DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. FAA–2005–22840; Amendment No. 25–121]

RIN 2120–AI14

Airplane Performance and Handling Qualities in Icing Conditions

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final rule.

SUMMARY: This action introduces new airworthiness standards to evaluate the performance and handling characteristics of transport category airplanes in icing conditions. This action will improve the level of safety for new airplane designs when operating in icing conditions, and harmonizes the U.S. and European airworthiness standards for flight in icing conditions.

DATES: This final rule becomes effective October 9, 2007.

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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. This regulation is within the scope of that authority because it prescribes new safety standards for the design of transport category airplanes.

I. Background

A. Statement of the Problem

Currently, § 25.1419, ''Ice protection,'' requires transport category airplanes with approved ice protection features be capable of operating safely within the icing conditions identified in appendix C of part 25. This section requires applicants to perform flight testing and conduct analyses to make this determination. Section 25.1419 only requires an applicant to demonstrate that the airplane can operate safely in icing conditions if the applicant is seeking to certificate ice protection features.

Although an airplane's performance capability and handling qualities are important in determining whether an airplane can operate safely, part 25 does not have specific requirements on airplane performance or handling qualities for flight in icing conditions. In addition, the FAA does not have a standard set of criteria defining what airplane performance capability and handling qualities are needed to be able to operate safely in icing conditions. Finally, § 25.1419 fails to address certification approval for flight in icing conditions for airplanes without ice protection features.

Service history shows that flight in icing conditions may be a safety risk for transport category airplanes. We found nine accidents since 1983 in the National Transportation Safety Board's accident database that may have been prevented if this rule had been in effect. In evaluating the potential for this rulemaking to avoid future accidents, we considered only past accidents involving tailplane stall or potential airframe ice accretion effects on drag or controllability. We did not consider accidents related to ground deicing since this amendment does not change the ground deicing requirements. We also limited our search to accidents involving aircraft certificated to the icing standards of part 25 (or its predecessor).

B. NTSB Recommendations

This amendment addresses the following National Transportation Safety Board (NTSB) safety recommendations related to airframe icing:[1]

1. NTSB Safety Recommendation A–91–087 [2] recommended requiring flight tests where ice is accumulated in those cruise and approach flap configurations in which extensive exposure to icing conditions can be expected, and requiring subsequent changes in configuration to include landing flaps. This safety recommendation resulted from an accident that was attributed to tailplane stall due to ice contamination.

This amendment requires applicants to investigate the susceptibility of airplanes to ice-contaminated tailplane stall during airworthiness certification. An accompanying Advisory Circular (AC) will provide detailed guidance on acceptable means of compliance, including flight tests in icing conditions where the airplane's configuration is changed from flaps and landing gear retracted to flaps and landing gear in the landing position.

[1] Refer to appendix 3 of the NPRM for more details on these safety recommendations (except for A–96–056, which was not discussed in the NPRM).

[2] ''Effect of Ice on Aircraft Handling Characteristics (1984 Trials),'' Jetstream 31—G–JSSD, British Aerospace Flight Test Report FTR.177/JM, dated May 13, 1985.

2. NTSB Safety Recommendation A–96–056 [3] recommended revising the icing certification testing regulation to ensure that airplanes are properly tested for all conditions in which they are authorized to operate, or are otherwise shown to be capable of safe flight into such conditions. Additionally, if safe operations 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.

This amendment partially addresses safety recommendation A–96–056 by revising the certification standards to ensure that transport category airplanes are properly tested for the critical icing conditions defined in appendix C of part 25. We are considering future rulemaking action to address icing conditions beyond those covered by appendix C of part 25, and to provide flightcrews with a means to positively determine when they are in icing conditions that exceed the limits for aircraft certification.

3. NTSB Safety Recommendation A–98–094 [4] recommended that manufacturers of all turbine-engine driven airplanes (including the EMB–120) provide minimum maneuvering airspeed information for all airplane configurations, phases, and conditions of flight (icing and non-icing conditions). Also, the NTSB recommended that minimum airspeeds should take into consideration the effects of various types, amounts, and locations of ice accumulations, including thin amounts of very rough ice, ice accumulated in supercooled large droplet icing conditions, and tailplane icing.

This amendment partially addresses safety recommendation A–98–094 by requiring the same maneuvering capability requirements at the minimum operating speeds in the most critical icing conditions defined in appendix C of part 25 as are currently required in non-icing conditions. We are considering future rulemaking action to address supercooled large droplet icing conditions.

4. NTSB Safety Recommendation A–98–096 is also a result of the same accident discussed under Safety Recommendation A–98–094, above. The NTSB recommended the FAA require, during type certification, that manufacturers and operators of all transport category airplanes certificated to operate in icing conditions install stall warning/protection systems that provide a cockpit warning (aural warning and/or stick shaker) before the onset of stall when the airplane is operating in icing conditions.

This amendment requires adequate stall warning margin to be shown with the most critical ice accretion for transport category airplanes approved to fly in icing conditions. Except for the short time before icing conditions are recognized and the ice protection system activated, this stall warning must be provided by the same means as for non-icing conditions. Although neither an aural stall warning or stick shaker is required under this amendment, all recently certificated transport category airplanes have used either a stick shaker or an aural warning to warn the pilot of an impending stall. We do not anticipate any future transport category airplane designs without a cockpit warning of an impending stall.

C. Summary of the NPRM

This amendment is based on the notice of proposed rulemaking (NPRM), Notice No. 05–10, which was published in the **Federal Register** on November 4, 2005 (70 FR 67278). In the NPRM, we proposed to revise the airworthiness standards for type certification of transport category airplanes to add a comprehensive set of new requirements for airplane performance and handling qualities for flight in icing conditions. We also proposed to add requirements that define the ice accretion (that is, the size, shape, location, and texture of the ice) that must be considered for each phase of flight.

These changes were proposed to ensure that minimum operating speeds determined during certification of all future transport category airplanes will provide adequate maneuver capability in icing conditions for all phases of flight and all airplane configurations. They would also harmonize the FAA's regulations with those expected to be adopted by the European Aviation Safety Agency (EASA). This harmonization would not only benefit the aviation industry economically, but also maintain the necessary high level of aviation safety.

II. Discussion of the Final Rule

A. General Summary

Twelve commenters responded to the NPRM: Four private citizens, Airbus Industrie (Airbus), the Air Line Pilots Association (ALPA), The Boeing Company (Boeing), Dassault Aviation (Dassault), the General Aviation Manufacturers Association (GAMA), the National Transportation Safety Board (NTSB), Raytheon Aircraft Company (Raytheon), and the United Kingdom Civil Aviation Authority (U.K. CAA).

Seven of these commenters explicitly expressed support for the rule, none opposed it. Many of the commenters suggested specific improvements or clarifications. Summaries of their comments and our responses (including explanations of changes to the final rule in response to the comments) are provided below.[5]

1. Engine Bleed Configuration for Showing Compliance With § 25.119

The proposed § 25.119 would require applicants to comply with the landing climb performance requirements in both icing and non-icing conditions. Raytheon stated that proposed § 25.119(b) is unclear as to whether the engine bleed configuration for showing compliance should include bleed extraction for operation of the airframe and engine ice protection systems (IPS). Raytheon pointed out that engine bleed extraction for operating the airframe and engine IPS could affect engine acceleration time, which would affect the thrust level used for showing compliance. Raytheon noted that the means of compliance in the proposed AC addresses this issue, but recommended that it be clarified within the rule.

While we agree that engine bleed extraction could affect the thrust level used to show compliance with § 25.119(b), we disagree that the rule needs to be revised to state the bleed configuration. For flight in icing conditions, § 25.21(g)(1) requires compliance to be shown assuming normal operation of the airplane and its IPS in accordance with the operating limitations and operating procedures established by the applicant and provided in the Airplane Flight Manual (AFM). The bleed configuration of the engines would be part of the AFM operating procedures that must be used to show compliance with § 25.119(b). As noted by Raytheon, the guidance provided in the AC accompanying this final rule reminds applicants that the

[3] National Transportation Safety Board, 1996. ''In-Flight Icing Encounter and Loss of Control, Simmons Airlines, d.b.a.American Eagle Flight 4184, Avions de Transport Regional (ATR) Model 72–212, N401AM, Roselawn, Indiana, October 31, 1994.'' Aircraft Accident Report NTSB/AAR–96/01. Washington, DC.

[4] National Transportation Safety Board, 1998. ''In-Flight Icing Encounter and Uncontrolled Collision With Terrain, Comair Flight 3272, Embraer EMB–120RT, N265CA, Monroe, Michigan, January 9, 1997.'' Aircraft Accident Report NTSB/AR–98/04. Washington, DC.

[5] The full text of each commenter's submission is available in the Docket.

engine bleed configuration should be considered when showing compliance with the requirements of this final rule.

2. Using the Landing Ice Accretion To Comply With § 25.121(d)(2)(ii)

Boeing proposed using the landing ice accretion for showing compliance with the approach climb gradient requirement in icing conditions, rather than the holding ice accretion as proposed in § 25.121(d)(2)(ii). Boeing recommended this change to harmonize with EASA's proposed rule.

We consider it inappropriate to use the landing ice accretion for compliance with § 25.121(d). Section 25.121(d) specifies the minimum climb capability, in terms of a climb gradient, that an airplane must be capable of achieving in the approach configuration with one engine inoperative. This requirement involves the approach phase of flight, which occurs before entering the landing phase. Depending on the IPS design and the procedures for its use, the landing ice accretion (which is defined as the ice accretion after exiting the holding phase and transitioning to the landing phase) may be smaller than the holding ice accretion. For example, there may be a procedure to use the IPS to remove the ice when transitioning to the landing phase so that the protected areas are clear of ice for landing. It would be inappropriate to allow any reduction in the ice accretion to be used for the approach climb gradient (in the approach phase) resulting from using the IPS in the landing phase.

We note that neither EASA's Notice of Proposed Amendment (NPA) covering the same icing-related safety issues (NPA 16/2004) nor our NPRM define an ice accretion specific to the approach phase of flight. Both proposals used holding ice for compliance in icing conditions because holding ice was considered to be conservative for this flight phase. Therefore, we believe that it is appropriate to define an additional ice accretion that would be specifically targeted at the approach phase of flight. We have added the following definition as paragraph (a)(5) in part II of appendix C:

''Approach ice is the critical ice accretion on the unprotected parts of the airplane, and any ice accretion on the protected parts appropriate to normal IPS operation following exit from the holding flight phase and transition to the most critical approach configuration.''

Section 25.121(d)(2)(ii) is also revised to refer to this definition. The definition of landing ice is revised to be the ice accretion after exiting from the approach phase (rather than after the holding phase as proposed) and redesignated as paragraph (a)(6).

Finally, applicants would still have the option to use a more conservative ice accretion in accordance with paragraph (b) of part II of appendix C. Therefore, applicants would have the option of using the holding ice accretion as proposed in the NPRM if it was more critical than the approach ice accretion.

3. V_{REF} Comparison at Maximum Landing Weight

Proposed § 25.125(a)(2) would require landing distances to be determined in icing conditions if the landing approach speed, V_{REF}, for icing conditions exceeds V_{REF} for non-icing conditions by more than 5 knots calibrated airspeed. Boeing proposed that the V_{REF} speed comparison for icing and non-icing conditions in proposed § 25.125(a)(2) be made at the maximum landing weight. This proposal would harmonize the FAA's rule with the expected EASA final rule. Boeing also stated that the proposed rule was deficient in that it did not specify the weight or weights at which this comparison must be made. The results of this comparison can depend on the weight at which the comparison is made.

We agree that this comparison should be made at the maximum landing weight and have revised § 25.125(a)(2) of the final rule accordingly. We consider this to be a clarifying change that will not impose an additional burden on applicants.

4. Landing Distance in Icing Conditions

As noted in the discussion of the previous comment, proposed § 25.125(a)(2) would require the landing distance to be determined in icing conditions if the landing approach speed, V_{REF}, for icing conditions exceeds the non-icing V_{REF} by more than 5 knots calibrated airspeed. An increase in V_{REF} for icing conditions is normally caused by an increase in stall speed in icing conditions because V_{REF} must be at least 1.23 times the stall speed.

Raytheon noted that a change in stall speed is not the only factor that might affect landing distance in icing conditions. For example, idle thrust might be adjusted by an engine control system designed to maintain sufficient bleed flow to support the demands of engine and airframe ice protection. Also, landing procedures for icing conditions might be different than for non-icing conditions. Raytheon suggested revising proposed § 25.125(a)(2) to require that the landing distance must also be determined in icing conditions if the thrust settings or landing procedures used in icing conditions would cause an increase in the landing distance.

One of the primary safety concerns addressed by proposed § 25.125 is to maintain a minimum speed margin above the stall speed for an approach and landing in icing conditions. This is achieved by increasing the landing approach speed (V_{REF}) if ice on the airplane results in a significant increase in stall speed. Under proposed § 25.125(b)(2)(ii)(B), a significant increase in stall speed relative to this requirement is one that results in an increase in V_{REF} of more than 5 knots calibrated airspeed, where V_{REF} is not less than 1.23 times the stall speed.

An increase in V_{REF} will increase the distance required by the airplane to land and come to a stop since the airplane will touch down at a higher speed. A significant increase in stall speed in the landing configuration due to ice has a secondary effect of increasing the required landing distance. We proposed in § 25.125(a)(2) that this increase in landing distance be taken into account. Proposed § 25.125(a)(2) resulted from the secondary effect of a significant increase in stall speed in the landing configuration due to ice, not to an evaluation of all of the possible reasons why the required landing distance may need to be longer in icing conditions. The commenter correctly points out that a longer landing distance may also be needed if higher thrust settings or different landing procedures are used in icing conditions.

In evaluating the potential costs and effects of the proposed change, we could not find any existing airplanes where, if the requirement proposed by the commenter had been in effect, it would have required an applicant to determine a longer landing distance in icing conditions. In nearly all cases, applicants have not used different thrust or power settings or different procedures for landing in icing conditions. Airplane manufacturers indicated that they did not anticipate this relationship to change for future designs.

When different thrust or power settings or procedures have been used for landing in icing conditions, V_{REF} has also increased by more than 5 knots. In these cases, applicants would be required by the proposed § 25.125(a) to determine the landing distance for icing conditions, and existing § 25.101(c) and (f) require applicants to include the effects of different power or thrust settings or landing procedures on this landing distance.

Therefore, we see no need to amend the proposed requirement as recommended by Raytheon.

5. Sandpaper Ice Accretion

Proposed appendix C, part II(a)(6) defined sandpaper ice as a thin, rough layer of ice. A private citizen notes the NPRM did not specifically state how sandpaper ice should be used or considered in showing compliance with any of the proposed airplane performance and handling qualities requirements. This commenter suggested amending proposed § 25.143(i)(1) to add that if normal operation of the horizontal tail IPS allows ice to form on the tail leading edge, sandpaper ice must also be considered in determining the critical ice accretion. (Proposed § 25.143(i)(1) would require applicants to demonstrate the airplane is safely controllable, per the applicable requirements of § 25.143, with the ice accretion defined in appendix C that is most critical for the particular flight phase.)

Appendix C, part II(a) requires applicants to use the most critical ice accretion to show compliance with the applicable subpart B airplane performance and handling requirements in icing conditions. The determination of the most critical ice accretion must consider the full range of atmospheric icing conditions of part I of appendix C as well as the characteristics of the IPS (per § 25.21(g)(1) and appendix C, part II(a)). This includes consideration of thin, rough layers of ice (known as sandpaper ice) as well as any other type of ice accretion that may occur in the applicable atmospheric icing conditions, taking into account the operating characteristics of the IPS and the flight phase.

Since the requirement to use the most critical ice accretion includes consideration of sandpaper ice and sandpaper ice is not referenced elsewhere in the rule, we have removed appendix C, part II(a)(6) from the final rule. The AC that we are issuing along with this final rule, or shortly thereafter, provides further information on the use of sandpaper ice in showing compliance. (This AC will be available in the Regulatory Guidance Library (RGL) when issued.)

6. Critical Ice Accretion for Showing Compliance With § 25.143(i)(1)

As noted in the discussion of the previous comment, proposed § 25.143(i)(1) would require applicants to demonstrate the airplane is safely controllable, per the applicable requirements of § 25.143, with the ice accretion defined in appendix C that is most critical for the particular flight phase. Raytheon stated that because ice accretion before normal system operation is addressed separately in § 25.143(j), the controllability demonstration required by § 25.143(i)(1) should be limited to only the most critical ice accretion defined in appendix C part II(a) rather than all of appendix C.

For purposes of the controllability demonstrations required by § 25.143(i)(1), appendix C, parts I and II(a), (b), (c), and (d) apply. Appendix C, part II(e) only applies to §§ 25.143(j) and 25.207(h), which are the only subpart B requirements pertaining to flight in icing conditions before activation of the IPS. We acknowledge that this limited applicability of appendix C, part II(e) is unclear in the language proposed, and we have revised the final rule to include a sentence that specifies this limitation.

7. Pushover Maneuver for Ice-Contaminated Tailplane Stall Evaluation

Raytheon stated that proposed § 25.143(i)(2), which states that a push force from the pilot must be required throughout a pushover maneuver down to zero g or full down elevator, is inconsistent with allowing a pull force for recovery from the maneuver. Raytheon noted that the FAA stated in the NPRM that a force reversal (that is, a push force becoming a pull force) is unacceptable, implying that the pilot should only be permitted to relax his or her push force to initiate recovery. The 50-pound limit for recovery in the proposed § 25.143(i)(2) appears to allow up to 50 pounds of force reversal to develop during the maneuver, including at the initiation of recovery from the maneuver. Raytheon stated that they object to the proposed requirement and continue to support the industry proposal for the pushover maneuver submitted to ARAC by the Flight Test Harmonization Working Group. The industry proposal specified there must be no force reversal down to 0.5 g (the limit of the operational flight envelope) and a prompt recovery from zero g (or full down elevator control if zero g cannot be obtained) with less than 50 pounds of stick force. Raytheon stated that the 50-pound pull force was not intended as a limit for the subsequent pull-up maneuver during recovery from the push-over test.

The FAA continues to disagree with the industry proposal, and Raytheon did not offer any new evidence or rationale that would lead us to reconsider our position. As stated in the NPRM, certification testing and service experience have shown that testing to only 0.5 g is inadequate, considering the relatively high frequency of experiencing 0.5 g in operations. Since the beginning of the 1980s, the practice of many certification authorities has been to require testing to lower load factors. The industry proposal for determining the acceptability of a control force reversal (as described in the NPRM) was subjective and would have led to inconsistent evaluations. Requiring a push force to zero g removes subjectivity in the assessment of the airplane's controllability and provides readily understood criteria of acceptability. Any lesser standard would not give confidence that the problem has been fully addressed.

We do not consider the requirement for a push force to be needed to reach zero g, coupled with allowing a pull force of up to 50 pounds during the recovery, to be inconsistent with our position that force reversals are unacceptable within the normal flight envelope. The pushover maneuver ends when zero g is reached (or when full down elevator is achieved if zero g cannot be reached). The recovery is a separate pull-up maneuver, initiated by the pilot, to regain the original flight path. It is acceptable for this maneuver to require a pull force, but the pull force must not exceed 50 pounds, which is the maximum pitch force permitted by the existing § 25.143(c) (renumbered as § 25.143(d) by this amendment) for short term application of force using one hand. No changes were made.

8. Pushover Maneuver Limited by Design Features Other Than Elevator Power

Airbus noted that proposed § 25.143(i)(2) would allow the required pushover maneuver to end before zero g is reached if the airplane is limited by elevator power. Airbus commented that safe design characteristics other than limited elevator power may also prevent an aircraft from reaching zero g during the pushover maneuver (e.g., flight envelope protections designed into fly-by-wire control systems). Airbus proposed revising the proposed rule to allow the pushover maneuver to end before reaching zero g for other safe design characteristics that prevent reaching zero g.

We agree with Airbus and have revised § 25.143(i)(2) to include consideration of other design characteristics of the flight control system that may prevent reaching zero g in the pushover maneuver.

9. Pitch Force Requirements During a Sideslip Maneuver

Raytheon stated that the proposed requirement for flight in icing conditions is more stringent than the requirements applicable to non-icing conditions. Proposed § 25.143(i)(3) would require that any changes in force that the pilot must apply to the pitch control to maintain speed with increasing sideslip angle must be steadily increasing with no force reversals. Raytheon notes the non-icing subpart B static lateral-directional stability requirements of § 25.177 do not specify that the pitch forces cannot reverse. For example, a push force at small sideslip angles that changes to a pull force as sideslip increases is acceptable.

Raytheon noted that it would not be unusual for an airplane to require an increase in pull force with increasing sideslip. If the tailplane or a portion of it developed aerodynamic separation as sideslip increases, then to maintain 1–g flight the elevator hinge moment would require further pull force that could be sudden or become excessive. Raytheon notes this undesirable characteristic would comply with proposed § 25.143(i)(3).

Raytheon and another commenter (a private citizen) proposed that the proposed rule be revised to eliminate the requirements that the pitch force be steadily increasing with increasing sideslip and that there be no reversal. Instead, these commenters suggested that the requirement should be limited to ensuring that there is no abrupt or uncontrollable pitching tendency.

The FAA agrees with the commenters that small, gradual changes in the pitch control force may not be objectionable or unsafe, and that the proposed requirement is unnecessarily more stringent than the requirements for non-icing conditions. The safety concern is sudden or large pitch force changes that would be difficult for the pilot to control. Therefore, we have changed § 25.143(i)(3) in the final rule to read as follows:

''Any changes in force that the pilot must apply to the pitch control to maintain speed with increasing sideslip angle must be steadily increasing with no force reversals, unless the change in control force is gradual and easily controllable by the pilot without using exceptional piloting skill, alertness, or strength.''

Under this new language, abrupt changes in the control force characteristic, unless so small as to be unnoticeable, would not be considered to meet the requirement that the force be steadily increasing. A gradual change in control force is a change that is not abrupt and does not have a steep gradient. It can be easily managed by a pilot of average skill, alertness, and strength. Control forces in excess of those permitted by § 25.143(d) would be considered excessive.

10. Stall Warning in Icing Conditions

Existing § 25.207(c) requires at least a 3 knot or 3% speed margin between the stall warning speed (V_{SW}) and the reference stall speed (V_{SR}). Existing § 25.207(d) requires at least a 5 knot or 5% speed margin between V_{SW} and the speed at which the behavior of the airplane gives the pilot a clear and distinctive indication of an acceptable nature that the airplane is stalled. Under proposed § 25.21(g), the stall warning requirements of § 25.207(c) and (d) would apply only to non-icing conditions. For icing conditions, proposed § 25.207(e) requires that stall warning be sufficient to allow the pilot to prevent stalling when the pilot starts the recovery maneuver not less than 3 seconds after the onset of stall warning in a one knot per second deceleration.

The U.K. CAA noted that proposed § 25.207(e) would allow stall warning in icing conditions to occur at a speed slower than the speed for the maximum lift capability of the wing (also known as the 1g stall speed). This would not be true for non-icing conditions because of § 25.207(c). According to U.K. CAA, if the stall warning speed is slower than the 1g stall speed, the airplane will have little or no maneuvering capability at the point that the airplane gives the pilot a warning of an impending stall. The U.K. CAA stated that in an operational scenario, if the airplane slows to a speed slightly above the stall warning speed, any attempt to maneuver the airplane or further reduce speed could lead to an immediate stall. This situation is of most concern to the U.K. CAA in the landing phase because, unlike the cruise or takeoff phases, there are limited options for the crew to recover from a stall. The airplane is already at low altitude and descending towards the ground, the power setting is low, and the potential to trade height for speed is extremely limited.

Due to this concern, the U.K. CAA recommended making the non-icing stall warning speed margin requirements of § 25.207(c) and (d) also apply to icing conditions, but only when the airplane is in the landing configuration. Since the proposed § 25.207(e) was intended to be used in place of § 25.207(c) and (d) for icing conditions, the U.K. CAA suggested that, if § 25.207(c) and (d) are applied to the landing configuration in icing conditions, then § 25.207(e) need not be applied to the landing configuration.

In developing the proposed rule, the FAA accepted a determination by the Flight Test Harmonization Working Group (FTHWG) that the same handling qualities standards should generally apply to flight in icing conditions as apply to flight in non-icing conditions. In certain areas, however, the FTHWG decided that the handling qualities standards for non-icing conditions were inappropriate for flight in icing conditions. In these areas, the FTHWG recommended alternative criteria for flight in icing conditions.

The stall warning margin was one of the areas where the FTHWG recommended alternative criteria for flight in icing conditions. The FTHWG determined that applying the existing stall warning margin requirements of § 25.207(c) and (d) to icing conditions would be far more stringent than the best current practices and would unduly penalize designs that have not exhibited safety problems in icing conditions. The FTHWG further determined the stall warning requirements of the existing § 25.207(c) and (d) could be made less stringent for icing conditions without compromising safety. As a result, we proposed the less stringent § 25.207(e) to address stall warning margin requirements for icing conditions in place of § 25.207(c) and (d).

No changes have been made to this final rule as a result of the U.K. CAA's comment. We acknowledge that the U.K. CAA has pointed out a deficiency with safety implications in the proposed stall warning requirements. However, U.S. manufacturers' initial cost analysis of the U.K. CAA's recommended changes indicates these changes may significantly increase the costs of this rulemaking beyond the benefits provided due to uncertainties in how the increased stall warning margin requirement would affect airplane type certification testing, certification program schedules, and the design of stall warning systems.

In addition, the U.K. CAA's recommended changes would introduce significant regulatory differences from EASA's airworthiness certification requirements, and might not completely resolve the potential safety issue. For these reasons we believe that additional time and aviation industry participation are needed to determine an appropriate way to address this safety concern. However, we do not believe it is appropriate to delay issuance of this final rule pending resolution of this issue.

This final rule significantly improves the affected airworthiness standards and the benefits of these improvements should be achieved as soon as possible. It also satisfies a number of important NTSB recommendations. As these improvements are being implemented, we will continue to work closely with EASA and industry to address the issue raised by the U.K. CAA. This subject has been included on EASA's 2008 rulemaking agenda, and we will work with them in that context to agree on a harmonized approach. Once these efforts are completed, we will initiate new rulemaking, if appropriate, to adopt any necessary revisions to part 25.

11. Stall and Stall Warning Requirements Prior to Activation of the IPS

Proposed § 25.207(h)(2)(ii) would require compliance with the stall characteristics requirements of § 25.203, using the stall demonstration prescribed by § 25.201, for flight in icing conditions before the IPS is activated. This requirement would apply if the stall warning required by § 25.207 is provided by a different means for flight in icing conditions than for non-icing conditions. The stall demonstration prescribed by § 25.201 requires that the stalling maneuver be continued to the point where the airplane gives the pilot a clear and distinctive indication of an acceptable nature that the airplane is stalled.

Raytheon disagreed with this proposal because the ice accretion resulting from a delay in activating the IPS is a short term transient condition. According to Raytheon, the intent should be to demonstrate only the ability to prevent a stall, rather than to also ensure that the airplane has good stall characteristics. Raytheon stated that it is unnecessary to consider that the pilot might ignore the stall buffeting and continue to increase angle-of-attack until the airplane is stalled. To comply with the proposed rule, Raytheon argued that an airplane with a stick pusher stall identification system would be required to have its stick pusher activation based on a contaminated wing leading edge for non-icing conditions. This would require increased takeoff and landing speeds and negatively impact all takeoff and landing performance.

Raytheon also stated that the cost impacts would be excessive for what is only a transient condition. Raytheon's position is that there is no need to consider the airplane's handling qualities after it has stalled. It should be sufficient to show that the pilot can prevent stalling if the recovery maneuver is not begun until at least three seconds after the onset of stall warning, which is also required by the proposed § 25.207(h)(2)(ii).

We do not agree with Raytheon's comments. Because of human factors considerations, proposed § 25.207(b) generally requires that the same means of providing a stall warning be used in both icing and non-icing conditions. Therefore, if a stick shaker is used for stall warning in non-icing conditions (as is the case for most transport category airplanes) it must also be used for stall warning in icing conditions. The reason for this proposed requirement is that in icing accidents and incidents where the airplane stalled before the stick shaker activated, flightcrews have not recognized the buffeting associated with ice contamination in time to prevent stalling. Proposed § 25.207(h)(2)(ii) allows a different means of providing stall warning in icing conditions only for the relatively short time period between when the airplane first enters icing conditions and when the IPS is activated. (This exception to the proposed § 25.207(b) is further limited such that it only applies when the procedures for activating the IPS do not involve waiting until a certain amount of ice has been accumulated.)

Because there is still a safety concern with flightcrews recognizing a stall warning that is provided by a different means than the flightcrew would normally experience, we consider it essential that the airplane also be shown to have safe stall characteristics. Poor stalling characteristics with an iced wing have directly contributed to the severity of icing accidents involving a stall in icing conditions.

As for Raytheon's comment about the cost impacts, we evaluated these as part of the regulatory evaluation conducted for the NPRM, and we do not agree that the cost impacts associated with this requirement are excessive. In addition, the adopted § 25.207 will not require airplanes with stick pusher stall identification systems to have their stick pusher activation based on a contaminated wing leading edge for non-icing conditions. Section 25.207(h)(2)(ii) does not apply if the same stall warning means is used for non-icing and icing conditions. If a stick shaker is used for stall warning and if the stick shaker activation point must be advanced due to the effect of the ice accreted before activation of the IPS, this would result in the same negative effect on takeoff and landing speeds. However, if the procedures for activating the IPS ensure that it is activated before any ice accretes on the wings, neither the stick shaker activation point nor the takeoff and landing speeds will be affected. This could be accomplished, for example, by using an ice detector that would activate the IPS before ice accretes on the wings, or by procedures for activating the IPS based on environmental conditions conducive to icing, but before ice would actually accrete on the wings.

12. Dissipation of Ice Shapes at High Altitudes and High Mach Numbers

Proposed § 25.253(c) specifies the maximum speed for demonstrating stability characteristics in icing conditions. Proposed § 25.253(c)(3) allows this speed to be limited to the speed at which it is demonstrated that the airframe will be free of ice accretion due to the effects of increased dynamic pressure. Raytheon stated that experience has shown that ice shapes dissipate quickly at high altitude and high Mach numbers. Raytheon suggested revising § 25.253(c)(3) to specify the altitude and/or Mach number range that ice shapes would dissipate.

Although we agree that past experience shows that ice shapes dissipate or detach at high altitude and high Mach numbers, the applicable range may vary with airplane type. The particular conditions under which the ice accretions dissipate or detach should be justified as part of the certification program. Since this is consistent with proposed § 25.253(c), we made no changes to the final rule.

13. Critical Ice Shapes

Proposed appendix C, part II(a) defines how to determine the critical ice accretions for each phase of flight. The NTSB commented that for each phase of flight, the applicant should be required to demonstrate that the shape, chordwise and spanwise, and the roughness of the shapes accurately reflect the full range of appendix C conditions in terms of mean effective drop diameter, liquid water content, and temperature during each phase of flight. Additionally, the NTSB suggested that we review the justification and selection of the most critical ice shape for each phase of flight.

Although we believe the proposed requirements already address the NTSB's concerns, we have revised appendix C, part II(a) for additional clarity. We added text to state that applicants must demonstrate that the full range of atmospheric icing conditions specified in part I of appendix C have been considered, including the mean effective drop diameter, liquid water content, and temperature appropriate to the flight conditions.

14. Takeoff Ice Accretions

ALPA noted that the takeoff ice accretions defined in proposed appendix C, part II(a)(2) do not include the entire takeoff flight path. As defined in § 25.111, the takeoff flight path ends at either 1,500 feet above the takeoff surface, or the height at which the transition from the takeoff to the en route configuration is completed and the final takeoff speed (V_{FTO}) is reached, whichever is higher. The takeoff flight path in proposed appendix C, part II(a)(2) ends at 1,500 feet above the takeoff surface. ALPA stated that there are many mountainous airport locations where the takeoff configuration must be maintained above 1,500 feet above the takeoff surface for terrain clearance at maximum takeoff gross weights. Since winter operations in these locations often involve icing conditions, ALPA requested that the takeoff flight path of Appendix C, part II(a)(2) be revised to match that of § 25.111.

ALPA's comment points out an oversight in the text of the proposal. Appendix C, part II(a)(2) has been revised to include the entire takeoff flight path as defined in § 25.111. We consider this to be a technical clarification that does not impose a significant additional burden on applicants.

15. Size of Ice Accretion Before Activation of the IPS

For the pre-activation ice identified in Appendix C, part II(e), ALPA did not support the 30-second time period for the flightcrew to see and respond to ice accreting on the airplane as stated in paragraphs 2c(4)(a) and (b) of Appendix 1, Airframe Ice Accretion, of proposed AC 25.21–1X. ALPA believes that the ice accreted during a more operationally realistic timeframe and the potential degradations in aircraft performance and handling qualities must be accounted for during certification in order to make the proposed requirements and acceptable means of compliance an effective combination. While a well designed human factors study could determine an appropriate time, ALPA proposed that at least the 2-minute time period contained in 14 CFR 33.77, Foreign object ingestion—ice, be used as the time to visually recognize ice is accreting until definitive studies can be completed.

The FAA believes that ALPA has misunderstood the use of the 30-second time period in the proposed AC 25.21–1X acceptable means of compliance. The FAA does not expect the flightcrew to see and respond to ice accumulating on the airplane within 30 seconds. In accordance with § 25.21(g), compliance must be shown using ice accretions consistent with the AFM operating procedures. First, applicants must determine the ice accretion that would be on the airplane when the AFM procedures call for activating the IPS. Then, the 30-second time period is used in combination with the continuous maximum icing environment, as defined in appendix C of part 25, as a standard for determining the additional ice that could accrete on the airplane before the pilot actually activates the IPS. Since the appendix C maximum continuous icing envelope represents at least the 99th percentile of encounters with continuous maximum icing (that is, 99% of the time, less icing would occur), it would take significantly longer than 30 seconds in nearly all actual icing events for the airplane to accrete this much ice.

As a result of this comment, the FAA reviewed the proposed AC 25.21–1X text. Although the use of a-30 second time period in a continuous maximum icing environment is clearly stated, the FAA believes that the text is incomplete regarding what we expect applicants to consider in determining the ice accretion specified by the AFM procedures for activating the IPS. The FAA is revising the proposed AC to state that this ice accretion should be easily recognizable by the pilot under all foreseeable conditions (for example, at night in clouds). No changes have been made to the regulatory requirements.

16. Maximum Size of the Critical Ice Accretion

Dassault noted that, in Europe, the critical ice accretion is limited to a maximum thickness of 3 inches. Dassault did not find such a limitation in the NPRM, nor in the proposed advisory circular (AC) 25.21–1X related to the NPRM. Dassault noted that this omission could result in carrying out performance and handling tests with unrealistic ice accretions (particularly those assumed to build up on the unprotected parts of the airplane during the 45-minute holding flight phase referenced in ACs 25.21–X and 25.1419–1A).

We did not make any changes to the final rule because several existing ACs provide guidance for the size of the most critical ice accretions that should be considered. This longstanding guidance considers a 45-minute holding condition within an icing cloud. Since this guidance is not regulatory, we have accepted applicants' use of service history and other experience with other compliance criteria to determine the maximum ice accretion that needs to be considered. We will continue to address this issue in the same manner. The AC being issued along with this final rule refers to these alternative methods of compliance and provides guidance for their use.

17. Detection of Icing Conditions

A private citizen commented that icing conditions should be monitored by more than the pilot's eyesight. We are unable to address the commenter's issue in this rulemaking because this rulemaking only addresses performance and handling qualities requirements for the current methods of ice detection (which include detection by visual means). However, we are pursuing separate rulemaking for future airplane designs relative to allowable methods for detecting icing and determining when to activate the IPS. In NPRM 07–07, ''Activation of Ice Protection,'' published in the **Federal Register** on April 26, 2007, we proposed to amend the airworthiness standards applicable to transport category airplanes to require a means to ensure timely activation of the airframe IPS.

18. Delayed Activation of the IPS

ALPA recommended modifying all rule language to eliminate references and rule provisions for waiting until a finite amount of ice has accumulated before activating the IPS. ALPA stated that delayed activation of the IPS has been a factor in several accidents and incidents. ALPA also pointed out that the FAA has adopted 17 airworthiness directives requiring immediate activation of IPS at the first sign of ice accretion for a number of airplane types where the previous practice was to wait until a specified amount of ice had accumulated on the airplane. ALPA noted that after an exhaustive review of accident and incident data, ARAC recommended an operating rule that would remove the option of delaying activation of the IPS.

Except for the airworthiness directives referenced by ALPA, current regulations do not prohibit AFM procedures that call for delaying activation of the IPS until a specified amount of ice has accreted. Although we strongly encourage activating the IPS at the first sign of ice accretion, there may be some designs for which delayed activation is currently acceptable, safe, and appropriate. For example, some thermal wing IPS can currently be used in either an anti-ice or deice mode. In the deice mode, the wing IPS is not activated until a certain amount of ice has accreted. This has not resulted in any safety issues, and can be a more economical way of operating the wing IPS.

The purpose of this rulemaking is to provide appropriate performance and handling qualities requirements, considering the currently accepted procedures for activating the IPS. Establishing new requirements for acceptable methods for activating the IPS is beyond the scope of this rulemaking. As ALPA noted, however, ARAC has recommended the FAA adopt new requirements that would ensure flightcrews are provided with a clear means to know when to activate the IPS in a timely manner. We are pursuing separate rulemaking in response to this ARAC recommendation. In NPRM 07–07, ''Activation of Ice Protection,'' published in the **Federal Register** on April 26, 2007, we proposed to amend the airworthiness standards applicable to transport category airplanes to require a means to ensure timely activation of the airframe IPS. We will update the requirements adopted by this final rule related to the means of activating the IPS, if necessary, to be consistent with any final action resulting from NPRM 07–07, ''Activation of Ice Protection.''

19. Harmonization With EASA's NPA

Several commenters noted that the FAA did not fully harmonize the NPRM with the EASA's NPA covering the same icing-related safety issues. They recommended harmonizing the two rule proposals.

We worked closely with EASA to ensure that there are no significant regulatory differences between this amendment and EASA's anticipated final rule. However, since EASA's final rule has not yet been issued, we cannot guarantee that the two final rules will be completely harmonized. We believe that any differences will be primarily editorial and not significant regulatory differences.

20. Accuracy of the Regulatory Flexibility Evaluation

GAMA requested that the FAA review the regulatory flexibility evaluation in the interest of accuracy.

We reviewed the regulatory flexibility evaluation and reaffirmed the determination that this proposed rule would not have a significant economic impact on a substantial number of small entities. All U.S. part 25 aircraft manufacturers exceed the Small Business Administration small-entity criteria of 1,500 employees for aircraft manufacturers.

21. Aircraft Population Used When Determining Cost Versus Benefit

GAMA stated that it appeared the cost proposal considered U.S. manufactured aircraft while the benefit section included international products. GAMA believes that the same aircraft population should be used when determining cost versus benefit. Additionally, GAMA stated that it appeared it was assumed that cost was only attributed to entirely new TC products. GAMA believes it would be appropriate to consider the economic impact to some amount of amended TC and STC projects as well.

Section 1 of Executive Order 12866 states ''Federal agencies should promulgate only such regulations as are required by law, are necessary to interpret the law, or are made necessary by compelling public need, such as material failures of private markets to protect or improve the health and safety of the public, the environment, or the well-being of the American people.'' Section 5 states ''In order to reduce the regulatory burden on the American people, their families, their communities, their State, local, and tribal governments and their industries * * *.'' Therefore, regulatory evaluations and flexibility analyses focus on American people and American industries.

American industries, such as manufacturers and operators of aircraft, must comply with regulations promulgated by Federal agencies. Foreign firms are not required to comply with U.S. regulations unless they choose to sell or operate their aircraft in America.

We determined the costs for this proposal by analyzing only American manufacturing industries, since foreign firms are not required to comply with U.S. regulations unless they choose to sell or operate their aircraft in America. While we do consider foreign manufactured aircraft in the benefit section, we determined the benefits by analyzing only American operators of those aircraft. Hence, the intent of Executive Order 12866 was satisfied.

We did include amended TCs in the analysis. Each TC includes all derivatives for a particular aircraft model. For example, TC No. A16WE initially covered only the Boeing 737–100, but was later amended to include the –200 through –900 Boeing 737 models.

Future applicants for approval of changed products are subject to § 21.101 (Changed Product Rule). There are several provisions of § 21.101 allowing future applicants of changed products to comply with earlier regulation amendments. We have already determined that benefits of the Changed Product Rule exceed the costs. Therefore, we do not estimate the benefits and costs of changed products for new certification rules.

22. Value of Fatalities Avoided

A private citizen claimed that the value of the fatalities avoided by this proposal would be in the neighborhood of $20 billion.

The number of averted fatalities and injuries is based on the historical accident rate extrapolated into the future. The FAA used $3.0 million for an avoided fatality and $132,700 for the additional associated medical and legal costs' for a fatality. The derivation for these values is discussed in the ''Economic Values for FAA Investment and Regulatory Decisions, A Guide.'' [6] Without the rule, we expect that over the 45-year analysis period, approximately three accidents will occur. These three accidents are expected to result in approximately 12 fatalities, six serious injuries, and two minor injuries. From these values, and expected future accidents based on past accident history, we estimated a benefit of about $90 million over the 45-year analysis period.

III. Rulemaking Analyses and Notices

Paperwork Reduction Act

There are no current or new requirements 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.

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

Changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs each Federal agency to propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs.

[6] *http://www.faa.gov/regulations_policies/policy_guidance/benefit_cost/media/050404%20Critical%20Values%20Dec%2031%20Report%2007Jan05.pdf.*

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. 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. 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 the base year of 1995.)

In conducting these analyses, FAA has determined this rule (1) has benefits that justify its costs, is not a ''significant regulatory action'' as defined in section 3(f) of Executive Order 12866 and is not ''significant'' as defined in DOT's Regulatory Policies and Procedures; (2) will not have a significant economic impact on a substantial number of small entities; (3) will not reduce 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.

Introduction

This portion of the preamble summarizes the FAA's analysis of the economic impacts of a final rule amending part 25 of Title 14, Code of Federal Regulations (14 CFR) to change the regulations applicable to transport category airplanes certificated for flight in icing conditions. It also includes summaries of the regulatory flexibility determination, the international trade impact assessment, and the unfunded mandates assessment. We suggest readers seeking greater detail read the full regulatory evaluation, a copy of which we have placed in the docket for this rulemaking.

Total Benefits and Costs of This Rulemaking

The estimated potential benefits of avoiding 3 accidents over the 45-year analysis interval are $89.2 million ($23.6 million in present value at seven percent). To obtain these benefits, over the 45-year analysis interval, manufacturers will incur additional certification costs of $9.8 million and the operators of these airplanes will pay $52.5 million in additional fuel-burn. We estimate the total cost of this final rule to be about $62.3 million and the seven percent present value cost of the rule will be about $23.0 million.

Who Is Potentially Affected by This Rulemaking

- Operators of part 25 U.S.-registered aircraft conducting operations under FAR Parts 121, 129, and 135, and
- Manufacturers of those part 25 aircraft.

Our Cost Assumptions and Sources of Information

This evaluation makes the following assumptions:

1. This final rule is assumed to become effective immediately.
2. The production runs for newly certificated part 25 airplane models is 20 years.
3. The average life of a part 25 airplane is 25 years.
4. We analyzed the costs and benefits of this final rule over the 45-year period (20 + 25 = 45) 2006 through 2050.
5. We used a 10-year certification compliance period. For the 10-year life-cycle period, the FAA calculated an average of four new certifications will occur.
6. We used $3.0 million as the value of an avoided fatality.
7. New airplane certifications will occur in year one of the analysis time period.

Benefits of This Rulemaking

The benefits of this final rule consist of the value of lives saved due to avoiding three accidents involving part 25 airplanes operating in icing conditions. Based on the historic accident rate, we estimate that a total of 12 fatalities could potentially be avoided by adopting the final rule. Over the 45-year period of analysis, the potential benefit of the propose rule will be $89.2 million ($23.6 million in present value at seven percent).

Costs of This Rulemaking

We estimate the costs of this final rule to be about $62.3 million ($23.0 million in present value at seven percent) over the 45-year analysis period. The total cost of $62.3 million equals the fixed certification costs of $9.8 million incurred in the first year plus the variable annual fuel burn cost of $52.5 million over the 45-year analysis period.

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.

In the interest of accuracy, one commenter requested we review the determination we made in the proposed rules regulatory flexibility evaluation. We reviewed the determination from the proposed rule and came to the same conclusions for this final rule for the reasons discussed below.

Currently U.S. manufactured part 25 aircraft type certificate holders include: The Boeing Company, Cessna Aircraft Company (a subsidiary of Textron Inc.), Raytheon Company, and Gulfstream Aerospace Corporation (a wholly owned subsidiary of General Dynamics). All United States part 25 aircraft manufacturers exceed the Small Business Administration small-entity criteria of 1,500 employees for aircraft manufacturers.

This rule will add an additional weighted average monthly fuel burn cost of about $42 per airplane, which is less than an hour of fuel burn and thus a minimal additional cost to all operators.

Given that manufacturers are not small entities and operators incur a minimal additional cost, as the FAA Administrator, I certify that this final 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 determined that it will 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 final rule does not contain such a mandate. The requirements of Title II 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 national 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 didn't 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 312f 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,'' and it is not likely to have a significant adverse effect on the supply, distribution, or use of energy.

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

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 § 25.21 by adding a new paragraph (g) to read as follows:

§ 25.21 Proof of compliance.

* * * * *

(g) The requirements of this subpart associated with icing conditions apply only if the applicant is seeking certification for flight in icing conditions.

(1) Each requirement of this subpart, except §§ 25.121(a), 25.123(c), 25.143(b)(1) and (b)(2), 25.149, 25.201(c)(2), 25.207(c) and (d), 25.239, and 25.251(b) through (e), must be met in icing conditions. Compliance must be shown using the ice accretions defined in appendix C, assuming normal operation of the airplane and its ice protection system in accordance with the operating limitations and operating procedures established by the applicant and provided in the Airplane Flight Manual.

(2) No changes in the load distribution limits of § 25.23, the weight limits of § 25.25 (except where limited by performance requirements of this subpart), and the center of gravity limits of § 25.27, from those for non-icing conditions, are allowed for flight in icing conditions or with ice accretion.

■ 3. Amend § 25.103 by revising paragraph (b)(3) to read as follows:

§ 25.103 Stall speed.

* * * * *

(b) * * *

(3) The airplane in other respects (such as flaps, landing gear, and ice accretions) in the condition existing in the test or performance standard in which V_{SR} is being used;

* * * * *

■ 4. Amend § 25.105 by revising paragraph (a) to read as follows:

§ 25.105 Takeoff.

(a) The takeoff speeds prescribed by § 25.107, the accelerate-stop distance prescribed by § 25.109, the takeoff path prescribed by § 25.111, the takeoff distance and takeoff run prescribed by § 25.113, and the net takeoff flight path prescribed by § 25.115, must be determined in the selected configuration for takeoff at each weight, altitude, and ambient temperature within the operational limits selected by the applicant—

(1) In non-icing conditions; and

(2) In icing conditions, if in the configuration of § 25.121(b) with the takeoff ice accretion defined in appendix C:

(i) The stall speed at maximum takeoff weight exceeds that in non-icing conditions by more than the greater of 3 knots CAS or 3 percent of V_{SR}; or

(ii) The degradation of the gradient of climb determined in accordance with § 25.121(b) is greater than one-half of the applicable actual-to-net takeoff flight path gradient reduction defined in § 25.115(b).

* * * * *

■ 5. Amend § 25.107 by revising paragraph (c)(3) and (g)(2) and adding new paragraph (h) to read as follows:

§ 25.107 Takeoff speeds.

* * * * *

(c) * * *

(3) A speed that provides the maneuvering capability specified in § 25.143(h).

* * * * *

(g) * * *

(2) A speed that provides the maneuvering capability specified in § 25.143(h).

(h) In determining the takeoff speeds V_1, V_R, and V_2 for flight in icing conditions, the values of V_{MCG}, V_{MC}, and V_{MU} determined for non-icing conditions may be used.

■ 6. Amend § 25.111 by revising paragraph (c)(3)(iii), (c)(4), and adding a new paragraph (c)(5) to read as follows:

§ 25.111 Takeoff path.

* * * * *

(c) * * *

(3) * * *

(iii) 1.7 percent for four-engine airplanes.

(4) The airplane configuration may not be changed, except for gear retraction and automatic propeller feathering, and no change in power or thrust that requires action by the pilot may be made until the airplane is 400 feet above the takeoff surface; and

(5) If § 25.105(a)(2) requires the takeoff path to be determined for flight in icing conditions, the airborne part of the takeoff must be based on the airplane drag:

(i) With the takeoff ice accretion defined in appendix C, from a height of 35 feet above the takeoff surface up to the point where the airplane is 400 feet above the takeoff surface; and

(ii) With the final takeoff ice accretion defined in appendix C, from the point where the airplane is 400 feet above the takeoff surface to the end of the takeoff path.

* * * * *

■ 7. Revise § 25.119 to read as follows:

§ 25.119 Landing climb: All-engines-operating.

In the landing configuration, the steady gradient of climb may not be less than 3.2 percent, with the engines at the power or thrust that is available 8 seconds after initiation of movement of the power or thrust controls from the minimum flight idle to the go-around power or thrust setting—

(a) In non-icing conditions, with a climb speed of V_{REF} determined in accordance with § 25.125(b)(2)(i); and

(b) In icing conditions with the landing ice accretion defined in appendix C, and with a climb speed of V_{REF} determined in accordance with § 25.125(b)(2)(ii).

■ 8. Amend § 25.121 by revising paragraphs (b), (c), and (d) to read as follows:

§ 25.121 Climb: One-engine inoperative.

* * * * *

(b) *Takeoff; landing gear retracted.* In the takeoff configuration existing at the point of the flight path at which the landing gear is fully retracted, and in the configuration used in § 25.111 but without ground effect:

(1) The steady gradient of climb may not be less than 2.4 percent for two-engine airplanes, 2.7 percent for three-engine airplanes, and 3.0 percent for four-engine airplanes, at V_2 with:

(i) The critical engine inoperative, the remaining engines at the takeoff power or thrust available at the time the landing gear is fully retracted, determined under § 25.111, unless there is a more critical power operating condition existing later along the flight path but before the point where the airplane reaches a height of 400 feet above the takeoff surface; and

(ii) The weight equal to the weight existing when the airplane's landing gear is fully retracted, determined under § 25.111.

(2) The requirements of paragraph (b)(1) of this section must be met:

(i) In non-icing conditions; and

(ii) In icing conditions with the takeoff ice accretion defined in appendix C, if in the configuration of § 25.121(b) with the takeoff ice accretion:

(A) The stall speed at maximum takeoff weight exceeds that in non-icing conditions by more than the greater of 3 knots CAS or 3 percent of V_{SR}; or

(B) The degradation of the gradient of climb determined in accordance with § 25.121(b) is greater than one-half of the applicable actual-to-net takeoff flight path gradient reduction defined in § 25.115(b).

(c) *Final takeoff.* In the en route configuration at the end of the takeoff path determined in accordance with § 25.111:

(1) The steady gradient of climb may not be less than 1.2 percent for two-engine airplanes, 1.5 percent for three-engine airplanes, and 1.7 percent for four-engine airplanes, at V_{FTO} with—

(i) The critical engine inoperative and the remaining engines at the available maximum continuous power or thrust; and

(ii) The weight equal to the weight existing at the end of the takeoff path, determined under § 25.111.

(2) The requirements of paragraph (c)(1) of this section must be met:

(i) In non-icing conditions; and

(ii) In icing conditions with the final takeoff ice accretion defined in appendix C, if in the configuration of § 25.121(b) with the takeoff ice accretion:

(A) The stall speed at maximum takeoff weight exceeds that in non-icing conditions by more than the greater of 3 knots CAS or 3 percent of V_{SR}; or

(B) The degradation of the gradient of climb determined in accordance with § 25.121(b) is greater than one-half of the applicable actual-to-net takeoff flight path gradient reduction defined in § 25.115(b).

(d) *Approach.* In a configuration corresponding to the normal all-engines-operating procedure in which V_{SR} for this configuration does not exceed 110 percent of the V_{SR} for the related all-engines-operating landing configuration:

(1) The steady gradient of climb may not be less than 2.1 percent for two-engine airplanes, 2.4 percent for three-engine airplanes, and 2.7 percent for four-engine airplanes, with—

(i) The critical engine inoperative, the remaining engines at the go-around power or thrust setting;

(ii) The maximum landing weight;

(iii) A climb speed established in connection with normal landing procedures, but not exceeding 1.4 V_{SR}; and

(iv) Landing gear retracted.

(2) The requirements of paragraph (d)(1) of this section must be met:

(i) In non-icing conditions; and

(ii) In icing conditions with the approach ice accretion defined in appendix C. The climb speed selected for non-icing conditions may be used if the climb speed for icing conditions, computed in accordance with paragraph (d)(1)(iii) of this section, does not exceed that for non-icing conditions by more than the greater of 3 knots CAS or 3 percent.

■ 9. Amend § 25.123 by revising paragraph (a) introductory text and paragraph (b) to read as follows:

§ 25.123 En route flight paths.

(a) For the en route configuration, the flight paths prescribed in paragraph (b) and (c) of this section must be determined at each weight, altitude, and ambient temperature, within the operating limits established for the airplane. The variation of weight along the flight path, accounting for the progressive consumption of fuel and oil by the operating engines, may be included in the computation. The flight paths must be determined at a speed not less than V_{FTO}, with—

* * *

(b) The one-engine-inoperative net flight path data must represent the actual climb performance diminished by a gradient of climb of 1.1 percent for two-engine airplanes, 1.4 percent for three-engine airplanes, and 1.6 percent for four-engine airplanes—

(1) In non-icing conditions; and

(2) In icing conditions with the en route ice accretion defined in appendix C, if:

(i) A speed of 1.18 V_{SR} with the en route ice accretion exceeds the en route speed selected for non-icing conditions by more than the greater of 3 knots CAS or 3 percent of V_{SR}; or

(ii) The degradation of the gradient of climb is greater than one-half of the applicable actual-to-net flight path reduction defined in paragraph (b) of this section.

* * * * *

■ 10. Revise § 25.125 to read as follows:

§ 25.125 Landing.

(a) The horizontal distance necessary to land and to come to a complete stop (or to a speed of approximately 3 knots for water landings) from a point 50 feet above the landing surface must be determined (for standard temperatures, at each weight, altitude, and wind within the operational limits established by the applicant for the airplane):

(1) In non-icing conditions; and

(2) In icing conditions with the landing ice accretion defined in appendix C if V_{REF} for icing conditions exceeds V_{REF} for non-icing conditions by more than 5 knots CAS at the maximum landing weight.

(b) In determining the distance in paragraph (a) of this section:

(1) The airplane must be in the landing configuration.

(2) A stabilized approach, with a calibrated airspeed of not less than V_{REF}, must be maintained down to the 50-foot height.

(i) In non-icing conditions, V_{REF} may not be less than:

(A) 1.23 V_{SR}0;

(B) V_{MCL} established under § 25.149(f); and

(C) A speed that provides the maneuvering capability specified in § 25.143(h).

(ii) In icing conditions, V_{REF} may not be less than:

(A) The speed determined in paragraph (b)(2)(i) of this section;

(B) 1.23 V_{SR}0 with the landing ice accretion defined in appendix C if that speed exceeds V_{REF} for non-icing conditions by more than 5 knots CAS; and

(C) A speed that provides the maneuvering capability specified in § 25.143(h) with the landing ice accretion defined in appendix C.

(3) Changes in configuration, power or thrust, and speed, must be made in accordance with the established procedures for service operation.

(4) The landing must be made without excessive vertical acceleration, tendency to bounce, nose over, ground loop, porpoise, or water loop.

(5) The landings may not require exceptional piloting skill or alertness.

(c) For landplanes and amphibians, the landing distance on land must be determined on a level, smooth, dry, hard-surfaced runway. In addition—

(1) The pressures on the wheel braking systems may not exceed those specified by the brake manufacturer;

(2) The brakes may not be used so as to cause excessive wear of brakes or tires; and

(3) Means other than wheel brakes may be used if that means—

(i) Is safe and reliable;

(ii) Is used so that consistent results can be expected in service; and

(iii) Is such that exceptional skill is not required to control the airplane.

(d) For seaplanes and amphibians, the landing distance on water must be determined on smooth water.

(e) For skiplanes, the landing distance on snow must be determined on smooth, dry, snow.

(f) The landing distance data must include correction factors for not more than 50 percent of the nominal wind components along the landing path opposite to the direction of landing, and not less than 150 percent of the nominal wind components along the landing path in the direction of landing.

(g) If any device is used that depends on the operation of any engine, and if the landing distance would be noticeably increased when a landing is made with that engine inoperative, the landing distance must be determined with that engine inoperative unless the use of compensating means will result in a landing distance not more than that with each engine operating.

■ 11. Amend § 25.143 by redesignating paragraphs (c) through (g) as paragraphs (d) through (h) respectively; adding a new paragraph (c); revising redesignated paragraphs (d), (e), and (f); amending redesignated paragraph (h) by removing the words ''Thrust power setting'' in the fourth column of the table and replacing them with the words ''Thrust/power setting''; and adding paragraphs (i), and (j) to read as follows:

§ 25.143 General.

* * * * *

(c) The airplane must be shown to be safely controllable and maneuverable with the critical ice accretion appropriate to the phase of flight defined in appendix C, and with the critical engine inoperative and its propeller (if applicable) in the minimum drag position:

(1) At the minimum V_2 for takeoff;

(2) During an approach and go-around; and

(3) During an approach and landing.

(d) The following table prescribes, for conventional wheel type controls, the maximum control forces permitted during the testing required by paragraph (a) through (c) of this section:

Force, in pounds, applied to the control wheel or rudder pedals	Pitch	Roll	Yaw
For short term application for pitch and roll control—two hands available for control	75	50	
For short term application for pitch and roll control—one hand available for control	50	25	
For short term application for yaw control			150
For long term application	10	5	20

(e) Approved operating procedures or conventional operating practices must be followed when demonstrating compliance with the control force limitations for short term application that are prescribed in paragraph (d) of this section. The airplane must be in trim, or as near to being in trim as practical, in the preceding steady flight condition. For the takeoff condition, the airplane must be trimmed according to the approved operating procedures.

(f) When demonstrating compliance with the control force limitations for long term application that are prescribed in paragraph (d) of this section, the airplane must be in trim, or as near to being in trim as practical.

* * * * *

(i) When demonstrating compliance with § 25.143 in icing conditions—

(1) Controllability must be demonstrated with the ice accretion defined in appendix C that is most critical for the particular flight phase;

(2) It must be shown that a push force is required throughout a pushover maneuver down to a zero g load factor, or the lowest load factor obtainable if limited by elevator power or other design characteristic of the flight control system. It must be possible to promptly recover from the maneuver without exceeding a pull control force of 50 pounds; and

(3) Any changes in force that the pilot must apply to the pitch control to

maintain speed with increasing sideslip angle must be steadily increasing with no force reversals, unless the change in control force is gradual and easily controllable by the pilot without using exceptional piloting skill, alertness, or strength.

(j) For flight in icing conditions before the ice protection system has been activated and is performing its intended function, the following requirements apply:

(1) If activating the ice protection system depends on the pilot seeing a specified ice accretion on a reference surface (not just the first indication of icing), the requirements of § 25.143 apply with the ice accretion defined in appendix C, part II(e).

(2) For other means of activating the ice protection system, it must be demonstrated in flight with the ice accretion defined in appendix C, part II(e) that:

(i) The airplane is controllable in a pull-up maneuver up to 1.5 g load factor; and

(ii) There is no pitch control force reversal during a pushover maneuver down to 0.5 g load factor.

■ 12. Amend § 25.207 by revising paragraph (b); redesignating paragraphs (e) and (f) as paragraphs (f) and (g) respectively; adding a new paragraph (e); revising redesignated paragraph (f) and adding paragraph (h) 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 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.

* * * * *

(e) In icing conditions, the stall warning margin in straight and turning flight must be sufficient to allow the pilot to prevent stalling (as defined in § 25.201(d)) when the pilot starts a recovery maneuver not less than three seconds after the onset of stall warning. When demonstrating compliance with this paragraph, the pilot must perform the recovery maneuver in the same way as for the airplane in non-icing conditions. Compliance with this requirement must be demonstrated in flight with the speed reduced at rates not exceeding one knot per second, with—

(1) The more critical of the takeoff ice and final takeoff ice accretions defined in appendix C for each configuration used in the takeoff phase of flight;

(2) The en route ice accretion defined in appendix C for the en route configuration;

(3) The holding ice accretion defined in appendix C for the holding configuration(s);

(4) The approach ice accretion defined in appendix C for the approach configuration(s); and

(5) The landing ice accretion defined in appendix C for the landing and go-around configuration(s).

(f) The stall warning margin must be sufficient in both non-icing and icing conditions to allow the pilot to prevent stalling when the pilot starts a recovery maneuver not less than one second after the onset of stall warning in slow-down turns with at least 1.5 g load factor normal to the flight path and airspeed deceleration rates of at least 2 knots per second. When demonstrating compliance with this paragraph for icing conditions, the pilot must perform the recovery maneuver in the same way as for the airplane in non-icing conditions. Compliance with this requirement must be demonstrated in flight with—

(1) The flaps and landing gear in any normal position;

(2) The airplane trimmed for straight flight at a speed of 1.3 V_{SR}; and

(3) The power or thrust necessary to maintain level flight at 1.3 V_{SR}.

* * * * *

(h) For flight in icing conditions before the ice protection system has been activated and is performing its intended function, the following requirements apply, with the ice accretion defined in appendix C, part II(e):

(1) If activating the ice protection system depends on the pilot seeing a specified ice accretion on a reference surface (not just the first indication of icing), the requirements of this section apply, except for paragraphs (c) and (d) of this section.

(2) For other means of activating the ice protection system, 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 the speed is reduced at rates not exceeding one knot per second and the pilot performs the recovery maneuver in the same way as for flight in non-icing conditions.

(i) If stall warning is provided by the same means as for flight in non-icing conditions, the pilot may not start the recovery maneuver earlier than one second after the onset of stall warning.

(ii) If stall warning is provided by a different means than for flight in non-icing conditions, the pilot may not start the recovery maneuver earlier than 3 seconds after the onset of stall warning. Also, compliance must be shown with § 25.203 using the demonstration prescribed by § 25.201, except that the deceleration rates of § 25.201(c)(2) need not be demonstrated.

■ 13. Amend § 25.237 by revising paragraph (a) to read as follows:

§ 25.237 Wind velocities.

(a) For land planes and amphibians, the following applies:

(1) A 90-degree cross component of wind velocity, demonstrated to be safe for takeoff and landing, must be established for dry runways and must be at least 20 knots or 0.2 V_{SR0}, whichever is greater, except that it need not exceed 25 knots.

(2) The crosswind component for takeoff established without ice accretions is valid in icing conditions.

(3) The landing crosswind component must be established for:

(i) Non-icing conditions, and

(ii) Icing conditions with the landing ice accretion defined in appendix C.

* * * * *

■ 14. Amend § 25.253 by revising paragraph (b), and adding a new paragraph (c) to read as follows:

§ 25.253 High-speed characteristics.

* * * * *

(b) *Maximum speed for stability characteristics.* V_{FC}/M_{FC}. V_{FC}/M_{FC} is the maximum speed at which the requirements of §§ 25.143(g), 25.147(E), 25.175(b)(1), 25.177, and 25.181 must be met with flaps and landing gear retracted. Except as noted in § 25.253(c), V_{FC}/M_{FC} may not be less than a speed midway between V_{MO}/M_{MO} and V_{DF}/M_{DF}, except that for altitudes where Mach number is the limiting factor, M_{FC} need not exceed the Mach number at which effective speed warning occurs.

(c) *Maximum speed for stability characteristics in icing conditions.* The maximum speed for stability characteristics with the ice accretions defined in appendix C, at which the requirements of §§ 25.143(g), 25.147(e), 25.175(b)(1), 25.177, and 25.181 must be met, is the lower of:

(1) 300 knots CAS;

(2) V_{FC}; or

(3) A speed at which it is demonstrated that the airframe will be free of ice accretion due to the effects of increased dynamic pressure.

■ 15. Amend § 25.773 by revising paragraph (b)(1)(ii) to read as follows:

§ 25.773 Pilot compartment view.

* * * * *

(b) * * *

(1) * * *

(i) * * *

(ii) The icing conditions specified in § 25.1419 if certification for flight in icing conditions is requested.

* * * * *

■ 16. Amend § 25.941 by revising paragraph (c) to read as follows:

§ 25.941 Inlet, engine, and exhaust compatibility.

* * * * *

(c) In showing compliance with paragraph (b) of this section, the pilot strength required may not exceed the limits set forth in § 25.143(d), subject to the conditions set forth in paragraphs (e) and (f) of § 25.143.

■ 17. Amend § 25.1419 by revising the introductory text to read as follows:

§ 25.1419 Ice protection.

If the applicant seeks certification for flight in icing conditions, the airplane must be able to safely operate in the continuous maximum and intermittent maximum icing conditions of appendix C. To establish this—

* * * * *

■ 18. Amend appendix C to part 25 by adding a part I heading and a new paragraph (c) to part I; and adding a new part II to read as follows:

Appendix C of Part 25

Part I—Atmospheric Icing Conditions

(a) * * *

(c) *Takeoff maximum icing.* The maximum intensity of atmospheric icing conditions for takeoff (takeoff maximum icing) is defined by the cloud liquid water content of 0.35 g/m3, the mean effective diameter of the cloud droplets of 20 microns, and the ambient air temperature at ground level of minus 9 degrees Celsius (-9(C). The takeoff maximum icing conditions extend from ground level to a height of 1,500 feet above the level of the takeoff surface.

Part II—Airframe Ice Accretions for Showing Compliance With Subpart B.

(a) *Ice accretions—General.* The most critical ice accretion in terms of airplane performance and handling qualities for each flight phase must be used to show compliance with the applicable airplane performance and handling requirements in icing conditions of subpart B of this part. Applicants must demonstrate that the full range of atmospheric icing conditions specified in part I of this appendix have been considered, including the mean effective drop diameter, liquid water content, and temperature appropriate to the flight conditions (for example, configuration, speed, angle-of-attack, and altitude). The ice accretions for each flight phase are defined as follows:

(1) *Takeoffice* is the most critical ice accretion on unprotected surfaces and any ice accretion on the protected surfaces appropriate to normal ice protection system operation, occurring between liftoff and 400 feet above the takeoff surface, assuming accretion starts at liftoff in the takeoff maximum icing conditions of part I, paragraph (c) of this appendix.

(2) *Final takeoff ice* is the most critical ice accretion on unprotected surfaces, and any ice accretion on the protected surfaces appropriate to normal ice protection system operation, between 400 feet and either 1,500 feet above the takeoff surface, or the height at which the transition from the takeoff to the en route configuration is completed and V_{FTO} is reached, whichever is higher. Ice accretion is assumed to start at liftoff in the takeoff maximum icing conditions of part I, paragraph (c) of this appendix.

(3) *En route ice* is the critical ice accretion on the unprotected surfaces, and any ice accretion on the protected surfaces appropriate to normal ice protection system operation, during the en route phase.

(4) *Holding ice* is the critical ice accretion on the unprotected surfaces, and any ice accretion on the protected surfaces appropriate to normal ice protection system operation, during the holding flight phase.

(5) *Approach ice* is the critical ice accretion on the unprotected surfaces, and any ice accretion on the protected surfaces appropriate to normal ice protection system operation following exit from the holding flight phase and transition to the most critical approach configuration.

(6) *Landing ice* is the critical ice accretion on the unprotected surfaces, and any ice accretion on the protected surfaces appropriate to normal ice protection system operation following exit from the approach flight phase and transition to the final landing configuration.

(b) In order to reduce the number of ice accretions to be considered when demonstrating compliance with the requirements of § 25.21(g), any of the ice accretions defined in paragraph (a) of this section may be used for any other flight phase if it is shown to be more critical than the specific ice accretion defined for that flight phase. Configuration differences and their effects on ice accretions must be taken into account.

(c) The ice accretion that has the most adverse effect on handling qualities may be used for airplane performance tests provided any difference in performance is conservatively taken into account.

(d) For both unprotected and protected parts, the ice accretion for the takeoff phase may be determined by calculation, assuming the takeoff maximum icing conditions defined in appendix C, and assuming that:

(1) Airfoils, control surfaces and, if applicable, propellers are free from frost, snow, or ice at the start of the takeoff;

(2) The ice accretion starts at liftoff;

(3) The critical ratio of thrust/power-to-weight;

(4) Failure of the critical engine occurs at V_{EF}; and

(5) Crew activation of the ice protection system is in accordance with a normal operating procedure provided in the Airplane Flight Manual, except that after beginning the takeoff roll, it must be assumed that the crew takes no action to activate the ice protection system until the airplane is at least 400 feet above the takeoff surface.

(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).

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Marion C. Blakey,

Administrator.

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