# Supplement to the Comment Response Document (CRD) to Notice of Proposed Amendment (NPA) 16/2004

## for amending the Executive Director Decision No. 2003/02/RM on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes (« CS-25 »)

## Flight in icing conditions

# Explanatory Note

## I. General

1. The purpose of the Notice of Proposed Amendment (NPA) 16-2004[1], dated 14 December 2004 was to propose an amendment to Decision N° 2003/02/RM of the Executive Director of the Agency of 17 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for large aeroplanes (CS-25) to propose changes related to performance and handling characteristics in icing conditions as outlined in task 25.008.

## II. Consultation

2. By the closing date of 25 January 2005, the Agency had received 60 comments from 6 national authorities, professional organisations and private companies to NPA 16-2004.

## III. Publication of the CRD

3. All comments received were acknowledged and incorporated into a Comment Response Document (CRD). This CRD contains a list of all persons and/or organisations that have provided comments and the answers of the Agency, and was published on the Agency's website 28 October 2005[2].

## IV. Supplement to CRD 16-2004

4. Strong reactions to the CRD have prompted the Agency to reconsider a number of the initial responses to the NPA-comments. Some reactions related to harmonisation with FAA regulation and guidance proposals that were published after the CRD publication. (FAA NPRM 05-10 in November 2005 and guidance material in AC 25.21-1X in February 2006.) Following this review a number of the responses and subsequently the resulting text of the amendments were changed using the following two principles:

   - Where possible harmonise with the FAA final text (which is not yet published but in the final adoption phase)
   - Where doubts on the safety level as achieved by the amendments were expressed the safer option was chosen.

   Applying these principles has lead to considerable changes in the final text as compared to the text after the initial CRD. The Agency however does not find the final text to be significantly different from that circulated at the start of the consultation process. It is therefore not felt appropriate to start a complete new consultation process but in stead the publication of this CRD supplement will give full transparency of the amendment process. Therefore the text of Book 1 of the Certification Specification resulting from this review of reactions is published as an annex to this supplement.

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[1] See NPA 16-2004: http://www.easa.europa.eu/doc/Rulemaking/NPA/NPA_16_2004.pdf
[2] See CRD 16-2004 : http://www.easa.europa.eu/doc/Rulemaking/rule_CRD_16_2004.pdf

Text changes of Book 2, resulting from the review of reactions, are provided in the right-hand column of the CRD supplement table.

5. The Executive Director intends to issue a decision not earlier than 2 months following the date of publication of this supplement to CRD 16-2004.
6. One issue (See Proposal 11, Comment 01 of this supplement) however remains unsolved at this moment and therefore the Agency has decided to issue a complete new consultation on this particular subject only. A dedicated NPA will be initiated following the two month period after issuance of this supplement.

7. Possible reactions from stakeholders on this supplement should be received by EASA not later than **28 May 2007** and should be sent by the following link: CRD@easa.europa.eu;

## Comments to Book 1 (Resulting text in Annex 1)

| NPA Reference | Comment from: | Original Comment/ Response | Disposition |
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| **Proposal 01**<br>**CS 25.21** | FAA | **Comment 06**<br>CS 25.21(g)<br>Replace the current text of CS 25.21(g) with - 'The requirements of this subpart associated with icing conditions apply only if certification for flight in icing conditions is desired. If certification for flight in icing conditions is desired, the following requirements also apply (see AMC 25.21(g)):'<br><br>**Justification/Reason.**<br>The subpart B requirements of this NPA that are associated with icing conditions should only apply if the applicant desires certification for flight in icing conditions. This is not clear with the current text.<br><br>**EASA CRD Response**<br>Through sub-paragraph (g) in CS 25.21 the requirements are specified that must be met in icing conditions if an applicant elects to seek certification for flight in icing. For this purpose the current text is considered clear and in line with the original JAA NPA 25BEF-332, accepted without comments.<br><br>Comment not accepted. | **Reaction from FAA**<br>The FAA continues to disagree with the CRD response to comment number 06.<br><br>**Justification**<br>CS 25.21(g) identifies the subpart B requirements that apply if an applicant desires certification for flight in icing conditions. It does this by identifying which subpart B requirements do **not** apply for certification of flight in icing conditions. Neither current nor proposed regulations clearly state that icing-related subpart B requirements are only applicable when the applicant chooses to certify for flight in icing conditions (that is, icing-related subpart B regulations are not applicable when the applicant chooses not to certify for flight in icing conditions). As there may be some misunderstanding over the applicability of some of the icing-related subpart B requirements when an applicant chooses not to certify for flight in icing conditions, the FAA suggests revising CS 25.21(g) as indicated in comment number 6.In response to the initial CRD the FAA supplied additional explanation and examples of possible misunderstandings if the proposed text should be retained.<br><br>**EASA Disposition**<br>Taking this reaction into account and in order to benefit from harmonisation, it is EASA opinion that a change in accordance with Comment 06 to CS 25.21(g) will improve the clarity of this paragraph and has no effect on its intent.<br><br>Comment 06 is accepted, and the text is harmonised with the FAA rule. |
| **Proposal 7**<br>**CS 25.121** | Transport Canada | **Comment 40**<br>CS 25.121(d)(2)(ii)<br>Suggest change to: 'In icing conditions with the 'Landing Ice' accretion defined..'<br><br>**Justification/Reason.**<br>This is the correct icing configuration for the approach climb. Approach climb performance is required following an engine failure and a go-around from a landing approach.<br><br>**EASA CRD Response** | **Reaction CAA UK**<br>Comment 40 proposes a significant change in the logic of the NPA in that "Landing Ice" now covers all configurations and flight phases between leaving the hold and touchdown. I trust that the reviewer recognises this and that this comment and comment no 47 are "a package".<br><br>**Justification**<br>CS 25.121(d)(2)(ii) must protect the aeroplane all down the approach and not just during a go-around following selection of the landing configuration. There are some types where the procedure is to cycle the IPS just before selection of landing configuration, hence the use of the original definition of |

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| | | Ice accretions for showing compliance with Subpart B are defined in Appendix C Part II.<br>Landing ice is normally Holding ice, unless modified by the ice protection system operation during the landing phase. In order to reduce the number of ice accretions to be considered, holding ice may be used for the en-route, holding, approach, landing and go-around flight phases. The use of landing ice in CS 25.121(d)(2)(ii) is more precise and also in line with CS 25.125(a)(2).<br><br>Comment accepted, text CS 25.121(d)(2)(ii) changed accordingly | "landing ice" would be unconservative in these cases.<br><br>**Reaction Boeing**<br>We agree with the EASA disposition of this Transport Canada comment regarding CS 25.121(d)(2)(ii). However, we note that the corresponding FAA NPRM does not include this text. We plan to submit a comment to the FAA requesting harmonization with the EASA text.<br><br>**Justification**<br>EASA/FAA harmonization of CS 25/Part 25 is highly desirable.<br><br>**Reaction FAA**<br>The FAA disagrees with the change to CS 25.121(d)(2)(ii) to reference “Landing Ice” in response to comment number 40. This change replaces the holding ice accretion with the landing ice accretion in the approach climb gradient requirement.<br><br>**Justification**<br>The approach climb performance requirement must also cover a one-engine-inoperative go-around in the approach phase of flight prior to entering the landing configuration. The airplane may never be in the landing phase of flight. Therefore, it would be inappropriate to allow any reduction in the ice accretion due to operation of the ice protection system in the landing phase.<br>Neither the EASA NPA nor the FAA NPRM define an ice accretion specific to the approach phase of flight. This gives rise to the question of which of the defined ice accretions is appropriate for the approach phase. The FAA NPRM and the EASA NPA use the holding ice accretion for the approach phase, while the EASA CRD changes the EASA final rule to use the landing ice accretion.<br><br>**EASA Disposition**<br>EASA has agreed that it will be appropriate to define an additional ice accretion that would be specifically targeted at the approach phase of flight. The approach phase is the only phase for which no specific ice accretion was defined in the NPRM or NPA.<br>Therefore, a new definition of “Approach ice” is added to Part II of Appendix C.<br>Subparagraph 25.121(d)(2)(ii) is also revised to refer to this approach ice accretion. |

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| **Proposal 9**<br>**CS 25.125** | Transport Canada | **Comment 42**<br>Suggest change to: "…if VREF in icing conditions, determined at maximum landing weight, is greater than VREF in non icing conditions…"<br>**Justification/Reason.**<br>The weight at which the determination of whether the 5 knot threshold is exceeded should be specified.<br>**EASA CRD Response**<br>Comment accepted, text CS25.125(a)(2) changed accordingly (including editorial change proposal in cmtnr 9) | **Reaction Boeing**<br>We agree with the EASA disposition of this Transport Canada comment regarding CS 25.125(a)(2). However, we note that the corresponding FAA NPRM does not include this text. We plan to submit a comment to the FAA requesting harmonization with the EASA text.<br>**Justification**<br>EASA/FAA harmonization of CS 25/Part 25 is highly desirable<br>**EASA Disposition**<br>EASA and FAA have agreed on a harmonised text of subparagraph 25.125(a)(2) that captures the intent of comment 42. |
| **Proposal 10**<br>**CS 25.143** | EASA | CS25.143(i)(1) | **EASA decision**<br><u>Use of Sandpaper Ice Accretion</u><br>From harmonization discussions with the FAA it was concluded that "sandpaper ice" is considered as one of the possible ice accretions captured within the scope of "the ice accretion described in Appendix C, that is most critical for the particular flight phase" in CS25.143(i)(1)<br>Sandpaper ice as such is therefore removed from CS 25.143(i)(1) and only specifically mentioned in the AMC. |
| **Proposal 10**<br>**CS 25.143** | FAA | **Comment 11**<br>CS25.143(i)(3)<br>Change 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.'<br>Justification/Reason.<br>Clarity and harmonization with the expected FAA rule text. The term 'steadily increasing,' in reference to the control force change associated with increasing sideslip angle, is suggested to replace 'progressive.' To avoid legal ambiguities, we suggest removing the reference to unacceptable discontinuities.' For example, how would one determine the acceptability of a given discontinuity? Allowing a discontinuity would also conflict with the requirement that the control force change be progressive (or steadily increasing).<br>The proposed text is also intended to allow a constant control force with increasing sideslip angle to be found compliant. | **Reaction**<br>The text change accepted by EASA was also used in the FAA NPRM, however there it received comments. These comments stated that the proposed requirement for flight in icing conditions was more stringent than the requirements applicable to non-icing conditions. The non-icing subpart B static lateral-directional stability requirements of CS25.177 do not specify that the pitch forces cannot reverse. The FAA and EASA agree with the commenter 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.<br>**EASA decision**<br>EASA and FAA have agreed on a harmonised text of subparagraph 25.143(i)(3). |

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| | | **EASA CRD Response**<br>The proposed revision improves the pass/fail criteria by removing qualitative assessment from the test pilot. As such clarification is provided.<br>Comment accepted, text CS25.143(i)(3) changed accordingly. | |
| **Proposal 11**<br>**CS 25.207** | CAA UK | **Comment 01**<br>Modify the proposed CS 25.21(g) so that CS 25.207(c) and (d) are not exempted for any landing configuration, i.e.<br><br>"25.21(g) If certification for flight in icing conditions is desired, the following requirements apply (see AMC 25.21(g)):<br>(1) Unless otherwise prescribed, each requirement of this subpart, except CS 25.121(a), 25.123(c), 25.143(b)(1) and (2), 25.149, 25.201(c)(2), 25.207(c) and (d), and 25.251(b) through (e), and, except for any landing configuration, 25.207(c) and (d) must be met for flight in icing conditions with the ice accretions defined in Appendix C during normal operation of the aeroplane in accordance with the operating limitations and operating procedures established by the applicant and contained in the aeroplane Flight Manual.<br><br>(2) The aeroplane must meet the requirements of.."<br><br>If considered necessary, CS 25.207(e) then need not be applied to the landing configuration. It is thought that revisions to AMC 25.21(g) are not required.<br><br>Justification/Reason.<br>Recent certification experience, obtained during a demonstration in a large aeroplane simulator of operation with simulated accreted ice, has shown the possibility of an aeroplane encountering a hazardous situation during the landing phase of flight. In this situation, there may be insufficient manoeuvring margin from the stall for the crew to recover the aircraft to safe controlled flight without significant loss of height. It is thought that discussions in the FTHWG, during development of this NPA, did not identify this concern.<br>The text for CS 25.207 proposed in the NPA specifically breaks the relationship between the stall warning speed ($V_{SW}$) and the stall reference speed $V_{SR}$ ($\geq V_{S1g}$) when certifying for flight in icing conditions. Since compliance with CS 25.207(c) and (d) is not required for icing conditions, | **Reaction CAA UK**<br>This is an important comment arising from specific certification experience after the NPA was developed. A specific rulemaking proposal should be prepared to address this.<br><br>**Justification**<br>If no commitment to hold the ongoing discussions is entered into, this important concern will be forgotten.<br><br>**Reaction ALPA**<br>Comment No 1, para 207(e), inadequate speed margin between Vsw and Vsr; ALPA disagrees with the proposal of an "… ongoing discussion outside of the present scope of the NPA" response to this serious issue. ALPA recommends either acceptance of the CAA, UK comment, or a very time-limited project to coordinate a proposal to address this problem. This issue was unknown to the ALPA participant in the FTHWG, who would have proposed a similar solution as proposed in comment 1 if the problem had been known.<br><br>**Justification**<br>A minimum maneuver margin at stall warning speed is absolutely required to provide the safe recovery of the aircraft upon receipt of the stall warning. Without the ability of a pilot to react to a stall warning without significant altitude loss, stall warning is operationally meaningless.<br><br>**Reaction DGAC**<br>Does the Agency already know how to further elaborate on this proposal (existing regulatory task, addition to the regulatory work program, further studies)?<br><br>**EASA Disposition**<br>EASA agrees that this is an important comment that arose from specific certification experience after the NPA. This view has been discussed with the FAA, and it is believed that a common understanding can be reached. EASA has therefore decided to issue a new NPA within this rulemaking task |

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| | | there is no constraint for these conditions that prevents $V_{SW}$ being below $V_{SR}$. Instead, CS 25.207(e) determines the stall warning setting for icing conditions solely by a speed/time margin above the stall identification speed. Hence, the minimum manoeuvring capability at VSW, available in non-icing conditions, may no longer be available in icing conditions.<br>If these conditions arose, the aeroplane would be at very low speed, just above the stall warning speed with effectively no manoeuvring capability. In an operational scenario, the aeroplane would be decelerating and/or descending more rapidly than anticipated due to the additional induced drag in this high incidence condition. Any attempt to manoeuvre the aeroplane or further reduce speed would lead to an immediate stall. This situation is of most concern in the landing phase because, unlike the cruise or take-off phases, there are limited options for the crew to effect an escape. The aeroplane is already at low altitude and descending towards the ground, the power setting is low with a longer time to achieve a significant increase in thrust and the potential to pitch nose-down and trade height for speed is extremely limited.<br>To address this concern and retain an adequate level of manoeuvrability, it is suggested that, in the particular case of the landing phase, the speed margin between $V_{SW}$ and $V_{SR}$ for non-icing conditions be retained also for icing conditions so that a prompt recovery from the hazardous situation can be achieved. This can be achieved by modifying the proposed CS 25.21(g) so that CS 25.207(c) and (d) are not exempted for any landing configuration.<br><br>**EASA CRD Response**<br>Sub-paragraph CS 25.207(b) would be revised to require that stall warning be provided by the same means for both icing and non-icing conditions. It also would reference a new sub-paragraph (e) containing the criteria for stall warning in icing conditions. A new sub-paragraph (h) would specify the stall warning margins that must exist with the ice accretions that will form on the unprotected and protected surfaces prior to normal operation of the ice protection system.<br>Note that CS 25.207(b) in theory still requires compliance with CS 25.207(c) and (d), which sub-paragraphs are made non applicable through CS 25.21(g)(1).<br>In icing conditions stall warning settings are required based on demonstration of adequacy to prevent stalling when recovery is initiated not less than 3 seconds after the onset of stall warning. In practice the criteria | that will contain a proposal addressing the inadequate speed margin between Vsw and Vsr which is discussed with the FAA. This new NPA will provide the required consultation of European stakeholders within a limited period of time, aiming at reaching a final text that can also be supported by the FAA.<br>Until this new NPA has passed through the rulemaking process the text for CS 25.21(g) in the decision resulting from the NPA 16-2004 is harmonised with the FAA rule. |

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| | | whether the aircraft has stalled or not is defined by the stall identification speed, which can be (slightly) lower than the stall speed $V_{SR}$.<br>Cmtnr 1 refers to the landing phase of flight. In icing conditions stall warning setting must be compliant with the proposal in NPA 16/2004. The situation that is referred to in cmtnr 1 addresses the condition where the aircraft speed is considerably reduced below $V_{REF}$ to a speed close to $V_{SW}$. Why the aircraft was flying close to $V_{SW}$ is not specified. The minimum manoeuvring capability at VSW especially in combination with the landing phase is raised as a concern.<br>Application of the stall warning settings required for the non-contaminated aircraft (3kts above VSR) in the landing configuration will slightly increase the manoeuvring capability available at $V_{SW}$.<br><br>The table in CS 25.143 (h) presents the speed for the manoeuvring capability demonstration. Tests below the normal operational speeds are required.<br>The proposed change to CS 25.21(g) so that CS 25.207(c) and (d) are not exempted for any landing configuration could also lead to more complexity if a reset of the stall warning system for flight in icing conditions would be required for the landing configuration only.<br>The comment is considered for ongoing discussion outside of the present scope of the NPA. | |
| **Proposal 11 CS 25.207** | Transport Canada | **Comment 44**<br>CS 25.207(e)(1)<br>Suggest change to: 'The 'En-route Ice' accretion described in Appendix C for the en-route configuration, the 'Holding Ice' accretion described in Appendix C for the holding configuration and the 'Landing Ice' accretion described in Appendix C for the approach, landing and go-around configurations..'<br><br>Justification/Reason.<br>It may be possible to use a common ice shape for compliance but the correct icing configurations should be specified in the requirement.<br><br>**EASA CRD Response**<br>CS 25.207 Sub-paragraph (e)(1) would permit the use of “Holding Ice” accretion to be used in evaluating the stall warning margin for the en-route, holding, approach, landing and go-around high lift configurations. Consistent with the use of the “Holding Ice” accretion for evaluating stall | **Reaction Boeing**<br>We disagree with the EASA disposition of this Transport Canada comment regarding CS 25.207(e)(1). We note that the corresponding FAA NPRM includes text consistent with the rejected Transport Canada comment, and we propose that EASA adopt the revised FAA text.<br><br>**Justification**<br>An airplane design may include the capability to boost ice protection system effectiveness following holding and prior to landing, with the result being that the landing ice accretion may be less penalizing than the holding ice accretion. The benefits of such a design would be obvious and the rule should not provide a disincentive. Additionally, EASA/FAA harmonization of CS 25/Part 25 is highly desirable.<br><br>**Reaction FAA**<br>The FAA disagrees with the decision not to accept comment number 44. |

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| | | warning in the listed configurations, the proposed definitions in part II of Appendix C for the ice accretions appropriate to the en-route and landing configurations permit the use of "Holding Ice" in lieu of defining additional accretions. In practice this reduces the number of configurations to be tested because holding ice is most critical.<br><br>Comment not accepted. | The commenter (Transport Canada) suggested that the regulatory text should identify the specific ice accretion corresponding to the flight phase in which the configuration is used. CS 25.207(e)(1), as currently written, requires the holding ice accretion to be used with the en route, holding, approach, landing, and go-around high lift configurations.<br><br>**Justification**<br>EASA's response states that CS 25.207(e)(1) would "permit the use of" the holding ice accretion in order to reduce the number of ice accretions/configurations to be tested. However, we believe this is incorrect. It is Appendix C, Part II, paragraph (b)(2) that would permit the use of the holding ice accretion. As currently written, CS 25.207(e)(1) would **require** the use of the holding ice accretion even if the applicant desired to use the specific ice accretion appropriate to each configuration.<br>This is a potential harmonization issue as the FAA NPRM<br><br>**Reaction ALPA**<br>Comment 44, rejection of the change ice appropriate to the phase of flight vs. holding ice in para 207(e)(1); ALPA believes there is a misunderstanding of the FTHWG intent to allow use of holding ice for requirements in various flight phases at the applicant's option (to reduce the number of ice shapes that must be tested) <u>when holding ice has been shown to be more critical</u>. The intent was always to use the most critical ice shape that would result from exposure to icing conditions in the configuration(s) appropriate for the particular flight phase, or the holding ice shape, if shown to be conservative. ALPA agrees with the Transport Canada proposal.<br><br>**Justification**<br>Some configurations and procedures for different flight phases result in ice in different locations than for holding. The 1998 accident at Roselawn, Indiana, USA was the result in a small amount of ice accumulation on the wing further aft than would have been possible in the normal holding configuration. The most critical ice shape for the configurations, speeds and operational procedures allowed by the manufacturer must be shown to be safe in each flight phase. To reduce the amount of flight testing, an ice shape shown to be the most critical could be used.<br><br>**EASA Disposition**<br>EASA agrees with the reactions that the text of CS 25.207(e)(1) should identify the specific ice accretion corresponding to the flight phase in which |

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| | | | the configuration is used. Appendix C, Part II, paragraph (b)(2) will provide the flexibility to use other ice accretions if shown to be more critical.<br>In accordance with the disposition to comment 40 the specific ice accretion for the approach phase will be added to this paragraph.<br>The text of the decision is harmonised with the FAA rule. |
| **Proposal 15 CS 25.1419** | FAA | **Comment 17**<br>CS 25.773<br>Change to read as follows: '(ii) The icing conditions specified in CS 25.1419 if certification for flight in icing conditions is requested.'<br><br>Justification/Reason.<br>The current text is "The icing conditions specified in CS 25.1419 if certification with ice protection provisions is requested." As with CS 25.1419, this requirement should apply whenever flight in icing conditions is requested, regardless of whether ice protection provisions are included.<br><br>**EASA CRD Response**<br>CS 25.773(b)(1)(ii) is a system design specification to maintain clear portion of the windshield in the icing conditions specified in CS 25.1419.<br>The comment is justified but not accepted within the scope of this NPA | **Reaction DGAC**<br>EASA has answered that comments 17 by FAA, were justified but not within the scope of the NPA and that they should be considered for further discussion.<br>Does the Agency already know how to further elaborate on this proposal (existing regulatory task, addition to the regulatory work program, further studies)?<br><br>**Reaction CAA UK**<br>Comment 17. This is a sensible comment from the FAA and it should not be discarded on a technicality.<br><br>**Justification**<br>This proposed editorial change was not identified during the development of the NPA but it follows the logic of 25.1419.<br><br>**Reaction ALPA**<br>Comment 17, replace "ice protection provisions" with "icing conditions" in para 773(b)(1)(ii); the FTHWG intended for aircraft operating in icing conditions to meet the clear windshield requirement even if ice protection provisions were not incorporated. The current wording does not require the windshield remain clear of ice in icing conditions unless ice protection provisions are provided. ALPA recommends the revised wording for a clear windshield for any airplane operating in icing conditions as recommended in this FAA comment.<br><br>**Justification**<br>It is possible that a very large aircraft may not need to incorporate airframe ice protection provisions to operate in icing conditions, but it will always be necessary for the pilots to be able to see through the windshield in icing conditions. The exemption of pilot compartment view requirements because of no installed ice protection equipment is unreasonable and was unintended by the FTHWG. |

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| | | | **EASA Disposition**<br>The initial disposition already accepted the technical content of this comment, but was considered outside the scope of this NPA. The FAA NPRM however contained the amendment to paragraph 25.773(b)(1)(ii), to which no comments were received.<br>EASA will therefore change CS 25.773(b)(1)(ii) in accordance with this comment and harmonise with the FAA final rule. |
| **Proposal 16 Appendix C** | Transport Canada | **Comment 47**<br>CS 25 Appendix C, Part II(a)(5)<br>Suggest change to: '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 holding flight phase and transition to the final landing configuration.'<br><br>Justification/Reason.<br>Aeroplane controllability incidents have occurred where ice on the unprotected leading edges of extended flap leading edge or flap vane leading edges have caused changes in aerodynamic characteristics. Following exit from the holding flight phase, which for most aeroplanes is normally conducted with flaps retracted, the aeroplane will transition to the approach flight phase followed by the landing flight phase. During this transition ice may accrete on flap leading edges. Hence it should be specified in the definition that the landing ice is a distinct configuration, although as allowed in paragraph (b) Holding Ice may be used if it is shown to be more critical.<br><br>**EASA CRD Response**<br>Part II(a) defines the ice accretions for showing compliance with Subpart B during the operational phases of flight. As such landing ice should refer to the actual aeroplane configuration during the landing phase. The permitted use of other configurations in order to reduce the number of ice accretions to be considered is covered in Part II(b).<br><br>Part II 9(a)(5) defines landing ice normally as holding ice, only taking into account change in ice protection system operation (e.g. reduce cycle time or apply more heat). Any change in aeroplane (high lift) configuration is not considered. Cmtnr 47 addresses this issue.<br><br>In practice the proposed change will probably result in additional flight tests | **Reaction Boeing**<br>We can accept the revised definition for the landing ice accretion. However, we disagree with the implication voiced in the EASA response that *"in practice the proposed change will probably result in additional flight tests, e.g., holding ice (clean configuration) plus ice accretion on unprotected leading edges of extended flap or flap vane during limited exposure in the transition phase from holding configuration into the final landing configuration."* Specifically, we consider that the CRD Response should not imply that it is necessary to conduct flight tests with artificial ice shapes on the leading edges of the extended flap or flap vane.<br><br>**Justification**<br>The underlying concern on the part of Transport Canada, and accepted by EASA, is the potential for controllability issues due to the accretion of ice on flap leading edges following a clean configuration hold. This possibility was explored by the Flight Test Harmonization Working Group, and is already addressed in the natural icing flight test portion of the NPA Advisory Material (and the corresponding FAA Draft Advisory Circular). Specifically, within Table 4, the testing calls for 0.25 inch of ice to be accreted at each intermediate flap detent and at the landing flap detent, with maneuvers to be performed at each configuration. For the intermediate flaps, the maneuvers include: 30-degree banked turns, and deceleration to stall warning. For the landing flap detent, the maneuvers also include a 40-degree bank and a full stall. These natural icing tests are sufficient to address controllability concerns associated with flap and vane ice accretion.<br>Inclusion of flap ice in evaluating airplane performance is not warranted by service history. Incidents quoted by Transport Canada relate to controllability issues that are best addressed in the natural ice flight testing discussed above. Inclusion of flap ice for performance testing would significantly increase the amount and complexity of artificial ice flight |

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| | | e.g. holding ice (clean configuration) plus ice accretion on unprotected leading edges of extended flap or flap vane during limited exposure in the transition phase from holding configuration into the final landing configuration.<br><br>Comment accepted, text CS 25 Appendix C, Part II(a)(5) changed accordingly. | testing required (due to restrictions on retracting flaps with artificial ice shapes) without an appreciable enhancement of safety.<br><br>**EASA Disposition**<br>Noted.<br>The sentence in the CRD mentioned in the reaction does not imply that it will be necessary to conduct flight tests with artificial ice shapes on the leading edges of extended flap or flap vane.<br>There is no resulting change to the AMC or CS. |
| **Proposal 16 Appendix C** | Transport Canada | **Comment 48**<br>CS 25 Appendix C, Part II(b)<br>Suggest changing to: '(2) Holding Ice may be used for the en-route flight phase provided that the en-route configuration is the same as the holding configuration.<br><br>And add new item: '(3) Holding ice may be used for the approach, landing and go-around flight phases, provided that it is shown that the effects of ice accretion on flap leading edges<br>and flap vane leading edges, are not significant.<br><br>Renumber existing item (3) to (4)<br><br>Justification/Reason.<br>Some aeroplanes may have a holding slat/flap position, which is different from the en route configuration.<br>As noted in earlier comment, the Landing Ice accretion can be different from the Holding Ice accretion due to ice accretion on flap leading edges and flap vane leading edges.<br><br>**EASA CRD Response**<br>Cmtnr 47 defines landing ice appropriate to the phase of flight.<br>Cmtnr 48 addresses the conditions where holding ice may be used for landing ice.<br>Comment accepted, text CS 25 Appendix C, Part II(b) changed accordingly. | **Reaction Boeing**<br>We agree with the EASA disposition of this Transport Canada comment regarding CS 25 Appendix C, Part II(b). However, we note that the corresponding FAA NPRM does not include this text. We plan to submit a comment to the FAA requesting harmonization with the EASA text.<br><br>**Justification**<br>EASA/FAA harmonization of CS 25/Part 25 is highly desirable.<br><br>**EASA Disposition**<br>EASA and FAA have harmonised the text of Appendix C, and generalised the use of other ice accretions for different flight phases if it is shown to be more conservative than the specific ice accretion defined for that flight phase. Configuration differences and their effects on ice accretions must be taken into account. |

## Comments to Book 2

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| **Proposal 26 AMC25.21(g) §4.6.4** | FAA | **Comment 24**<br>Change to read as follows: For probable failure conditions that are annunciated to the flight crew, with an associated operating procedure that requires the aeroplane to leave the icing conditions as soon as practicable, it should be shown that the aeroplane's resulting performance and handling characteristics with the 'Failure Ice' configuration are commensurate with the hazard level as determined by a system safety analysis in accordance with CS 25.1309. ..is capable of continued safe flight and landing with the 'Failure Ice' configuration..(DELETE). The operating procedures and related speeds may restrict the operating envelope, but the size of the restricted envelope should be consistent with the safety analysis. ..provide an adequate operating envelope and acceptable performance and handling characteristics to ensure continued safe flight and<br>landing..(DELETE)<br>**Justification/Reason.**<br>The ice protection system must comply with CS 25.1309. Therefore, failures must be<br>assessed in a manner that in accordance with and consistent with CS 25.1309. For<br>probable failure conditions, the airplane should meet a higher level of safety than just<br>'continued safe flight and landing.' In accordance with CS 25.1309, probable failures should<br>have no more than a minor effect<br><br>**EASA CRD Response**<br>Primary objectives of NPA 16/2004 (evolved from NPA 25F-219 Issue2) is to be more precise on safe operation (see also cmtnr 51).<br>The comment proposes to apply the relation between probability of the failure and the classification of the failure condition as given in AMC CS 25.1309, figure 2. For the severity classification minor, the effect on the aeroplane should only be a slight reduction in functional capabilities or safety margins.<br>Operational procedures and related speeds should provide an adequate operating envelope to ensure continued safe flight and landing with acceptable handling and performance characteristics as demonstrated in the flight test program in AMC 21.21(g), sub-paragraph 6.22. | **Reaction FAA**<br>The FAA disagrees with the CRD response to comment number 24.<br><br>**Justification**<br>The FAA believes that the current text of the NPA does not ensure compliance with CS 25.1309. In accordance with CS 25.1309, probable failure conditions can have only a minor effect. This is more stringent than the guidance contained in this NPA, which only requires the airplane to be capable of continued safe flight and landing<br>This is a potential harmonization issue as the proposed FAA guidance material adopts text in line with this comment.<br><br>**EASA Disposition**<br>The reaction to this response is accepted by EASA.<br>It is agreed that the AMC should not just meet the objective of the NPA, but must also comply with CS 25.1309.<br>The AMC text will be changed to read:<br><br>4.6.4 For probable failure conditions that are annunciated to the flight crew, with an associated operating procedure that requires the aeroplane to leave the icing conditions as soon as practicable, it should be shown that the aeroplane's resulting performance and handling characteristics with the failure ice accretion are commensurate with the hazard level as determined by a system safety analysis in accordance with CS 25.1309. The operating procedures and related speeds may restrict the aeroplane's operating envelope, but the size of the restricted envelope should be consistent with the safety analysis. |

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| | | The intention of the AMC 25.21(g) sub-paragraph 4.6.4 is clear. The proposed revision to refer to the level of safety required by CS 25.1309 will not change the intention of nor provide additional clarification to AMC 25.21(g), sub-paragraph 4.6.4 .<br>Comment not accepted. | |
| **Proposal 26 AMC25.21(g) §5.2.3** | Transport Canada | **Comment 55**<br>AMC 25.21(g), Paragraph 5.2.3.1, 5.2.3.2<br>Suggest changing, Paragraph 5.2.3.1, to: 'Where flight testing with ice accretions obtained in natural icing conditions..'<br>Suggest changing, Paragraph 5.2.3.2, to: '..should be conducted with ice accretions obtained in natural icing conditions.'<br><br>**Justification/Reason.**<br>The handling and performance tests are to be conducted with the ice accretions obtained in natural icing conditions. Flight test practice normally requires exiting the actual natural atmospheric icing conditions in order to do the tests.<br><br>**EASA CRD Response**<br>The performance and handling tests may be based on flight testing in dry air using artificial ice shapes that have been agreed by the Authority. Shape and texture of the artificial ice should be established and substantiated by agreed methods as listed in AMC 25.21(g), Appendix 2 paragraph A2.2.1. Most likely the artificial ice shapes are substantiated using an ice accretion code validated in natural icing.<br>AMC 25.21(g), Paragraph 5.2.3.1 requires atmospheric conditions to be measured when flight test in natural icing conditions is the primary means of compliance. In practice this is also required to demonstrate compliance with CS 25.1419 for the adequacy of the ice protection system.<br>The justification to this comment that the handling and performance tests are to be conducted with the ice accretions obtained in natural icing conditions is not supported.<br>Comment not accepted. | **Reaction Transport Canada**<br>The response to the comment reflects a possible misunderstanding of the intent. The intent was to clarify that the handling tests do not need to be done in the actual IMC conditions associated with natural icing. Rather the tests can be done in suitable flight test atmospheric conditions after leaving the icing conditions that caused the accretion.<br><br>**Justification**<br>The proposed text gives the impression that the handling and performance tests have to be done in the actual IMC conditions associated with natural icing. Whereas in order to do the tests, the flight test practice normally requires exiting the actual natural atmospheric icing conditions after the ice accretion.<br><br>**Reaction FAA**<br>The FAA disagrees with the CRD response given to comment number 55. The commenter (Transport Canada) suggested a minor change to the text that applies to tests conducted in natural ice conditions. Rather than referring to testing in natural icing, the commenter suggested to refer to tests conducted with ice accretions obtained in natural icing conditions. The reason for the suggestion is that when these tests are conducted in natural icing conditions (at the applicant's option), the test procedure is normally to accrete the ice in natural icing conditions, but then to leave the icing cloud to conduct the test.<br><br>**Justification**<br>The CRD response was to reject this comment on the basis that requiring performance and handling qualities testing to be conducted in natural icing conditions was unsupported.<br>It is evident from the CRD response that the comment was misunderstood. The comment was not to suggest that performance and handling qualities testing must be conducted in natural icing conditions. This paragraph in the AMC provides guidance for applicants who **choose** to do this testing in natural icing conditions. The suggestion was only to clarify the wording to |

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| | | | better reflect typical test practice.<br>This is a potential harmonization issue as the proposed FAA guidance material adopts text in line with this comment.<br>**EASA Disposition**<br>The reactions have showed a misunderstanding of the initial comment. EASA accepts the initial comment. and changes the final wording in the AMC as follows:<br>5.2.3.1 Where flight testing with ice accretions obtained in natural atmospheric icing conditions is the primary means of compliance, the conditions should be measured and recorded. ….<br><br>5.2.3.2 Where flight testing with artificial ice shapes is the primary means of compliance, additional limited flight tests should be conducted with ice accretions obtained in natural icing conditions. …. |
| **Proposal 26 AMC25.21(g) §6.9.2** | Transport Canada | **Comment 57**<br>AMC 25.21(g), Paragraph 6.9.2.c.i, 6.21.1.1, 6.21.2.2<br>Comment: In 6.9.2.c.i, the terminology '30o banked turns left and right with rapid reversals" is used. In 6.21.1.1 and 6.21.2.2, the terminology 'Bank-to-bank rapid roll, 30o - 30o ' is used. It is believed that the same flight test maneuver is intended in both cases. The text should be clarified.<br>Possible text is as follows (extracted for Transport Canada Discussion Paper No. 33, attached):<br>'Trim aircraft in level flight<br>Establish 30 degree bank level turn in one direction<br>Using step input of approximately 1/3 full lateral control deflection, roll aircraft in other direction<br>Maintain step input as aircraft passes through wings level.<br>At approximately 20 degrees bank apply step input in opposite direction to the same deflection from neutral as initially input<br>Release input and recover as aircraft passes wings level<br>Repeat test procedure with 2/3 and up to full lateral control deflection unless roll rate is judged to be excessive'<br>**EASA CRD Response**<br>AMC 25.21(g), Paragraph 6.9 covers general controllability and manoeuvrability.<br>The comment addresses the text that describes the roll capability test, which | **Reaction FAA**<br>The FAA disagrees with the CRD response given to comment number 57. The commenter (Transport Canada) suggested adding a more detailed description of the 30 degree bank-to-bank roll capability test referenced in AMC paragraphs 6.9 and 6.21. The CRD response did not accept the comment on the basis that the same test procedure will be applied as used for the handling tests for the uncontaminated airplane.<br>**Justification**<br>The referenced tests are examples of test conditions specifically intended to evaluate handling qualities in icing conditions, particularly for the possibility of aileron an aileron hinge moment reversal. The FAA is unaware of equivalent tests conducted in the same manner for the same objective on the uncontaminated airplane. In any case, the FAA considers that providing the additional test procedure details, which were agreed to by the Flight Test Harmonization Working Group, to be a valuable addition to the guidance material.<br>This is a potential harmonization issue as the proposed FAA guidance material adopts text in line with this comment.<br>**EASA Disposition**<br>Further evaluations of this reaction and comments received by the FAA on the NPRM have lead to the following harmonised disposition. The detailed |

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| | | indeed is not consistent. In practice the applicant will apply the same test procedure as used for the handling tests with the non-contaminated aeroplane. The proposal to add a detailed description of the test procedure is not supported.<br>Comment not accepted. | test that was proposed by the FTHWG will be introduced in a new sub paragraph 6.9.3 which is a specific evaluation of susceptibility to aileron hinge moment reversal.<br>Although this manoeuvre is intended to be conducted at a high angle-of-attack, hence low speed condition, it will be added that the aileron deflection should be limited to that which will not result in excessive roll rates or structural loads.<br>The new sub-paragraph will read as follows:<br><br>6.9.3 *Evaluation of Lateral Control Characteristics*. Aileron hinge moment reversal and other lateral control anomalies have been implicated in icing accidents and incidents. The following manoeuvre, along with the evaluation of lateral controllability during a deceleration to the stall warning speed covered in paragraph 6.17.2(e) of this AMC and the evaluation of static lateral-directional stability covered in paragraph 6.15 of this AMC, is intended to evaluate any adverse effects arising from both stall of the outer portion of the wing and control force characteristics.<br><br>(a) Holding configuration, holding ice accretion, maximum landing weight, forward centre-of-gravity position, minimum holding speed (highest expected holding angle-of-attack); and<br><br>(b) Landing configuration, most critical of holding, approach, and landing ice accretions, medium to light weight, forward centre-of-gravity position, $V_{REF}$ (highest expected landing approach angle-of-attack).<br><br>1 Establish a 30-degree banked level turn in one direction.<br><br>2 Using a step input of approximately 1/3 full lateral control deflection, roll the aeroplane in the other direction.<br><br>3 Maintain the control input as the aeroplane passes through a wings level attitude.<br><br>4 At approximately 20 degrees of bank in the other |

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| | | | direction, apply a step input in the opposite direction to approximately 1/3 full lateral control deflection.<br><br>5 Release the control input as the aeroplane passes through a wings level attitude.<br><br>6 Repeat this test procedure with 2/3 and up to full lateral control deflection unless the roll rate or structural loading is judged excessive. It should be possible to readily arrest and reverse the roll rate using only lateral control input, and the lateral control force should not reverse with increasing control deflection.<br><br>The proposed sub-paragraph 6.9.3 and 6.9.4 will be renumbered to 6.9.4 and 6.9.5. |
| **Proposal 26 AMC25.21(g) §6.9.3.2** | EASA | AMC25.21(g)<br>§6.9.3.2 | **EASA decision**<br>In line with the disposition to proposal 10/comment 11 as provided in this supplement, the following AMC to CS25.143(i)(3) has replaced the proposed text in AMC25.21(g) §6.9.3.2.<br>§6.9.3.2. 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. Discontinuities 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 that can be easily managed by a pilot of average skill, alertness, and strength. Control forces in excess of those permitted by CS25.143(c) would be considered excessive. |
| **Proposal 26 AMC25.21(g) §6.14.1** | Transport Canada | **Comment 60**<br>AMC 25.21(g), Paragraph 6.14.1<br>Suggest deleting last sentence : 'Although ..with increasing speed)'<br>Justification/Reason.<br>It is unclear how a stick force gradient can be satisfactorily extrapolated.<br><br>**EASA CRD Response** | **Reaction FAA**<br>The FAA disagrees with the decision to not fully accept comment number 29 or to accept comment number 60. The applicable proposed guidance material would allow compliance to be demonstrated to a lower speed than is required by the applicable rule "if the stick force gradient can be satisfactorily extrapolated." The FAA does not know how a stick force |

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| | | The acceptance of the maximum speed for demonstration to be limited to 519 km/h (280 knots) is to avoid extensive repeated testing e.g. change of natural ice shedding at high speed. This limitation is acceptable provided the stickforce gradient can be satisfactorily extrapolated to higher speed as proposed in CS 25.25399c).<br>Cmtnr 60 suggests deleting the acceptance of the lower speed for demonstration, because it is unclear how a stickforce gradient can be satisfactorily extrapolated. No guidance material is available. This issue will be subject for discussion between the applicant and the Authority on a case by case basis. See cmtnr 29.<br>Comment not accepted. | gradient can be extrapolated to a higher speed. The CRD response sidesteps the issue, stating that this will be a subject of discussion between the applicant and the Authority.<br>**Justification**<br>There is not a valid method for extrapolating stick force gradients to higher speeds.<br>This is a potential harmonization issue as the proposed FAA guidance material does not contain the reference to showing compliance to a lesser speed if the stick force gradient can be extrapolated to a higher speed.<br>**EASA Disposition**<br>Since the original comment 60, the reaction from the FAA and the original response from EASA all agree that there is at present no clear guidance to satisfactorily extrapolate a stickforce gradient; this will be removed from the AMC. The AMC text is changed to read:<br>6.14.1 To show compliance with CS 25.175, each of the following cases should be tested. In general, it is not necessary to test the cruise configuration at low speed (CS 25.175(b)(2)) or the cruise configuration with landing gear extended (CS 25.175(b)(3)); nor is it necessary to test at high altitude. ~~Although~~ The maximum speed for substantiation of stability characteristics in icing conditions (as prescribed by CS 25.253(c)) is the lower of 556 km/h (300 knots) CAS, VFC, or a speed at which it is demonstrated that the airframe will be free of ice accretion due to the effects of increased dynamic pressure. ~~(CS 25.253(c)), the maximum speed for demonstration can be limited to 519 km/h (280 knots) CAS, provided that the stick force gradient can be satisfactorily extrapolated to 556 km/h (300 knots) CAS or VFC (e.g. there is no gradient decrease with increasing speed).~~ |
| **Proposal 26 AMC25.21(g) §6.17.2** | FAA | **Comment 27**<br>AMC 25.21(g), sub-paragraph 6.17.2<br>Add the following new text to the end of this sub-paragraph: 'Slow decelerations (much slower than 1 knot/sec) may be critical on airplanes with anticipation logic in their stall protection system or on airplanes with low directional stability, where large sideslip angles could develop.'<br>Justification/Reason.<br>Certification experience from testing of several part 25 turboprop airplanes | **Reaction ALPA**<br>Comment 27, require a slow deceleration check of the stall warning system in AMC 25.21(g), sub-paragraph 6.17.2. As submitted by the FAA in its comment, this check has uncovered problems with stall warning logic on several turboprop certification programs. This comment was rejected in the CRD as unnecessary with the logic that tests on the uncontaminated airplane would uncover any problems and lead to these tests during icing testing. ALPA strongly supports the FAA recommended wording to insure that stall warning characteristics in icing conditions are acceptable. |

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| | | **EASA CRD Response**<br>With respect to the flight test program on handling and performance characteristics in icing conditions it is clearly stated that the applicant should consider the results obtained with the non-contaminated aeroplane (ref AMC 25.21(g), sub-paragraph 5.2.1.1).<br>The approach to define the test matrix based on review of the non-contaminated aeroplane characteristics is again outlined in AMC 25.21(g), sub-paragraph 6.17.1<br>Cmtnr 27 provides useful information based on certification experience, the proposed addition however is not followed since this is a possible performance characteristic that should be considered based on the non-contaminated test results.<br>Comment not accepted. | **Justification**<br>Stall characteristics in icing conditions can change dramatically from those with uncontaminated surfaces. Stalls in icing conditions have caused many accidents. There is no reason to expect warning systems designed for clean stall characteristics to automatically perform correctly with ice contamination. Several turboprop certification programs have discovered this problem.<br>**EASA Disposition**<br>From the additional support and substantiation from ALPA to comment 27, and the already acknowledged usefulness of this certification experience it is concluded that it is beneficial to include this into the example acceptable test program.<br>6.17.2 *Acceptable Test Programme*. Turning flight stalls at decelerations greater than 1 knot/sec are not required. Slow decelerations (much slower than 1 knot/sec) may be critical on aeroplanes with anticipation logic in their stall protection system or on aeroplanes with low directional stability, where large sideslip angles could develop. The following represents an example of an acceptable test program subject to the provisions outlined above. ~~Turning flight stalls at decelerations greater than 1 knot/sec are not required.~~<br>….<br>d. In the configurations listed below, trim the aeroplane at the same initial stall speed factor used for stall speed determination. For power-on stalls, use the power setting as defined in CS 25.201(a)(2) but with ice accretions on the aeroplane. Decrease speed at a rate not to exceed 1 knot/sec to stall identification and recover using the same test technique as for the non-contaminated aeroplane.<br>….<br>e For the configurations listed in paragraph 6.17.2(d)i and iv, and any other configuration if deemed more critical, in 1 knot/second deceleration rates down to stall warning with wings level and power off, roll the airplane left and right up to 10 degrees of bank using the lateral control. |
| **Proposal 26 AMC25.21(g) §6.21** | Transport Canada | **Comment 61**<br>AMC 25.21(g), Paragraph 6.21.2.1.b<br>Comment: See earlier comments on 'Bank-to-bank rapid roll, 30o - 30o'<br>Comment: It may be inappropriate to use the Holding speed as the trim speed | **Reaction FAA**<br>The FAA disagrees with the CRD response given to a portion of comment number 61. The commenter (Transport Canada) suggested clarifying that the "deceleration to stall warning tests" referenced in the tables in paragraph |

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| | | for a full stall. Also it should be clarified that a power off, straight, 1 knot/s stall is intended.<br>Comment: It should be clarified that the 'Deceleration to stall warning' tests are to stall warning plus 3 seconds<br>**EASA CRD Response**<br>Comment refers to Table 3 in AMC 25.21(g), Paragraph 6.21.2.1.<br>The table summarises the manoeuvres that should be carried out in natural icing conditions (with the ice accretions representative of normal operation of the ice protection system) when flight testing with artificial shapes is the primary means of compliance demonstration.<br>The description of the manoeuvres in Table 3 is short. Actual test procedures are to be defined by the applicant and agreed by the Authority.<br>Comment not accepted (see also cmtnr 57) | 6.21.2 should actually refer to three seconds after stall warning (in a one knot per second deceleration maneuver). The CRD response did not accept this comment on the basis that the actual test procedures are to be defined by the applicant and agreed by the Authority.<br>**Justification**<br>Although the FAA agrees that the actual test procedures are to be defined by the applicant and agreed by the Authority, that is no reason to improperly reflect the intentions of the test procedure recommended by the Flight Test Harmonization Working Group (FTHWG) in the guidance material. The FAA believes that the commenter's suggestion is more in line with the intention of the FTHWG.<br>This is a potential harmonization issue as the proposed FAA guidance material adopts text in line with this comment.<br>**EASA Disposition**<br>EASA agrees to harmonisation between AMC and AC reflecting the intentions of the test procedure recommended by the Flight Test Harmonization Working Group (FTHWG). The Table 3 of the AMC is amended in line with the comment. |
| **Proposal 26 AMC25.21(g) A1.2.1.3** | FAA | **Comment 31**<br>AMC 25.21(g), sub-paragraph A1.2.1.3<br>Revise this sub-paragraph to read as follows: 'The applicant should determine the effect of the 45 minute hold in continuous maximum icing conditions. The analysis should assume that the airplane will remain in a rectangular 'race track' pattern, with all turns being made within the icing cloud. Therefore, no horizontal extent correction should be used for this analysis. The applicant should substantiate the critical mean effective drop diameter, LWC, and temperature that result in the formation of an ice shape that is critical to the airplane's performance and handling qualities. The shape and texture of the ice are important and<br>should be agreed by the Authority.'<br>Justification/Reason.<br>This comment highlights an issue that remains unharmonized between the FAA and EASA. This issue is currently undergoing further discussion within the Flight Test Harmonization Working Group (FTHWG) and the Ice Protection Harmonization Working Group (IPHWG).<br>We recommend that EASA revise this paragraph in accordance with the | **Reaction Boeing**<br>We suggest that EASA/FAA harmonization of this paragraph may be achieved by EASA and FAA acceptance of the following proposal provided in the final report of the Ice Protection Harmonization Working Group for this sub-paragraph. The text reads:<br>"*For unprotected surfaces an analysis may be performed to determine the maximum ice accretion. Assume a 45 minute hold, no reduction for cloud horizontal extent. It is allowable to truncate the pinnacle height of 3 inches (75 mm) if sufficient service history exists on similar ice protection system designs. The shape and texture of the ice are important and should be agreed with the Authority.*"<br>**Justification**<br>The Flight Test Harmonization Working Group was unable to reach a harmonized position on this issue; however, the Ice Protection Harmonization Working Group was able to develop the compromise position quoted above. The Discussion regarding this proposal in the final IPHWG Working Group Report is as follows: |

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| | | harmonized agreement that is expected to be reached shortly in the FTHWG and IPHWG.<br><br>**EASA CRD Response**<br>Cmtnr 31 highlights a fundamental non-consensus issue between FAA and EASA.<br>The proposed revision to AMC 25.21(g), sub-paragraph A1.2.1.3 defines the atmospheric conditions of Appendix C Part I(a) to be considered to calculate the holding ice accretion. The exposure time is explicitly added. No maximum pinnacle height is applied.<br>In summary, the non-consensus is:<br>EASA<br>-exposure time not specified,<br>-maximum pinnacle height 3 inch on most critical unprotected main airfoil surface<br>FAA<br>-45 minutes exposure<br>-pinnacle height not defined (not limited)<br>Experience indicates the following approach made by the applicant.<br>1)Calculate exposure time to accrete 3 inch ice in direction of flight on most critical part unprotected main airfoil surface (usually the tip which has the highest collection<br>efficiency)<br>2)Check resulting exposure time, that should be between 30 and 45 minutes<br>3)Calculate ice accretion on other parts of main airfoil surface considered with the exposure time resulting from 1). As shown in practice a mix between FAA and EASA regulations is applied, because the majority of the large aeroplanes apply for both FAA and EASA type certification.<br>The comment is considered for ongoing discussion outside of the present scope of this rulemaking task, and will be covered in rulemaking task 25.022 and 25.058, which are<br>part of the Rulemaking Advance planning. | *This issue has been debated extensively in both the FTHWG and IPHWG without resolution. The FTHWG-provided language is essentially unchanged from the draft 25.21(g) materials relative to Appendix C. The FTHWG could not achieve consensus in the time available and elected to leave the language unchanged.*<br><br>*The IPHWG is not in agreement with the draft 25.21(g) materials with respect to using a 3" criterion as the primary means of determining ice shapes. Ice shape size varies with geometry, which can lead to ice shapes less than or greater than the 3" ice shape. The time base criteria allows for differing ice shapes based on geometry, yet retains a consistent level of safety (with respect to exposure time). The proposed language is offered as a compromise in that the 3" criterion can be used if sufficient justification exists. In addition, since this language resides in the advisory materials, alternate methods of compliance are possible provided the same level of safety is achieved.*<br><br>EASA/FAA harmonization of this sub-paragraph, without undue delay, is highly desirable. We plan to also make this comment to the FAA regarding the relevant section in their corresponding NPRM.<br><br>**EASA Disposition**<br>This comment was initially considered for ongoing discussion outside the scope of this rulemaking task and it was intended to be addressed by rulemaking tasks 25.022 and 25.058. However, it appeared that these tasks are not expected to provide a solution in the near future. Therefore the Agency has decided to proceed within this part of the AMC within this task and to establish a text harmonised with the FAA.<br>The paragraph A1.2.1.3 will therefore read as follows:<br>A1.2.1.3 For holding ice, the applicant should determine the effect of a 45-minute hold in continuous maximum icing conditions. The analysis should assume that the aeroplane remains in a rectangular “race track” pattern, with all turns being made within the icing cloud. Therefore, no horizontal extent correction should be used for this analysis. For some previous aeroplane certification programs, the maximum pinnacle height was limited to 75 mm (3 inches). This method of compliance may continue to be accepted for follow-on products if service experience has been satisfactory, and the designs are similar enough to conclude that the previous experience |

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| | | | is applicable. The applicant should substantiate the critical mean effective drop diameter, liquid water content, and temperature that result in the formation of an ice accretion that is critical to the aeroplane's performance and handling qualities. The shape and texture of the ice are important and should be agreed with the Authority. |
| **Proposal 26 AMC25.21(g) A2.2.2** | FAA | **Comment 36**<br>AMC 25.21(g), paragraph A2.2.2, and sub-paragraphs A2.2.2.1 and A2.2.2.2.<br>Revise to read as follows:<br>'In the absence of another agreed definition of texture the roughness height should be 3 mm with a particle density of 8 to 10/cm2.'<br>Justification/Reason.<br>Icing tunnel tests (DOT/FAA/AR-02/68, Effect of Residual and Intercycle Ice Accretions on Airfoil Performance, plus other recent part 23 certification tests, Certification of Part 23 Airplanes for Flight in Icing, presentation to SAE Aircraft Icing Technology Subcommittee AC 9C, April 20, 2004 ) have shown that the amount of clear and mixed ice that accretes during de-icing boot rest times is rougher than 1 mm. Intercycle ice can continue to accrete for up to 20 boot cycles until a steady state roughness of 3 mm is reached. Using the smaller roughness height that would be permitted by the AMC should not be allowed without further showing that it was appropriate for the particular airplane design.<br><br>**EASA CRD Response**<br>AMC 25.21(g), paragraph A2.2.2 defines typically roughness to be applied on artificial ice shapes to simulate the texture of natural ice. These values have been applied since introduction of NPA 25F-219 Issue 2.<br>The comment proposes to apply a 3mm roughness height for small amounts of ice for example residual ice or intercycle ice. Information is based on ice tunnel tests plus recent part 23 certification. FAA is requested to provide additional information for discussion on this issue.<br>The comment is considered for ongoing discussion outside of the present scope of the NPA. | **Reaction FAA**<br>The CRD requests the FAA to provide further information with respect to comment number 36 regarding intercycle ice roughness height.<br><br>**Justification**<br>The reports identified in the FAA comment are attached.<br><br>**EASA Disposition**<br>Based on evidence provided it is decided to harmonise the content of the EASA AMC and FAA AC.<br>The need to divide into the sub-paragraph A2.2.2.1 and A2.2.2.2 for small or large amounts of ice is no longer applicable. The paragraph 2.2.2 is therefore changed to read as follows:<br><br>A2.2.2 In absence of another agreed definition of texture the following may be used:<br>• roughness height: 3 mm<br>• particle density: 8 to 10/$cm^2$ |

# BOOK 1

## SUBPART B – FLIGHT

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

### CS 25.21 Proof of compliance

....

(g) The requirements of this subpart associated with icing conditions apply only if certification for flight in icing conditions is desired. If certification for flight in icing conditions is desired, the following requirements also apply (see AMC 25.21(g)):

(1) Each requirement of this subpart, except CS 25.121(a), 25.123(c), 25.143(b)(1) and (b)(2), 25.149, 25.201(c)(2), 25.207(c) and (d), 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 aeroplane and its ice protection system in accordance with the operating limitations and operating procedures established by the applicant and provided in the Aeroplane Flight Manual.

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

....

### CS 25.103 Stall speed

(b) ....

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

....

### CS 25.105 Take-off

(a) The take-off speeds ~~de~~prescribed ~~in~~by CS 25.107, the accelerate-stop distance ~~de~~prescribed ~~in~~by CS 25.109, the take-off path ~~de~~prescribed ~~in~~by CS 25.111, ~~and~~ the take-off distance and take-off run ~~de~~prescribed ~~in~~by CS 25.113, ~~must be determined –~~

~~(1) At each weight, altitude, and ambient temperature within the operational limits selected by the applicant; and~~

~~(2) In the selected configuration for take-off.~~

and the net take-off flight path prescribed by CS 25.115, must be determined in the selected configuration for take-off 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 CS 25.121(b) with the "Take-off Ice" accretion defined in Appendix C:

(i) The stall speed at maximum take-off weight exceeds that in non-icing conditions by more than the greater of 5.6 km/h (3 knots) CAS or 3% of $V_{SR}$; or

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

....

### CS 25.107 Take-off speeds

(c) ....

(3) A speed that provides the manoeuvring capability specified in CS 25.143(~~g~~h).

....

(g) ....

(2) A speed that provides the manoeuvring capability specified in CS25.143(~~g~~h).

(h) In determining the take-off 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.

**CS 25.111 Take-off path**
(See AMC 25.111)

(c) ....

(3) ....

(iii) 1·7% for four-engined aeroplanes, ~~and~~

(4) ~~Except for gear retraction and automatic propeller feathering, the aeroplane configuration may not be changed.~~ The aeroplane 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 aeroplane is 122 m (400 ft) above the take-off surface; and

(5) If CS 25.105(a)(2) requires the take-off path to be determined for flight in icing conditions, the airborne part of the take-off must be based on the aeroplane drag:

(i) With the "Take-off Ice" accretion defined in Appendix C, from a height of 11 m (35 ft) above the take-off surface up to the point where the aeroplane is 122 m (400 ft) above the take-off surface; and

(ii) With the "Final Take-off Ice" accretion defined in Appendix C, from the point where the aeroplane is 122 m (400 ft) above the take-off surface to the end of the take-off path.

....

**CS 25.119 Landing climb: all-engines-operating**

In the landing configuration, the steady gradient of climb may not be less than 3·2%, with –

~~(a)~~ 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 (see AMC 25.119~~(a)~~); and

~~(b) A climb speed which is –~~

~~(1) Not less than –~~

~~(i) 1·08 $V_{SR}$ for aeroplanes with four engines on which the application of power results in a significant reduction in stall speed; or~~

~~(ii) 1·13 $V_{SR}$ for all other aeroplanes;~~

~~(2) Not less than $V_{MCL}$; and~~

~~(3) Not greater than $V_{REF}$.~~

(a) In non-icing conditions, with a climb speed of $V_{REF}$ determined in accordance with CS 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 CS 25.125(b)(2)(ii).

**CS 25.121 Climb: one-engine-inoperative**
(See AMC 25.121)

....

(b) *Take-off; landing gear retracted.* In the take-off configuration existing at the point of the flight path at which the landing gear is fully retracted, and in the configuration used in CS25.111 but without ground effect,

(1) the steady gradient of climb may not be less than 2·4% for two-engined aeroplanes, 2·7% for three-engined aeroplanes and 3·0% for four-engined aeroplanes, at $V_2$ ~~and~~ with–

~~(1)~~(i) The critical engine inoperative, the remaining engines at the take-off power or thrust available at the time the landing gear is fully retracted, determined under CS 25.111, unless there is a more critical power operating condition existing later along the flight path but before the point where the aeroplane reaches a height of 122 m (400 ft) above the take-off surface (see AMC 25.121(b)(1)(i)) ; and

~~(2)~~(ii)The weight equal to the weight existing when the aeroplane's landing gear is fully retracted, determined under CS 25.111.

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

(i) In non-icing conditions; and

(ii) In icing conditions with the "Take-off Ice" accretion defined in Appendix C, if in the configuration of CS 25.121(b) with the "Take-off Ice" accretion:

(A) The stall speed at maximum take-off weight exceeds that in non-icing conditions by more than the greater of 5.6 km/h (3 knots) CAS or 3% of $V_{SR}$; or

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

(c) *Final take-off.* In the en-route configuration at the end of the take-off path determined in accordance with CS 25.111:

(1) The steady gradient of climb may not be less than 1.2% for two-engined aeroplanes, 1.5% for three-engined aeroplanes, and 1.7% for four-engined aeroplanes, at $V_{FTO}$ with -

(~~1~~i) The critical engine inoperative and the remaining engines at the available maximum continuous power or thrust; and

(~~2~~ii) The weight equal to the weight existing at the end of the take-off path, determined under CS 25.111.

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

(i) In non-icing conditions; and

(ii) In icing conditions with the "Final Take-off Ice" accretion defined in Appendix C, if in the configuration of CS 25.121(b) with the "Take-off Ice" accretion:

(A) The stall speed at maximum take-off weight exceeds that in non-icing conditions by more than the greater of 5.6 km/h (3 knots) CAS or 3% of $V_{SR}$; or

(B) The degradation of the gradient of climb determined in accordance with CS 25.121(b) is greater than one-half of the applicable actual-to-net take-off flight path gradient reduction defined in CS 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% of the $V_{SR}$ for the related all-engines-operating landing configuration, ~~the~~:

(1) The steady gradient of climb may not be less than 2.1% for two-engined aeroplanes, 2.4% for three-engined aeroplanes, and 2.7% for four-engined aeroplanes, with -

(~~1~~i) The critical engine inoperative, the remaining engines at the go-around power or thrust setting;

(~~2~~ii) The maximum landing weight;

(~~3~~iii) A climb speed established in connection with normal landing procedures, but not exceeding 1.4 $V_{SR}$: and

(~~4~~iv) Landing gear retracted.

(2) The requirements of sub-paragraph (d)(1) of this paragraph 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 sub-paragraph (d)(1)(iii) of this paragraph, does not exceed that for non-icing conditions by more than the greater of 5.6 km/h (3 knots) CAS or 3%.

**CS 25.123 En-route flight paths**
(See AMC 25.123)

(a) For the en-route configuration, the flight paths prescribed in sub-paragraphs (b) and (c) of this paragraph must be determined at each weight, altitude, and ambient temperature, within the operating limits established for the aeroplane. 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 selected 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% for two-engined aeroplanes, 1·4% for three-engined aeroplanes, and 1·6% for four-engined aeroplanes.

(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 $1.18V_{SR}$ with the “En-route Ice ” accretion exceeds the en-route speed selected in non-icing conditions by more than the greater of 5.6 km/h (3 knots) CAS or 3% 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 sub-paragraph (b) of this paragraph.

....

**CS 25.125 Landing**

(a) The horizontal distance necessary to land and to come to a complete stop from a point 15 m (50 ft) 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 aeroplane) ~~as follows~~:

(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 9.3 km/h (5 knots) CAS at the maximum landing weight

(b) In determining the distance in (a):

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

(2) A stabilised approach, with a calibrated airspeed of not less than $V_{REF}$, must be maintained down to the 15 m (50 ft) height.

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

(~~i~~A) $1.23V_{SR0}$;

(~~ii~~B) $V_{MCL}$ established under CS 25.149(f); and

(~~iii~~C) A speed that provides the manoeuvring capability specified in CS25.143(~~g~~h).

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

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

(B) 1.23 $V_{SR0}$ with the "Landing Ice" accretion defined in Appendix C if that speed exceeds $V_{REF}$ selected in non-icing conditions by more than 9.3 km/h (5 knots) CAS; and

(C) A speed that provides the manoeuvring capability specified in CS 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. (See AMC 25.125(~~a~~b)(3).)

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

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

(~~b~~c) The landing distance must be determined on a level, smooth, dry, hard-surfaced runway. (See AMC 25.125(~~b~~c) 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 tyres (see AMC 25.125(~~b~~c)(2)); 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 aeroplane.

(~~e~~d) ~~Not required for CS -25~~*Reserved.*

(~~d~~e) ~~Not required for CS–25~~*Reserved.*

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

(~~f~~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.

## CONTROLLABILITY AND MANOEUVRABILITY

### CS 25.143 General

....

(c) The aeroplane must be shown to be safely controllable and manoeuvrable 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 take-off;

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

(3) During an approach and landing.

(~~c~~d) The following table prescribes, for conventional wheel type controls, the maximum control forces permitted during the testing required by sub-paragraphs (a) ~~and (b)~~ through (c) of this paragraph. (See AMC 25.143(~~c~~d)):

| Force, in newton (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 | 334 (75) | 222 (50) | – |
| For short term application for pitch and roll control – one hand available for control | 222 (50) | 111 (25) | – |
| For short term application for yaw control | – | – | 667 (150) |
| For long term application | 44,5 (10) | 22 (5) | 89 (20) |

(~~d~~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 sub-paragraph (~~c~~d) of this paragraph. The aeroplane must be in trim, or as near to being in trim as practical, in the immediately preceding steady flight condition. For the take-off condition, the aeroplane must be trimmed according to the approved operating procedures.

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

(~~f~~g) When manoeuvring at a constant airspeed or Mach number (up to $V_{FC}/M_{FC}$), the stick forces and the gradient of the stick force versus manoeuvring load factor must lie within satisfactory limits. The stick forces must not be so great as to make excessive demands on the pilot's strength when manoeuvring the aeroplane (see AMC No. 1 to CS 25.143 (~~f~~g)), and must not be so low that the aeroplane can easily be overstressed inadvertently. Changes of gradient that occur with changes of load factor must not cause undue difficulty in maintaining control of the aeroplane, and local gradients must not be so low as to result in a danger of over-controlling. (See AMC No. 2 to CS 25.143 (~~f~~g)).

(~~g~~h) (See AMC 25.143(~~g~~h)). The manoeuvring capabilities in a constant speed coordinated turn at forward centre of gravity, as specified in the following table, must be free of stall warning or other characteristics that might interfere with normal manoeuvring.

| CONFIGURATION | SPEED | MANOEUVRING BANK ANGLE IN A COORDINATED TURN | THRUST/POWER SETTING |
|---|---|---|---|
| TAKE-OFF | $V_2$ | 30° | ASYMMETRIC WAT-LIMITED [(1)] |
| TAKE-OFF | $V_2$ + xx [(2)] | 40° | ALL ENGINES OPERATING CLIMB [(3)] |
| EN-ROUTE | $V_{FTO}$ | 40° | ASYMMETRIC WAT-LIMITED [(1)] |
| LANDING | $V_{REF}$ | 40° | SYMMETRIC FOR –3° FLIGHT PATH ANGLE |

[(1)] A combination of weight, altitude and temperature (WAT) such that the thrust or power setting produces the minimum climb gradient specified in CS 25.121 for the flight condition.

[(2)] Airspeed approved for all-engines-operating initial climb.

[(3)] That thrust or power setting which, in the event of failure of the critical engine and without any crew action to adjust the thrust or power of the remaining engines, would result in the thrust or power specified for the take-off condition at $V_2$, or any lesser thrust or power setting that is used for all-engines-operating initial climb procedures.

(i) When demonstrating compliance with CS 25.143 in icing conditions -

(1) Controllability must be demonstrated with the ice accretion described 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 manoeuvre down to zero g 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 manoeuvre without exceeding 222 N. (50 lbf) pull control force; 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 CS 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 aeroplane is controllable in a pull-up manoeuvre up to 1.5 g load factor; and

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

## STALLS

....

### CS 25.207 Stall warning

....

(b) The warning ~~may~~ must be furnished either through the inherent aerodynamic qualities of the aeroplane 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 aeroplane configurations prescribed in sub-paragraph (a) of this paragraph at the speed prescribed in sub-paragraphs (c) and (d) of this paragraph. 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. (See AMC 25.207(b).)

....

....

(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 CS 25.201(d)) when the pilot starts a recovery manoeuvre not less than three seconds after the onset of stall warning. When demonstrating compliance with this paragraph, the pilot must perform the recovery manoeuvre 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 0.5 m/sec$^2$ (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);

(~~e~~f) The stall warning margin must be sufficient in both non-icing and icing conditions to allow the pilot to prevent stalling ~~(as defined in CS 25.201(d))~~ when ~~recovery is initiated~~ the pilot starts a recovery manoeuvre 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 1m/sec$^2$ (2 knots per second), ~~with the flaps and landing gear in any normal position, with the aeroplane trimmed for straight flight at a speed of 1.3 $V_{SR}$, and with the power or thrust necessary to maintain level flight at 1.3 $V_{SR}$.~~ When demonstrating compliance with this paragraph for icing conditions, the pilot must perform the recovery manoeuvre 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 aeroplane trimmed for straight flight at a speed of 1.3 VSR; and

(3) The power or thrust necessary to maintain level flight at 1.3 VSR.

(~~f~~g) Stall warning must also be provided in each abnormal configuration of the high lift devices that is likely to be used in flight following system failures (including all configurations covered by Flight Manual procedures).

(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).

(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 0.5 m/sec$^2$ (one knot per second) and the pilot performs the recovery manoeuvre 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 manoeuvre 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 manoeuvre earlier than 3 seconds after the onset of stall warning. Also, compliance must be shown with CS 25.203 using the demonstration prescribed by CS 25.201, except that the deceleration rates of CS 25.201(c)(2) need not be demonstrated.

## GROUND HANDLING CHARACTERISTICS

### CS 25.237 Wind velocities

(a) The following applies:

(~~a~~1) A 90º cross component of wind velocity, demonstrated to be safe for take-off and landing, must be established for dry runways and must be at least 37 km/h (20 kt) or 0·2 $V_{SR0}$, whichever is greater, except that it need not exceed 46 km/h (25 kt).

(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.

## MISCELLANEOUS FLIGHT REQUIREMENTS

....

### CS 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 CS 25.143(~~f~~g), 25.147(e), 25.175(b)(1), 25.177(a) through (c ), and 25.181 must be met with wing-flaps and landing gear retracted. Except as noted in CS 25.253(c), ~~It~~ $V_{FC}/M_{FC}$ 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 CS 25.143(g), 25.147(e), 25.175(b)(1), 25.177(a) through (c) and 25.181 must be met, is the lower of:

(1) 556 km/h (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."

# BOOK 1

## SUBPART C – DESIGN AND CONSTRUCTION

### PERSONNEL AND CARGO ACCOMMODATIONS

....

### CS 25.773 Pilot compartment view

....

(b) ….

(1) ….

(i) ….

(ii) The icing conditions specified in CS 25.1419 if certification ~~with ice protection provisions~~ for flight in icing conditions is requested. (See AMC 25.773(b)(1)(ii).)

....

## BOOK 1

### SUBPART E – POWERPLANT

....

**CS 25.941 Inlet, engine, and exhaust compatibility**

....

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

....

**BOOK 1**

### SUBPART F – EQUIPMENT

....

### SAFETY EQUIPMENT

**CS 25.1419 Ice Protection**
(See AMC 25.1419)

If certification for flight in icing conditions is desired, the aeroplane must be able to safely operate in the continuous maximum and intermittent maximum icing conditions of Appendix C. To establish this ~~that the aeroplane can operate within the continuous maximum and intermittent maximum conditions of Appendix C~~

**BOOK 1**

**APPENDIX C**

Introduce a new header preceding the existing first paragraph of Appendix C to read as follows:

**Part I - Atmospheric Icing Conditions**

(a) *Continuous maximum icing*

.....

(b) *Intermittent maximum icing.*

.....

Introduce a new sub-paragraph (c) to this newly introduced Part I of Appendix C to read as follows:

(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/m$^3$, 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 457 m (1500 ft) above the level of the takeoff surface.

Introduce a new Part II of Appendix C to read as follows:

**Part II - Airframe Ice Accretions for Showing Compliance with Subpart B**

(a) Ice accretions - General. The most critical ice accretion in terms of aeroplane performance and handling qualities for each flight phase must be used to show compliance with the applicable aeroplane 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) Take-off 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, occurring between lift-off and 122 m (400 ft) above the take-off surface, assuming accretion starts at lift-off in the take-off maximum icing conditions of Part I, paragraph (c) of this Appendix.

(2) Final Take-off 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 122 m (400 ft) and either 457 m (1500 ft) above the take-off 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 lift-off in the take-off 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 paragraph CS 25.21(g), any of the ice accretions defined in sub-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 characteristics may be used for aeroplane performance tests provided any difference in performance is conservatively taken into account.

(d) Ice accretions for the takeoff phase. For both unprotected and protected parts, the ice accretion 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 lift-off;

(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 Aeroplane 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 122 m (400 ft) above the takeoff surface.

(e) Ice accretion before the ice protection system has been activated and is performing its intended function. 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 CS 25.143(j) and 25.207(h).