope of that authority because it prescribes new safety standards for the design of transport category airplanes.

I. Background

On October 31, 1994, an accident involving an Avions de Transport Regional ATR 72 series airplane occurred in icing conditions.[1] This prompted the FAA to initiate a review of aircraft inflight icing safety and determine changes that could be made to increase the level of safety. In May 1996, the FAA sponsored the International Conference on Aircraft Inflight Icing where icing specialists recommended improvements to increase the level of safety of aircraft operating in icing conditions. The FAA reviewed the conference recommendations and developed a comprehensive multi-year icing plan. The FAA Inflight Aircraft Icing Plan (Icing Plan), dated April 1997,[2] described various activities the FAA was contemplating to improve safety when operating in icing conditions. In accordance with the Icing Plan, the FAA tasked the Aviation Rulemaking Advisory Committee (ARAC),[3] through its Ice Protection Harmonization Working Group, to consider the need for ice detectors or other acceptable means to warn flightcrews of ice accretion on critical surfaces requiring crew action. This rule

[1] This accident and an Empressa Brasilia accident resulted in NTSB recommendations nos. A–96–56 and A–98–91. This final rule partially addresses these safety recommendations.

[2] FAA Inflight Aircraft Icing Plan, dated April 1997, available in the Docket.

[3] Published in the **Federal Register**, December 8, 1997 (62 FR 64621).

is based on ARAC's recommendations to the FAA.

A. Summary of the NPRM

The notice of proposed rulemaking (NPRM), Notice No. 07–07, published in the **Federal Register** on April 26, 2007 (72 FR 20924), is the basis for this amendment. The comment period closed July 25, 2007. In the NPRM, we proposed to revise the airworthiness standards for type certification of transport category airplanes to add requirements to ensure the timely activation of an airframe ice protection system (IPS). We also proposed to add requirements to reduce the flightcrew workload associated with operation of an airframe IPS that is manually cycled, and to ensure the Airplane Flight Manual includes IPS procedures for operation.

B. Summary of the Final Rule

The FAA is adopting this final rule because accidents and incidents occurred where the flightcrew did not operate the airframe IPS in a timely manner and because of concerns over the flightcrew workload required to operate an airframe IPS that the flightcrew must manually cycle when they observe ice accretions. The final rule addresses these concerns by ensuring that flightcrews are provided with a clear means to know when to activate the airframe IPS. The final rule reduces the workload associated with monitoring ice accretions by requiring a system that operates continuously, a system that automatically cycles the IPS, or an alert to the flighcrew each time the IPS must be cycled.

This final rule adopts the proposed rule with minor changes and adds minor conforming changes to rules that were added by the final rule entitled ''Airplane Performance and Handling Qualities in Icing Conditions (72 FR 44656, August 8, 2007) (Amendment 25–121).[4] Amendment 25–121 added specific requirements for airplane performance and handling qualities for flight in icing conditions. Sections 25.143(j) and 25.207(h), at Amendment 25–121, define requirements that apply if activating the IPS depends on the pilot seeing a specified ice accretion on a reference surface (not just the first sign of ice accretion).

Section 25.1419(e) of this final rule requires one of three methods of detecting icing and activating the airframe IPS.[5] Activation based on the pilot seeing a specified ice accretion on a reference surface (not just the first sign of ice accretion) is not one of the three methods allowed under this rulemaking, so any requirements associated with this method are no longer relevant. Therefore, minor conforming changes have been made to §§ 25.143(j) and 25.207(h) to remove the references to, and requirements associated with, activating the IPS in response to the pilot seeing a specified ice accretion on a reference surface. Additional minor changes have been made to § 25.207(h) to improve readability, including moving a portion of existing § 25.207(h)(2)(ii) to a new § 25.207(i). The text of part 25, appendix C, part II(e) has been revised to include a reference to the new § 25.207(i).

In addition, minor changes have been made to § 25.207(b) to improve clarity and to correct an error introduced by Amendment 25–121. Section 25.207(b), as amended by Amendment 25–121, states, ''Except for the stall warning prescribed in paragraph (h)(2)(ii) of this section, the stall warning for flight in icing conditions prescribed in paragraph (e) of this section must be provided by the same means as the stall warning for flight in non-icing conditions.'' However, the stall warning prescribed by § 25.207(h)(2)(ii) is an exception only to the § 25.207(b) requirement that stall warning in icing conditions be provided by the same means as for non-icing conditions. It is not an exception to, nor is it associated with, the stall warning margin prescribed by § 25.207(e). The reference to § 25.207(e) is incorrect and potentially confusing. Therefore, it is removed by this final rule.

Because of the reformatting of § 25.207(h), as discussed above, the previous § 25.207(h)(2)(ii) is now § 25.207(h)(3)(ii). The reference to this paragraph in § 25.207(b) is changed accordingly. Other minor wording changes have been made to improve clarity. We consider all of these changes to § 25.207(b) to be technical clarifications that do not change the intent of this paragraph or impose an additional burden on applicants.

Below is a more detailed discussion of the rule as it relates to the comments we received on the NPRM. Appendix 1 defines terms used in this preamble.

II. Summary of Comments

The FAA received 14 comments concerning the following general areas of the proposal:

- Acceptable methods to determine if the airframe IPS must be activated.
- Automatic cycling of the airframe IPS.

Four of the commenters, the Airline Pilots Association (ALPA), National Transportation Safety Board (NTSB), BAE Systems Regional Aircraft, and The Boeing Company (Boeing), expressed support for the rule. ALPA supported the rule without recommendations to revise the rule. Twelve commenters suggested specific improvements or clarifications. They were the NTSB, BAE Systems Regional Aircraft, Boeing, the Air Crash Victims Families Group, Bombardier Aerospace, Marinvent Corporation, the Regional Airline Association, Swan International Sensors, Transport Canada, and three individuals. Ameriflight LLC (Ameriflight) opposed certain provisions of the rule. Summaries of the comments and our responses (including explanations of any changes to the final rule in response to the comments) are provided below.[6]

A. Ice Detection, Activation of Airframe IPS, and Automatic Cycling of Airframe IPS

In the NPRM, we proposed one of the following three methods for ice detection and activation of the airframe IPS to ensure timely activation of the airframe IPS (proposed § 25.1419(e)):

- A primary ice detection system that automatically activates or alerts the flightcrew to activate the airframe IPS;
- Visual cues for recognition of the first sign of ice accretion combined with an advisory ice detection system that alerts the flightcrew to activate the airframe IPS; or
- Identification of conditions conducive to airframe icing for use by the flightcrew to activate the airframe IPS when those conditions exist.

In addition, proposed § 25.1419(g) would require an airframe IPS that operates cyclically (for example, deicing boots) to automatically cycle after the initial activation, or installation of an ice detection system to alert the flightcrew each time the deicing boots must be activated.

The following comments were received on these proposals.

1. Oppose Installation of an Ice Detection System

Ameriflight opposed the installation of an ice detection system because properly trained flightcrews can easily detect ice accretion by means such as ice forming in the corners of the

[4] *See* Docket No. FAA–2005–22840 for complete details.

[5] The three methods are: (1) Primary ice detection system, (2) visual cues of the first sign of ice accretion combined with an advisory ice detector, and (3) specifying conditions conducive to airframe icing.

[6] The full text of each commenter's submission is available in the Docket.

windshield or on windshield wiper arms. An individual commenter believed nothing, including an ice detector, can replace pilots looking out the window to gather information on icing.

Ameriflight also suggested that it would be difficult or impossible to design a sufficiently reliable ice detection system that would be economically feasible and a practicable substitute for flightcrew training and vigilance. The individual commenter opposed installation of an ice detection system because of his experience on a military airplane that was equipped with an unreliable icing warning light.

The FAA agrees that flightcrew training and vigilance are extremely important to ensure the safe operation of aircraft in icing conditions. However, visual observation of ice accretion alone, as suggested by Ameriflight and the individual commenter, is not sufficient to ensure timely operation of the airframe IPS. The flightcrew's observation of ice accretions can be difficult during times of high workload, nighttime operations, or when clear ice has accumulated. In addition, there have been icing accidents and incidents where the flightcrew was either completely unaware of ice accretion on the airframe, or was aware of ice accretion but judged that it was not significant enough to warrant operation of the airframe IPS. Therefore, reliance on only flightcrew visual observation of ice accretion alone is not adequate and must be supplemented with an advisory ice detection system to provide an acceptable level of safety.

The FAA acknowledges that it is not a simple task to design and certificate an ice detection system. However, ice detection systems exist today that meet the reliability requirements of part 25. Section 25.1309 ensures the degree of reliability of an airframe IPS is commensurate with the hazard level associated with the failure of the airframe IPS.

In response to the contention that an ice detector would not be economically feasible, the FAA notes that on recent part 25 airplane certifications manufacturers sought and received approval for installation of ice detectors without an FAA requirement for such a system. Therefore, the FAA infers that these manufacturers consider the installation of ice detectors economically feasible.

2. Reliability of Advisory Ice Detection System

Transport Canada suggested that the reliability level of the advisory ice detection system should be on the order of 1×10^{5} failure per flight hour. Transport Canada indicated the classification assigned to the unannunciated loss of an advisory ice detection system would appear to depend upon the advisory ice detection system design, the IPS design, and the airplane on which it is installed. Therefore, it is Transport Canada's position that specific cases may need to consider the unannunciated loss of the advisory ice detection system as a major failure. The natural tendency of flightcrews to become accustomed to using the advisory ice detection system may increase the need to make flightcrews aware of failure of the advisory ice detection system. The flightcrews may need to take extra precautions when they have detected a possible failure of the advisory ice detection system.

The FAA infers that Transport Canada would like the proposed rule changed to include a minimum reliability requirement for the advisory ice detection system. The FAA finds it is unnecessary to revise this rule to include a minimum reliability requirement for the advisory ice detection system because § 25.1309 requires the determination of the hazard level associated with failure of any airplane system which then drives the required degree of reliability of that system. Additionally it would not be appropriate to pick a specific minimum reliability requirement for the advisory ice detection system because, as pointed out by the commenter, the hazard level associated with the unannunciated loss of the advisory ice detection system may depend upon the advisory ice detection system design, the airframe IPS design, and the airplane on which it is installed. However, the FAA may consider including guidance on advisory ice detection system reliability in the associated advisory circular.

3. Do Not Activate Pneumatic Deicing Boots at First Sign of Ice Accretion

Ameriflight did not support activation of pneumatic deicing boots at the first sign of ice accretion, noting that these boots work better and continue to shed ice more effectively for a longer period if airfoil leading-edge ice is allowed to build to a sufficient thickness before cycling the boots. The commenter stated that when the boots are operated at the first indication of ice, the ice is only partially shed. The ice remaining on the boot provides a rough surface on which additional ice accumulates more readily than on a smooth boot surface, shortening the duration of the boots' ability to clean the wing effectively.[7] Thus, the commenter believed that activating the boots at the first sign of ice was actually contrary to safety and Ameriflight's long experience with this system.

The FAA has issued airworthiness directives requiring activation of pneumatic deicing boots early and often. The airworthiness directives and this rule address icing accidents and incidents where the flightcrew was either completely unaware of ice accretion on the airframe, or was aware of ice accretion but judged that it was not significant enough to warrant operation of the airframe IPS.

The commenter raised concerns over residual ice, which is ice remaining (not shed) after a complete boot cycle. The FAA participated in high and low speed icing wind tunnel tests that contradict the commenter's position that boots work better, and continue to shed ice effectively, for a longer period if airfoil leading ice is allowed to build before cycling the boots.

The higher speed icing wind tunnel tests (≥180 KCAS) showed that ice was shed after each boot activation and that after 2 or 3 cycles there was no discernible difference between ice accretions from early versus delayed activation of the boots. The residual ice that remained on the boot after cycling at the first sign of ice accretion was always smaller than the amount of ice that was present on the boot during the time that it took for ¼-inch of ice to form.

The lower speed icing wind tunnel tests (≤144 KCAS) showed large amounts of residual ice which the boots had difficulty shedding, regardless of the activation method employed. Immediate activation of an automatic system did not degrade ice shedding performance. Cycling early and often resulted in shedding sooner than waiting for a specified ice accretion thickness. For example, simulating an automatic one minute system activated at first sign of icing at 14 °F, 108 KCAS, resulted in a ''good shed'' at the 15th cycle at 15 minutes. Waiting for a ¼ inch accretion before cycling resulted in a ''good shed'' at the 12th cycle at 20 minutes. The residual ice after ''good sheds'' was similar regardless of the boot activation method. Based on the results of these tests, we do not agree with Ameriflight's position about the

[7] The commenter noted that this is particularly true of older boots that have been on the wing for several seasons and which—although completely airworthy—have leading edges which have become somewhat roughened by the impacts of ice crystals, snow, hail, *etc.*, and provide a better ''tooth'' to which structural ice can adhere.

effectiveness of pneumatic deicing boots.

4. Oppose Automatic Activation and Cycling of Airframe IPS

Ameriflight also opposed any system that would automatically activate ice protection equipment or automatically cycle pneumatic deicing boots. Ameriflight suggested automatic activation of deicing boots during low speed operation, takeoff, or in the landing flare could cause handling quality problems on some aircraft. The commenter stated that although such automatic operation could be inhibited by airspeed, landing gear position, or other sensors, these in turn add increments of complexity and potential unreliability that tend to offset the automatic systems' safety value.

The FAA agrees that automatic activation of the deicing boots during some phases of flight (for example, landing flare) could result in handling quality problems on some airplanes. As Ameriflight pointed out, inhibiting automatic activation during these phases of flight to prevent any handling quality problems adds complexity to the system and could potentially increase the chances for the system not to activate when it is needed. However, the FAA finds that the increase in safety afforded by automatic activation of the airframe IPS outweighs the concerns expressed by Ameriflight and that compliance with other regulations would mitigate those concerns.

Section 25.143(a) requires airplanes to be safely controllable and maneuverable during takeoff, climb, level flight, descent, and landing. Section 25.143(b) states that it must be possible to make a smooth transition from one flight condition to another without exceptional piloting skill, alertness, or strength under any probable operating condition. If the airplane cannot operate safely with the airframe IPS activated during a particular phase of flight, automatic activation of the airframe IPS would need to be inhibited during that phase of flight.

Any potential effect on the reliability of the system to activate would be assessed in accordance with § 25.1309, which requires that systems must be designed to perform their intended function under any foreseeable operating condition. Section 25.1309 also establishes the minimum allowable system reliability, which is based on the hazard that would result from failure of the system. Therefore, the increase in safety afforded by automatic activation of the airframe IPS would not be offset by the increase in complexity and potential effect on reliability if automatic activation must be inhibited in certain flight phases.

Ameriflight commented that IPS other than deicing boots should be controlled by active involvement of the flightcrew, rather than automatically. IPS operation at inopportune times could actually decrease safety, for example by causing (i) preexisting ice accumulations to be shed into engine inlets, (ii) undesired drawdown of engine bleed air, or (iii) an excess electrical load. Systems could be designed with sensors to protect against such inopportune operation, but only at the price of additional complexity and unreliability. Ameriflight opposed any system that would automatically activate ice protection equipment or automatically recycle pneumatic deicing boots because automatic systems may fail, and the flightcrew might be unaware the IPS is not operating. ''Automatic'' systems add complexity, testing requirements, and systems interfaces, and often result in decreased overall reliability and tend to remove the flightcrew from the operational loop.

The final rule does not require automatic activation of airframe IPS, but does allow it if a primary ice detection system is installed. If an applicant chooses to certificate a system to activate the airframe IPS automatically, compliance with part 25 regulations ensure the airplane can operate safely any time the airframe IPS is operated. Issues raised by the commenter such as ice shedding, bleed air, and electrical power are considered during airplane certification. As previously mentioned, any system that would be necessary to inhibit automatic activation would be required to comply with § 25.1309, which ensures system reliability commensurate with the hazard associated with the failure of that system. As indicated by the commenter, an automatic system may fail. However, § 25.1309 requires assessing the hazard associated with the failure and providing appropriate warnings commensurate with the hazard. Compliance with part 25 ensures the safe operation of the airplane if the airframe IPS is automatically activated regardless of whether the airframe IPS is a thermal anti-ice system or a deicing boot system.

5. Necessity for Visual Cues in Combination With an Advisory Ice Detector

Bombardier noted the requirement for an advisory system, in combination with visual cues for recognition of ice accretion, implies that visual cues are necessary because of ice detector failure and not ice detector performance. The fact that no visual cues are necessary for a primary ice detection system (dual ice detectors) seems to indicate an intent to focus on ice detection failure. Therefore, the commenter believed that it would be appropriate to address how primary ice detectors should be certified knowing these potential limitations.

The FAA reviewed our airworthiness directives that require operating deicing boots at the first sign of ice accretion. We determined that this means of IPS operation should be improved because such observations can be difficult during times of high workload, nighttime operations, or when clear ice has accumulated. Therefore, to mitigate the effects of human sensory limitations and inadequate attention due to workload, the final rule requires visual cues of ice accretions in combination with an advisory ice detector. The combination of visual cues and advisory ice detectors is intended to address the potential limitations of human beings, not of the ice detectors, as suggested by the commenter. Limitations of primary ice detectors, as well as advisory ice detectors, are addressed during certification through the requirements of §§ 25.1301 and 25.1309. These regulations require that equipment function properly when installed, perform its intended functions under any foreseeable operation condition, and ensure system reliability commensurate with the hazard associated with a failure of that system.

6. Require Automatic Activation of Airframe IPS

An individual commenter requested that § 25.1419(e) be revised to allow only automatic activation of airframe IPS in appendix C icing conditions, and to require IPS status displays. The commenter suggested that all other proposed options to ensure timely activation of the airframe IPS be deleted. The commenter believed that visual cues are not adequate, there is no correlation between the ice formed on the airframe and the thickness of the ice formed on the ice detector, and automatic activation would minimize hazards by making flightcrews aware of icing conditions early.

The FAA disagrees and maintains that the proposed standard that allows several means to ensure timely activation of the airframe ice protection equipment is acceptable. Icing accidents and incidents do not support the suggested revision. The FAA acknowledges that automatic activation of airframe IPS based on icing conditions will likely result in earlier activation and minimize the effects of icing compared to waiting until ice accretions have formed on the airframe.

However, later activation is acceptable, provided an applicant substantiates the airplane can operate safely with the ice accretion present at the time the airframe IPS is activated and becomes effective. Consequently, if the airframe IPS is activated based on an ice detector, it is the ice accretion present on the airframe that is important, not the correlation between the ice shape on the ice detector and the airframe. The commenter pointed out icing accidents and incidents where the flightcrew was unaware of ice accretions and concluded that visual cues are inadequate. The FAA concurs that visual cues alone are not adequate, but visual cues in addition to an advisory ice detection system would provide an acceptable level of safety and mitigate the effects of human sensory limitations and inadequate attention due to workload.

7. Remove Option To Activate Airframe IPS Based on Temperature and Visible Moisture

Proposed § 25.1419(e)(3) would allow activation of the airframe IPS based on conditions conducive to airframe icing as defined by appropriate static or total air temperature and visible moisture. Three commenters, Transport Canada, Swan International Sensors, and an individual commenter did not consider proposed § 25.1419(e)(3) an acceptable alternative to requiring an ice detection system. Transport Canada noted that it is common to base temperature indication on a single sensor, which may not have the required reliability and failure monitoring. Moreover, the display of temperature may not be conspicuous particularly on electronic flight instrument systems. In addition, it may not be easy to see visible moisture at night. The commenter requested that if paragraph (e)(3) is retained, it should be limited to airplanes that are at a lower risk of icing related incidents and accidents. The individual commenter stated that training flightcrews to recognize conditions conducive to icing is not an adequate solution because such training and documentation have existed for some time, yet icing related accidents still occurred.

The FAA concludes that § 25.1419(e)(3) should be retained as proposed because activation of the airframe IPS using visible moisture and temperature is based on the methodology currently being used safely for activating engine IPS. Flightcrews are trained to recognize conditions conducive to icing (that is, visible moisture and temperature) and have used this method safely for the operation of engine IPS. While there may be some challenges to observing visible moisture at night, the challenge is no different than for engine IPS activation. The FAA expects that activation of the airframe IPS using the same type of cues will result in timely activation just as it has for engines.

Furthermore, the accident and incident history does not support the commenter's position that training flightcrews to recognize conditions conducive to icing has not been successful. For airplanes with an airframe IPS that is activated based on visible moisture and temperature, the FAA is unaware of accidents or incidents attributed to the flightcrew not activating the airframe IPS.

Regarding the concern over the reliability of the current equipment used to detect temperature, the equipment must meet the requirements of § 25.1309. This could result in the need to install different temperature sensing equipment than what is used on aircraft today.

8. Allow Temperature and Visible Moisture in Combination With an Advisory Ice Detection System

Transport Canada recommended the FAA include temperature and visible moisture in combination with an advisory ice detection system as an acceptable configuration under the proposed rule.

The FAA determines there is no need to revise the rule to explicitly provide the suggested option. The regulations provide minimum requirements and an applicant has the option of exceeding these requirements. Therefore, even though the suggested option is not identified in the proposed rule, it would be acceptable for an applicant to comply with proposed § 25.1419(e)(3) and voluntarily go beyond that requirement and install an advisory ice detection system.

9. Need Definition of Environmental Conditions Conducive to Icing

The National Transportation Safety Board (NTSB) commented that industry could not realistically be expected to implement § 25.1419(e)(3) until the FAA provides a more specific definition of "environmental conditions conducive to icing." Swan International Sensors stated that the flightcrew would be required to interpret icing conditions because they are not defined adequately by paragraph (e)(3).

The FAA concludes that the proposed rule adequately defined environmental conditions conducive to icing and does not require interpretation by the flightcrew. The rule requires the manufacturer to identify conditions conducive to airframe icing as defined by an appropriate static or total air temperature and visible moisture for use by the flightcrew to activate the airframe IPS. The proposed rule defined the environmental conditions as a static or total air temperature and visible moisture. Advisory circular (AC) 25–1419–2, Compliance with the Ice Protection Requirements of §§ 25.1419(e), (f), (g), will provide guidance on determining the temperature cue. Therefore, we made no changes to proposed § 25.1419(e)(3) in this final rule.

10. Require Aircraft Be Equipped With All Three Proposed Methods of Airframe Ice Detection

The proposed § 25.1419(e) would require one of three ice detection and activation methods. The Air Crash Victims Families Group and an individual commenter requested that the final rule require all three ice detection and activation methods identified in proposed § 25.1419(e). The commenters also requested that the FAA require automatic ice detection systems to warn pilots of icing and to activate IPS automatically. The commenters referenced the Circuit City airplane accident in Pueblo, Colorado, on February 16, 2005, where the NTSB found the probable cause to be the flightcrew's failure to monitor and maintain airspeed and comply with procedures for ice boot activation on approach.[8] In addition, the NTSB found that distractions impeded the flightcrew's ability to monitor and maintain airspeed and manage the deicing system.

The FAA finds that icing accidents and incidents do not support the commenters' suggestion to require all three proposed methods to ensure timely activation of the airframe IPS or require a system to activate the airframe IPS automatically. The three proposed methods would independently ensure timely activation of the airframe IPS. The FAA is unaware of any icing accidents or incidents attributed to untimely activation of the airframe IPS on an airplane that had equipment compliant with this rule. The flightcrew of the Circuit City airplane relied on visual observation of ice accretions for determining if the airframe IPS should be activated and cycled manually. There was not a detector to tell the flightcrew to cycle the airframe IPS. This rule requires an advisory ice detection

[8] The commenter noted that the Cessna Citation 560 was equipped with deice boots that do not cycle automatically, which require pilots to continually monitor accumulation and reactivate the deice boots each time.

system in addition to visual observation of the first sign of ice accretion as a means to determine the airframe IPS must be activated. In addition, the rule addresses flightcrew workload by requiring deice boots to automatically cycle or by equipping the airplane with an ice detection system to alert the flightcrew each time the airframe IPS must be cycled. For these reasons, the suggested revisions are not being adopted.

11. Require Manual Back-Up to Automatic Activation of Airframe IPS

Proposed § 25.1419(g) addressed the flightcrew workload associated with an airframe IPS that operates cyclically and that requires continuous monitoring of ice accretions to determine when to activate the IPS. Proposed paragraph (g)(2) requires that these systems automatically cycle the airframe IPS to eliminate the need to continuously monitor ice accretions. An individual commenter requested that proposed paragraph (g) be revised to require manual system activation as a back-up to automatic activation. Compliance with § 25.1309, which requires an assessment of the hazard associated with the failure of a system, will determine whether a manual system is required as a back-up to an automatic activation system. Therefore, the FAA finds it is unnecessary to require a back-up manual system as suggested by the commenter.

12. Allow an Aerodynamic Performance Monitoring System

Marinvent and the Regional Airline Association requested revising the proposed rule to include an aerodynamic performance monitoring (APM) system as an alternative to ice detection systems.[9] The commenters believed APMs have several advantages over ice detectors, but that they do not inherently detect ice. Therefore, the proposed rule text did not directly address APMs because they are not strictly ''ice detection systems.'' The commenters understood that applicants may propose the APM as an alternative means of compliance by demonstrating an equivalent level of safety. However, the commenters thought the process of obtaining an equivalent level of safety finding would discourage the use of this alternative and believed there was a fundamental conceptual difference between the ice detection and aerodynamic monitoring, making it difficult for the applicant and the regulator to establish common ground to demonstrate an equivalent level of safety. The commenters contended the existing proposed rule text would effectively exclude the APM systems as a viable alternative means of compliance with the regulation.

The Regional Airline Association added that at least one of their associate members currently provides an APM system as an option in their aircraft (Aerospatiale model ATR 72) for their airline members.

The FAA concludes that, at this time, APMs are not sufficiently mature to use as a method to ensure timely activation of the airframe IPS. Further, contrary to the commenters' beliefs, the equivalent level of safety process is commonly used in certification programs and would not discourage the use of alternatives such as an APM.

In response to the Regional Airline Association's comment that an APM is currently offered as an option on the Aerospatiale ATR 72 aircraft, the FAA is aware that Aerospatiale has certificated an aircraft performance monitor, not an aerodynamic performance monitor. The aircraft performance monitor system used on the ATR 72 is intended to provide the flightcrew with information that could help them manage a severe icing encounter. The ATR 72's aircraft performance monitor system is not intended, nor certificated, to provide the flightcrew with information to ensure the airframe IPS is activated in a timely manner.

B. Airframe Ice Protection System Operation

Proposed § 25.1419(f) would allow an applicant to substantiate that the airframe IPS need not be operated during specific phases of flight. An individual commenter requested that § 25.1419(f) be revised to allow airplane operations with the IPS inactive if the airplane can be operated safely with the ice accretions associated with probable failures. The commenter also requested that § 25.1419(f) be revised to require that safe operation be demonstrated by flight test, icing tunnel tests, or other means.

The FAA finds the suggestion to consider only the ice accretions associated with probable failures unacceptable. Compliance with § 25.1309 determines the failures that must be considered, and this rule should not predetermine that only probable failures need be considered. Regarding the suggestion to specify the acceptable means of showing compliance, the FAA finds it is not necessary because § 25.1419(a) and (b) already specify the means that can be used to substantiate that an airplane can operate safely in icing conditions. For these reasons, the FAA did not adopt the suggested changes to § 25.1419(f).

C. Airplane Flight Manual Requirements

Proposed section § 25.1419(h) would require that procedures for operation of the IPS be established and documented in the Airplane Flight Manual (AFM).

BAE Systems Regional Aircraft requested the word ''airframe'' be added to § 25.1419(h). The FAA finds that adding the word ''airframe'' to § 25.1419(h) is not necessary because the procedures for operation of both engine and airframe IPS must be in the AFM. Traditionally, manufacturers provide adequate information in the AFM regarding the operation of the engine IPS, but information for an airframe IPS is sometimes lacking or is not consistent with the methods of operation used during certification. Proposed paragraph (h) is included to ensure future AFMs also include information for the operation of airframe IPS.

Another commenter requested that § 25.1419(h) be deleted because the requirement is already covered by the existing regulation in the section titled ''Airplane Flight Manual.''

The FAA finds that the sections relating to the AFM in part 25, Subpart G (§§ 25.1581–25.1587) do not explicitly address IPS operations. Therefore, the Subpart G regulations must be supplemented with the proposed § 25.1419(h) to ensure that procedures for operating the IPS are included in the AFM and are consistent with the requirements of § 25.1419. For these reasons, the suggested revision is not being adopted in this final rule.

Boeing requested that proposed § 25.1419(g)(1) be changed to require that the IPS must operate continuously only while the aircraft remains in icing conditions. The proposed rule would require operating the anti-icing system continuously throughout a potentially long flight after exiting icing conditions. Such continued operation while not in icing conditions is not necessary and wastes fuel. Boeing suggested that the proposed rule be revised to specify when an IPS that operated continuously can be deactivated.

Based on Boeing's comment, it appears the intent of § 25.1419(g) may be unclear. Proposed § 25.1419(g) provided three options to minimize the flightcrew workload associated with airframe IPS operation. One option (§ 25.1419(g)(1)) is an airframe IPS that operates continuously. Section 25.1419(g)(1) has been revised to clarify

[9] Aerodynamic performance monitoring systems directly measure the degradation of airfoil performance caused by the roughness and profile changes induced by the contamination of the airfoil.

that the airframe IPS must be designed to operate continuously, not to require continuous operation of an airframe IPS. We also clarified that procedures for operation of the IPS as specified in § 25.1419(h) include both activation and deactivation procedures. In addition, we revised § 25.1419(g)(1) to say that the IPS must be designed to operate continuously.

For future certification programs (as with past certification programs), it is incumbent upon the manufacturer to propose and substantiate when it is acceptable to deactivate the IPS. The only difference from past certifications will be that the activation requirements of § 25.1419(e) must be considered.

D. Other Comments

1. Clarify the Rule Is Applicable to Airframe IPS

BAE Systems Regional Aircraft requested that § 25.1419(f) and (g) be modified to indicate the ''airframe'' IPS are being referenced.

The FAA agrees that §§ 25.1419(f) and (g) should be clarified by adding the word ''airframe.'' Therefore, in § 25.1419(f), we revised the introductory language to reference the airframe IPS (''Unless the applicant shows that the airframe ice protection system * * *). In § 25.1419(g), we made a similar revision to the introductory language (''After the initial activation of the airframe ice protection system * * *).

2. Expand Rule To Include Certain Existing Airplanes and Prohibitions With IPS Inoperable

The NTSB requested a revision to address its perceived ongoing disconnect between the industry's guidance on deicing boot activation and what the FAA has learned and research has shown regarding ice bridging and deice boot effectiveness. The NTSB noted the Cessna 208 Caravan AFM instructs crews to wait for ¼ to ¾ inch of ice to accrete before activating the pneumatic deicing boots.

The FAA finds that for the new part 25 airplane and for existing part 25 airplanes that are modified in the future with significant airframe IPS design changes, this rule precludes the potential for perpetuating the belief that flightcrews should wait for a specific amount of ice to accumulate before activating the deicing boots. The final rule requires activation of the airframe IPS based on ice detectors or icing conditions and requires procedures for operating the IPS in the AFM. Therefore, for new part 25 airplanes, the industry guidance in the AFM will reflect the FAA regulatory requirements for activation of the IPS which does not allow activation of deicing boots based on the flightcrew determining that a specified thickness of ice has accumulated.

The NTSB, Air Crash Victims Families Group, and one other commenter requested the proposed rule be expanded to include existing airplanes equipped with pneumatic deicing boots and reference the NTSB safety recommendations A–98–91, A–98–100, A–07–14, and A–07–16 (which recommend icing related actions the FAA should take for existing airplanes).

We disagree. The NPRM did not address this issue, and revising this final rule to include retrofit requirements for existing airplanes would delay its issuance, which is not in the interest of safety. However, the FAA may consider additional rulemaking to address activation of the IPS on part 121 airplanes at a later date.

The NTSB also believed the proposed rule should prohibit crews from operating the airplane when certain functions of the IPS are inoperable, and should prohibit flight into known icing conditions if certain functions of the IPS are inoperable.

The FAA maintains that if certain equipment is inoperable, transport category airplanes should be prohibited from flight in forecasted icing conditions in addition to prohibiting flight in known icing conditions (as suggested by the NTSB). However, we do not concur with incorporating such a requirement into a certification rule. The FAA utilizes the Master Minimum Equipment List (MMEL) to evaluate whether an airplane may be operated with a particular piece of equipment inoperative. Each airplane is unique and the MMEL is the best way to determine the impact of an inoperable piece of equipment.

3. Revise Rule To Encourage Specific Airfoil Designs

The Regional Airline Association noted that several aircraft types over many years have been operated safely without any incidents or accidents attributed to icing. The commenter requested the proposed rule be rewritten to encourage airfoil design as the best means to address safety concerns due to operations in icing conditions.

Although the FAA does not write regulations to ''encourage'' specific airfoil designs, we do establish the performance and handling requirements an airplane must meet to substantiate that the airplane can operate safely in icing conditions. These safety requirements (to a certain extent) drive the design of the airfoil. However, it is the responsibility of the airframe manufacturer to design an airplane that meets the Federal Aviation Regulations icing regulations.

E. Economic Analysis

An individual commenter stated that the Goodrich Corporation cost estimates identified in the NPRM appear to be realistic, but the non-recurring costs could be reduced by a system that uses a detector that is different than the assumed ice detector. The commenter suggested using a ''universal'' sensor or detector that is independent of the airplane type and installation location; like a pressure sensor, a temperature sensor, a humidity sensor, or a system that consists of sensors that are universal.[10]

The commenter provided cost estimates that are less than the ice detector certification estimates used in our economic assessment. However, even with the more costly estimates, the FAA concluded the economic impact of the rulemaking is minimal. Since decreasing the cost estimates would not affect this conclusion, the FAA has determined it is not necessary to revise the costs in our economic assessment.

The FAA requested comments from U.S. manufacturers on their plans to produce a new part 25 certificated aircraft with deicing systems that operate cyclically and the associated certification costs. Bombardier and Transport Canada referenced this FAA request, but did not provide any data. Bombardier believes the FAA's economic analysis, which noted the trend of part 25 manufacturers to install thermal anti-ice protection systems in newly certificated part 25 airplanes, implied that the FAA considered ''cyclical'' deicing systems to be anachronistic. Bombardier indicated that technology in development may reintroduce cyclical deicing systems. Transport Canada indicated that if cyclical deicing systems are being considered for the future, then the FAA trend noted in the NPRM would not be correct.

While technology development may result in the reintroduction of cyclical deicing systems in the future, the FAA is unaware of any actual plans to produce a new part 25 certificated aircraft with deicing systems that operate cyclically and the associated certification costs. Without such information, we believe the economic assessment stating that the trend for

[10] The commenter estimated the non-recurring costs could be: Architecture/integration $7,500, qualification testing $10,000, system certification $50,000, and installation design $5,000.

new part 25 aircraft certifications is toward thermal anti-ice ice protection systems is accurate.

Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. We have determined that there is no current or new requirement for information collection associated with this amendment.

International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to comply with International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA has determined that there are no ICAO Standards and Recommended Practices that correspond to these regulations.

III. Regulatory Evaluation, Regulatory Flexibility Determination, International Trade Impact Assessment, and Unfunded Mandates Assessment

Changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 (Pub. L. 96–354) requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (Pub. L. 96–39) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, this Trade Act requires agencies to consider international standards and, where appropriate, that they be the basis of U.S. standards. Fourth, the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or Tribal governments, in the aggregate, or by the private sector, of $100 million or more annually (adjusted for inflation with base year of 1995). This portion of the preamble summarizes the FAA's analysis of the economic impacts of this final rule.

An assessment has been conducted of the economic cost impact of the final rule amending § 25.1419 of Title 14 of the Code of Federal Regulations (14 CFR) part 25, and we have determined the final rule has minimal costs. This final rule is the result of information gathered from a review of historical icing accidents and incidents. It is intended to improve the level of safety when part 25 airplanes are operated in icing conditions.

Amendment 25–121 revised § 25.207 to add requirements for considering the effects of icing on stall warning. At the time we issued Amendment 25–121, it was permissible for type certificate applicants to instruct pilots to wait for a specified amount of ice accretion to accumulate before activating the ice protection system (IPS). Section 25.207(h)(1), as adopted in Amendment 25–121, addressed this scenario by requiring flight testing with the specified amount of ice accretion to show the airplane could be operated safely until the IPS is functioning. This rule will prohibit use of this method for activating the IPS. Therefore, there is no longer any need to have the existing provision § 25.207(h)(1) that provides stall warning margin requirements for this method, and we are removing those provisions from § 25.207. This is a conforming change, and does not add any new requirements or costs. In addition, § 25.207 has been revised to improve its readability and to correct an error introduced by Amendment 25–121, but none of these revisions affect the substantive requirements.

This final rule requires newly certificated part 25 transport category airplanes certificated for flight in icing conditions to have one of the following methods to detect ice and activate the airframe IPS:

- A primary ice detection system, automatic or manual;
- The definition of visual cues for recognition of ice accretion on a specified surface combined with an advisory ice detection system that alerts the flightcrew; or
- The identification of icing conditions by an appropriate static or total air temperature and visible moisture cues.

The FAA did not receive comments causing us to change our NPRM determination that the expected costs are minimal. Bombardier indicated future technology may reintroduce cyclical deicing systems. Since 1971, no U.S. manufacturer has certificated cyclical deicing systems. Also, recent part 23 Very Light Jet (VLJ) certification programs have automatic cyclical deicing systems. We do not anticipate manufacturers to certificate manually-cycled deicing systems.

A. Cost Discussion

1. Major Assumptions

This evaluation makes the following assumptions:

- We used a $50 hourly rate for a mechanic/technician and a $75 hourly rate for an engineer working for an airplane manufacturer or modifier.
- Whenever various compliance options are available to the manufacturers, we chose the least costly option in our analysis.

Other data and derived assumptions are discussed in the following sections on costs and benefits.

2. Estimate of Costs

This section discusses the costs of a new requirement for transport category airplane manufacturers to include a method of ice detection on newly certificated airplanes. The cost estimate included below is not an estimate per manufacturer, rather an estimate per new part 25 airplane certification.

This final rule will require manufacturers of part 25 airplanes to provide the flightcrew with an effective method of ice detection. Such a method can provide a means, using an ice detection system (IDS), to alert the flightcrew of icing conditions and enable timely activation of the airframe IPS for the initial and any subsequent cycles.

The requirements for ice detection and activation of the airframe IPS are applicable to all phases of flight, unless it can be shown that the airframe IPS need not be operated during specific phases of flight. If the airframe IPS operates in a cyclical manner, it must either include a system that automatically cycles the airframe IPS, or there must be a method that alerts the flightcrew each time the airframe ice protection system must be cycled. This final rule requires:

- (e)(1) A primary IDS that automatically activates or alerts the flightcrew to activate the airframe IPS;
- (e)(2) A definition of visual cues for recognition of the first sign of ice accretion on a specified surface combined with an advisory IDS that alerts the flightcrew to activate the airframe IPS; or
- (e)(3) Identification of conditions conducive to airframe icing as defined by an appropriate static or total air temperature and visible moisture for use by the flightcrew to activate the airframe IPS.

Any of the three ice detection methods will enable timely activation of the airframe IPS and satisfy the requirements of this final rule.

The first method of ice detection is the use of a primary IDS. A primary IDS usually has two ice detectors. The cost of an ice detector used in this analysis is based on the Goodrich Corporation's average price of $6,000 per ice detector for a production airplane. The Aviation Rulemaking Advisory Committee (ARAC) Ice Protection Harmonization Working Group provided us with manufacturer cost estimates for System Design, System Qualification, Hardware, Installation, and Maintenance. Assuming the primary IDS has two ice detectors, we estimate the average cost for a primary IDS to be about $485,000 per certification, $12,000 ($6,000 × 2) for the hardware and $2,500 for the installation, or $14,500 ($12,000 + $2,500) per airplane. Table 1 shows a detailed breakout of these cost estimates.

One commenter to the NPRM, regarding Goodrich costs, stated there was a cheaper alternative system than the Goodrich system. The FAA notes a lower cost alternative is feasible.

TABLE 1—COSTS FOR § 25.1419(E)(1)—PRIMARY ICE DETECTION SYSTEM

Manufacturer non-recurring costs (per aircraft group/type) 2006$	Hours	Hourly rate	Additional cost	Cost
System Design:				
System architecture/Integration	3,000	$75		$225,000
Ice detector positioning	300	75		22,500
Procedures for AFM, AOM/FCOM & MMEL	200	75		15,000
System Qualification/certification:				
Ice detector qualification	300	75		22,500
Ice detection system certification	600	75		45,000
Flight tests	400	75	100,000	130,000
Installation Design:				
Installation drawings	500	50		25,000
Total	5,300			485,000
Costs (per airplane):				
Hardware (Primary Ice Detection System)			12,000	12,000
Installation	50	50		2,500
Additional weight is 5–10 kg				0
Total				14,500

The second method of ice detection is the use of an advisory IDS along with visual cues. The major difference between a primary and an advisory IDS is that the primary is the principal means to determine when the airframe IPS should be activated and has two ice detectors. In contrast, an advisory IDS is a backup to the flightcrew and has only one ice detector. The average cost for an advisory IDS is estimated to be $447,500 per certification, $6,000 for the hardware and $1,250 for the installation, or $7,250 ($6,000 + $1,250) per airplane. Table 2 shows a detailed breakout of these costs estimates.

TABLE 2—COSTS FOR § 25.1419(E)(2)—ADVISORY ICE DETECTION SYSTEM AND VISUAL CUES

Manufacturer non-recurring costs (per aircraft group/type) 2006$	Hours	Hourly rate	Additional cost	Cost
System Design:				
System architecture/Integration	2,500	$75		$187,500
Ice detector positioning	200	75		15,000
Visual cue determination/design	200	75		15,000
Procedures for AFM, AOM/FCOM & MMEL	200	75		15,000
System Qualification/certification:				
Ice detection qualification	300	75		22,500
Visual cue substantiation	200	75		15,000
Ice detection system certification	300	75		22,500
Flight tests	400	75	$100,000	130,000
Installation Design:				
Installation drawings	500	50		25,000
Total	4,800			447,500
Costs (per airplane):				
Hardware (Advisory Ice Detection System)			6,000	6,000
Installation	25	50		1,250
Additional weight is 5–10 kg				0
Total				7,250

The third method of ice detection is a definition of conditions conducive to airframe icing that will be used by the flightcrew to activate the airframe IPS. This definition will be included in the Airplane Flight Manual. There are no costs imposed on the airplane manufacturers with this option. Table 3 shows a summary of the costs for each alternative.

TABLE 3—COST SUMMARY—§ 25.1419(E)

	Costs	
	Per certification	Per airplane
§ 25.1419 Alternatives:		
(e)(1) Primary IDS	$485,000	$14,500
(e)(2) Advisory IDS and Visual Cues	447,500	7,250
(e)(3) Temperature and Moisture	0	0

The least cost alternative is to activate the airframe IPS whenever the airplane is operating in conditions conducive to airframe icing based on a specific air temperature threshold and the presence of visible moisture. Since there are no additional certification or production costs to manufacturers by complying with § 25.1419(e)(3) through this alternative, we have determined there are no costs associated with compliance with § 25.1419(e).

We are aware some manufacturers may choose to install more complex systems ((e)(1) or (e)(2)), and want to note these more complex systems are acceptable alternatives to (e)(3).

§ 25.1419(f)

Section 25.1419(f) describes the applicability of the final rule to all phases of flight, so there are no additional costs associated with this section.

§ 25.1419(g)

After the initial operation of the airframe IPS, § 25.1419(g) provides alternatives the manufacturer must provide to the operator for safe flight. These alternatives are:

- The IPS must be designed to operate continuously (§ 25.1419(g)(1)), or
- The airplane must be equipped with a system that automatically cycles the IPS (§ 25.1419(g)(2)), or
- An IDS must be provided to alert the flightcrew each time the IPS must be cycled (§ 25.1419(g)(3)).

Section 25.1419(g) applies to airplanes with either a thermal anti-icing IPS or an IPS that operates in a cyclical manner. Thermal anti-icing systems typically operate continuously while deicing systems usually operate cyclically.

Section 25.1419(g)(1) applies primarily to a thermal anti-icing IPS, which typically uses heat to keep protected surfaces of the airplane free of ice accretions.

No additional manufacturing costs are associated with § 25.1419(g)(1) because, once a thermal anti-IPS is activated, it is capable of operating continuously.

The cost estimates for each option do not include primary and advisory ice detection system maintenance, which would make the costs for these alternatives higher. The FAA has determined that the trend for new part 25 aircraft certification is toward anti-ice protection systems so the maintenance costs associated with deicing ice protection systems are not considered. The cost estimates for § 25.1419(g)(1) do not include the associated maintenance costs for anti-ice protection systems as operators are already incurring these costs.

Sections 25.1419(g)(2) and (3) apply to an airframe IPS that operates in a cyclical manner. Past delivery history has shown that about 97% of U.S. manufactured part 25 airplanes delivered have thermal anti-icing IPS and 3% have deicing IPSs that operate in a cyclical manner. Cessna is the only U.S. manufacturer that currently delivers part 25 certificated airplanes with an IPS that operates in a cyclical manner. Those airplanes were certificated in September 1971.[11] Newer variants of airplanes from that September 1971 type certificate and all newer part 25 new Cessna certifications have thermal anti-icing IPS that operate continuously. We believe the trend for new part 25 aircraft certifications is toward a thermal anti-icing IPS that operates continuously. Because of the trend of part 25 manufacturers to install thermal anti-icing IPS in their newly certificated part 25 airplanes, we believe there are no costs imposed on the airplane manufacturers by § 25.1419(g).

Bombardier indicated future technology may reintroduce cyclical deicing systems. No U.S. manufacturer has certificated cyclical deicing systems since 1971. Since recent part 23 Very Light Jet (VLJ) certification programs have automatic cyclical deicing systems, we do not anticipate airplane manufacturers to certificate manually-cycled deicing systems.

[11] Type Certification Data Sheet No. A22CE.

We received no comments from U.S. manufacturers on their plans to produce a newly part 25 certificated aircraft with deicing systems that operate cyclically and the associated certification costs; therefore, we believe § 25.1419(g) will add no additional costs.

§ 25.1419(h)

Future Airplane Flight Manuals can be readily prepared to include appropriate icing procedures for future certificated air transport category airplanes. Thus, minimal costs are associated with § 25.1419(h).

B. Benefits

The FAA is adopting this final rule because accidents and incidents occurred where the flightcrew did not operate the airframe IPS in a timely manner and because of concerns over the flightcrew workload required to operate an airframe IPS that the flightcrew must manually cycle. The final rule addresses these concerns by ensuring that flightcrews are provided with a clear means to know when to activate the airframe IPS and by reducing the workload associated with an airframe IPS that operates cyclically. The safety benefit of this final rule is that it will improve the level of safety of new airplane designs for operations in icing conditions.

C. Conclusions

The FAA has determined that this final rule has benefits that justify its minimal costs. However, the Office of Management and Budget has determined that this final rule is a ‘‘significant regulatory action,’’ because it harmonizes U.S. aviation standards with those of other civil aviation authorities.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (Pub. L. 96–354) (RFA) establishes ‘‘as a principle of regulatory issuance that agencies shall endeavor, consistent with the objectives of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the businesses, organizations, and governmental jurisdictions subject to regulation. To achieve this principle, agencies are required to solicit and consider flexible regulatory proposals and to explain the rationale for their actions to assure that such proposals are given serious consideration.'' The RFA covers a wide-range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a rule will have a significant economic impact on a substantial number of small entities. If the agency determines that it will, the agency must prepare a regulatory flexibility analysis as described in the RFA.

However, if an agency determines that a rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the RFA provides that the head of the agency may so certify and a regulatory flexibility analysis is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear.

As we stated in the NPRM, all United States transport category aircraft manufacturers exceed the Small Business Administration small-entity criteria of 1,500 employees. We received no public comments disputing this determination. Therefore, as the FAA Administrator, I certify that this rule will not have a significant economic impact on a substantial number of small entities.

International Trade Impact Assessment

The Trade Agreements Act of 1979 (Pub. L. 96–39) prohibits Federal agencies from establishing any standards or engaging in related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards. The FAA has assessed the potential effect of this final rule and has no basis for believing the rule will impose substantially different costs on domestic and international entities. Thus the FAA believes the rule has a neutral trade impact.

Unfunded Mandates Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in an expenditure of $100 million or more (in 1995 dollars) in any one year by State, local, and Tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a ''significant regulatory action.'' The FAA currently uses an inflation-adjusted value of $136.1 million in lieu of $100 million. This final rule does not contain such a mandate; therefore, the requirements of title II of the Act do not apply.

Executive Order 13132, Federalism

The FAA has analyzed this final rule under the principles and criteria of Executive Order 13132, Federalism. We determined that this action will not have a substantial direct effect on the States, or the relationship between the Federal Government and the States, or on the distribution of power and responsibilities among the various levels of government, and, therefore, does not have federalism implications.

Regulations Affecting Intrastate Aviation in Alaska

Section 1205 of the FAA Reauthorization Act of 1996 (110 Stat. 3213) requires the FAA, when modifying its regulations in a manner affecting intrastate aviation in Alaska, to consider the extent to which Alaska is not served by transportation modes other than aviation, and to establish appropriate regulatory distinctions. In the NPRM, we requested comments on whether the proposed rule should apply differently to intrastate operations in Alaska. We did not receive any comments, and we have determined, based on the administrative record of this rulemaking, that there is no need to make any regulatory distinctions applicable to intrastate aviation in Alaska.

Environmental Analysis

FAA Order 1050.1E identifies FAA actions that are categorically excluded from preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act in the absence of extraordinary circumstances. The FAA has determined this rulemaking action qualifies for the categorical exclusion identified in paragraph 4(j) and involves no extraordinary circumstances.

Regulations That Significantly Affect Energy Supply, Distribution, or Use

The FAA has analyzed this final rule under Executive Order 13211, Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use (May 18, 2001). We have determined that it is not a ''significant energy action'' under the executive order because while it is a ''significant regulatory action,'' it is not likely to have a significant adverse effect on the supply, distribution, or use of energy.

Availability of Rulemaking Documents

You can get an electronic copy of rulemaking documents using the Internet by—

1. Searching the Federal eRulemaking Portal (*http://www.regulations.gov*);
2. Visiting the FAA's Regulations and Policies Web page at *http://www.faa.gov/regulations_policies/*; or
3. Accessing the Government Printing Office's Web page at *http://www.gpoaccess.gov/fr/index.html.*

You can also get a copy by sending a request to the Federal Aviation Administration, Office of Rulemaking, ARM–1, 800 Independence Avenue, SW., Washington, DC 20591, or by calling (202) 267–9680. Make sure to identify the amendment number or docket number of this rulemaking.

Anyone is able to search the electronic form of all comments received into any of our dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.). You may review DOT's complete Privacy Act statement in the **Federal Register** published on April 11, 2000 (Volume 65, Number 70; Pages 19477–78) or you may visit *http://DocketsInfo.dot.gov.*

Small Business Regulatory Enforcement Fairness Act

The Small Business Regulatory Enforcement Fairness Act (SBREFA) of 1996 requires FAA to comply with small entity requests for information or advice about compliance with statutes and regulations within its jurisdiction. If you are a small entity and you have a question regarding this document, you may contact your local FAA official, or the person listed under the **FOR FURTHER INFORMATION CONTACT** heading at the beginning of the preamble. You can find out more about SBREFA on the Internet at *http://www.faa.gov/regulations_policies/rulemaking/sbre_act/.*

Appendix 1—Definition of Terms Used in This Preamble

For the preamble of this rulemaking, the following definitions are applicable. These definitions of terms are for use *only* with this rulemaking's preamble:

a. *Advisory ice detection system:* An advisory ice detection system annunciates the presence of icing conditions or ice accretion. The advisory ice detection system provides information advising the flightcrew of the presence of ice accretion or icing conditions. An advisory ice detection system differs from a primary ice detection system in that it usually consists of a single ice detector without redundancies that provide sufficient reliability to comply with § 25.1309. Therefore, it can only be used in conjunction with other means (most commonly, visual observation by the flightcrew) to determine the need for, or timing of, activating the anti-icing or deicing system. The flightcrew is responsible for monitoring the icing conditions or ice accretion as defined in the AFM (typically using total air temperature and visible moisture criteria or visible ice accretion) and activating the anti-icing or deicing system(s).

b. *Airframe icing:* Airframe icing is ice accretions on the airplane, except for the propulsion system.

c. *Anti-icing:* Anti-icing is the prevention of ice accretions on a protected surface, either:

- By evaporating the impinging water; or
- By allowing it to run back and off the protected surface or freeze on non-critical areas.

d. *Automatic cycling mode:* An automatic cycling mode is a mode of operation of the airframe deicing system that provides repetitive cycles of the system without the need for the pilot to select each cycle. This is generally done with a timer, and there may be more than one timing mode.

e. *Deicing:* Deicing is the removal or the process of removal of an ice accretion after it has formed on a surface.

f. *Ice Protection System:* An ice protection system (IPS) is a system that protects certain critical aircraft parts from ice accretion. To be an approved system, it must satisfy the requirements of § 25.1419.

g. *Primary ice detection system:* A primary ice detection system is used to determine when the IPS must be activated. A primary ice detection system is a system with redundancies that provide sufficient reliability to comply with § 25.1309 so the flight crew does not need to visually monitor the icing accretions that may be building on the airplane. The system annunciates the presence of ice accretion or icing conditions, and may also provide information to other aircraft systems. A primary automatic system automatically activates the anti-icing or deicing IPS. With a primary manual system, the flightcrew activates the anti-icing or deicing IPS upon indication from the primary ice detection system.

h. *Static air temperature:* The air temperature as would be measured by a temperature sensor not in motion with respect to that air. This temperature is also referred to in other documents as ''outside air temperature,'' ''true outside temperature,'' or ''ambient temperature.''

i. *Total air temperature:* The temperature of a parcel of air brought to rest relative to the aircraft resulting from adiabatic compression of the parcel. This temperature is also referred to in other documents as ''stagnation temperature.''

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements, Safety, Transportation.

The Amendment

■ In consideration of the foregoing, the Federal Aviation Administration amends Part 25 of Title 14, Code of Federal Regulations as follows:

PART 25—AIRWORTHINESS STANDARDS, TRANSPORT CATEGORY AIRPLANES

■ 1. The authority citation for part 25 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702, and 44704.

■ 2. Amend § 25.143 by revising paragraph (j) to read as follows:

§ 25.143 General.

* * * * *

(j) For flight in icing conditions before the ice protection system has been activated and is performing its intended function, it must be demonstrated in flight with the ice accretion defined in appendix C, part II(e) of this part that:

(1) The airplane is controllable in a pull-up maneuver up to 1.5 g load factor; and

(2) There is no pitch control force reversal during a pushover maneuver down to 0.5 g load factor.

■ 3. Amend § 25.207 by revising paragraphs (b) and (h), and adding a new paragraph (i) to read as follows:

§ 25.207 Stall warning.

* * * * *

(b) The warning must be furnished either through the inherent aerodynamic qualities of the airplane or by a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself. If a warning device is used, it must provide a warning in each of the airplane configurations prescribed in paragraph (a) of this section at the speed prescribed in paragraphs (c) and (d) of this section. Except for showing compliance with the stall warning margin prescribed in paragraph (h)(3)(ii) of this section, stall warning for flight in icing conditions must be provided by the same means as stall warning for flight in non-icing conditions.

* * * * *

(h) For flight in icing conditions before the ice protection system has been activated and is performing its intended function, with the ice accretion defined in appendix C, part II(e) of this part, the stall warning margin in straight and turning flight must be sufficient to allow the pilot to prevent stalling without encountering any adverse flight characteristics when:

(1) The speed is reduced at rates not exceeding one knot per second;

(2) The pilot performs the recovery maneuver in the same way as for flight in non-icing conditions; and

(3) The recovery maneuver is started no earlier than:

(i) One second after the onset of stall warning if stall warning is provided by the same means as for flight in non-icing conditions; or

(ii) Three seconds after the onset of stall warning if stall warning is provided by a different means than for flight in non-icing conditions.

(i) In showing compliance with paragraph (h) of this section, if stall warning is provided by a different means in icing conditions than for non-icing conditions, compliance with § 25.203 must be shown using the accretion defined in appendix C, part II(e) of this part. Compliance with this requirement must be shown using the demonstration prescribed by § 25.201, except that the deceleration rates of § 25.201(c)(2) need not be demonstrated.

■ 4. Amend § 25.1419 by adding new paragraphs (e), (f), (g), and (h) to read as follows:

§ 25.1419 Ice protection.

* * * * *

(e) One of the following methods of icing detection and activation of the airframe ice protection system must be provided:

(1) A primary ice detection system that automatically activates or alerts the flightcrew to activate the airframe ice protection system;

(2) A definition of visual cues for recognition of the first sign of ice accretion on a specified surface combined with an advisory ice detection system that alerts the flightcrew to activate the airframe ice protection system; or

(3) Identification of conditions conducive to airframe icing as defined by an appropriate static or total air temperature and visible moisture for use by the flightcrew to activate the airframe ice protection system.

(f) Unless the applicant shows that the airframe ice protection system need not be operated during specific phases of flight, the requirements of paragraph (e) of this section are applicable to all phases of flight.

(g) After the initial activation of the airframe ice protection system—

(1) The ice protection system must be designed to operate continuously;

(2) The airplane must be equipped with a system that automatically cycles the ice protection system; or

(3) An ice detection system must be provided to alert the flightcrew each time the ice protection system must be cycled.

(h) Procedures for operation of the ice protection system, including activation and deactivation, must be established and documented in the Airplane Flight Manual.

■ 5. Amend appendix C to part 25 by revising part II (e) to read as follows:

Appendix C to Part 25

* * * * *

Part II—Airframe Ice Accretions for Showing Compliance With Subpart B

* * * * *

(e) The ice accretion before the ice protection system has been activated and is performing its intended function is the critical ice accretion formed on the unprotected and normally protected surfaces before activation and effective operation of the ice protection system in continuous maximum atmospheric icing conditions. This ice accretion only applies in showing compliance to §§ 25.143(j) and 25.207(h), and 25.207(i).

Issued in Washington, DC, on July 17, 2009.

Lynne A. Osmus,

Acting Administrator.

[FR Doc. E9–18483 Filed 7–31–09; 8:45 am]

BILLING CODE 4910–13–P

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 39

[Docket No. FAA–2009–0227; Directorate Identifier 2007–SW–65–AD; Amendment 39–15978; AD 2009–15–15]

RIN 2120–AA64

Airworthiness Directives; Bell Helicopter Textron Canada Model 427 Helicopters

AGENCY: Federal Aviation Administration (FAA), Department of Transportation (DOT).

ACTION: Final rule.

SUMMARY: We are adopting a new airworthiness directive (AD) for Bell Helicopter Textron Canada (BHTC) Model 427 helicopters. This AD results from mandatory continuing airworthiness information (MCAI) originated by the aviation authority of Canada to identify and correct an unsafe condition on an aviation product. Transport Canada, the aviation authority of Canada, with which we have a bilateral agreement, states that it has been determined that the existing hardware connecting the vertical fin to the tail rotor gearbox needs to be upgraded to prevent the vertical fin from becoming loose.

BHTC has received reports of loose vertical fins discovered during inspections. Investigation revealed that the current vertical fin attachment hardware may not provide adequate clamp-up. If not corrected, the vertical fin could become loose and cause vibration, which could lead to subsequent loss of control of the helicopter. This AD requires actions that are intended to address this unsafe condition.

DATES: This AD becomes effective on September 8, 2009.

ADDRESSES: You may examine the AD docket on the Internet at *http://regulations.gov* or in person at the Docket Operations office, U.S. Department of Transportation, M–30, West Building Ground Floor, Room W12–140, 1200 New Jersey Avenue, SE., Washington, DC between 9 a.m. and 5 p.m. Monday through Friday, except Federal holidays.

You may get the service information identified in this AD from Bell Helicopter Textron Canada Limited, 12,800 Rue de l'Avenir, Mirabel, Quebec J7J1R4, telephone (450) 437–2862 or (800) 363–8023, fax (450) 433–0272, or at *http://www.bellcustomer.com/files/*.

Examining the AD Docket: The AD docket contains the Notice of proposed rulemaking (NPRM), the economic evaluation, any comments received, and other information. The street address and operating hours for the Docket Operations office (telephone (800) 647–5527) are in the **ADDRESSES** section of this AD. Comments will be available in the AD docket shortly after they are received.

FOR FURTHER INFORMATION CONTACT: Sharon Miles, Aviation Safety Engineer, FAA, Rotorcraft Directorate, Regulations and Guidance Group, 2601 Meacham Blvd., Fort Worth, Texas 76137, telephone (817) 222–5122, fax (817) 222–5961.

SUPPLEMENTARY INFORMATION:

Discussion

We issued an NPRM to amend 14 CFR part 39 to include an AD that would apply to BHTC Model 427 helicopters on March 4, 2009. That NPRM was published in the **Federal Register** on March 23, 2009 (74 FR 12098). That NPRM proposed to require actions to prevent the vertical fin from becoming loose and causing vibration, which could lead to subsequent loss of control of the helicopter. You may obtain further information by examining the MCAI and any related service information in the AD docket.

Comments

By publishing the NPRM, we gave the public an opportunity to participate in developing this AD. However, we received no comment on the NPRM or on our determination of the cost to the public. Therefore, based on our review and evaluation of the available data, we have determined that air safety and the public interest require adopting the AD as proposed.

Relevant Service Information

Bell Helicopter Textron has issued Alert Service Bulletin No. 427–06–15, dated December 14, 2006. The actions described in the MCAI are intended to correct the same unsafe condition as that identified in the service information.

Differences Between This AD and the MCAI AD

We have reviewed the MCAI AD and related service information and, in general, agree with their substance. This AD differs from the MCAI AD as follows:

- We do not require compliance ''no later than November 27, 2007'', because that date has passed.
- We refer to the compliance time as ''hours time-in-service'' rather than ''air time hours.''

These differences are highlighted in the ''Differences Between this AD and the MCAI AD'' section in the AD.

Costs of Compliance

We estimate that this AD will affect about 17 products of U.S. registry. We also estimate that it will take about 2 work-hours per helicopter to remove and visually inspect the vertical fin and the tail rotor gearbox attachment legs and to re-install the vertical fin. The average labor rate is $80 per work-hour. Required parts will cost about $227 per helicopter. Based on these figures, we estimate the cost of this AD on U.S. operators to be $6,579 for the fleet, or $387 per helicopter, to perform the inspections and remove and re-install the vertical fin.

Authority for This Rulemaking

Title 49 of the United States Code specifies the FAA's authority to issue rules on aviation safety. Subtitle I, section 106, describes the authority of the FAA Administrator. ''Subtitle VII:

Federal Register

Thursday,
April 26, 2007

Part II

Department of Transportation

Federal Aviation Administration

14 CFR Part 25

Activation of Ice Protection; Proposed Rule

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. FAA–2007–27654; Notice No. 07–07]

RIN 2120–AI90

Activation of Ice Protection

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of proposed rulemaking (NPRM).

SUMMARY: The Federal Aviation Administration proposes to amend the airworthiness standards applicable to transport category airplanes certificated for flight in icing conditions. The proposed standards would require a means to ensure timely activation of the airframe ice protection system. This proposed regulation is the result of information gathered from a review of icing accidents and incidents, and is intended to improve the level of safety for new airplane designs for operations in icing conditions.

DATES: Send your comments on or before July 25, 2007.

ADDRESSES: You may send comments identified by Docket Number FAA–2007–27654 using any of the following methods:

- DOT Docket Web site: Go to *http://dms.dot.gov* and follow the instructions for sending your comments electronically.
- Government-wide rulemaking Web site: Go to *http://www.regulations.gov* and follow the instructions for sending your comments electronically.
- Mail: Docket Management Facility; U.S. Department of Transportation, 400 Seventh Street, SW., Nassif Building, Room PL–401, Washington, DC 20590–0001.
- Fax: 1–202–493–2251.
- Hand Delivery: Room PL–401 on the plaza level of the Nassif Building, 400 Seventh Street, SW., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

For more information on the rulemaking process, see the **SUPPLEMENTARY INFORMATION** section of this document.

Privacy: We will post all comments we receive, without change, to *http://dms.dot.gov,* including any personal information you provide. For more information, see the Privacy Act discussion in the **SUPPLEMENTARY INFORMATION** section of this document.

Docket: To read background documents or comments received, go to *http://dms.dot.gov* at any time or to Room PL–401 on the plaza level of the Nassif Building, 400 Seventh Street, SW., Washington, DC, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

FOR FURTHER INFORMATION CONTACT: Kathi Ishimaru, FAA, Propulsion/Mechanical Systems Branch, ANM–112, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue, SW., Renton, WA 98057–3356; telephone (425) 227–2674; facsimile (425) 227–1320, e-mail *kathi.ishimaru@faa.gov.*

SUPPLEMENTARY INFORMATION:

Comments Invited

The FAA invites interested persons to participate in this rulemaking by submitting written comments, data, or views. We also invite comments relating to the economic, environmental, energy, or federalism impacts that might result from adopting the proposals in this document. The most helpful comments reference a specific portion of the proposal, explain the reason for any recommended change, and include supporting data. We ask that you send us two copies of written comments.

We will file in the docket all comments we receive, as well as a report summarizing each substantive public contact with FAA personnel concerning this proposed rulemaking. The docket is available for public inspection before and after the comment closing date. If you wish to review the docket in person, go to the address in the **ADDRESSES** section of this preamble between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays. You may also review the docket using the Internet at the web address in the **ADDRESSES** section.

Privacy Act: Using the search function of our docket web site, anyone can find and read the comments received into any of our dockets, including the name of the individual sending the comment (or signing the comment on behalf of an association, business, labor union, etc.). You may review DOT's complete Privacy Act Statement in the **Federal Register** published on April 11, 2000 (65 FR 19477–78) or you may visit *http://dms.dot.gov.*

Before acting on this proposal, we will consider all comments we receive on or before the closing date for comments. We will consider comments filed late if it is possible to do so without incurring expense or delay. We may change this proposal in light of the comments we receive.

If you want the FAA to acknowledge receipt of your comments on this proposal, include with your comments a pre-addressed, stamped postcard on which the docket number appears. We will stamp the date on the postcard and mail it to you.

Proprietary or Confidential Business Information

Do not file in the docket information that you consider to be proprietary or confidential business information. Send or deliver this information directly to the person identified in the **FOR FURTHER INFORMATION CONTACT** section of this document. You must mark the information that you consider proprietary or confidential. If you send the information on a disk or CD ROM, mark the outside of the disk or CD ROM and also identify electronically within the disk or CD ROM the specific information that is proprietary or confidential.

Under Title 14, Code of Federal Regulations (14 CFR) 11.35(b), when we are aware of proprietary information filed with a comment, we do not place it in the docket. We hold it in a separate file to which the public does not have access, and place a note in the docket that we have received it. If we receive a request to examine or copy this information, we treat it as any other request under the Freedom of Information Act (5 U.S.C. 552). We process such a request under the DOT procedures found in 49 CFR part 7.

Availability of Rulemaking Documents

You can get an electronic copy using the Internet by:

(1) Searching the Department of Transportation's electronic Docket Management System (DMS) web page (*http://dms.dot.gov/search*);

(2) Visiting the FAA's Regulations and Policies web page at *http://www.faa.gov/regulations_policies*; or

(3) Accessing the Government Printing Office's web page at *http://www.gpoaccess.gov/fr/index.html.*

You can also get a copy by sending a request to the Federal Aviation Administration, Office of Rulemaking, ARM–1, 800 Independence Avenue, SW., Washington, DC 20591, or by calling (202) 267–9680. Make sure to identify the docket number, notice number, or amendment number of this rulemaking.

Authority for This Rulemaking

The FAA's authority to issue rules regarding aviation safety is found in Title 49 of the United States Code. Subtitle I, Section 106 describes the authority of the FAA Administrator. Subtitle VII, Aviation Programs, describes in more detail the scope of the agency's authority.

This rulemaking is promulgated under the authority described in Subtitle VII, Part A, Subpart III, Section 44701, ''General requirements.'' Under that section, the FAA is charged with promoting safe flight of civil aircraft in air commerce by prescribing minimum standards required in the interest of safety for the design and performance of aircraft; regulations and minimum standards in the interest of safety for inspecting, servicing, and overhauling aircraft; and regulations for other practices, methods, and procedures the Administrator finds necessary for safety in air commerce. This regulation is within the scope of that authority because it prescribes—

- New safety standards for the design of transport category airplanes.
- New safety requirements that are necessary for the design, production, operations, and maintenance of those airplanes, and for other practices, methods and procedures relating to those airplanes.

Background

On October 31, 1994, an accident involving an Avions de Transport Regional ATR 72 series airplane occurred in icing conditions. This prompted the FAA to initiate a review of aircraft inflight icing safety and determine changes that could be made to increase the level of safety. In May 1996, the FAA sponsored the International Conference on Aircraft Inflight Icing where icing specialists recommended improvements to increase the level of safety of aircraft operating in icing conditions. The FAA reviewed the conference recommendations and developed a comprehensive multi-year icing plan. The FAA Inflight Aircraft Icing Plan (Icing Plan), dated April 1997,[1] described various activities the FAA was contemplating to improve safety when operating in icing conditions. In accordance with the Icing Plan, the FAA tasked the Aviation Rulemaking Advisory Committee (ARAC),[2] through its Ice Protection Harmonization Working Group, to consider the need for ice detectors or other acceptable means to warn flightcrews of ice accretion on critical surfaces requiring crew action. This proposed rule is based on ARAC's recommendations to the FAA.

[1] FAA Inflight Aircraft Icing Plan, dated April 1997, available in the Docket.

[2] Published in the **Federal Register**, December 8, 1997 (62 FR 64621).

Appendix 1 defines terms used in this notice of proposed rulemaking (NPRM).

A. Existing Regulations for Flight in Icing Conditions

Currently, the certification regulations applicable to transport category airplanes for flight in icing conditions require: ''the airplane must be able to operate safely in the continuous maximum and intermittent maximum icing conditions of appendix C.''[3]

Parts 91, 121, and 135 contain regulations that apply to airplane operations in icing conditions. Operating regulations under part 91 and 135 address limitations in icing conditions for airplanes operated under these regulations.[4] Part 121 addresses operations in icing conditions that might adversely affect safety and installation of certain types of ice protection equipment and wing illumination equipment.[5]

Neither the operating regulations nor the certification regulations require a means to warn flightcrews of ice accretion on critical surfaces requiring crew action.

B. National Transportation Safety Board Safety Recommendations

The National Transportation Safety Board (NTSB) issued the following safety recommendations related to airframe icing that are partially addressed by this proposal:

- NTSB Safety Recommendation No. A–96–56[6] is a result of the Avions de Transport Regional ATR 72 series airplane accident in Roselawn, Indiana on October 31, 1994, where 68 people died. The accident airplane crashed during a rapid descent after an uncommanded roll excursion while operating in icing conditions. The NTSB recommended that the FAA require a means for flightcrews to positively determine when they are in icing conditions that exceed the limits for aircraft certification.
- NTSB Safety Recommendation No. A–98–91[7] is a result of the Empresa Brasileira de Aeronautica, S/A (Embraer) EMB–120 series airplane accident near Monroe, Michigan, on January 9, 1997, where 29 people died. The accident airplane crashed while operating in icing conditions. The flightcrew may not have activated the airframe ice protection system. The NTSB recommended that the FAA require manufacturers and operators to revise their manuals and training to emphasize that leading edge deicing boots should be activated as soon as the airplane enters icing conditions.

[3] Section 25.1419, Ice Protection.

[4] 14 CFR 91.527, Operating in icing conditions; and § 135.227, Icing conditions: Operating limitations.

[5] 14 CFR 121.629(a), Operation in icing conditions and § 121.341, Equipment for operations in icing conditions.

[6] NTSB recommendation A–96–56; available in the Docket and on the Internet at: *http://www.ntsb.gov/Recs/letters/1996/A96_48_69.pdf.*

[7] NTSB recommendation A–98–91, available in the Docket and on the Internet at *http://www.ntsb.gov/Recs/letters/1998/A98_88_106.pdf.*

C. Authorities

1. Federal Aviation Administration

Title 14 CFR part 25 contains the U.S. airworthiness standards for type certification of transport category airplanes. These standards apply to airplanes manufactured within the U.S. and to airplanes manufactured in other countries and imported to the U.S. under a bilateral airworthiness agreement.

2. Joint Aviation Authorities

The Joint Airworthiness Requirements (JAR)–25 contain the European airworthiness standards for type certification of transport category airplanes. Thirty-seven European countries accept airplanes type certificated to JAR–25 standards, including airplanes manufactured in the U.S. that are type certificated to JAR–25 standards for export to Europe.

3. European Aviation Safety Agency

A new aviation regulatory body, the European Aviation Safety Agency (EASA), was established by the European community to develop standards to ensure the highest level of safety and environmental protection, oversee their uniform application, and promote them internationally. The EASA formally became operational for certification of aircraft, engines, parts, and appliances on September 28, 2003. The EASA will eventually absorb all functions and activities of the Joint Aviation Authorities, including its efforts to harmonize EASA's airworthiness certification regulations with those of the U.S.

The JAR–25 standards have been incorporated into EASA's ''Certification Specifications for Large Aeroplanes,'' (CS)–25, in similar if not identical language. The EASA's CS–25 became effective October 17, 2003.

D. Harmonization of U.S. Standards With Those of Other Countries

The airworthiness standards proposed in this NPRM were developed before EASA began operations. They were developed in coordination with the Joint Aviation Authorities (JAA), United Kingdom Civil Aviation Authority, and Transport Canada.

E. Related Rulemaking Activity

1. Docket No. 2005–22840; Notice No. 05–10

The proposed rulemaking would amend part 25 by adding specific requirements for airplane performance and handling qualities for flight in icing conditions. Further, the proposal amends § 25.1419 to address certification approval for flight in icing conditions for airplanes without ice protection features. Those proposed changes do not impact this rulemaking. However, this rulemaking may result in minor conforming changes to the airplane performance and handling qualities for flight in icing conditions rules.

2. ARAC Ice Protection Harmonization Working Group Recommendations

The ARAC has submitted additional rulemaking recommendations to the FAA to improve the safety of operations in icing conditions:

- Part 121 recommendations to address activation of ice protection systems.
- Part 121 recommendations to require certain airplanes to exit icing conditions.
- Part 25 and 33 recommendations to address operations in supercooled large droplet, mixed phase, and glaciated icing conditions.

The recommendations may lead to future rulemaking, but do not directly impact this NPRM.

F. Advisory Material

In addition to this NPRM, the FAA is developing Advisory Circular (AC) 25.1419–2x, Compliance with the Ice Protection Requirements of §§ 25.1419(e), (f), (g), and (h). This proposed AC would provide guidance material for one acceptable means, but not the only means, of demonstrating compliance with this proposed rule. The proposed AC will be posted on ''Aircraft Certification Draft Documents Open for Comment'' Web site, *http://www.faa.gov/aircraft/draft_docs,* on the same date this NPRM is published in the **Federal Register** The date comments are due is indicated on that Web site.

Discussion of the Proposal

A. Safety Concern

The ARAC Ice Protection Harmonization Working Group reviewed icing events and found accidents and incidents where the flightcrew was either completely unaware of ice accretion on the airframe, or was aware of ice accretion, but judged that it was not significant enough to warrant operation of the airframe ice protection system (IPS). The ARAC Ice Protection Harmonization Working Group concluded and recommended to the FAA that flightcrews must be provided with a clear means to know when to activate the IPS.

B. Means To Address the Safety Concern

The FAA has issued airworthiness directives to address the safety concern of when to activate the IPS on certain airplanes. These airworthiness directives require activation of pneumatic deicing boots at the first signs of ice accretion on the airplane. This requirement relieves the pilot of the responsibility for determining if the amount of ice accumulated on the wing warrants activation of the IPS. However, activation of the deicing boots is still subject to the flightcrew's observation of ice accretions, and such observations can be difficult during times of high workload, operations at night, or when clear ice has accumulated. Also, the difficulties of observing ice accretions are applicable to *any* IPS that relies on the flightcrew's observations for activating the system, not just pneumatic deicing boots.

The ARAC Ice Protection Harmonization Working Group concluded that installing a device to alert the flightcrew to activate the IPS would be an improved means to address these situations for future airplanes. A primary ice detection system would be one acceptable means. A primary ice detection system typically consists of two independent detectors. It could either automatically activate the IPS, or provide an indication to the flightcrew when the system must be activated manually. An advisory ice detection system, in conjunction with substantiated visual cues, would also be an acceptable means. The acceptability is contingent upon:

- An advisory ice detection system that annunciates when icing conditions exist or when the substantiated visual cues are present.
- The substantiated visual cues rely on the flightcrew's observation of the first sign of ice accretion on the airplane and do not depend on the pilot determining the thickness of the accretion.
- The flightcrew activates the ice protection system when they observe the ice accretion or when the ice detector annunciates, whichever occurs first.

An advisory ice detection system typically consists of one detector. Such a system does not have sufficient reliability to be the primary means of determining when the IPS must be activated. However, the advisory ice detection system would provide a much higher level of safety than visual cues alone and would mitigate the effects of human sensory limitations and inadequate attention due to workload.

The ARAC Ice Protection Harmonization Working Group also concluded that an acceptable alternative to requiring an ice detector would be to require operating the IPS whenever the airplane is operating in conditions conducive to airframe icing. In this case, the flightcrew would activate the IPS in response to a specific air temperature threshold and the presence of visible moisture. Because ambient temperature is indicated by flightdeck instruments and the flightcrew can readily observe visible moisture, deciding when to initiate the system would require little increased effort by the flightcrew.

The IPS activation method should be applicable during all phases of flight, unless it can be shown that the IPS need not be activated during certain phases of flight. For example, if the IPS is not operated during takeoff until after the second segment climb, then the applicant must substantiate that the airplane can operate safely with ice accretions that could form prior to this point.

The FAA concurs with the safety concern that flightcrews must be provided with a clear means to know when to activate the IPS. To ensure timely activation of the IPS, the proposed § 25.1419(e) requires one of the three acceptable methods recommended by the ARAC Ice Protection Harmonization Working Group: a primary ice detector, visual cues and an advisory ice detector, or operation based on temperature and visible moisture.

Specifically, proposed § 25.1419(e) requires one of the following methods of icing detection and activation of the airframe IPS:

(1) A primary ice detection system that automatically activates or alerts the flightcrew to activate the airframe IPS; or

(2) A definition of visual cues for recognition of the first sign of ice accretion on a specified surface combined with an advisory ice detection system that alerts the flightcrew to activate the airframe IPS; or

(3) Identification of conditions conducive to airframe icing as defined by an appropriate static or total air temperature and visible moisture for use by the flightcrew to activate the airframe IPS.

Proposed § 25.1419(f) requires the activation method be applicable to all phases of flight unless it can be shown that the ice protection system need not be operated during specific phases of flight. Proposed § 25.1419(h) requires that the procedures for operating the ice protection system be included in the Airplane Flight Manual.

C. Flightcrew Workload

The FAA is concerned with the flightcrew workload created if an IPS must be manually cycled. Manual operation of the IPS could be a distraction during the approach and landing phases of flight which typically involve higher pilot workloads. During these critical phases of flight, flightcrews have less time to devote to managing the airplane ice accretions. An IPS that is automatically cycled or operates on a continuous basis (for example, an anti-icing system) does not create this additional workload and, therefore, is not a concern. Section 25.1419(g) of this proposed rule alleviates the workload concerns by requiring airplanes to be equipped with an IPS that would operate in a cyclical manner. This would include a system that would automatically cycle the IPS or an ice detection system that would alert the flightcrew whenever IPS cycling is necessary.

D. Applicability of the Proposed Rule

A review of icing events found discriminating design factors, such as wing chord length or airplane weight, significantly influence the risk of icing accidents and incidents. The FAA and the ARAC Ice Protection Harmonization Working Group, however, determined that a certification rule dealing with ice detectors should not be limited to a specific group of airplanes because of past performance. Since future airplane designs could change, a similar safety record might not be achieved. Relying solely on past performance data for future airplane designs would not be prudent. Therefore, the proposed rule is applicable to all part 25 airplanes.

E. Technology

The FAA and ARAC Ice Protection Harmonization Working Group reviewed the current state of ice detector technology and found that it provides a viable means of compliance with the proposed rule. Several methods exist that can reliably alert the flightcrew to activate the IPS. This technology has been certificated for use on airplanes to alert or advise the pilot of ice or as the primary means of determining when the IPS should be activated.

One ice detection system that is commercially available indicates when a deicing IPS should be initially activated and subsequently activated if the IPS operates in a cyclical manner. This system has sensors installed on the protected airplane surfaces that sense the accretion of ice sufficient to warrant cycling of a deicing system. Other ice detection systems are capable of sensing the rate of ice accretion and are able to indicate when a deicing IPS should be cycled based on ice accretion since the preceding cycling of the system.

F. Differences From the ARAC Recommendation

The ARAC Ice Protection Harmonization Working Group recommended identification of conditions conducive to airframe icing as one method of icing detection and activation of the airframe ice protection system. However, identification of conditions conducive to airframe icing is only a method of icing detection and not of activation. Therefore, the FAA revised the ARAC recommendation by clarifying that identification of conditions conducive to airframe icing is to be used for both icing detection and activation of the IPS. The revision is considered a minor change and does not affect the intent of the ARAC recommendation.

Rulemaking Notices and Analyses

Paperwork Reduction Act

The Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)) requires that the FAA consider the impact of paperwork and other information collection burdens imposed on the public. An Airplane Flight Manual is required by existing part 25 regulations and must contain information that is necessary for safe operation of the airplane. The proposed rule requires that the procedures for operating the ice protection system be included in the Airplane Flight Manual. The proposed rule is applicable to future certification programs and does not require changes to existing Airplane Flight Manuals. Therefore, we have determined that there are no new information collection requirements associated with this proposed rule.

International Compatibility

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to comply with International Civil Aviation Organization (ICAO) Standards and Recommended Practices to the maximum extent practicable. The FAA determined that there are no ICAO Standards and Recommended Practices that correspond to these proposed regulations.

Executive Order 12866 and DOT Regulatory Policies and Procedures

Executive Order 12866, ''Regulatory Planning and Review,'' dated September 30, 1993 (58 FR 51736) directs the FAA to assess both the costs and the benefits of a regulatory change. We are not allowed to propose or adopt a regulation unless we make a reasoned determination that the benefits of the intended regulation justify the costs. Our assessment of this rulemaking indicates that its economic impact is minimal. Because the costs and benefits of this action do not make it a ''significant regulatory action'' as defined in the Order, we have not prepared a ''regulatory evaluation,'' which is the written cost/benefit analysis ordinarily required for all rulemaking under the DOT Regulatory Policies and Procedures. We do not need to do a full evaluation where the economic impact of a rule is minimal.

Economic Evaluation, Regulatory Flexibility Determination, Trade Impact Assessment, and Unfunded Mandates Assessment

Changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 (Pub. L. 96–354) requires agencies to analyze the economic impact of regulatory changes on small entities. Third, the Trade Agreements Act (Pub. L. 96–39) prohibits agencies from setting standards that create unnecessary obstacles to the foreign commerce of the United States. In developing U.S. standards, the Trade Act requires agencies to consider international standards and, where appropriate, that they be the basis of U.S. standards. Fourth, the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) requires agencies to prepare a written assessment of the costs, benefits, and other effects of proposed or final rules that include a Federal mandate likely to result in the expenditure by State, local, or tribal governments, in the aggregate, or by the private sector, of $100 million or more annually (adjusted for inflation with base year of 1995). This portion of the preamble summarizes the FAA's analysis of the economic impacts of this proposed rule.

Department of Transportation Order DOT 2100.5 prescribes policies and procedures for simplification, analysis, and review of regulations. If the expected cost impact is so minimal that a proposed or final rule does not warrant a full evaluation, this order permits that a statement to that effect and the basis for it be included in the preamble if a full regulatory evaluation of the cost and benefits is not prepared. Such a determination has been made for this proposed rule. The reasoning for this determination follows.

An assessment has been conducted of the economic cost impact of the proposed rule amending § 25.1419 of Title 14 of the Code of Federal Regulations (14 CFR) part 25. The FAA proposes to change the regulations applicable to transport category airplanes certificated for flight in icing conditions. This proposal would require newly certificated part 25 transport category airplanes certificated for flight in icing to have one of the following methods to detect ice and activate the airframe IPS:

- A primary ice detection system, automatic or manual;
- The definition of visual cues for recognition of the first sign of ice accretion on a specified surface combined with an advisory ice detection system that alerts the flightcrew; or
- The identification of icing conditions by an appropriate static or total air temperature and visible moisture cues.

This proposal is the result of information gathered from a review of historical icing accidents and incidents. This proposal is intended to improve the level of safety when part 25 airplanes are operated in icing conditions.

A. Cost Discussion

1. *Major Assumptions.* This evaluation makes the following assumptions:

- We used a $50 hourly rate for a mechanic/technician and a $75 hourly rate for an engineer working for an airplane manufacturer or modifier.[8]
- Whenever various compliance options are available to the manufacturers, we chose the least costly option in our analysis.

Other data and derived assumptions are discussed in the following sections on costs and benefits.

2. *Industry Estimate of Costs.* This section discusses the costs to require part 25 manufacturers to include a method of ice detection for newly certificated transport category airplanes.

This proposal would require manufacturers of part 25 airplanes to provide the flightcrew with an effective method of ice detection. Such a method would provide a means, via an ice detection system (IDS), to alert the flightcrew of icing conditions and enable timely activation of the airframe ice protection system (IPS) for the initial and any subsequent cycles.

The requirements for ice detection and activation of the airframe IPS are applicable to all phases of flight, unless it can be shown that the IPS need not be operated during specific phases of flight. If the IPS operates in a cyclical manner, it must either include a system that automatically cycles the IPS, or there must be a method that alerts the flightcrew each time the IPS must be cycled. In addition, this proposal would require that the Airplane Flight Manual contain procedures for activation and operation of the IPS.

The Goodrich Corporation and the ARAC Ice Protection Harmonization Working Group provided us with manufacturer cost estimates for System Design, System Qualification, Hardware, Installation, and Maintenance.

3. *Section-by-Section Estimate of Costs.* The cost estimates, by section, are discussed next.

§ 25.1419(e)

This section proposes three alternative methods of ice detection:

- A primary IDS, automatic or manual; or
- The definition of visual cues for recognition of the first sign of ice accretion on a specified surface combined with an advisory ice detection system that alerts the flightcrew; or
- The identification of icing conditions by an appropriate static or total air temperature and visible moisture cues.

Any of the three proposed ice detection methods would enable timely activation of the airframe IPS and satisfy the intent of this proposal.

The first method of ice detection is the use of a primary IDS. A primary IDS usually has two ice detectors. The cost of an ice detector used in this analysis is based on the Goodrich Corporation's average price of $6,000 per ice detector for a production airplane. Assuming the primary IDS has two ice detectors, we estimate the average cost for a primary IDS to be about $485,000 per certification, $12,000 ($6,000 × 2) for the hardware and $2,500 for the installation, or $14,500 ($12,000 + $2,500) per airplane. Table 1 shows a detailed breakout of these cost estimates.

TABLE 1.—COSTS FOR § 25.1419(e)(1)—PRIMARY ICE DETECTION SYSTEM

Manufacturer non-recurring costs (per aircraft group/type) 2006$	Hours	Hourly rate	Additional cost	Cost
System Design:				
System architecture/Integration	3,000	$75		$225,000
Ice detector positioning	300	75		22,500
Procedures for AFM, AOM/FCOM & MMEL	200	75		15,000
System Qualification/certification:				
Ice detector qualification	300	75		22,500
Ice detection system certification	600	75		45,000
Flight tests	400	75	$100,000	130,000
Installation Design:				
Installation drawings	500	50		25,000
Total	5,300			485,000
Costs (per airplane):				
Hardware (Primary Ice Detection System)			12,000	12,000
Installation	50	50		2,500
Additional weight is 5–10 kg				0

[8] "APO–300 Guidance on Labor Costs", May 2006.

TABLE 1.—COSTS FOR § 25.1419(e)(1)—PRIMARY ICE DETECTION SYSTEM—Continued

Manufacturer non-recurring costs (per aircraft group/type) 2006$	Hours	Hourly rate	Additional cost	Cost
Total				14,500

The second method of ice detection is the use of an advisory IDS along with visual cues. The major difference between a primary and an advisory IDS is that the primary IDS is the principal means to determine when the airframe IPS should be activated. In contrast, an advisory IDS is a backup to the flightcrew and has only one ice detector. The average cost for an advisory IDS is estimated to be $447,500 per certification, $6,000 for the hardware and $1,250 for the installation, or $7,250 ($6,000 + $1,250) per airplane. Table 2 shows a detailed breakout of these cost estimates.

TABLE 2.—COSTS FOR § 25.1419(e)(2)—ADVISORY ICE DETECTION SYSTEM AND VISUAL CUES

Manufacturer non-recurring costs (per aircraft group/type) 2006$	Hours	Hourly rate	Additional cost	Cost
System Design:				
System architecture/Integration	2,500	$75		$187,500
Ice detector positioning	200	75		15,000
Visual cue determination/design	200	75		15,000
Procedures for AFM, AOM/FCOM & MMEL	200	75		15,000
System Qualification/certification:				
Ice detection qualification	300	75		22,500
Visual cue substantiation	200	75		15,000
Ice detection system certification	300	75		22,500
Flight tests	400	75	$100,000	130,000
Installation Design:				
Installation drawings	500	50		25,000
Total	4,800			447,500
Costs (per airplane):				
Hardware (Advisory Ice Detection System)			6,000	6,000
Installation	25	50		1,250
Additional weight is 5–10 kg				0
Total				7,250

The third method of ice detection is a definition of conditions conducive to airframe icing that would be used by the flightcrew to activate the airframe IPS. This definition would be included in the Airplane Flight Manual. There are no costs imposed on the airplane manufacturers with this option.

A summary of the costs for each alternative is shown in Table 3:

TABLE 3.—COST SUMMARY—§ 25.1419(e)

§ 25.1419 Alternatives	Costs	
	Per certification	Per airplane
(e)(1) Primary IDS	$485,000	$14,500
(e)(2) Advisory IDS and Visual Cues	447,500	7,250
(e)(3) Temperature and Moisture	0	0

The least cost alternative is to activate the existing airframe IPS whenever the airplane is operating in conditions conducive to airframe icing based on a specific air temperature threshold and the presence of visible moisture. Since there are no additional certification or production costs to manufacturers by complying with § 25.1419(e)(3) through this alternative, we have determined there are no costs associated with compliance with § 25.1419(e).

We are aware some manufacturers may choose to install more complex systems ((e)(1) or (e)(2)), and want to note these more complex systems are acceptable alternatives to (e)(3).

§ 25.1419(f). Section 25.1419(f) describes the applicability of the proposed rule, so there are no additional costs associated with this section.

§ 25.1419(g). After the initial operation of the IPS, § 25.1419(g) provides alternatives the manufacturer must provide to the operator for safe flight. These alternatives are:

- The IPS must operate continuously, or
- The airplane must be equipped with a system that automatically cycles the IPS, or
- An ice detection system must be provided to alert the flightcrew each time the IPS must be cycled.

Section 25.1419(g) applies to airplanes with either a thermal anti-ice protection system or an IPS that operates in a cyclical manner. Thermal anti-ice protection systems operate continuously while deicing systems usually operate cyclically.

Section 25.1419(g)(1) applies primarily to thermal anti-ice protection systems. Thermal anti-ice protection systems typically use heat or freezing point depressant fluids to keep protected surfaces of the airplane free of ice accretions.

No additional manufacturing costs are associated with § 25.1419(g)(1) because once a thermal anti-ice protection system is activated, it is capable of operating continuously.

Section 25.1419(g)(2) and (3) applies to IPS that operate in a cyclical manner. Past delivery history has shown that about 97% of U.S manufactured part 25 airplanes delivered have thermal anti-ice protection systems and 3% have deicing IPSs that operate in a cyclical manner. Cessna is the only U.S. manufacturer that currently delivers new part 25 certificated airplanes with an IPS that operates in a cyclical manner. Those airplanes delivered with an IPS that operates in a cyclical manner were certificated in September 1971.[9] Later variants from that September 1971 type certificate and all later part 25 new Cessna certifications have thermal anti-ice protection systems that operate continuously. We believe the trend for new part 25 aircraft certifications is toward thermal anti-ice protection systems that operate continuously. Because of the trend of part 25 manufacturers to install thermal anti-ice protection systems in their newly certificated part 25 airplanes, we believe there are no costs imposed on the airplane manufacturers by § 25.1419(g).

We seek comments from U.S. manufacturers on their plans to produce a newly part 25 certificated aircraft with deicing systems that operate cyclically and the associated certification costs.

§ 25.1419(h). Future Airplane Flight Manuals can readily be prepared to include appropriate icing procedures for future certificated air transport category airplanes. Thus minimal costs are associated with § 25.1419(h).

4. *Conclusion.* Since this final rule has minimal costs, a full regulatory evaluation was not prepared. The FAA requests comments with supporting justification about our determination of a minimal impact from this proposal.

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (Pub. L. 96–354) (RFA) establishes "as a principle of regulatory issuance that agencies shall endeavor, consistent with the objectives of the rule and of applicable statutes, to fit regulatory and informational requirements to the scale of the businesses, organizations, and governmental jurisdictions subject to regulation. To achieve this principle, agencies are required to solicit and consider flexible regulatory proposals and to explain the rationale for their actions to assure that such proposals are given serious consideration." The RFA covers a wide-range of small entities, including small businesses, not-for-profit organizations, and small governmental jurisdictions.

Agencies must perform a review to determine whether a rule will have a significant economic impact on a substantial number of small entities. If the agency determines that it will, the agency must prepare a regulatory flexibility analysis as described in the RFA.

However, if an agency determines that a rule is not expected to have a significant economic impact on a substantial number of small entities, section 605(b) of the RFA provides that the head of the agency may so certify and a regulatory flexibility analysis is not required. The certification must include a statement providing the factual basis for this determination, and the reasoning should be clear.

All United States transport category aircraft manufacturers exceed the Small Business Administration small-entity criteria of 1,500 employees.

Therefore, the FAA certifies that this proposed rule would not have a significant economic impact on a substantial number of small entities. The FAA solicits comments regarding this determination.

Trade Impact Assessment

The Trade Agreements Act of 1979 (Pub. L. 96–39) prohibits Federal agencies from establishing any standards or engaging in related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards. The FAA has assessed the potential effect of this proposed rule and has determined that it would impose the same costs on domestic and international entities and thus has a neutral trade impact.

Unfunded Mandates Assessment

Title II of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) requires each Federal agency to prepare a written statement assessing the effects of any Federal mandate in a proposed or final agency rule that may result in an expenditure of $100 million or more (adjusted annually for inflation with the base year 1995) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a "significant regulatory action." The FAA currently uses an inflation-adjusted value of $128.1 million in lieu of $100 million. This proposed rule does not contain such a mandate.

Executive Order 13132, Federalism

The FAA has analyzed this proposed rule under the principles and criteria of Executive Order 13132, Federalism. We determined that this action would not have a substantial direct effect on the States, on the relationship between the national Government and the States, or on the distribution of power and responsibilities among the various levels of government, and therefore would not have federalism implications.

Regulations Affecting Intrastate Aviation in Alaska

Section 1205 of the FAA Reauthorization Act of 1996 (110 Stat. 3213) requires the Administrator, when modifying regulations in 14 CFR in a manner affecting intrastate aviation in Alaska, to consider the extent to which Alaska is not served by transportation modes other than aviation, and to establish such regulatory distinctions as he or she considers appropriate. Because this proposed rule would apply to the certification of future designs of transport category airplanes and their subsequent operation, it could, if adopted, affect intrastate aviation in Alaska. The FAA therefore specifically requests comments on whether there is justification for applying the proposed rule differently in intrastate operations in Alaska.

Plain English

Executive Order 12866 (58 FR 51735, Oct. 4, 1993) requires each agency to write regulations that are simple and easy to understand. We invite your comments on how to make these proposed regulations easier to understand, including answers to questions such as the following:

• Are the requirements in the proposed regulations clearly stated?

• Do the proposed regulations contain unnecessary technical language or jargon that interferes with their clarity?

• Would the proposed regulations be easier to understand if they were divided into more (but shorter) sections?

• Is the description in the preamble helpful in understanding the proposed regulations?

[9] Type Certification Data Sheet No. A22CE.

Please send your comments to the address specified in the **ADDRESSES** section.

Environmental Analysis

FAA Order 1050.1E identifies FAA actions that are categorically excluded from preparation of an environmental assessment or environmental impact statement under the National Environmental Policy Act in the absence of extraordinary circumstances. The FAA has determined that this proposed rulemaking action qualifies for the categorical exclusion identified in paragraph 4(j).

Regulations That Significantly Affect Energy Supply, Distribution, or Use

The FAA has analyzed this NPRM under Executive Order 13211, Actions Concerning Regulations that Significantly Affect Energy Supply, Distribution, or Use (May 18, 2001). We have determined that it is not a ''significant energy action'' under the executive order because it is not a ''significant regulatory action'' under Executive Order 12866, and it is not likely to have a significant adverse effect on the supply, distribution, or use of energy.

Appendix 1—Definition of Terms Used in This NPRM

For the purposes of this NPRM, the following definitions are applicable. These definitions of terms are intended for use *only* with this NPRM:

a. *Advisory ice detection system:* An advisory system annunciates the presence of icing conditions or ice accretion. The advisory ice detection system provides information advising the flightcrew of the presence of ice accretion or icing conditions. It can only be used in conjunction with other means (most commonly, visual observation by the flightcrew) to determine the need for, or timing of, activating the anti-icing or deicing system. The flightcrew is responsible for monitoring the icing conditions or ice accretion as defined in the AFM (typically using total air temperature and visible moisture criteria or visible ice accretion) and activating the anti-icing or deicing system(s).

b. *Airframe icing:* Airframe icing is ice accretions on portions of the airplane, with the exception of the propulsion system, on which supercooled liquid droplets may impinge.

c. *Anti-icing:* Anti-icing is the prevention of ice accretions on a protected surface, either:

- By evaporating the impinging water; or
- By allowing it to run back and off the surface or freeze on non-critical areas.

d. *Automatic cycling mode:* An automatic cycling mode is a mode of operation of the airframe deicing system that provides repetitive cycles of the system without the need for the pilot to select each cycle. This is generally done with a timer, and there may be more than one timing mode.

e. *Deicing:* Deicing is the removal or the process of removal of an ice accretion after it has formed on a surface.

f. Ice *Protection System:* An ice protection system (IPS) is a system that protects certain critical airframe parts from ice accretion. To be an approved system, it must satisfy the requirements of § 25.1419.

g. *Primary ice detection system:* A primary ice detection system is used to determine when the IPS must be activated. The system annunciates the presence of ice accretion or icing conditions, and may also provide information to other aircraft systems. A primary *automatic* system automatically activates the anti-icing or deicing IPS. With a primary *manual* system, the flightcrew activates the anti-icing or deicing IPS upon indication from the primary ice detection system.

h. *Static air temperature:* The air temperature as would be measured by a temperature sensor not in motion with respect to that air. This temperature is also referred to in other documents as ''outside air temperature,'' ''true outside temperature,'' or ''ambient temperature.''

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements, Safety, Transportation.

The Proposed Amendment

In consideration of the foregoing, the Federal Aviation Administration proposes to amend part 25 of Title 14, Code of Federal Regulations, as follows:

PART 25—AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

1. The authority citation for part 25 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701, 44702 and 44704.

2. Amend § 25.1419 by adding new paragraphs (e), (f), (g), and (h) to read as follows:

§ 25.1419 Ice Protection.

* * * * *

(e) One of the following methods of icing detection and activation of the airframe ice protection system must be provided:

(1) A primary ice detection system that automatically activates or alerts the flightcrew to activate the airframe ice protection system;

(2) A definition of visual cues for recognition of the first sign of ice accretion on a specified surface combined with an advisory ice detection system that alerts the flightcrew to activate the airframe ice protection system; or

(3) Identification of conditions conducive to airframe icing as defined by an appropriate static or total air temperature and visible moisture for use by the flightcrew to activate the airframe ice protection system.

(f) Unless the applicant shows that the ice protection system need not be operated during specific phases of flight, the requirements of paragraph (e) are applicable to all phases of flight.

(g) After the initial activation of the ice protection system—

(1) The ice protection system must operate continuously;

(2) The airplane must be equipped with a system that automatically cycles the ice protection system; or

(3) An ice detection system must be provided to alert the flightcrew each time the ice protection system must be cycled.

(h) Procedures for operation of the ice protection system must be established and documented in the Airplane Flight Manual.

Issued in Washington, DC, on April 11, 2007.

John J. Hickey,

Director, Aircraft Certification Service.

[FR Doc. E7–7944 Filed 4–25–07; 8:45 am]

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