[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

14 CFR Part 25

[Docket No.FAA-2014-0366; Special Conditions No. 25-564-SC]

Special Conditions: Embraer S.A.; Model EMB-550 Airplane; Flight Envelope Protection: High Incidence Protection System

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Final special conditions.

SUMMARY: These special conditions are issued for the Embraer S.A. Model EMB-550 airplane. This airplane will have a novel or unusual design feature when compared to the state of technology and design envisioned in the airworthiness standards for transport category airplanes. This design feature is a high incidence protection system that limits the angle of attack at which the airplane can be flown during normal low speed operation. The applicable airworthiness regulations do not contain adequate or appropriate safety standards for this design feature. 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 date: [Insert date of publication in the *Federal Register*].

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SUPPLEMENTARY INFORMATION:

Background

On May 14, 2009, Embraer S.A. applied for a type certificate for its new Model EMB-550 airplane, which was subsequently revised to August 29, 2009. The Model EMB-550 airplane is the first of a new family of jet airplanes designed for corporate flight, fractional, charter, and private owner operations. The airplane has a configuration with low wing and T-tail empennage. The primary structure is metal with composite empennage and control surfaces. The Model EMB-550 airplane is designed for 8 passengers, with a maximum of 12 passengers. It is equipped with two Honeywell AS907-3-1E medium bypass ratio turbofan engines mounted on aft fuselage pylons. Each engine produces approximately 6,540 pounds of thrust for normal takeoff.

Type Certification Basis

Under the provisions of Title 14, Code of Federal Regulations (14 CFR) 21.17, Embraer S.A. must show that the Model EMB-550 meets the applicable provisions of part 25, as amended by Amendments 25-1 through 25-128 thereto.

If the Administrator finds that the applicable airworthiness regulations (i.e., 14 CFR part 25) do not contain adequate or appropriate safety standards for the Model EMB-550 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, the Model EMB-550 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, and the FAA must issue a finding of regulatory adequacy under section 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).

Novel or Unusual Design Features

The Model EMB-550 will incorporate the following novel or unusual design features: A high incidence protection system that replaces the stall warning system during normal operating conditions, prohibits the airplane from stalling, limits the angle of attack at which the airplane can be flown during normal low speed operation, and that cannot be overridden by the flightcrew. The application of this angle-of-attack limit impacts the stall speed determination, the stall characteristics and stall warning demonstration, and the longitudinal handling characteristics. The current regulations do not address this type of protection feature.

Discussion

The high incidence protection function prevents the airplane from stalling at low speeds, and, therefore, a stall warning system is not needed during normal flight conditions. However, if there is a failure of the high incidence protection function that is not shown to be extremely improbable, stall warning must be provided in a conventional manner. Also the flight characteristics at the angle of attack for maximum lift coefficient (C_{Lmax}) must be suitable in the traditional sense.

These special conditions address this novel or unusual design feature on the EMB-550. These special conditions, which include airplane performance requirements, establish a level of

safety equivalent to the current regulations for reference stall speeds, stall warning, stall characteristics, and miscellaneous other minimum reference speeds.

Discussion of the Comments

Notice of proposed special conditions No. 25-14-04-SC for the Embraer Model EMB-550 airplane was published in the *Federal Register* on June 10, 2014, (79 FR 33140). No comments were received, and the special conditions are adopted as proposed.

Applicability

As discussed above, these special conditions are applicable to the Embraer Model EMB-550 airplane. Should Embraer S.A. 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 Embraer Model EMB-550 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 one model of airplanes. 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, the Federal Aviation Administration (FAA) issues the following special conditions as part of the type certification basis for Embraer S.A. Model EMB-550.

Flight Envelope Protection: High Incidence Protection System

The current airworthiness standards do not contain adequate safety standards for the unique features of the high incidence protection system on the Embraer EMB-550. Part I of the following special conditions are issued in lieu of the specified paragraphs of §§ 25.21, 25.103, 25.145, 25.201, 25.203, 25.207, and 25.1323. Part II are in lieu of the specified paragraphs of §§ 25.103, 25.105, 25.107, 25.121, 25.123, 25.125, 25.143, and 25.207.

Special Conditions Part I

Stall Protection and Scheduled Operating Speeds

The following special conditions are in lieu of §§ 25.21(b), 25.103, 25.145(a), 25.145(b)(6), 25.201, 25.203, 25.207, and 25.1323(d).

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 a novel or unusual design feature of the EMB-550 airplane and use terminology that does not appear in 14 CFR part 25.

These terms relating to the novel or unusual design feature addressed by these special conditions are the following:

- 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-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_{min}: The minimum steady flight speed in the airplane configuration under consideration with the high incidence protection system operating. See section 3 Part I of these special conditions.

- $V_{min}1g$: V_{min} corrected to 1g conditions. See section 3 of Part I 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

The 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 Part I 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 Part I 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, we propose the following requirements:

(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.

(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 automatic thrust system (if applicable) inhibited;

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

(4) The weight used when reference stall speed, 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 1-g 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 subparagraph (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_{CLmax} = Calibrated airspeed obtained when the load factor-corrected lift coefficient ($\frac{n_{zw}W}{qS}$) is first a maximum during the maneuver prescribed in paragraph (e)(8) below.

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}; and

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

(7) 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, we propose the following requirements:

4.1 Normal Operation

If the capabilities of the high incidence protection system are met, then the conditions of section 2, "Capability and Reliability of the High Incidence Protection System," are satisfied. These conditions provide safety equivalent 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 (a), (b), and (c) of section 2, "Capability and Reliability of the High Incidence Protection System," stall warning must be provided and must protect against encountering unacceptable stall 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 in paragraphs (d) and (e) below.

(d) In non-icing conditions stall warning must provide sufficient margin to prevent encountering unacceptable stall 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 calibrated airspeed, 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, we propose the following requirements:

5.1 High Incidence Handling Demonstration

In lieu of § 25.201:

(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; and

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;

(3) Flaps, landing gear, and deceleration devices in any likely combination of positions;

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

(5) 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;

(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; and

(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 3 knots per second; and

(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 requirements must also be met in deceleration at 1 knot per second up to full back stick.

5.2 Characteristics in High Incidence Maneuvers

In lieu of § 25.203:

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.

(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 paragraph 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

Also in lieu of § 25.201:

(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 section 3, "Minimum Steady Flight Speed and Reference Stall Speed," must be demonstrated in straight flight and in 30° banked turns in the following configurations:

(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 (if applicable);

(3) Engines idling;

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

(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 paragraph 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 (if applicable);

(3) Engines idling;

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

(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. Proof of Compliance

We propose the following requirement be added in lieu of § 25.21(b), [Reserved]:

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

8.Sections 25.145(a), 25.145(b)(6), and 25.1323(d)

We propose the following requirements:

- For § 25.145(a), add "V_{min}" in lieu of "stall identification."
- For § 25.145(b)(6), and "V_{min}" in lieu of "$V_{SW.}$"
- For § 25.1323(d), add "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

The following special conditions are in lieu of the specified paragraphs of §§ 25.103, 25.105, 25.107, 25.121, 25.123, 25.125, 25.143, and 25.207.

1. Define the stall speed as provided in these special conditions, Part I, in lieu of § 25.103.

2. We propose the following requirements in lieu of § 25.105(a)(2)(i):

In lieu of § 25.105(a)(2)(i) Takeoff:

(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

3. In lieu of § 25.107(c) and (g) we propose the following requirements, with additional sections (c□) and (g□):

In lieu of § 25.107(c) and (g) Takeoff 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 "takeoff ice" accretion defined in part 25, appendix C, V_2 may not be less than—

(1) The V_2 speed determined in non-icing conditions; and

(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 takeoff ice" accretion defined in part 25, 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).

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

In lieu of § 25.121(b)(2)(ii)(A):

(A) 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

In lieu of § 25.121(c)(2)(ii)(A):

(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

In lieu of § 25.121(d)(2)(ii):

(d)(2) The requirements of subparagraph (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).

5. In lieu of § 25.123(b)(2)(i) we propose the following requirements**:**

In lieu of § 25.123(b)(2)(i):

(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

6. In lieu of § 25.125(b)(2)(ii)(B) and § 25.125(b)(2)(ii)(C), we propose the following requirement:

(B) A speed that provides the maneuvering capability specified in § 25.143(h) with the landing ice accretion defined in part 25, appendix C.

7. In lieu of § 25.143(j)(2)(i), we propose the following requirement:

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

8. In lieu of § 25.207, Stall warning, to read as the requirements defined in these special conditions Part I, Section 4.

Issued in Renton, Washington, on August 27, 2014.

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[FR Doc. 2014-20893 Filed 09/02/2014 at 8:45 am; Publication Date: 09/03/2014]