[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No. FAA-2012-1207; Special Conditions No. 25-517-SC]

Special Conditions: Airbus Model A350-900 series airplane; flight-envelope protection (icing and non-icing conditions); high-incidence protection and alpha-floor systems.

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions.

SUMMARY: These special conditions are issued for Airbus Model A350-900 series airplanes. These airplanes will have novel or unusual design features, associated with flight-envelope protection in icing and non-icing conditions, that use low-speed incidence protection and an alpha-floor function that automatically advances throttles whenever the airplane angle of attack reaches a predetermined value. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for these design features. These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

DATES: Effective [Insert date of publication in Federal Register].

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SUPPLEMENTARY INFORMATION:

Background

On August 25, 2008, Airbus applied for a type certificate for their new Model A350-900 series airplane. Later, Airbus requested, and the FAA approved, an extension to the application for FAA type certification to November 15, 2009. The Model A350-900 series airplane has a conventional layout with twin, wing-mounted, Rolls-Royce Trent XWB engines. It features a twin-aisle, 9-abreast, economy-class layout, and accommodates side-by-side placement of LD-3 containers in the cargo compartment. The basic Model A350-900 series airplane configuration accommodates 315 passengers in a standard two-class arrangement. The design cruise speed is Mach 0.85 with a maximum take-off weight of 602,000 lbs.

Type Certification Basis

Under title 14, Code of Federal Regulations (14 CFR) 21.17, Airbus must show that the Model A350-900 series airplane meets the applicable provisions of 14 CFR part 25, as amended by Amendments 25-1 through 25-129.

If the Administrator finds that the applicable airworthiness regulations (i.e., part 25) do not contain adequate or appropriate safety standards for the Model A350-900 series airplane because of a novel or unusual design feature, special conditions are prescribed under the provisions of § 21.16.

Special conditions are initially applicable to the model for which they are issued. Should the type certificate for that model be amended later to include any other model that incorporates the same or similar novel or unusual design feature, the special conditions would also apply to the other model under § 21.101.

In addition to the applicable airworthiness regulations and special conditions, Model A350-900 series airplanes must comply with the fuel-vent and exhaust-emission requirements of

14 CFR part 34, and the noise-certification requirements of 14 CFR part 36. The FAA must issue a finding of regulatory adequacy under § 611 of Public Law 92 574, the “Noise Control Act of 1972.”

The FAA issues special conditions, as defined in 14 CFR 11.19, in accordance with § 11.38, and they become part of the type-certification basis under § 21.17(a)(2).

The current airworthiness standards do not contain adequate safety standards for the unique features of the high-incidence protection system and the alpha-floor system for the Airbus Model A350-900 series airplane. Part I of the following special conditions is in lieu of §§ 25.103, 25.145(a), 25.145(b)(6), 25.201, 25.203, 25.207, and 25.1323(d). Part II is in lieu of §§ 25.21(g), 25.105, 25.107, 25.121, 25.123, 25.125, and 25.143.

Novel or Unusual Design Features

The Airbus Model A350-900 series airplane will incorporate the following novel or unusual design features: high-incidence protection and alpha-floor systems.

The high-incidence protection system replaces the stall-warning system during normal operating conditions by prohibiting the airplane from stalling. The high-incidence protection system limits the angle of attack at which the airplane can be flown during normal low-speed operation, impacts the longitudinal airplane handling characteristics, and cannot be overridden by the crew. The existing regulations do not provide adequate criteria to address this system.

The function of the alpha-floor system is to increase automatically the thrust on the operating engines under unusual circumstances where the airplane pitches to a predetermined high angle of attack or bank angle. The regulations do not provide adequate criteria to address this system.

Discussion

The current airworthiness standards do not contain adequate safety standards for the high-incidence protection system and the alpha-floor system for Airbus Model A350-900 series airplanes. Special conditions are needed.

The high-incidence protection system prevents the airplane from stalling and therefore, the stall-warning system is not needed during normal flight conditions. However, during failure conditions (which are not shown to be extremely improbable), the requirements of Title 14 Code of Federal Regulations (14 CFR) sections 25.203 and 25.207 apply, although slightly modified (i.e., the flight characteristics at the angle of attack for C_{LMAX} must be suitable in the traditional sense, and stall warning must be provided in a conventional manner).

The alpha-floor function automatically advances the throttles on the operating engines under flight circumstances of low speed if the airplane reaches a predetermined high angle of attack. This function is intended to provide increased climb capability.

These special conditions are intended to parallel the requirements provided in EASA A350 Certification Review Item (CRI):

- B-1, “Stalling and Scheduled Operating Speeds,” and
- B-09, “Flight in Icing Conditions,” to adapt the new standards for performance and handling characteristics of transport-category airplanes in icing conditions introduced by Amendment 25-121 to the envelope-protected Airbus Model A350-900 series airplane.

These special conditions contain the additional safety standards that the Administrator considers necessary to establish a level of safety equivalent to that established by the existing airworthiness standards.

Discussion of Comments

Notice of proposed special conditions No.25-12-09-SC for the Airbus Model A350-900 series airplanes was published in the Federal Register on December 19. 2012 (77 FR 75066). Comments were received from Transport Canada Civil Aviation (TCCA) and Agência Nacional De Aviação Civil (ANAC).

TCCA Comments and FAA Responses

1. TCCA commented that, despite informal attempts to obtain harmonization on requirements for high-incidence protection systems, harmonization has not been achieved. However, TCCA also correctly points out that this will be the subject of an ARAC harmonization effort through the Flight Test Harmonization Working Group (FTHWG).

   The FAA agrees with TCCA that the ARAC FTHWG will attempt to reach a harmonized position with regard to TCCA and ANAC comments; these special conditions are necessary in the interim.

2. TCCA also commented that the concept of using V_{SR} to establish operational speeds in both icing and non-icing conditions was well established, and not significantly commented upon, in earlier rulemaking efforts. Because these special conditions modify that concept in icing conditions, TCCA requested that this point be carefully evaluated.

   The FAA agrees with TCCA that this point should be carefully evaluated in the ARAC FTHWG. However, at this time, the FAA considers that the robust flight-envelope protection requirements of these special conditions provide compensating requirements that result in an adequate level of safety.

3. In consideration of a recent accident on a test airplane, TCCA requested that consideration be given to including specific requirements for having the protection system functioning in ground-effect during takeoff and landing.

   The FAA agrees that this point deserves consideration, and notes that it should be carefully evaluated in the ARAC FTHWG. However, at this time, the FAA considers that the general requirements (those that apply in all phases of flight) of these special conditions provide an adequate level of safety.

4. The TCCA notes that many airframe ice-protection systems have a probable failure condition (single failure) where some or all of the airframe ice protection is lost. TCCA further notes that no proposed demonstration requirements are specified for failures of airframe ice protection, which are most likely in the probable/remote range.

   The FAA acknowledges this point, and notes that it will be further evaluated in the ARAC FTHWG. However, at this time, it is the FAA's opinion that these special conditions, along with the requirements of § 25.1309, provide an adequate level of safety.

5. Demonstration requirements for failures of the airframe ice-protection system less than extremely improbable should be specified, according to the TCCA.

   The FAA agrees that this point should be carefully evaluated in the ARAC FTHWG. However, at this time, the FAA believes that the general requirements of these special conditions, along with the general requirements of § 25.1309, provide an adequate level of safety.

6. TCCA also opined that the protection system should be effective in foreseeable maneuvers such as the sideslip that is developed during takeoff and landing in crosswind conditions.

The FAA agrees that this point should receive additional evaluation in the ARAC FTHWG. However, after consideration, it is the FAA's position that the general requirements of these special conditions, combined with the current demonstration requirements in crosswind conditions, provide an adequate level of safety.

7. TCCA recommended introducing a new requirement: "The protection system must be designed to operate and perform its intended function in sideslip angles appropriate to normal airplane operation."

   The FAA intends that this point will be part of the analysis conducted by the ARAC FTHWG. However, at this time, it is the FAA's position that the general requirements of these special conditions, combined with the general flight-test requirements in various sideslip conditions, provide an adequate level of safety.

8. TCCA also recommended guidance on the adverse effects of airframe and system tolerances that should be taken into account when determining $V_{Min}1g$.

   The FAA considers that the general requirements of these special conditions, along with the guidance in AC 25-7, provide an adequate level of safety. However, additional evaluation may be conducted in the ARAC FTHWG.

9. TCCA requested clarification on whether the stall warning required for each abnormal configuration likely to be used, following system failure, should include both icing and non-icing requirements.

   Whether the stall warning must include both icing and non-icing requirements depends upon the failure scenario, and whether it meets § 25.1309. Reliance on § 25.1309 requirements provides an adequate level of safety in this case. However, this subject may be revisited in the upcoming ARAC FTHWG.

10. TCCA recommended that the FAA issue guidance on accounting for the adverse effects of airframe and system tolerances as a result of leading-edge degradation due to damage within permissible limits, and contamination due to dirt and insects (when demonstrating handling characteristics to alpha max).

    The FAA may issue such guidance, subsequent to evaluation in the ARAC FTHWG. However, at this time, it is the FAA's opinion that the general requirements of these special conditions, along with the guidance in AC 25-7, provide an adequate level of safety.

11. TCCA also recommended additional flight testing requirements to ensure the "robustness" of the high-angle-of-attack protection systems, in both icing and non-icing conditions.

    The FAA agrees that this point should be carefully evaluated in the ARAC FTHWG. However, at this time, the FAA considers that additional flight testing requirements are not necessary, as the requirements of these special conditions provide an adequate level of safety.

12. TCCA requested that the FAA add further clarification for sections 5.1(b)(3)i and 5.1(b)(3)ii of these special conditions regarding the requirement for straight or turning flight, and power setting.

    The FAA agrees that this point should be carefully revisited in the ARAC FTHWG. However, at this time, the FAA considers that the requirements of these sections are sufficiently defined in section 5.1(a).

13. TCCA recommended that the FAA delete section 5.3(b) , if it adopted TCCA's earlier comments.

    The FAA agrees that this point should be carefully evaluated in the ARAC FTHWG.

14. TCCA recommended that operational speeds should be determined based on a factored V_{SR} or $V_{min}1g$ in icing conditions, in addition to the requirement for minimum maneuver margins. TCCA has provided specific proposals for those factors.

    The FAA agrees that this point should be carefully evaluated in the ARAC FTHWG. However, at this time, the FAA considers that the requirements of these special conditions provide an adequate level of safety because minimum maneuver margins are typically more limiting than those based on factored V_{SR} or $V_{min}1g$.

ANAC Comments

1. ANAC questioned the use of different operational-speed bases for icing and non-icing conditions.

   The FAA agrees that this point should be carefully evaluated in the ARAC FTHWG. However, at this time, it is the FAA's opinion that the differing requirements for icing and non-icing conditions are appropriate and provide an adequate level of safety. The non-icing speed basis is used for nearly every flight, while the icing speed basis is based on an assumed lengthy accumulation of ice, which may not be present on every flight in icing conditions. Therefore, the safety trade-off (i.e., differing requirements) between increased approach speeds and margin to stall is more appropriate in icing conditions.

2. ANAC proposed to have the same basic requirements in icing and non-icing, allowing only some degradation in handling characteristics at V_{CLmax} in icing conditions.

   The FAA agrees that this point should be carefully evaluated in the ARAC FTHWG. However, at this time, the FAA considers that the rationale for differing requirements in icing and non-icing conditions is appropriate and provides an adequate level of safety.

3. ANAC recommended that the same high-incidence-protection demonstration of "maximum rate achievable" should be required for icing conditions.

The FAA agrees that this point should be carefully evaluated in the ARAC FTHWG. However, at this time, the FAA considers that the requirements of these special conditions provide an adequate level of safety. Historically, the FAA has allowed a small degradation for stall demonstrations in icing conditions (i.e., exceptions for high-entry-rate stalls). We have extended this philosophy to the requirements of these special conditions.

Additional FAA Response to Comments

The FAA acknowledges these comments, which will be fully discussed and resolved in the upcoming ARAC FTHWG sessions. The FAA notes that these special conditions are intended to parallel the requirements provided in EASA (as the certificating authority) A350 Certification Review Item (CRI):

- B-1, "Stalling and Scheduled Operating Speeds," and
- B-09, "Flight in Icing Conditions," to adapt the new standards for performance and handling characteristics of transport-category airplanes in icing conditions introduced by Amendment 25-121 to the envelope-protected Airbus Model A350-900 series airplane.

In the meantime, the FAA, as the validating authority, finds that these special conditions provide an adequate level of safety. No changes to the special conditions were made based on TCCA and ANAC comments.

Applicability

As discussed above, these special conditions are applicable to Airbus Model A350-900 series airplanes. Should Airbus apply at a later date for a change to the type certificate to include another model incorporating the same novel or unusual design feature, the special conditions would apply to that model as well.

Under standard practice, the effective date of final special conditions would be 30 days after the date of publication in the Federal Register; however, as the certification date for the Airbus Model A350-900 series airplane is imminent, the FAA finds that good cause exists to make these special conditions effective upon publication.

Conclusion

This action affects only certain novel or unusual design features on the Airbus Model A350-900 series airplane. It is not a rule of general applicability.

List of Subjects in 14 CFR Part 25

Aircraft, Aviation safety, Reporting and recordkeeping requirements.

The authority citation for these special conditions is as follows:

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

The Special Conditions

Accordingly, pursuant to the authority delegated to me by the Administrator, the following special conditions are issued as part of the type certification basis for Airbus Model A350-900 series airplanes.

The current airworthiness standards do not contain adequate safety standards for the unique features of the high-incidence protection system and the alpha-floor system for the Airbus A350. Part I of the following special conditions is in lieu of §§ 25.103, 25.145(a), 25.145(b)(6), 25.201, 25.203, 25.207, and 25.1323(d). Part II is in lieu of §§ 25.21(g), 25.105, 25.107, 25.121, 25.123, 25.125, and 25.143.

Note: In the following paragraphs, "In icing conditions" means with the ice accretions (relative to the relevant flight phase) as defined in 14 CFR Part 25, Amendment 121 appendix C.

Special Conditions Part I: Stall Protection and Scheduled Operating Speeds

Foreword

In the following paragraphs, "In icing conditions" means with the ice accretions (relative to the relevant flight phase) as defined in 14 CFR part 25, Amendment 121 appendix C.

1. Definitions

These special conditions address novel or unusual design features of the Airbus Model A350-900 series airplane and use terminology that does not appear in 14 CFR part 25. For the purpose of these special conditions, the following terms describe certain aspects of these novel or unusual design features:

High-incidence protection system

A system that operates directly and automatically on the airplane's flying controls to limit the maximum angle of attack that can be attained to a value below that at which an aerodynamic stall would occur.

Alpha-floor system

A system that automatically increases thrust on the operating engines when angle of attack increases through a particular value.

Alpha-limit

The maximum angle of attack at which the airplane stabilizes with the high-incidence protection system operating and the longitudinal control held on its aft stop.

V_{CLmax}

An airspeed calculated from a variety of factors including load factor normal to the flight path at V_{CLmax}, airplane gross weight, aerodynamic reference wing area, and dynamic pressure.

V_{min}

The minimum steady flight speed in the airplane configuration under consideration with the high-incidence protection system operating. See paragraph 3 of these special conditions.

V_{min}1g

V_{min} corrected to 1g conditions. See paragraph 3 of these special conditions. It is the minimum calibrated airspeed at which the airplane can develop a lift force normal to the flight path and equal to its weight when at an angle of attack not greater than that determined for V_{min}.

2. Capability and Reliability of the High-Incidence-Protection System

These special conditions are issued in lieu of the paragraphs of 14 CFR part 25 referenced below. Acceptable capability and reliability of the high-incidence-protection system can be established by flight test, simulation, and analysis, as appropriate. The capability and reliability required are as follows:

1- It must not be possible during pilot induced maneuvers to encounter a stall and handling characteristics must be acceptable, as required by section 5 of these Special Conditions.

2- The airplane must be protected against stalling due to the effects of wind-shears and gusts at low speeds as required by section 6 of these Special Conditions.

3- The ability of the high-incidence protection system to accommodate any reduction in stalling incidence must be verified in icing conditions.

4- The high-incidence protection system must be provided in each abnormal configuration of the high lift devices that is likely to be used in flight following system failures

5- The reliability of the system and the effects of failures must be acceptable in accordance with § 25.1309.

3. Minimum Steady Flight Speed and Reference Stall Speed

In lieu of § 25.103, Minimum steady flight speed and Reference stall speed, the following requirements apply:

(a) The minimum steady flight speed, V_{min}, is the final stabilized calibrated airspeed obtained when the airplane is decelerated until the longitudinal control is on its stop in such a way that the entry rate does not exceed 1 knot per second. (See Appendix A, paragraph 3)

(b) The minimum steady flight speed, V_{min}, must be determined in icing and non-icing conditions with:

(1) The high-incidence protection system operating normally.

(2) Idle thrust and alpha-floor system inhibited;

(3) All combinations of flaps setting and, landing gear position for which V_{min} is required to be determined;

(4) The weight used when V_{SR} is being used as a factor to determine compliance with a required performance standard;

(5) The most unfavorable center of gravity allowable; and

(6) The airplane trimmed for straight flight at a speed achievable by the automatic trim system.

(c) The 1g minimum steady-flight speed, $V_{min}1g$, is the minimum calibrated airspeed at which the airplane can develop a lift force (normal to the flight path) equal to its weight, while at an angle of attack not greater than that at which the minimum steady flight speed of sub-paragraph (a) was determined. It must be determined in icing and non-icing conditions.

(d) The reference stall speed, V_{SR}, is a calibrated airspeed defined by the applicant. V_{SR} may not be less than a 1g stall speed. V_{SR} must be determined in non-icing conditions and expressed as:

$$V_{SR} \geq \frac{V_{CL_{MAX}}}{\sqrt{n_{zw}}}$$

Where:

$V_{C_{L_{MAX}}}$ = Calibrated airspeed obtained when the load factor-corrected lift coefficient ($\frac{n_{zw}W}{qS}$) is first a maximum during the maneuver prescribed in sub-paragraph (e)(8) of this paragraph.

n_{ZW} = Load factor normal to the flight path at V_{CLmax}

W = Airplane gross weight;

S = Aerodynamic reference wing area; and

q = Dynamic pressure.

(e) V_{CLmax} is determined in non-icing conditions with:

(1) Engines idling, or, if that resultant thrust causes an appreciable decrease in stall speed, not more than zero thrust at the stall speed;

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

(3) The weight used when V_{SR} is being used as a factor to determine compliance with a required performance standard;

(4) The center of gravity position that results in the highest value of reference stall speed;

(5) The airplane trimmed for straight flight at a speed achievable by the automatic trim system, but not less than 1.13 V_{SR} and not greater than 1.3 V_{SR};

(6) Alpha-floor system inhibited; and

(7) The high-incidence protection system adjusted, at the option of the applicant, to allow higher incidence than is possible with the normal production system.

(8) Starting from the stabilized trim condition, apply the longitudinal control to decelerate the airplane so that the speed reduction does not exceed 1 knot per second.

4. Stall warning

In lieu of § 25.207, the following requirements apply:

4.1 Normal operation

If the capabilities of the high-incidence protection system are met, then the conditions of paragraph 2 are satisfied. These conditions provide an equivalent level of safety to § 25.207, Stall Warning, so the provision of an additional, unique warning device is not required.

4.2 High-incidence protection system failure

Following failures of the high-incidence protection system, not shown to be extremely improbable, such that the capability of the system no longer satisfies items 1, 2, and 3 of paragraph 2, stall warning must be provided and must protect against encountering unacceptable characteristics and against encountering stall.

(a) Stall warning with the flaps and landing gear in any normal position must be clear and distinctive to the pilot and meet the requirements specified in paragraphs (d) and (e) below.

(b) 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.

(c) The warning may be furnished either through the inherent aerodynamic qualities of the airplane or by a device that will give clearly distinguishable indications under expected conditions of flight. However a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself. If a warning device is used, it must provide a warning in each of the airplane configurations prescribed in paragraph (a) above and for the conditions prescribed below in paragraphs (d) and (e) below.

(d) In non-icing conditions stall warning must meet the following requirements:

Stall warning must provide sufficient margin to prevent encountering unacceptable characteristics and encountering stall in the following conditions:

> (1) In power-off straight deceleration not exceeding 1 knot per second to a speed 5 knots or 5 percent CAS, whichever is greater, below the warning onset.
>
> (2) In turning flight stall deceleration at entry rates up to 3 knots per second when recovery is initiated not less than 1 second after the warning onset.

(e) In icing conditions stall warning must provide sufficient margin to prevent encountering unacceptable characteristics and encountering stall, in power off straight and turning flight decelerations not exceeding 1 knot per second, when the pilot starts a recovery maneuver not less than three seconds after the onset of stall warning.

(f) An airplane is considered stalled when the behavior of the airplane gives the pilot a clear and distinctive indication of an acceptable nature that the airplane is stalled. Acceptable indications of a stall, occurring either individually or in combination are:

> (1) A nose-down pitch that cannot be readily arrested
>
> (2) Buffeting, of a magnitude and severity that is strong and effective deterrent to further speed reduction; or

(3) The pitch control reaches the aft stop and no further increase in pitch attitude occurs when the control is held full aft for a short time before recovery is initiated

(g) An aircraft exhibits unacceptable characteristics during straight or turning flight decelerations if it is not always possible to produce and to correct roll and yaw by unreversed use of aileron and rudder controls, or abnormal nose-up pitching occurs.

5. Handling Characteristics at High Incidence

In lieu of both § 25.201 and § 25.203, the following requirements apply:

5.1 High-incidence Handling Demonstrations

In lieu of § 25.201: High-incidence handling demonstration in icing and non-icing conditions

(a) Maneuvers to the limit of the longitudinal control, in the nose up pitch, must be demonstrated in straight flight and in 30° banked turns with:

(1) The high-incidence protection system operating normally.

(2) Initial power conditions of:

I: Power off

II: The power necessary to maintain level flight at 1.5 V_{SR1}, where V_{SR1} is the reference stall speed with flaps in approach position, the landing gear retracted and maximum landing weight. (See Appendix A, paragraph 5)

(3) Alpha-floor system operating normally unless more severe conditions are achieved with inhibited alpha floor.

(4) Flaps, landing gear and deceleration devices in any likely combination of positions (see Appendix A, paragraph 6).

(5) Representative weights within the range for which certification is requested; and

(6) The airplane trimmed for straight flight at a speed achievable by the automatic trim system.

(b) The following procedures must be used to show compliance in non-icing and icing conditions:

(1) Starting at a speed sufficiently above the minimum steady flight speed to ensure that a steady rate of speed reduction can be established, apply the longitudinal control so that the speed reduction does not exceed 1 knot per second until the control reaches the stop (see Appendix A, paragraph 3)

(2) The longitudinal control must be maintained at the stop until the airplane has reached a stabilized flight condition and must then be recovered by normal recovery techniques.

(3) Maneuvers with increased deceleration rates

i) In non-icing conditions, the requirements must also be met with increased rates of entry to the incidence limit, up to the maximum rate achievable.

ii) In icing conditions, with the anti-ice system working normally, the requirements must also be met with increased rates of entry to the incidence limit, up to 3kt/s.

(4) Maneuver with ice accretion prior to operation of the normal anti-ice system

With the ice accretion prior to operation of the normal anti-ice system, the requirement must also be met in deceleration at 1kt/s up to FBS (with and without alpha floor).

5.2 Characteristics in High-incidence Maneuvers

In lieu of § 25.203: Characteristics in High Incidence (see Appendix A, paragraph 7).

In icing and non-icing conditions:

(a) Throughout maneuvers with a rate of deceleration of not more than 1 knot per second, both in straight flight and in 30° banked turns, the airplane's characteristics must be as follows:

(1) There must not be any abnormal nose-up pitching.

(2) There must not be any uncommanded nose-down pitching, which would be indicative of stall. However reasonable attitude changes associated with stabilizing the incidence at Alpha limit as the longitudinal control reaches the stop would be acceptable. (See Appendix A, paragraph 7.3)

(3) There must not be any uncommanded lateral or directional motion and the pilot must retain good lateral and directional control, by conventional use of the controls, throughout the maneuver.

(4) The airplane must not exhibit buffeting of a magnitude and severity that would act as a deterrent from completing the maneuver specified in 5.1.(a).

(b) In maneuvers with increased rates of deceleration some degradation of characteristics is acceptable, associated with a transient excursion beyond the stabilized Alpha-limit. However the airplane must not exhibit dangerous characteristics or characteristics that would deter the pilot from holding the longitudinal control on the stop for a period of time appropriate to the maneuver.

(c) It must always be possible to reduce incidence by conventional use of the controls.

(d) The rate at which the airplane can be maneuvered from trim speeds associated with scheduled operating speeds such as V_2 and V_{REF} up to Alpha-limit must not be unduly damped or be significantly slower than can be achieved on conventionally controlled transport airplanes.

5.3 Characteristics up to maximum lift angle of attack

(a) In non-icing conditions:

Maneuvers with a rate of deceleration of not more than 1 knot per second up to the angle of attack at which V_{CLmax} was obtained as defined in paragraph 3 must be demonstrated in straight flight and in 30° banked turns with:

(1) The high-incidence protection deactivated or adjusted, at the option of the applicant, to allow higher incidence than is possible with the normal production system.

(2) Automatic thrust increase system inhibited

(3) Engines idling

(4) Flaps and landing gear in any likely combination of positions

(5) The airplane trimmed for straight flight at a speed achievable by the automatic trim system.

(b) In icing conditions:

Maneuvers with a rate of deceleration of not more than 1 knot per second up to the maximum angle of attack reached during maneuvers from 5.1(b)(3)(ii) must be demonstrated in straight flight with:

(1) The high-incidence protection deactivated or adjusted, at the option of the applicant, to allow higher incidence than is possible with the normal production system.

(2) Automatic thrust increase system inhibited

(3) Engines idling

(4) Flaps and landing gear in any likely combination of positions

(5) The airplane trimmed for straight flight at a speed achievable by the automatic trim system.

(c) During the maneuvers used to show compliance with paragraphs (a) and (b) above, the airplane must not exhibit dangerous characteristics and it must always be possible to reduce angle of attack by conventional use of the controls. The pilot must retain good lateral and directional control, by conventional use of the controls, throughout the maneuver.

6. Atmospheric Disturbances

Operation of the high-incidence protection system must not adversely affect aircraft control during expected levels of atmospheric disturbances, nor impede the application of recovery procedures in case of wind-shear. This must be demonstrated in non-icing and icing conditions.

7. Alpha floor

In icing and non-icing conditions, the Alpha-floor setting must be such that the airplane can be flown at the speeds and bank angles specified in § 25.143(h). It also must be shown that the alpha-floor setting does not interfere with normal maneuvering of the airplane. In addition, there must be no alpha-floor triggering unless appropriate when the aircraft is flown in usual operational maneuvers and in turbulence.

8. Proof of compliance

In addition to those in § 25.21(b), the following requirement applies:

(b) The flying qualities must be evaluated at the most unfavorable center of gravity (CG) position.

9. For §§ 25.145(a), 25.145(b)(6), and 25.1323(d), the following requirements apply:

§ 25.145(a) V_{min} in lieu of "stall identification"

§ 25.145(b)(6) V_{min} in lieu of V_{SW}

§ 25.1323(d) "From 1.23 V_{SR} to V_{min}" in lieu of "1.23 V_{SR} to stall warning speed" and "speeds below V_{min}" in lieu of "speeds below stall warning"

Special Conditions Part II: Credit for Robust Envelope Protection in Icing Conditions

1. In lieu of § 25.21(g)(1), the following requirement applies:

In lieu of § 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 AC 25-25):

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

2. Define the stall speed as provided in SC Part I, in lieu of § 25.103.

3. The following requirements apply in lieu of § 25.105(a)(2)(i):

In lieu of § 25.105, Take-off :

(a) The take-off speeds prescribed by § 25.107, the accelerate-stop distance prescribed by § 25.109, the take-off path prescribed by § 25.111, and the take-off distance and take-off run prescribed by § 25.113, must be determined, and the net take-off flight path prescribed by § 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 -

. . .

(2) In icing conditions, if in the configuration of § 25.121(b) with the “Take-off Ice” accretion defined in Appendix C:

i) the V_2 speed scheduled in non-icing conditions does not provide the maneuvering capability specified in § 25.143(h) for the takeoff configuration, or

4. In lieu of § 25.107(c) and (g), the following requirements apply, with additional sections (c’) and (g’):

In lieu of § 25.107, Take-off speeds:

(c) in non-icing conditions V_2, in terms of calibrated airspeed, must be selected by the applicant to provide at least the gradient of climb required by § 25.121(b) but may not be less than –

(1) V_{2MIN};

(2) V_R plus the speed increment attained

(in accordance with § 25.111(c)(2)) before reaching a height of 35 feet above the takeoff surface; and

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

(c’) in icing conditions with the “take-off ice” accretion defined in Appendix C, V_2 may not be less than –

(1) the V_2 speed determined in non-icing conditions

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

(g) in non-icing conditions, $V_{FTO,}$ in terms of calibrated airspeed, must be selected by the applicant to provide at least the gradient of climb required by § 25.121(c), but may not be less than

(1) 1.18 V_{SR}; and

(2) A speed that provides the

maneuvering capability specified in § 25.143(h).

(g') in icing conditions with the "Final take-off ice" accretion defined in Appendix C, V_{FTO}, may not be less than

(1) the V_{FTO} speed determined in non-icing conditions

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

5. In lieu of §§ 25.121(b)(2)(ii)(A), 25.121(c)(2)(ii)(A), and 25.121(d)(2)(ii), the following requirements apply:

In lieu of § 25.121, Climb: one-engine inoperative:

(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 § 25.111 but without ground effect,

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

. . .

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

(A) The V_2 speed scheduled in non-icing conditions does not provide the maneuvering capability specified in § 25.143(h) for the take-off configuration; or

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

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

. . .

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

(A) The V_{FTO} speed scheduled in non-icing conditions does not provide the maneuvering capability specified in § 25.143(h) for the en-route configuration; or

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

ii) In icing conditions with the approach Ice accretion defined in Appendix C, in a configuration corresponding to the normal all-engines-operating procedure in which $V_{min}1g$ for this configuration does not exceed 110% of the $V_{min}1g$ for the related all-engines-operating landing configuration in icing, with a climb speed established with normal landing procedures, but not more than 1.4 V_{SR} (V_{SR} determined in non-icing conditions).

6. In lieu of § 25.123(b)(2)(i), the following requirements apply:

In lieu of § 25.123, En-route flight paths:

(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 airplanes, 1.4% for three-engined airplanes, and 1.6% for four engined airplanes.

(2) In icing conditions with the "En-route ice" accretion defined in Appendix C if

(i) The minimum en-route speed scheduled in non-icing conditions does not provide the maneuvering capability specified in § 25.143(h) for the en-route configuration, or

7. In lieu of § 25.125(b)(2)(ii)(B), remove § 25.125(b)(2)(ii)(C) and replaced with the following requirements:

In lieu of § 25.125, Landing.

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

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

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

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

(A) $1.23V_{SR0}$;

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

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

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

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

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

8. In lieu of § 25.143(j)(2)(i), the following requirements for controllability and maneuverability apply:

In lieu of § 25.143, General:

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

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

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

(i) The airplane is controllable in a pull-up maneuver up to 1.5 g load factor or lower if limited by AOA protection; and

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

9. In lieu of § 25.207, Stall warning, change to read as the requirements defined in Special Conditions Part I, above.

Appendix A - Guidance Material: Stalling and Scheduled Operating Speeds

1. Introduction

This Guidance Material provides suggested means of compliance for various aspects of Special Conditions Part I and replaces the AC 25-7C sections that are no longer applicable due to the conditions of Special Conditions Part 1.

2. Alpha protection tolerances

Flight testing for handling characteristics should be accomplished with the airplane build and system tolerances set to the most adverse condition for high-incidence protection. Flight testing for minimum steady flight speed and reference stall speed may be made with nominal airframe tolerances and AOA protection system settings if the combined root-sum-square (square root of the sum of the squares of each tolerance) effect of the tolerances is less than ±1 knot. If the effect is greater than ±1 knot, the most adverse airframe build and high-incidence protection system tolerance should be used.

3. Minimum Steady Flight Speed Entry Rate

In lieu of § 25.103(a) and § 25.203(a), see paragraphs 3 and 5.2 of Special Conditions Part I.

The minimum steady flight speed entry rate is defined as follows:

$$\text{Entry rate} = \frac{1.15\ V_{min}1g - 1.05\ V_{min}\ 1g}{\text{Time to decelerate from } 1.15\ V_{min}1g \text{ to } 1.05\ V_{min}1g}\ \text{(knot CAS/sec)}$$

4. Maneuvering Capabilities at Scheduled Operating Speeds

(See § 25.143 (h))

(1) The maneuver capabilities specified in § 25.143 (h) should be achieved at constant CAS.

(2) A low thrust or power setting normally will be the critical case for demonstrating the required maneuver capabilities. The thrust/power settings specified in paragraph § 25.143

(h) are the maximum values that may be used in such cases. However, if the angle of attack at which the stick stop is reached (or other relevant characteristic occurs) is reduced with increasing thrust or power, it should be ensured that the required maneuver capabilities are retained at all higher thrust or power settings appropriate to the flight condition.

(3) The thrust or power setting for the all-engines operating condition at V_{2+xx} should include any value used in noise abatement procedure.

5. Power Setting for Power-on Handling to High Incidence

(In lieu of § 25.201(a)(2), see paragraph 5.1 of Special Conditions Part I)

The power for power-on maneuver demonstrations to high incidence is that power necessary to maintain level flight without ice at a speed of 1.5 V_{SR1} at maximum landing weight, with flaps in the approach position and landing gear retracted, where V_{SR1} is the reference stall speed without ice in the same conditions (except power and effect of ice). The flap position to be used to determine this power setting is that position in which the reference stall speed does not exceed 110% of the reference stall speed with the flaps in the most extended landing position.

6. Position of Deceleration Devices During Handling to High Incidence

(In lieu of § 25.201, see paragraph 5.1 of Special Conditions Part I)

Demonstrations of maneuvers to high incidence for compliance with § 25.201 should include demonstrations with deceleration devices deployed for all flap positions unless limitations against use of the devices with particular flap positions are imposed. “Deceleration devices" include spoilers when used as air brakes, and thrust reversers when use in flight is permitted. High-incidence maneuver demonstrations with deceleration devices deployed should normally be carried out with an initial power setting of power off, except where deployment of the deceleration devices while power is applied is likely to occur in normal operations (e.g. use of extended air brakes during landing approach). Demonstrations with Alpha-floor both inhibited and operating normally should be included.

7. Characteristics During High-incidence Maneuvers

In lieu of § 25.203, see paragraph 5.2 of Special Conditions Part I.

1) The behavior of the airplane includes the behavior as affected by the normal functioning of any systems with which the airplane is equipped, including devices intended to alter the high-incidence handling characteristics of the airplane.

2) Unless the design of the automatic flight control system of the airplane protects against such an event, the high-incidence characteristics, when the airplane is maneuvered under the control of the automatic flight control system should be investigated.

3) Any reduction of pitch attitude associated with stabilizing the incidence at Alpha limit should be achieved smoothly, at a low pitch rate, such that it is not likely to be mistaken for natural stall identification.

8. Atmospheric Disturbances

See paragraph 6 of Special Conditions Part I.

In establishing compliance with paragraph 6 of Special Conditions Part I, the high-incidence protection system and alpha-floor system should be assumed to be operating normally.

Simulator studies and analyses may be used but will need to be validated by limited flight testing to confirm handling qualities, at critical loadings, up to the maximum incidence shown to be reached by such studies and analyses.

9. Alpha Floor

See paragraph 7 of Special Conditions Part I.

Compliance with paragraph 7 of Special Conditions Part I should be considered as being met if alpha-floor setting provides a maneuvering capability of 40° bank angle,

- in the landing configuration

- at V_{REF} without ice, and at the recommended final approach speed with ice

- with the thrust for wings level unaccelerated -3° glide path,

without alpha-floor triggering.

Appendix B - Guidance Material

The following guidance is in lieu of AC 25-25, Performance and Handling Characteristics in the Icing Conditions Specified in Part 25, Appendix C::

Section 3. ACCEPTABLE MEANS OF COMPLIANCE – FLIGHT TEST PROGRAM

1. In lieu of b. Stall Speed, 25.103, the requirements in Special Conditions Part 1, 3. Minimum Steady Flight Speed and Reference Stall Speed are made.

2. In lieu of d., Takeoff Path, § 25.111, the following guidance is made.

If V_2 speed scheduled in icing conditions is greater than V_2 in non-icing conditions take-off demonstrations should be repeated to substantiate the speed schedule and distances for take-off in icing conditions. The effect of the take-off speed increase, thrust loss, and drag increase on the take-off path may be determined by a suitable analysis.

3. In lieu of i., Controllability and Maneuverability – General, § 25.143, the following guidance is made:

a. § 25.143(4)(c)4 Test maneuver for showing compliance with § 25.143(i)(3): Conduct steady heading sideslips to full rudder input, 180 pounds rudder force, or full lateral control authority (whichever comes first) at a trim speed corresponding to the minimum AFM speed and the power or thrust for a minus 3 degrees flight path angle.

b. § 25.143(5)(b) If activation of the ice protection system depends on a means of recognition other than that defined in paragraph (a) above, it is acceptable to demonstrate adequate controllability with the ice accretion prior to normal system operation, as follows. In the configurations listed below, trim the airplane at the specified speed, conduct a pull-up maneuver to 1.5g (or lower if limited by AOA protections) and pushover maneuver to 0.5g, and show that longitudinal control forces do not reverse.

(1) High lift devices retracted configuration (or holding configuration if different), holding speed, power or thrust for level flight.

(2) Landing configuration, V_{REF} for non-icing conditions, power or thrust for landing approach. (stop pull up after achievement of 1.5g or peak load factor with Full Back Stick).

4. In lieu of j., Longitudinal Control, § 25.145(2)(c), the following guidance is made for (c):

((1), (2), (a) and (b) are retained)

In the configurations listed below, trim the airplane at the minimum AFM speed. Reduce speed using elevator control to the minimum steady achievable speed and demonstrate prompt recovery to the trim speed using elevator control.

1 High lift devices retracted configuration, maximum continuous power or thrust.

2 Maximum lift landing configuration, maximum continuous power or thrust.

5. In lieu of q., Stall Demonstration, § 25.201, see the requirements in Special Conditions Part I, *Stall Protection and Scheduled Operating Speeds.*

6. In lieu of r., Stall Warning, § 25.207, see the requirements in Special Conditions Part I, paragraph 4 – *Stall Warning.*

7. In lieu of u., Natural Icing Conditions, § 25.1419(b), revise the ice accretion Tables 3 & 4 as follows:

TABLE 3: Holding Scenario - Maneuvers

Configuration	**CG**	**Trim speed**	**Maneuver**
Flaps up, gear up	Optional (aft range)	Holding, except at Minimum AFM speed for the high AoA maneuver	• Level, 40° banked turn, • Bank-to-bank rapid roll, 30° -30°, • Speed-brake extension, retraction, • Deceleration to alpha-max (1 knot/second deceleration rate, wings level, power off)
Flaps in intermediate positions, gear up	Optional (aft range)	Minimum AFM speed	Level deceleration in a 1 knot/ second deceleration until deceleration is stopped due to alpha-floor triggering.
Landing flaps, gear down	Optional (aft range)	VREF (Minimum AFM speed)	• Level, 40° banked turn, • Bank-to-bank rapid roll, 30° - 30°, • Speed-brake extension, retraction (if approved), • Deceleration to alpha-max (1 knot/second deceleration rate, wings level, power off)

TABLE 4: Approach/Landing Scenario – Maneuvers

Test Condition	Ice accretion thickness (*)	Configuration	CG	Trim speed	Maneuver
-	First 13 mm (0.5 inch)	Flaps up, gear up	Optional (aft range)	Holding	No specific test.
1	Additional 6.3 mm (0.25 in) (19 mm (0.75 in) total)	First intermediate flaps, gear up	Optional (aft range)	Minimum AFM speed	• Level 40° banked turn, • Bank-to-bank rapid roll, 30°- 30°, • Speed brake extension and retraction (if approved), • 1kt/s Level deceleration until the deceleration is stopped due to alpha-floor triggering
2	Additional 6.3 mm (0.25 in) (25 mm (1.00 in) total)	First intermediate flaps, gear up (as applicable)	Optional (aft range)	Minimum AFM speed	• Bank-to-bank rapid roll, 30°- 30°, • Speed brake extension and retraction (if approved), • 1kt/s Level deceleration until the deceleration is stopped due to alpha-floor triggering
3	Additional 6.3 mm (0.25 in) (31 mm (1.25 in) total)	Landing flaps, gear down)	Optional (aft range)	V_{REF} (Minimum AFM speed)	• Bank-to-bank rapid roll, 30°- 30°, • Speed brake extension and retraction (if approved), • Bank to 40° • Deceleration to alpha-max

(*) The indicated thickness is that obtained on the parts of the unprotected airfoil with the highest collection efficiency.

8. In lieu of AC 25-25, 3. v., Failure conditions, § 25.1309, the following guidance is made for (2)(d):

(2) Acceptable Test Program

(d) In the configurations listed below, trim the airplane at the minimum AFM speed. Decrease speed to the minimum steady achievable speed, plus 1 second and demonstrate prompt recovery using the same recovery maneuver as for the non-contaminated airplane. It is acceptable for stall warning to be provided by a different means (for example, by the behavior of the airplane) for failure cases not considered probable.

1 High lift devices retracted configuration: Straight/Power Off.

2 Landing configuration: Straight/Power Off.

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