

FAA Final Rule –

Part 25 Airplane Performance and Handling Qualities in Appendix C Icing Conditions

Presented to: SAE 2007 Aircraft & Engine Icing
International Conference

By: Don Stimson, FAA Transport Standards Staff

Date: September 27, 2007



Federal Aviation
Administration



Agenda

- **Introduction**
- **Reasons for the Rule**
- **Rulemaking Process Used**
- **Brief Overview of the New Requirements and Guidance**
- **Future Work**
- **Summary**



Introduction

- **Introduces new type certification standards for the performance and handling characteristics of transport category airplanes in icing conditions**
- **Final rule was published on August 8, 2007. It becomes effective on October 9, 2007 as Amendment 25-121 to 14 Code of Federal Regulations 25 (part 25)**
- **Based on Notice of Proposed Rulemaking 05-10, published on November 4, 2005**
- **Accompanying Advisory Circular, AC 25-25, published on September 10, 2007, provides information on ways to comply with the new standards**



Why Did We Issue This Rule?

- **Corrects a deficiency in the regulations by providing specific airplane performance and handling qualities requirements for flight in icing conditions**
- **Raises the level of safety for future airplanes**
- **Addresses several icing-related U.S. National Transportation Board (NTSB) safety recommendations**
- **Accomplishes part of Commercial Aviation Safety Team (CAST) Safety Enhancement #39**
- **Completes one of the tasks from the FAA Inflight Aircraft Icing Plan.**
- **Harmonizes with European Airworthiness Requirements (JAA/EASA)**



Why Did We Issue This Rule?

(continued)

- **To address deficiencies in the regulations:**
 - **Part 25 (§ 25.1419) requires transport category airplanes certified with ice protection provisions to “be able to safely operate” in icing conditions**
 - **No FAA standards or criteria to define what is meant by “be able to safely operate” in terms of airplane performance and handling characteristics**
- **This final rule provides specific airplane performance and handling qualities requirements for flight in icing conditions**

Why Did We Issue This Rule?

(continued)

- **To raise the level of safety for future airplane designs**
 - **9 accidents since 1983 may have been prevented by the requirements contained in this final rule.**
 - **Immediate safety concerns with the current fleet were addressed by airworthiness directives**
 - **An amendment to part 25 was needed to address future designs.**



Why Did We Issue This Rule?

(continued)

- **Airframe structural icing is listed as one of the NTSB's Most Wanted Safety Improvements. This final rule addresses 5 NTSB icing-related safety recommendations:**
 - **A-91-87 – Rule and AC fully address**
 - **A-96-56 – Rule partially addresses**
 - **A-96-58 – AC partially addresses**
 - **A-98-94 – Rule partially addresses (now closed)**
 - **A-98-96 – Rule partially addresses**

Why Did We Issue This Rule?

(continued)

- **To accomplish Commercial Aviation Safety Team (CAST) Safety Enhancement #39 (Final rule by June 2007):**
 - **“Issue Part 25 amendment for airplane performance and flight characteristics in the icing conditions defined in Appendix C.”**
- **To complete one of the tasks from the FAA Inflight Aircraft Icing Plan:**
 - **“...complete the harmonization project to standardize performance and handling requirements and guidance material for certification of FAR/JAR 25 airplanes to safely operate in the icing conditions of Appendix C.”**

Why Did We Issue This Rule?

(continued)

- **To harmonize with the Joint Aviation Authorities (JAA) and the European Aviation Safety Agency (EASA) requirements.**
 - **Draft JAA flight in icing certification guidance material has existed and been used for 10+ years.**
 - **Public comments on the JAA material strongly urged the FAA and JAA to develop harmonized requirements and guidance.**
- **EASA/JAA published a similar proposal for comment.**
- **EASA published its final rule as part of Amendment 3 to CS-25, dated 19 September 2007.**



How Was This Final Rule Developed?

- **The Aviation Rulemaking Advisory Committee (ARAC) was tasked to provide advice and recommendations for FAA rulemaking:**
 - **On June 10, 1994, the Flight Test Harmonization Working Group was tasked with recommending new or revised requirements and compliance methods related to airplane performance and handling characteristics in icing conditions.**
 - **On April 4, 2000, the ARAC submitted their recommendations to the FAA.**
- **Notice of Proposed Rulemaking 05-10 was published for public comment on November 4, 2005**
- **Comments received on NRPM were taken into account**

How Was This Final Rule Developed? (continued)

- **Comments were received from:**
 - **4 Private Citizens**
 - **Airbus Industrie**
 - **Air Line Pilots Association**
 - **Boeing Company**
 - **Dassault Aviation**
 - **General Aviation Manufacturers Association**
 - **U.S. National Transportation Safety Board**
 - **Raytheon Aircraft Company**
 - **U.K. Civil Aviation Authority**



Major Icing Issues Addressed

- **Stall speeds**
 - **Stall warning margin***
 - **Minimum operating speeds**
 - **Tailplane stall***
 - **Controllability***
 - **Critical ice accretions for each flight phase**
- * Including before and after activation of the ice protection system**

Part 25 Sections Affected

The rule amends the following sections of part 25:

- 25.21 Proof of compliance
- 25.103 Stall speed
- 25.105 Takeoff
- 25.107 Takeoff speeds
- 25.111 Takeoff path
- 25.119 Landing climb: all engines operating
- 25.121 Climb: one engine operating
- 25.123 En route flight paths
- 25.125 Landing
- 25.143 Controllability and Maneuverability – General
- 25.207 Stall warning
- 25.237 Wind velocities
- 25.253 High speed characteristics
- 25.773 Pilot compartment view
- 25.941 Inlet, engine, and exhaust compatibility
- 25.1419 Ice protection
- Appendix C



What Does The New Rule Require?

Airplane Performance

- **Some reduction in airplane performance permitted relative to non-icing conditions before effects of icing must be taken into account**
- **Icing stall speeds must be determined**
- **Icing effects on takeoff speeds, accelerate-stop distance, takeoff path, takeoff distance, takeoff run, takeoff flight path, and 2nd segment and final takeoff climb gradients need only be determined if:**
 1. **Icing stall speeds are more than 3 knots or 3% higher than non-icing stall speeds, or**
 2. **The 2nd segment takeoff climb gradient is reduced by more than 1/2 the gross-to-net gradient margin**

What Does The New Rule Require?

(continued)

Airplane Performance (continued)

- Any icing effects on approach climb and landing climb gradient performance must be determined and taken into account
- Approach climb speed for non-icing conditions may continue to be used if the speed for icing conditions would not be increased by more than 3 knots or 3%
- Icing effects on landing distance need only be determined if V_{REF} is increased by more than 5 knots

What Does The New Rule Require?

(continued)

Handling Qualities

- **Must meet all handling qualities requirements in icing conditions, except:**
 - **Ability to make “smooth transition” after sudden engine failure**
 - **Minimum control speeds**
 - **High entry rate stalling characteristics**
 - **Dedicated vibration and buffeting demonstrations**

What Does The New Rule Require?

(continued)

Handling Qualities (continued)

- **Additional one-engine-inoperative controllability and maneuverability evaluations**
 - **Minimum V_2 for takeoff**
 - **During an approach and go-around**
 - **During an approach and landing**
- **Intended to ensure that using the minimum control speeds for non-icing conditions would not result in controllability and maneuverability safety concerns when the same speeds are used for icing conditions.**

What Does The New Rule Require?

(continued)

Handling Qualities (continued)

- **Ice accretions must not cause buffeting or vibration that would prevent continued safe flight**
- **Modified stall warning requirements:**
 - **Stall warning in icing conditions must be provided by the same means as for non-icing conditions**
 - **Stall warning must allow the pilot to prevent stalling if no action is taken for 3 seconds after the warning**

What Does The New Rule Require?

(continued)

Handling Qualities (continued)

- **Tailplane stall requirements:**
 - **Pushover maneuver – a push force must be needed throughout the maneuver down to a zero g load factor (or lowest load factor achievable)**
 - **Prompt recovery must be possible without exceeding a 50 pound pull force**
 - **Pitch force changes with increasing sideslip must be steadily increasing, with no force reversals, unless easily controllable**

What Does The New Rule Require?

(continued)

- Requirements that apply to flight in icing before activation of the ice protection system:
 - If activation depends on the pilot seeing (and waiting for) a specific accretion amount (like ½ inch on a deicing boot):
 - Controllability, tailplane stall, and stall warning requirements must be met with the critical pre-activation ice accretion

What Does The New Rule Require?

(continued)

- For other means of activation (e.g., first sign of icing, primary ice detector), with the critical pre-activation ice accretion :
 - Airplane must be controllable in a 1.5 g pull-up and no pitch control force reversal in a pushover to 0.5 g
 - Stall warning must allow the pilot to prevent stalling if, after the warning, no action is taken for:
 - 1 second if warning is provided by same means as in non-icing conditions
 - 3 seconds if different means is used. Also stall characteristics must be demonstrated if a different stall warning means is used for icing conditions

What Does The New Rule Require?

(continued)

- **Critical ice accretions**
 - **Applicant must demonstrate that the full range of Appendix C icing conditions have been considered, including the mean effective drop diameter, liquid water content, and temperature appropriate to the flight conditions**
 - **Ice accretions are defined per flight phase: Takeoff, final takeoff, en route, holding, approach, landing**
 - **Can use any of these ice accretions for any other flight phase as long as the ice accretion used is more critical**
 - **Critical ice accretion for handling qualities can be used for performance if any difference in performance is conservatively taken into account**

How Do I Show Compliance With the New Requirements?

- **Advisory Circular (AC) 25-25, published on September 10, 2007, provides compliance guidance**
 - **Covers acceptable methods of compliance, including:**
 - **Flight testing**
 - **Dry air with simulated ice accretions**
 - **Natural icing**
 - **Wind tunnel testing and analysis**
 - **Engineering simulator testing and analysis**
 - **Engineering analysis**
 - **Ancestor (derivative) airplane analysis**

How Do I Show Compliance With the New Requirements?

(continued)

Advisory Circular (AC) 25-25 (continued)

- **Example flight test program (no need to repeat the extensive test program conducted without ice accretions)**
- **Criteria for determining applicable ice accretions**
 - **Protected and unprotected surfaces**
 - **Before and after ice protection system activation**
 - **Failures of the ice protection system**
- **Icing compliance guidance will be removed from AC 25-7A**

Future Work

- **Address comment on NPRM from U.K. CAA:**
 - **Comment: Stall warning could occur after C_{LMAX}**
 - **Little or no maneuvering capability left**
 - **Any maneuvering or speed reduction near stall warning could lead to a stall without adequate warning**
 - **Not addressed in final rule due to uncertainties about cost, harmonization with EASA, and effectiveness of U.K. CAA's proposed solution**
 - **Issue included on EASA's 2008 rulemaking agenda**
 - **We will work with EASA to achieve a harmonized resolution**

Future Work

(continued)

- **Alignment with “Activation of Ice Protection” rulemaking**
 - **Notice of Proposed Rulemaking 07-07 published April 26, 2007**
 - **Proposes to amend part 25 to require timely activation of the airframe ice protection system using –**
 - **A primary ice detection system**
 - **Visual cues of the first sign of ice accretion combined with an advisory ice detection system, or**
 - **Conditions conducive to icing defined by an appropriate temperature and presence of visible moisture**

Future Work (continued)

- **Alignment with “Activation of Ice Protection” rulemaking (continued)**
 - **The requirements in Amendment 25-121 that differentiate between different methods of ice protection system activation may need to be revised**
 - **For example, NPRM 07-07 would not allow activation based on the pilot waiting for a specific accretion amount (like 1/2 inch on a deicing boot)**
 - **Any necessary revisions are likely to be included in the Activation of Ice Protection final rule**

Summary

- **Amendment 25-121 introduces new type certification standards for the performance and handling characteristics of transport category airplanes in icing conditions**
- **Amendment 25-121 becomes effective on October 9, 2007**
- **Focuses on design features and operating procedures shown by service history to be safety issues**
- **Addresses several NTSB safety recommendations**
- **Harmonizes with EASA CS-25**
- **AC 25-25 provides guidance on how to comply with the new standards**

