CS-25 AMENDMENT 18 — CHANGE INFORMATION

The Agency publishes amendments to Certification Specifications as consolidated documents. These documents are used for establishing the certification basis for applications made after the date of entry into force of the amendment.

Consequently, except for a note '[Amdt No: 25/18]' under the amended paragraph, the consolidated text of CS-25 does not allow readers to see the detailed changes introduced by the new amendment. To allow readers to also see these detailed changes this document has been created. The same format as for publication of Notices of Proposed Amendments (NPAs) has been used to show the changes:

(a) deleted text is marked with ~~strike through~~;

(b) new or amended text is highlighted in grey;

(c) an ellipsis (…) indicates that the remaining text is unchanged in front of or following the reflected amendment.

BOOK 1

SUBPART B — FLIGHT

Amend CS 25.21 as follows:

CS 25.21 Proof of compliance

(See AMC 25.21)

(…)

(d) Parameters critical for the test being conducted, such as weight, loading (centre of gravity and inertia), airspeed, power, and wind, must be maintained within acceptable tolerances of the critical values during flight testing. (See AMC 25.21(d))

(…)

(g) The requirements of this subpart associated with icing conditions apply only if the applicant is seeking certification for flight in icing conditions. (See AMC 25.21(g))

(…)

(2) If the applicant does not seek certification for flight in all icing conditions defined in Appendix O (…). Compliance must be shown using the ice accretions defined in part II, paragraphs (b) and (d) of Appendix O, 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. If applicable, a comparative analysis (refer to CS 25.1420) may be used to show compliance as an alternative to using the ice accretions defined in part II, paragraphs (b) and (d) of Appendix O.

(3) If the applicant seeks certification for flight in any portion of the icing conditions of Appendix O (…). Compliance must be shown using the ice accretions defined in part II, paragraphs (c) and (d) of Appendix O, 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. If applicable, a comparative analysis (refer to CS 25.1420) may be used to show compliance as an alternative to using the ice accretions defined in part II, paragraphs (c) and (d) of Appendix O.

(…)

Amend CS 25.101 as follows:

CS 25.101 General

(…)

(g) Procedures for the execution of balked landings and missed approaches associated with the conditions prescribed in CS 25.119 and 25.121(d) must be established. (See AMC 25.101(g))

(…)

Amend CS 25.103 as follows:

CS 25.103 Stall speed

(See AMC 25.103)

(…)

(b)(6) (…) and not greater than 1.3 V_{SR}. (See AMC 25.103(b))

(…)

(d) In addition to the requirements of subparagraph (a) (…)at which the device operates. (See AMC 25.103(d))

Amend CS 25.107 as follows:

CS 25.107 Take-off speeds

(See AMC 25.107)

(…)

Amend CS 25.109 as follows:

CS 25.109 Accelerate-stop distance

(See AMC 25.109)

(…)

Amend CS 25.113 as follows:

CS 25.113 Take-off distance and take-off run

(See AMC 25.113)

(…)

(c)(2)(ii) (…) by a procedure consistent with CS 25.111. (See AMC 25.113(a)(2), (b)(2) and (c)(2).)

Amend CS 25.119 as follows:

CS 25.119 Landing climb: all- engines operating

(See AMC 25.119)

In the landing configuration, the steady gradient of climb may not be less than 3·2 %, with the engines at the power or thrust that is available 8 seconds after initiation of movement of the power or thrust controls from the minimum flight idle to the go-around power or thrust setting ~~(see AMC 25.119)~~;

(…)

Amend CS 25.125 as follows:

CS 25.125 Landing

(See AMC 25.125)

(…)

Amend CS 25.143 as follows:

CS 25.143 General

(See AMC 25.143)

(a) (See AMC 25.143(a) and (b).)

(…)

(b) (See AMC 25.143(a) and (b).)

(…)

(l) Electronic flight control systems

For electronic flight control systems (EFCS) which embody a normal load factor limiting system and in the absence of aerodynamic limitation (lift capability at maximum angle of attack),

(1) The positive limiting load factor must not be less than:

(i) 2.5 g with the EFCS functioning in its normal mode and with the high-lift devices retracted up to V_{MO}/M_{MO}. The positive limiting load factor may be gradually reduced down to 2.25 g above V_{MO}/M_{MO}.;

(ii) 2.0 g with the EFCS functioning in its normal mode and with the high-lift devices extended;.

(2) The negative limiting load factor must be equal to or more negative than:

(i) 1.0 g with the EFCS functioning in its normal mode and with the high-lift devices retracted;

(ii) 0 g with the EFCS functioning in its normal mode and with the high-lift devices extended.

(3) The mMaximum reachable positive load factor wings level may be limited by flight control system characteristics or flight envelope protections (other than load factor limitation), provided that:

(i) the required values are readily achievable in turn, and

(ii) wings level pitch up responsiveness is satisfactory.

(4) The mMaximum reachable negative load factor may be limited by flight control system characteristics or flight envelope protections (other than load factor limitation), provided that:

(i) pitch down responsiveness is satisfactory, and

(ii) from level flight, 0 g is readily achievable, or, at least, a trajectory change of 5 degrees per second is readily achievable at operational speeds (from VLS to Max speed – 10 kt). VLS is the lowest speed that the crew may fly with auto thrust or auto pilot engaged. Max speed – 10 kt is intended to cover typical margin from VMO/MMO to cruise speeds and typical margin from VFE to standard speed in high-lift configurations.

(5) Compliance demonstrations with the ~~above~~ requirements (1) through (4) above may be performed without ice accretion on the airframe.

Amend CS 25.145 as follows:

CS 25.145 Longitudinal control

(See AMC 25.145)

(…)

Amend CS 25.147 as follows:

CS 25.147 Directional and lateral control

(See AMC 25.147)

(…)

Amend CS 25.173 as follows:

CS 25.173 Static longitudinal stability

(See AMC 25.173)

(…)

Amend CS 25.177 as follows:

CS 25.177 Static directional and lateral stability

(See AMC 25.177)

(…)

(b) (…)following airspeed ranges ~~(see AMC 25.177(b))~~:

(…)

Amend CS 25.201 as follows:

CS 25.201 Stall demonstration

(See AMC 25.201)

(…)

Amend CS 25.207 as follows:

CS 25.207 Stall warning

(See AMC 25.207)

(…)

(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 (c) and (d)) when (…)

(…)

Amend CS 25.251 as follows:

CS 25.251 Vibration and buffeting

(See AMC 25.251)

(…)

Amend CS 25.253 as follows:

CS 25.253 High-speed characteristics

(See AMC 25.253)

(…)

SUBPART C — STRUCTURE

Amend CS 25.301 as follows:

CS 25.301 Loads

(See AMC 25.301)

(…)

Amend CS 25.331 as follows:

CS 25.331 Symmetric manoeuvring conditions

(See AMC 25.331)

(…)

Amend CS 25.333 as follows:

CS 25.333 Flight manoeuvring envelope

(See AMC 25.333)

(…)

Amend CS 25.335 as follows:

CS 25.335 Design airspeeds

(See AMC 25.335)

(…)

Amend CS 25.345 as follows:

CS 25.345 High lift devices

(See AMC 25.345)

(…)

Amend CS 25.349 as follows:

CS 25.349 Rolling conditions

(See AMC 25.349)

(…)

Amend CS 25.365 as follows:

CS 25.365 Pressurised compartment loads

(See AMC 25.365)

(…)

Amend CS 25.393 as follows:

CS 25.393 Loads parallel to hinge line

(See AMC 25.393)

(...)

Amend CS 25.397 as follows:

CS 25.397 Control system loads

(...)

(d) (...)

(1) For all components between and including the handle and its control stops:

~~PITCH~~ ~~ROLL~~

~~Nose up~~	~~890 N (200 lbf)~~	~~Nose left~~	~~445 N (100lbf)~~
~~Nose down~~	~~890 N (200 lbf)~~	~~Nose right~~	~~445 N (100 lbf)~~

PITCH		ROLL	
Nose Up	890 N (200 lbf)	Roll Left	445 N (100 lbf)
Nose Down	890 N (200 lbf)	Roll Right	445 N (100 lbf)

(2) For all other components of the side stick control assembly, but excluding the internal components of the electrical sensor assemblies, to avoid damage as a result of an in-flight jam:

~~PITCH~~ ~~ROLL~~

~~Nose up~~	~~556 N (125 lbf)~~	~~Nose left~~	~~222 N (50 lbf)~~
~~Nose down~~	~~556 N (125 lbf)~~	~~Nose right~~	~~222 N (50 lbf)~~

PITCH		ROLL	
Nose Up	556 N (125 lbf)	Roll Left	222 N (50 lbf)
Nose Down	556 N (125 lbf)	Roll Right	222 N (50 lbf)

Amend CS 25.415 as follows:

CS 25.415 Ground gust conditions

(See AMC 25.415)

(…)

Amend CS 25.491 as follows:

CS 25.491 Taxi, take-off and landing roll

(See AMC 25.491)

Within the range of appropriate ground speeds and approved weights, the aeroplane structure and landing gear are assumed to be subjected to loads not less than those obtained when the aircraft is operating over the roughest ground that may reasonably be expected in normal operation. ~~(See AMC 25.491.)~~

Amend CS 25.571 as follows:

CS 25.571 Damage- tolerance and fatigue evaluation of structure

(See AMC 25.571)

(…)

Amend CS 25.581 as follows:

CS 25.581 Lightning protection

(See AMC 25.581)

(a) The aeroplane must be protected against catastrophic effects from lightning. (See also CS 25.899 ~~and AMC 25.581.~~)

(…)

SUBPART D — DESIGN AND CONSTRUCTION

Amend CS 25.603 as follows:

CS 25.603 Materials

(See AMC 25.603; Ffor Composite Materials see AMC 20-29)

(…)

Amend CS 25.609 as follows:

CS 25.609 Protection of structure

(See AMC 25.609)

Each part of the structure must (see AMC 25.609)

(…)

Amend CS 25.629 as follows:

CS 25.629 Aeroelastic stability requirements.

(See AMC 25.629)

(a) General. The aeroelastic stability (…) or some combination thereof as found necessary by the Agency (see AMC 25.629).

(…)

Amend CS 25.631 as follows:

CS 25.631 Bird strike damage

(See AMC 25.631)

The aeroplane must be designed to assure (…). Compliance may be shown by analysis only when based on tests carried out on sufficiently representative structures of similar design. (See AMC 25.631.)

Amend CS 25.671 as follows:

CS 25.671 General

(See AMC 25.671)

(…)

Amend CS 25.672 as follows:

CS 25.672 Stability augmentation and automatic and power-operated systems

(See AMC 25.672)

(…)

Amend CS 25.679 as follows:

CS 25.679 Control system gust locks

(See AMC 25.679)

(…)

Amend CS 25.685 as follows:

CS 25.685 Control system details

(See AMC 25.685)

(…)

Amend CS 25.701 as follows:

CS 25.701 Flap and slat interconnection

(See AMC 25.701)

(…)

Amend CS 25.729 as follows:

CS 25.729 Extending and ~~R~~retracting mechanisms

(See AMC 25.729)

(a) *General*. -For aeroplanes with retractable landing gear, the following apply:

(1) The landing gear extending and retracting mechanisms, wheel well doors, and supporting structure, must be designed for~~–~~:

(i) ~~T~~the loads occurring in the flight conditions when the gear is in the retracted position;

(ii) ~~T~~the combination of friction loads, inertia loads, brake torque loads, air loads, and gyroscopic loads resulting from the wheels rotating at a peripheral speed equal to 1.23 V_{SR} (with the flaps in take-off position at design take-off weight), occurring during retraction and extension at any airspeed up to 1.5 V_{SR1} with the wing-flaps in the approach position at design landing weight, and

(iii) ~~A~~any load factor up to those specified in CS 25.345 (a) for the wing-flaps extended condition.

(2) Unless there are other means to decelerate the aeroplane in flight at this speed, the landing gear, the extending and retracting mechanisms, and the aeroplane structure (including wheel well doors) must be designed to withstand the flight loads occurring with the landing gear in the extended position at any speed up to 0.67 V_C.

(3) Landing gear doors, their operating mechanism, and their supporting structures must be designed for the yawing manoeuvres prescribed for the aeroplane in addition to the conditions of airspeed and load factor prescribed in sub-paragraphs (a)(1) and (2) of this paragraph.

(b) *Landing gear lock*. There must be positive means to keep the landing gear extended in flight and on the ground. There must be positive means to keep the landing gear and doors in the correct retracted position in flight, unless it can be shown that lowering of the landing gear or doors, or flight with the landing gear or doors extended, at any speed, is not hazardous.

(c) *Emergency operation*. There must be an emergency means for extending the landing gear in the event of –

(1) ~~A~~any reasonably probable failure in the normal extension and retraction systems; or

(2) ~~T~~the failure of any single source of hydraulic, electric, or equivalent energy supply.

(d) *Operation test*. The proper functioning of the extending and retracting mechanisms must be shown by operation tests.

(…)

<u>Amend CS 25.745 as follows:</u>

CS 25.745 Nose-wheel steering

(See AMC 25.745)

(…)

<u>Amend CS 25.773 as follows:</u>

CS 25.773 Pilot compartment view

(See AMC 25.773 ~~AMC 25.773(b)(1)(ii), AMC 25.773(b)(4), AMC 25.773(c)~~)

(…)

(b) *Precipitation conditions*. (…)

(1)(ii) The icing conditions specified in Appendix C and the following icing conditions specified in Appendix O, if certification for flight in icing conditions is sought (See AMC 25.773(b)(1)(ii)):

(…)

(4)(ii) An encounter with severe hail, birds, or insects. (See AMC 25.773(b)(4))

(c) *Internal windshield and window fogging*. (…) in which the aeroplane is intended to be operated. (See AMC 25.773(c))

(…)

<u>Amend CS 25.775 as follows:</u>

CS 25.775 Windshields and windows

(See AMC 25.775)

(…)

Amend CS 25.783 as follows:

CS 25.783 Fuselage Doors

(See AMC 25.783)

(…)

Amend CS 25.787 as follows:

CS 25.787 Stowage compartments

(See AMC 25.787)

(…)

Amend CS 25.795 as follows:

CS 25.795 Security considerations

(…)

(a) (…)

(1) Resist forcible intrusion (…) including the doorknob or handle (See AMC 25.795(a)(1)); and

(…)

(2)(ii) Demonstration Projectile #2. (…) velocity 436 m/s (1,430 ft/s). (See AMC 25.795(a)(2))

(b) (…)

(1) Flight deck smoke protection. Means must be provided to limit entry of smoke, fumes, and noxious gases into the flight deck. (See AMC 25.795(b)(1))

(2) Passenger (…) carbon dioxide. (See AMC 25.795(b)(2))

(3)(iv) (…) from the cargo compartment. (See AMC 25.795(b)(3))

(c) (…)

(1) (…) the case of detonation. (See AMC 25.795(c)(1))

(2)(ii) (…) the survivability of those systems. (See AMC 25.795(c)(2))

(3)(iii) Life preservers or their storage locations must be designed so that tampering is evident. (See AMC 25.795(c)(3))

(…)

Amend CS 25.807 as follows:

CS 25.807 Emergency exits

(…)

(f) *Location*. (See AMC 25.807(f))

(…)

Amend CS 25.810 as follows:

CS 25.810 Emergency egress assisting means and escape routes

(See AMC 25.810)

(…)

(a)(1)(iv) It must have the capability, (…) to evacuate occupants safely to the ground. (See AMC 25.810(a)(1)(iv))

(…)

(c)(2) The escape route surface must have a reflectance of at least 80 %, and must be defined by markings with a surface-to-marking contrast ratio of at least 5:1.

(…)

Amend CS 25.813 as follows:

CS 25.813 Emergency exit access and ease of operation

(See AMC 25.813~~ and AMC 25.813(c)~~)

(…)

(c) The following must be provided for each Type III or Type IV exit — (See AMC 25.813(c))

(…)

Amend CS 25.831 as follows:

CS 25.831 Ventilation

(See AMC 25.831)

(…)

Amend CS 25.851 as follows:

CS 25.851 Fire extinguishers

(See AMC 25.851)

(…)

Amend CS 25.856 as follows:

CS 25.856 Thermal/acoustic insulation materials

(See AMC 25.856~~(a) and AMC 25.856(b)~~)

(a) (…) of Appendix F to CS-25. (See AMC 25.856(a))

(b) (…) fire penetration resistance. (See AMC 25.856(b))

Amend CS 25.863 as follows:

CS 25.863 Flammable fluid fire protection

(See AMC 25.863)

(…)

Amend CS 25.869 as follows:

CS 25.869 Fire protection: systems

(See AMC 25.869)

(…)

SUBPART E — POWERPLANT

Amend CS 25.901 as follows:

CS 25.901 Installation

(See AMC 25.901)

(…)

Amend CS 25.903 as follows:

CS 25.903 Engines

(See AMC 25.903)

(…)

Amend CS 25.905 as follows:

CS 25.905 Propellers

(See AMC 25.905)

(…)

Amend CS 25.925 as follows:

CS 25.925 Propeller clearance

(…)

(c)(1) At least 25 mm (1·0 inches) (…)

(…)

Amend CS 25.929 as follows:

CS 25.929 Propeller de-icing

(See AMC 25.929)

(…)

Amend CS 25.933 as follows:

CS 25.933 Reversing systems

(See AMC 25.933)

(…)

Amend CS 25.954 as follows:

CS 25.954 Fuel system lightning protection

(See AMC 25.954)

(…)

Amend CS 25.955 as follows:

CS 25.955 Fuel flow

(See AMC 25.955)

(…)

Amend CS 25.963 as follows:

CS 25.963 Fuel tanks: general

(See AMC 25.963)

(…)

Amend CS 25.967 as follows:

CS 25.967 Fuel tank installations

(See AMC 25.967)

(…)

Amend CS 25.979 as follows:

CS 25.979 Pressure fuelling system

(See AMC 25.979)

(…)

Amend CS 25.981 as follows:

CS 25.981 Fuel tank ignition prevention

(See AMC 25.981)

(…)

Amend CS 25.1043 as follows:

CS 25.1043 Cooling tests

(See AMC 25.1043)

(…)

Amend CS 25.1091 as follows:

CS 25.1091 Air intake

(See AMC 25.1091)

(…)

Amend CS 25.1093 as follows:

CS 25.1093 Powerplant Icing

(See AMC 25.1093)

(…)

(b)(2) (…) in accordance with CS 25.1521. (See AMC 25.1093(b))

Amend CS 25.1103 as follows:

CS 25.1103 Air intake system ducts and air duct systems

(See AMC 25.1103)

(…)

Amend CS 25.1121 as follows:

CS 25.1121 General

(See AMC 25.1121)

(…)

Amend CS 25.1141 as follows:

CS 25.1141 Powerplant controls: general

(See AMC 25.1141)

(…)

(f)(2)(ii)(…) to the selected position or function. (See AMC 25.1141(f))

Amend CS 25.1155 as follows:

CS 25.1155 Reverse thrust and propeller pitch settings below the flight regime

(See AMC 25.1155)

(…)

Amend CS 25.1193 as follows:

CS 25.1193 Cowling and nacelle skin

(See AMC 25.1193)

(…)

Amend CS 25.1195 as follows:

CS 25.1195 Fire-extinguisher systems

(See AMC 25.1195)

(…)

SUBPART F — EQUIPMENT

Amend CS 25.1303 as follows:

CS 25.1303 Flight and navigation instruments

(See AMC 25.1303)

(…)

Amend CS 25.1305 as follows:

CS 25.1305 Powerplant instruments

(See AMC 25.1305)

(…)

(a)(2)(iv)(B) (…) are not adversely affected by the same single failure. (See AMC 25.1305(a)(2))

(…)

Amend CS 25.1310 as follows:

CS 25.1310 Power source capacity and distribution

(See AMC 25.1310)

(…)

Amend CS 25.1315 as follows:

CS 25.1315 Negative acceleration

(See AMC 25.1315)

(…) expected for the acceleration. ~~(See also AMC 25.1315.)~~

Amend CS 25.1323 as follows:

CS 25.1323 Airspeed indicating system

(See AMC 25.1323)

(…)

Amend CS 25.1333 as follows:

CS 25.1333 Instrument systems

(See AMC 25.1333)

(…)

Amend CS 25.1351 as follows:

CS 25.1351 General

(See AMC 25.1351)

(…)

Amend CS 25.1353 as follows:

CS 25.1353 Electrical equipment and installations

(See AMC 25.1353)

(…)

Amend CS 25.1355 as follows:

CS 25.1355 Distribution system

(See AMC 25.1355)

(…)

Amend CS 25.1357 as follows:

CS 25.1357 Circuit protective devices

(See AMC 25.1357)

(…)

Amend CS 25.1360 as follows:

CS 25.1360 Precautions against injury

(See AMC 25.1360)

(…)

Amend CS 25.1420 as follows:

CS 25.1420 Supercooled large drop icing conditions

(see AMC 25.1420)

(…)

(d) A comparative analysis may be used as an alternative to CS 25.1420(b) to establish that the aeroplane can operate safely as required in CS 25.1420(a), and as an alternative to CS 25.1420(c) regarding methods of icing detection and activation of the airframe ice protection system. In this case, tests may not be required (see AMC 25.1420(f)).

(…)

Amend CS 25.1436 as follows:

CS 25.1436 Pneumatic systems –— high pressure

(See AMC 25.1436)

(…)

Amend CS 25.1438 as follows:

CS 25.1438 Pressurisation and low pressure pneumatic systems

(See AMC 25.1438)

(…)

Amend CS 25.1441 as follows:

CS 25.1441 Oxygen equipment and supply

(See AMC 25.1441)

(…)

Amend CS 25.1447 as follows:

CS 25.1447 Equipment standards for oxygen dispensing units

(See AMC 25.1447)

(…)

Amend CS 25.1459 as follows:

CS 25.1459 Flight recorders

(See AMC 25.1459)

(…)

SUBPART G — OPERATING LIMITATIONS AND INFORMATION

Amend CS 25.1519 as follows:

CS 25.1519 Weight, centre of gravity and weight distribution

(See AMC 25.1519)

The aeroplane weight, centre of gravity, and weight distribution limitations determined under CS 25.23 to CS 25.27 must be established as operating limitations. ~~(See AMC 25.1519.)~~

Amend CS 25.1523 as follows:

CS 25.1523 Minimum flight crew

(See AMC 25.1523)

The minimum flight crew must be established ~~(see AMC 25.1523)~~ so that (…)

Amend CS 25.1533 as follows:

CS 25.1533 Additional operating limitations

(See AMC 25.1533)

(…)

Amend CS 25.1545 as follows:

CS 25.1545 Airspeed limitation information

(See AMC 25.1545)

The airspeed limitations required by CS 25.1583(a) must be easily read and understood by the flight

crew. ~~(See AMC 25.1545.)~~

Amend CS 25.1557 as follows:

CS 25.1557 Miscellaneous markings and placards

(See AMC 25.1557)

(…)

Amend CS 25.1583 as follows:

CS 25.1583 Operating limitations

(See AMC 25.1583)

(…)

(i) *Manoeuvring flight load factors*. The positive manoeuvring limit load factors for which the structure is proven, described in terms of accelerations, must be furnished. (See AMC 25.1583(i))

(…)

SUBPART J — AYXILIARY POWER UNIT INSTALLATIONS

Amend CS 25J901 as follows:

CS 25J901 Installation

(See AMC 25J901)

(…)

Amend CS 25J955 as follows:

CS 25J955 Fuel flow

(See AMC 25J955)

(…)

Amend CS 25J1093 as follows:

CS 25J1093 Air intake system icing protection

(See AMC 25J1093)

(…)

(b)(2) (…)the aeroplane operating limitations. (See AMC 25J1093(b))

Amend CS 25J1195 as follows:

CS 25J1195 Fire extinguisher systems

(See AMC 25J1195)

(…)

APPENDICES

Amend Appendix F as follows:

(…)

Appendix F

Part IV — Test Method to Determine the Heat Release Rate ~~Ffrom~~ Cabin Materials Exposed to Radiant Heat

(See AMC to Appendix F, Part IV)

(…)

Amend Appendix H as follows:

Appendix H

Instructions for Continued Airworthiness

(See AMC to Appendix H)

(…)

Amend Appendix N as follows:

Appendix N

Fuel Tank Flammability Exposure

(See AMC to Appendix N)

(…)

Amend Appendix Q as follows:

Appendix Q

Additional airworthiness requirements for approval of a Steep Approach Landing (SAL) capability

(See AMC to Appendix Q)

(…)

BOOK 2

AMC - SUBPART B

Amend AMC 25.21(g) as follows:

AMC 25.21(g)

Performance and Handling Characteristics in Icing Conditions

(…)

1 *Purpose*.

(…)

1.4 Section 5 describes acceptable methods and procedures that an applicant may use to show that an aeroplane meets these requirements. Depending on the design features of a specific aeroplane as discussed in Appendix 3 of this AMC, its similarity to other types or models, and the service history of those types or models, some judgement will often be necessary for determining that any particular method or procedure is adequate for showing compliance with a particular requirement. AMC 25.1420(f) provides guidance for comparative analysis as an acceptable means of compliance to meet these requirements.

(…)

4 *Requirements and Guidance*.

(…)

4.4.6 Certification experience has also shown that runback ice may be critical for propellers, and propeller analyses do not always account for it. Therefore, runback ice on the propeller should be addressed. Research has shown that ice accretions on propellers, and resulting thrust decrement, may be larger in Appendix O (supercooled large drop) icing conditions than in Appendix C icing conditions for some designs. This may be accomplished through aeroplane performance checks in natural icing conditions, icing tanker tests, icing wind tunnel tests, aerodynamic analysis,or the use of an assumed (conservative) loss in propeller efficiency. Testing should include a range of outside air temperatures, including warmer (near freezing) temperatures that could result in runback icing. For the Appendix O icing conditions, the applicant may use a comparative analysis. AMC 25.1420(f) provides guidance for comparative analysis.

(…)

4.8.2.2 Normal operating procedures provided in the AFM should reflect the procedures used to certify the aeroplane for flight in icing conditions. This includes configurations, speeds, ice protection system operation, power plant and systems operation, for take-off, climb, cruise, descent, holding, go-around, and landing. For aeroplanes not certified for flight in all of the supercooled large drop atmospheric icing conditions defined in Appendix O to CS-25, procedures should be provided for safely exiting all icing conditions if the aeroplane encounters Appendix O icing conditions that exceed the icing conditions the aeroplane is certified for. Information to be provided in the AFM may be based on the information provided in the reference fleet AFM(s), or other operating manual(s) furnished by the TC holder, when comparative analysis is used as the means of compliance.

(…)

5 *Acceptable Means of Compliance - General*.

(…)

5.1.5 Appropriate means for showing compliance include the actions and items listed in Table 1 below. These are explained in more detail in the following sections of this AMC.

TABLE 1: Means for Showing Compliance

Flight Testing	Flight testing in dry air using artificial ice shapes or with ice shapes created in natural icing conditions.
Wind Tunnel Testing and Analysis	An analysis of results from wind tunnel tests with artificial or actual ice shapes.
Engineering Simulator Testing and Analysis	An analysis of results from engineering simulator tests.
Engineering Analysis	An analysis which may include the results from any of the other means of compliance as well as the use of engineering judgment.
Ancestor Aeroplane Analysis	An analysis of results from a closely related ancestor aeroplane.
Comparative analysis for showing compliance in SLD icing conditions	An analysis which substantiates that a new or derivative aeroplane model has at least the same level of safety in all supercooled liquid water icing conditions that a reference fleet has achieved. Guidance is provided in AMC 25.1420(f). The use of a comparative analysis is only an option for showing compliance with CS-25 specifications relative to Appendix O icing conditions; it is not an option for showing compliance with CS-25 specifications relative to Appendix C icing conditions.

(…)

5.6 *Ancestor Aeroplane Analysis*.

5.6.1 To help substantiate acceptable performance and handling characteristics, the applicant may use an analysis of an ancestor aeroplane that includes the effect of the ice accretions as defined in Part II of Appendix C and Appendix O to CS-25. This analysis should consider the similarity of the configuration, operating envelope, performance and handling characteristics, and ice protection system of the ancestor aeroplane to the one being certified.

5.6.2 The analysis may include flight test data, dry air wind tunnel test data, icing tunnel test data, engineering simulator analysis, service history, and engineering judgement.

5.7 *Comparative Analysis*.

For showing compliance with the CS-25 certification specifications relative to SLD icing conditions represented by Appendix O, the applicant may use a comparative analysis. AMC 25.1420 (f) provides guidance for comparative analysis.

(…)

Appendix 1 - Airframe Ice Accretion

A1.1 *General*.

(…)

f. The applicant should determine the most critical ice accretion in terms of handling characteristics and performance for each flight phase. Parameters to be considered include:

- flight conditions (for example, aeroplane configuration, speed, angle-of-attack, altitude) and
- atmospheric icing conditions for which certification is desired (for example, temperature, liquid water content (LWC), mean effective drop diameter (MED), drop median volume diameter (MVD)).

If a comparative analysis (refer to AMC 25.1420(f)) is used as the means of compliance with the CS-25 certification specifications relative to the Appendix O icing conditions, the most critical ice accretions determined for Appendix C icing conditions are acceptable.

AMC - SUBPART D

Amend AMC 25.629 as follows:

AMC 25.629

Aeroelastic stability requirements

(…)

5.1.4.5. *Ice Accumulation*. Aeroelastic stability analyses should use the mass distributions derived from ice accumulation up to and including those that can accrete in the applicable icing conditions in Appendices C and O to CS-25. This includes any accretions that could develop on control surfaces. The analyses need not consider the aerodynamic effects of ice shapes. For aeroplanes approved for operation in icing conditions, all of the CS-25 Appendix C icing conditions and the Appendix O icing conditions for which certification is sought are applicable. For aeroplanes not approved for operation in icing conditions, all of the Appendix C and O icing conditions are applicable since the inadvertent encounter discussed in paragraph 3.2.3 of this AMC can occur in any icing condition. For all aeroplanes, the ice accumulation determination should take into account the ability to detect the ice and, if appropriate, the time required to leave the icing condition.

For showing compliance with the CS-25 specifications relative to SLD icing conditions represented by Appendix O, the applicant may use a comparative analysis. AMC 25.1420(f) provides guidance for comparative analysis.

(…)

Amend AMC 25.729 as follows:

AMC 25.729

Extending and ~~R~~retracting ~~M~~mechanisms

(…)

2. RELATED DOCUMENTS.

a. *Related Certification Specifications*. CS 25.729 and other paragraphs relating to landing gear extending and retracting mechanisms installations together with their applicable AMCs, if any. Paragraphs which prescribe requirements for the design, substantiation, and certification of landing gear extending and retracting mechanisms include:

(…)

CS 25.729 Extending and ~~R~~retracting mechanisms

(…)

b. FAA *Advisory Circulars (AC's)*.

(…)

AC 25-7~~A~~C Flight Test Guide for Certification of Transport Category Airplanes

(…)

4. DISCUSSION.

a. *Intent of rule*. (Reference CS 25.729 Extending and ~~R~~retracting mechanisms)

This rule provides minimum design and certification requirements for landing gear actuation systems to address:

(1) Structural integrity for the nose and main landing gear, extending and retracting mechanism(s), doors, gear supporting structure for loads imposed during flight;

(…)

b. *Demonstration of extending and retracting mechanisms proper functioning*. (Reference CS 25.729(d) Operation test)

Guidance addressing flight testing used to demonstrate compliance with this paragraph may be found in ~~EASA AMC equivalent to~~ FAA Advisory Circular (AC) 25-7~~A~~C, Flight Test Guide for Transport Category Aeroplanes, ~~c~~Chapter 4, ~~s~~Section 4, paragraph 52, ~~issued June 3, 1999~~dated 16 October 2012.

c. *Extending and ~~R~~retracting mechanisms ~~I~~indication*. (Reference CS 25.729(e) Position indicator and warning device)

(…)

d. *Definitions*. For definitions of V_{SR} and V_C, see CS-Definitions Chapter 2, entitled 'Abbreviations and symbols'.

Amend AMC 25.735 as follows:

AMC 25.735

Brakes and Braking Systems Certification Tests and Analysis

(…)

2. RELATED REGULATORY MATERIAL AND COMPLEMENTARY DOCUMENTS

a. Related EASA Certification Specifications

(…)

CS 25.729 Extending and ~~R~~retracting mechanisms

(…)

b. Complementary Documents

(…)

(ii) Advisory Circulars/Acceptable Means of Compliance

(…)

AC 25-7~~A~~C Flight Test Guide for Certification of Transport Category Airplanes

(…)

4. DISCUSSION

a. Ref. CS 25.735(a) Approval

(…)

(2) Respecting brake energy qualification limits

The ETSO standard for wheels and wheel and brake assemblies includes an '*Accelerate-Stop Test*' and a '*Most Severe Landing Stop Test*' (if applicable), which establish the kinetic energy (KE) absorption capability of the brake assembly. The ETSO tests demonstrate the KE absorption capability of the brake with that brake at a predetermined (threshold) start temperature. Both of these tests are required to be performed on (new and worn) brakes with threshold temperatures that must 'as closely as practicable, be representative of a typical in-service condition'.

Two methods are permitted and accepted by the Agency to calculate the energy required to bring the heat pack to this representative thermal condition:

(a) by a rational analysis; or

(b) by the addition of a percentage of the KE_{RT} Wheel/Brake Rated Accelerate-Stop Energy: 10 % for '*Accelerate-Stop Test*' or 5 % for '*Most Severe Landing Stop Test*'.

A brake with an initial temperature higher than the threshold temperature has less KE absorption capability than it has at the threshold temperature. This could lead to the brake being unable to generate the required torque to stop the aeroplane in the available distance, or being unable to safely dissipate the additional thermal energy generated during the stop (hence, a risk of fire). Therefore, the applicant should ensure that the demonstrated brake KE absorption capability is not exceeded when the brake is installed on the aeroplane.

It should be demonstrated how the temperature thresholds, determined for the brake qualification testing, will not be exceeded.

Acceptable methods of demonstrating this include, but are not limited to, the following:

(a) use of brake temperature monitoring: by allowing the crew to check the brake temperature prior to a take-off, it can be ensured that that the brake temperature does not exceed the temperature threshold of the demonstrated brake qualification testing, or

(b) use of brake cool-down charts: by establishing the cool-down rate of the brake heat sink, an estimate can be made that relates the energy absorbed by the brake to its temperature and also to the appropriate cool-down time.

Appropriate limitations have to be specified in the Aeroplane Flight Manual (AFM).

(~~2~~3) Refurbished and Overhauled Equipment. (…)

(~~3~~4) Replacement and Modified Equipment. (…)

(…)

f. Ref. CS 25.735(f) Kinetic Energy Capacity

(…)

(2) *Heat Sink Condition at Commencement of the Stop*.

(…)

(d) The brake temperature at the commencement of the braking manoeuvre should be determined using the rational analysis method. However, in the absence of such analysis, an arbitrary heat sink temperature should be used equal to the normal ambient temperature, increased by the amount that would result from a 10 percent maximum kinetic energy accelerate-stop for the accelerate-stop case and from a 5 percent maximum kinetic energy accelerate-stop for landing cases. The temperature determined for the beginning of the test becomes the highest allowable temperature at commencement of the take-off run unless another test is performed at a higher temperature.

(…)

Amend AMC 25.773(b)(1)(ii) as follows:

AMC 25.773(b)(1)(ii)

Pilot compartment view in icing conditions

(…)

An evaluation of visibility, including distortion effects through the protected area, should be made for both day and night operations. In addition, the size and location of the protected area should be reviewed to confirm that it provides adequate visibility for the flight crew, especially during the approach and landing phases of flight.

For showing compliance with the CS-25 certification specifications relative to SLD icing conditions represented by Appendix O, the applicant may use a comparative analysis. AMC 25.1420(f) provides guidance for comparative analysis.

Amend AMC 25.773(b)(4) as follows:

AMC 25.773(b)(4)

Pilot compartment non openable windows

(…)

1. Ice and heavy rain

Unless system failures leading to loss of a sufficient field of view for safe operation are shown to be extremely improbable, the following provides acceptable means to show compliance with CS 25.773(b)(4):

- Each main windshield should be equipped with an independent protection system. The systems should be designed so that no malfunction or failure of one system will adversely affect the other.
- For each forward side window it should be shown that any ice accumulations (Appendix C icing conditions and any applicable Appendix O icing conditions) will not degrade visibility, or the applicant should provide individual window ice protection system capability.
- The icing accretion limits should be determined by analysis and verified by test. The extent of icing of side windows should be verified during natural or simulated icing flight tests with window ice protection systems unpowered. A limited number of test points, sufficient to validate the analysis, are required within Appendix C or Appendix O.
- For the demonstration of compliance under Appendix O icing conditions, the applicant may use a comparative analysis. AMC 25.1420(f) provides guidance for comparative analysis.

2. Hail, birds and insects

(…)

Create a new AMC 25.810(a)(1)(iv) as follows:

AMC 25.810(a)(1)(iv)

Capability of assisting means in wind conditions

The applicability of the combined effect of a 46 km/hr (25-knot) wind and the engine(s) running at ground idle should be only to escape slides positioned forward of the engine(s) and in such proximity to the engine air intake(s) that the deployment of the escape slide could be influenced.

AMC — SUBPART E

Amend AMC 25.929(a) as follows:

AMC 25.929(a)

Propeller ~~D~~de-icing

1. Analysis.

(…)

Similarity to prior designs with successful service histories in icing may be used to show compliance. A demonstration of similarity requires an evaluation of both system and installation differences. The applicant should show specific similarities in the areas of physical, functional, thermodynamic, pneumatic, and aerodynamic characteristics as well as in environmental exposure. The analysis should show that propeller installation, operation, and effect on the aeroplane's performance and handling are equivalent to that of the same or similar propeller in the previously approved configuration. Differences should be evaluated for their effect on IPS functionality and on safe flight in icing. If there is uncertainty about the effects of the differences, the applicant should conduct additional tests and/or analysis as necessary and appropriate to resolve the open issues.

For showing compliance with the CS-25 certification specifications relative to SLD icing conditions represented by Appendix O, the applicant may use a comparative analysis. AMC 25.1420(f) provides guidance for comparative analysis.

(…)

Amend AMC 25.1093(b) as follows:

AMC 25.1093(b)

Power plant ~~I~~icing

(…)

(a) Compliance with CS 25.1093(b)(1)

(…)

2. Testing

(…)

3. Comparative Analysis.

For showing compliance with the CS-25 certification specifications relative to SLD icing conditions represented by Appendix O, the applicant may use a comparative analysis. AMC 25.1420(f) provides guidance for comparative analysis.

(b) Compliance with CS 25.1093(b)(2)

(…)

2. Ground taxi exposure to Appendix O conditions.

The service experience indicates that engine fan damage events exist from exposure to SLD during ground taxi operations. For this reason, an additional condition of a 30-minute, idle power/thrust exposure to SLD on the ground must be addressed. Applicants should include the terminal falling velocity of SLD (for example, freezing rain, freezing drizzle) in their trajectory assessment, relative to the protected sections of the air intake. The 100 micron minimum mean effective diameter (MED) is selected as a reasonably~~e~~ achievable condition, given current technology. To certify by analysis the applicant should evaluate the Appendix O drop sizes up to a maximum of 3 000 microns particle size to find a critical condition.

For showing compliance with the CS-25 certification specifications relative to SLD icing conditions represented by Appendix O, the applicant may use a comparative analysis. AMC 25.1420(f) provides guidance for comparative analysis.

(…)

AMC — SUBPART F

Amend AMC 25.1322 as follows:

AMC 25.1322

Flight Crew Alerting

(...)

Appendix 3

Regulations

(...)

CS-25 Paragraph	**Subject**
(...)	(...)
CS 25.729(e)	Extending and ~~R~~retracting mechanisms
(...)	(...)

Appendix 4

Related Documents

(...)

2. ACs.

(...)

Number	**Title**
(...)	(...)
AC 25-7C~~A, Change 1~~	Flight Test Guide for Certification of Transport Category Airplanes
(...)	(...)

(...)

Amend AMC 25.1324 as follows:

AMC 25.1324

Flight instrument external probes

(…)

11. Supercooled Large Drop Liquid Conditions

Based on the design of the probe, the drop size may not be a significant factor to consider as compared to the other parameters and in particular the Liquid Water Content (LWC). The SLD LWC defined in Appendix O (between 0.18 and 0.44 g/m^3) ~~are~~is largely covered by the Appendix C continuous maximum LWC (between 0.2 and 0.8 g/m^3) and the Appendix C intermittent maximum LWC (between 0.25 and 2.9 g/m^3).

Testing SLD conditions may not be necessary if it can be shown that the Supercooled Liquid Conditions of Appendix C are more critical. If some doubt exists, the applicant shall propose a set of critical test points to cover adequately the Icing Environment defined in the Appendix O.

For showing compliance with the CS-25 certification specifications relative to SLD icing conditions represented by Appendix O, the applicant may use a comparative analysis. AMC 25.1420(f) provides guidance for comparative analysis.

(…)

Amend AMC No. 1 to CS 25.1329 as follows:

AMC No. 1 to CS 25.1329

Flight Guidance System

(…)

3 RELATED ADVISORY MATERIAL

(…)

(...)	(...)
FAA AC 25-7C~~A~~	Flight Test Guide for Certification of Transport Category Airplanes
(...)	(...)

(…)

10.1 Normal Performance

The FGS should provide guidance or control, as appropriate, for the intended function of the active mode(s) in a safe and predictable manner within the aeroplane’s normal flight envelope.

The FGS should be designed to operate in all aeroplane configurations for its intended use within the aeroplane's normal flight envelope to provide acceptable performance for the following types of environmental conditions:

- Winds (light and moderate)
- Wind gradients (light and moderate)

NOTE: In the context of this AMC, "'wind gradient'" is considered a variation in wind velocity as a function of altitude, position, or time.

- Gusts (light and moderate)
- Turbulence (light and moderate)
- Icing - all icing conditions covered by Appendix C to CS-25 and applicable icing conditions covered by Appendix O to CS-25, with the exception of "'asymmetric icing'" discussed under "'Rare Normal Conditions'" in Section 10.2 below. For showing compliance with the CS-25 certification specifications relative to SLD icing conditions represented by Appendix O, the applicant may use a comparative analysis. AMC 25.1420(f) provides guidance for comparative analysis.

NOTE: Representative levels of the environmental effects should be established consistent with the aeroplane's intended operation.

(…)

Amend AMC 25.1403 as follows:

AMC 25.1403

Wing icing detection lights

Unless operations at night in icing conditions are prohibited by an operating limitation, CS 25.1403 requires that a means be provided, during flight at night, to illuminate or otherwise determine ice formation on parts of the wings that are critical from the standpoint of ice accumulations. resulting from Appendix C and Appendix O icing conditions. For showing compliance with the CS-25 certification specifications relative to SLD icing conditions represented by Appendix O, the applicant may use a comparative analysis. AMC 25.1420(f) provides guidance for comparative analysis.

(…)

Amend AMC 25.1420 as follows:

AMC 25.1420

Supercooled large drop icing conditions

(…)

(d) CS 25.1420 (b)

1. Analysis

AMC 25.1419(a) applies and in addition, the following should be considered specifically for compliance with CS 25.1420(b):

1.1 Analysis of areas and components to be protected.

In assessing the areas and components to be protected, unless comparative analysis is used as the means of compliance, considerations should be given on the fact that areas that do not accrete ice in Appendix C conditions may accrete ice in the Appendix O conditions.

1.2 Failure analysis

Applying the system safety principles of CS 25.1309 is helpful in determining the need for system requirements to address potential hazards from an Appendix O icing environment. The following addresses application of the CS 25.1309 principles to Appendix O conditions and may be used for showing compliance with CS 25.1309. Alternatively, a comparative analysis, if applicable, may be used as defined in paragraph (e) of this AMC.

1.2.1 Hazard classification

Assessing a hazard classification for compliance with CS 25.1309 is typically a process combining quantitative and qualitative factors based on the assessment of the failure conditions and the associated severity of the effects. If the design is new and novel and has little similarity to previous designs, a hazard classification based on past experience may not be appropriate. If the design is derivative in nature, the assessment can consider the icing event history of similarly designed aeroplanes and, if applicable, the icing event history of all conventional design aeroplanes. The applicant should consider specific effects of supercooled large drop icing when assessing similarity to previous designs.

1.2.2 Qualitative Analysis

The following qualitative analysis may be used to determine the hazard classification for an unannunciated encounter with Appendix O icing conditions. The analysis can be applied to aeroplanes shown to be similar to previous designs with respect to Appendix O icing effects, and to which the icing event history of all conventional design aeroplanes is applicable.

1.2.2.1 Assumptions

The aeroplane is certificated to either:

a. Detect Appendix O icing conditions and safely exit all icing conditions after detection of Appendix O icing conditions, or

b. Safely operate in a selected portion of Appendix O icing conditions and safely exit all icing conditions after detection of Appendix O icing conditions beyond those for which it is certificated.

The ‘unannunciated encounter with Appendix O’ refers to Appendix O icing conditions in which the aeroplane has not been shown to operate safely.

The airframe and propulsion ice protection systems have been activated prior to the unannunciated encounter.

1.2.2.2 Service history

The applicant may use service history, design, and installation appraisals to support hazard classifications for CS 25.1309. Service history may be appropriate to support a hazard classification if a new or derivative aeroplane has similar design features to a previously certificated aeroplane. Service history data are limited to the fleet of aeroplane type(s) ~~owned by~~ for which the applicant is the holder of the Type Certificate(s), the owner of the data, or, if accepted by the Agency, has an agreement in place with the owner of the data that permits its use by the applicant for this purpose (see also paragraph (f)3.2 of this AMC).

1.2.2.3 Historical perspective

While definitive statistics are not available, a historical perspective can provide some guidance. Many aeroplanes flying through icing have been exposed to supercooled large drop conditions without the pilot being aware of it. The interval of exposure to the supercooled large drop conditions may have varied from a brief amount of time (such as could occur during a vertical transition through a cloud) to a more sustained exposure (such as during a hold). Severity of the exposure conditions in terms of water content may have varied significantly. Therefore, the hazard from encountering supercooled large drop conditions may be highly variable and dependent on various factors.

1.2.2.4 Icing event history of ~~conventionally designed~~ aeroplanes of conventional design certified~~cated~~ before the introduction of CS 25.1420.

Given the volume of aeroplane operations and the number of reported incidents that did not result in a catastrophe, a factor of around 1 in 100 is a reasonable assumption of probability for a catastrophic event if an aeroplane encounters the icing conditions represented by Appendix O ~~conditions~~ in which it has not been shown capable of safely operating, while the aeroplane's ice protection systems are operating normally (in accordance with approved procedures for the icing conditions represented by Appendix C). An applicant may assume that the hazard classification for an unannunciated encounter with the icing conditions represented by Appendix O ~~conditions~~ while these ice protection systems ~~is~~ are operating normally ~~activated~~ is ~~H~~hazardous in accordance with AMC 25.1309, provided that the following are true:

- The aeroplane is similar to previous designs with respect to icing effects in the icing conditions represented by Appendix O ~~icing effects~~, and
- The applicant can show that the icing event history of all ~~conventionally designed~~ aeroplanes of conventional design is relevant to the aeroplane being considered for certification.

1.2.2.5 Hazard assessment

If an aeroplane is not similar to a previous design, an assessment of the hazard classification may require more analysis or testing. One method of hazard assessment would be to consider effects of ice accumulations similar to those expected for aeroplanes being certified under CS 25.1420. Such ice shapes may be defined from a combination of analysis and icing tanker or icing wind tunnel testing. Aerodynamic effects of such shapes could be evaluated with wind tunnel testing or, potentially, computational fluid dynamics. Hazard classification typically takes place early in a certification program. Therefore, a conservative assessment may be required until sufficient supporting data is available to reduce the hazard classification.

1.2.3 Probability of encountering the icing conditions represented by Appendix O ~~icing conditions~~

Appendix C was designed to include 99 percent of icing conditions. Therefore, the probability of encountering icing outside of Appendix C drop conditions is on the order of 10^{-2}. The applicant may assume that the average probability for encountering the icing conditions represented by Appendix O ~~icing conditions~~ is 1×10^{-2} per flight hour. This probability should not be reduced based on phase of flight.

1.2.4 Numerical safety analysis.

For the purposes of a numerical safety analysis, the applicant may combine the probability of equipment failure with the probability, defined above, of encountering Appendix O icing conditions. If the applicant can support a hazard level of 'Hazardous' using the above probability (10^{-2}) of encountering the specified supercooled large drop conditions, the probability of an unannunciated failure of the equipment that alerts the flight crew to exit icing conditions should be less than 1×10^{-5}.

1.2.5 Assessment of visual cues.

Typical system safety analysis do not address the probability of crew actions, such as observing a visual cue before performing a specified action. As advised in AMC 25.1309, quantitative assessments of crew errors are not considered feasible. When visual cues are to be the method for detecting Appendix O conditions and determining when to exit them, the applicant should assess the appropriateness and reasonableness of the specific cues. Reasonable tasks are those for which the applicant can take full credit because the tasks can realistically be anticipated to be performed correctly when required. The applicant should assess the task of visually detecting Appendix O conditions to determine if it could be performed when required. The workload for visually detecting icing conditions should be considered in combination with the operational workload during applicable phases of flight. The applicant may assume that the flight crew is already aware that the aeroplane has encountered icing. The assessment of whether the task is appropriate and reasonable is limited to assessing the task of identifying Appendix O accumulations that require exiting from the icing conditions.

1.3 Similarity

On derivative or new aeroplane designs, the applicant may use similarity to previous type designs which have been certified ~~proven safe~~ for operation in SLD icing conditions~~,~~. M~~m~~eanwhile the effects of differences will be substantiated. Natural ice flight testing may not be necessary for a design shown to be similar. ~~At a minimum, the following differences should be addressed:~~

- ~~Aerofoil size, shape, and angle of attack.~~
- ~~Ice Protection System (IPS) design.~~
- ~~Flight phases, operating altitude and airspeed.~~

- ~~Centre of gravity.~~
- ~~Flight control system.~~
- ~~Engine and propeller operation.~~

The guidance provided in AMC 25.1419(a)(8) applies.

The applicant must possess all the data required to substantiate compliance with applicable specifications, including data from past certifications upon which the similarity analysis is based.

2. Tests

CS 25.1420 requires two or more means of compliance for approval of flight in icing, except when a comparative analysis is used to show compliance. It is common to use a combination of methods in order to adequately represent the conditions and determine resulting degradation effects with sufficient confidence to show compliance.

(…)

(e) CS 25.1420 (c)

CS 25.1420(c) requires that aeroplanes certified in accordance with subparagraph CS 25.1420(a)(2) or (a)(3) comply with the requirements of CS 25.1419 (e), (f), (g), and (h) for the icing conditions defined in Appendix O in which the aeroplane is certified to operate.

Paragraphs (d), (e), (f), and (g) of AMC 25.1419 apply.

If applicable, a comparative analysis, as defined in AMC 25.1420(f), may be used to show compliance.

(f) CS 25.1420(d) Comparative analysis

For showing compliance with the CS-25 certification specifications relative to SLD icing conditions as represented by Appendix O, the applicant may use a comparative analysis to show similarity of a new or derivative aeroplane model to existing model(s) with features and/or margins which are deemed to have contributed to a safe fleet history in all icing conditions.

When using comparative analysis as a means of compliance, flight testing in measured natural SLD icing conditions and/or flight testing with simulated ice shapes defined in accordance with Appendix O — part II is not required. Nevertheless, other types of tests may be required.

1. Definitions

- *Accident:* The definition of the term 'accident' is provided in ICAO Annex 13, Chapter 1.
- *Certification ice shapes/ice shape data:* Ice shapes or ice shape data used to show compliance with certification specifications for flight in icing conditions. As used in this document, these are the ice shapes or data used to represent

the critical ice shapes with the intent that they convey the ice that represents the most adverse effect on performance and flight characteristics. The data which is used to represent these shapes may be comprised of flight test data (artificial or natural ice), wind tunnel data, analytical data, or combinations of the above as allowed during previous certification projects.

- *Comparative analysis:*
  - The use of analyses to show that an aeroplane is comparable to models that have previously been certified for operation in icing conditions via the environment represented by Appendix C and have a proven safe operating history in any supercooled liquid water icing conditions, but that may not have already been explicitly certified for operation in the icing environment represented by Appendix O.
  - Key elements:
    - The new or derivative model is certifiable for Appendix C icing conditions,
    - Aeroplane models previously certified for Appendix C icing conditions are used to establish a reference fleet,
    - The new or derivative model has similar design features and/or margins for key parameters relative to the reference fleet,
    - The reference fleet has a safe fleet history in supercooled liquid water icing conditions.
- *Events:* Within this document the word 'event' means 'accident and/or serious incident' as defined in ICAO Annex 13, Chapter 1. For the purpose of identifying serious incidents with respect to the in-service history used for the comparative analysis, this should include reports where the flight crew encountered difficulties controlling the aeroplane, or temporarily lost its control, when flying in icing conditions.
- *Key parameters:* Parameters deemed to have contributed to the safe operation in icing conditions of the reference fleet. These parameters should be defined and provided by the applicant for each of the topics addressed using the comparative analysis. They should be agreed with the Agency.
- *Reference fleet:* The fleet of previously certified aeroplanes used to establish safe fleet history in order to enable the use of comparative analysis as a means of compliance.
- *Serious incident:* The definition of the term 'serious incident' is provided in ICAO Annex 13, Chapter 1.
- *Similarity analysis:*
  - The direct comparison of a new or derivative aeroplane model to models already certified for operation in the icing environment of Appendix C

and/or Appendix O. The similarity can be established for the aeroplane, the systems and/or the components.

– Key elements:
  - Similar design features,
  - Similar performance and functionality.

2. Introduction

This paragraph introduces comparative analysis as a means of compliance with the CS-25 certification specifications addressing SLD icing conditions represented by Appendix O. The Agency acknowledges that there are a significant number of large aeroplane models which have an exemplary record of safe operation in all icing conditions, which inherently include SLD icing conditions. A comparative analysis provides an analytical certification path for new aeroplane models and derivatives by allowing the applicant to substantiate that a new or derivative model will have at least the same level of safety in all supercooled liquid water icing conditions that previous models have achieved.

For derivative models, the applicable certification specifications are determined through the application of the 'Changed Product Rule (CPR)'. Rather than demonstrating compliance with the certification specifications in effect at the date of application, an applicant may demonstrate compliance with an earlier amendment of the certification specifications when meeting one of the conditions provided in Part-21, point 21.A.101(b). After application of the CPR, if the derivative model must comply with an amendment that includes the SLD-related certification specifications, compliance by comparative analysis may be used.

To use a comparative analysis as means of compliance for a new or derivative aeroplane model, four main elements should be established:

a. A reference fleet with an adequately safe history in icing conditions;

b. An analysis of aeroplane design features and/or margins that are deemed to contribute to the safe history of the reference fleet.

c. A comparison showing that the new or derivative aeroplane model shares the comparable design features and/or margins, with the reference fleet.

d. The compliance of the new or derivative aeroplane model with the applicable CS-25 certification specifications relative to flight in the icing conditions defined by Appendix C.

3. Determining Adequately Safe Fleet History

In order to use a comparative analysis, a safe fleet history has to be established for the reference fleet of aeroplane model(s) to be used for comparison.

3.1 Fleet History Composition

The reference fleet should include the previous aeroplane model(s) sharing the design features and/or margins that will be used to substantiate the comparative analysis. The applicant should present to the Agency any known supercooled-liquid-water-icing-related accidents or serious incidents of the reference fleet. The applicant should present an analysis of any such events and explain how the identified root causes were addressed. Unless it can be justified, credit should not be taken for those flights of any aeroplane model that has experienced accidents or serious incidents due to flight in supercooled liquid water icing conditions. If design changes were made to correct deficiencies that contributed to or caused the accidents or serious incidents, including those which may have occurred in SLD, credit for flights may be taken only for the fleet of aeroplanes that have the changes incorporated (i.e. post-modification number of flights).

3.2 Use of Fleet History Data Not Owned by the Applicant

The use of fleet history data from the fleets of other certificate holders for Supplemental Type Certificate, new Type Certificate, or Major change to Type Certificate applications may be accepted by the Agency when formal agreements between the applicant and the certificate holder permitting the use of the relevant fleet history are in place. The Agency will determine the acceptability and the applicability of the data.

3.3 Applicability of Fleet History for the Certification Options of CS 25.1420(a)

When compiling data for aeroplane model(s) which will comprise the applicant's reference fleet, operational limitations or restrictions imposed by either the AFM(s) or the operating manuals furnished by the TC holder for the model(s), should be considered. Relevant operational limitations existing for the reference fleet (e.g. AFM or operating manual prohibition against take-off into freezing drizzle or light freezing rain, direction to avoid such conditions in flight, directions to exit severe icing, etc.) will limit the certification options available for the use of a comparative analysis.

If the aeroplane model(s) proposed to be included in the applicant's reference fleet has (have) limitations or restrictions applicable to SLD, the certification options for which comparative analysis could be used are limited to CS 25.1420(a)(1) or (a)(2). The applicant should demonstrate within the comparative analysis that the means of ice and/or icing condition detection for the reference fleet remain valid and are applicable to the new or derivative aeroplane.

3.4 Safe Fleet History Requirements

The reference fleet should have accumulated two million or more flights in total with no accidents or serious incidents in supercooled liquid water icing conditions aloft.

4. Compliance with the Applicable CS-25 Certification Specifications Relative to Appendix C Icing Conditions

A comparative analysis is an acceptable means of compliance only with the CS-25 certification specifications relative to Appendix O icing conditions. The use of a comparative analysis is not an option for showing compliance with CS-25 certification specifications relative to Appendix C icing conditions.

5. Conducting Comparative Analysis

If a safe fleet history in icing conditions can be substantiated, and compliance with the CS-25 certification specifications for safe flight in Appendix C icing conditions can be shown, then the reference fleet can be used for comparative analysis.

The substantiation of the reference fleet's design features and/or margins which have contributed to the safe fleet history can be used for a new or derivative model having comparable design features and/or margins, to show compliance with the CS-25 certification specifications relative to flight in SLD icing conditions. When conducting a comparative analysis, the effects of key parameters for individual components or systems should be considered at the aeroplane level. A different design feature or margin may be shown to be acceptable when considered at the aeroplane level, taking into account the other aircraft design features and margins that are deemed to contribute to safe flight in icing conditions. The following aspects should be addressed:

a. Ice protection systems,

b. Unprotected components,

c. Ice or icing conditions detection,

d. Ice accretion and ice shedding sources,

e. Performance and handling characteristics,

f. Aeroplane Flight Manual information,

g. Additional considerations — Augmenting comparative analysis

5.1 Applicable CS-25 certification specifications

The applicable certification specifications relative to SLD icing are listed in Table 1 below. This guidance is applicable to these certification specifications.

Table 1: List of applicable CS 25 certification specifications

Reference	Title
CS 25.21(g)	Performance and Handling Characteristics in Icing Conditions
CS 25.629	Aeroelastic stability requirements
CS 25.773(b)(1)(ii)	Pilot compartment view — icing conditions
CS 25.773(b)(4)	Pilot compartment view — non-openable windows
CS 25.929(a)	Propeller de-icing
CS 25 1093(b)	Powerplant icing — turbine engines
CS 25.1324	Flight instrument external probes
CS 25.1329	Flight Guidance System
CS 25.1403	Wing icing detection lights
CS 25.1420	Supercooled large drop icing conditions
CS 25J1093	Air intake system icing protection

5.2 Ice Protection Systems

The applicant should demonstrate similar levels of protection against the effects of ice accretion at the aeroplane level in the icing conditions of Appendix C. In doing so, the applicant should consider the ice protection system performance, modes of operation and the other factors identified by the applicant that contribute to the overall safety of the aeroplane for flight in the icing conditions of Appendix C. The assessment could include, but is not necessarily limited to, an analysis of the protection limits relative to supercooled liquid water impingement limits, runback and residual ice, as applicable.

5.3 Failure Analysis

The reference fleet will have been certified considering only the supercooled liquid water icing conditions of Appendix C and will have demonstrated an adequate level of safety when flying in both Appendix C and SLD icing conditions. Therefore, if a comparative analysis is used as a means of compliance with the CS-25 certification specifications relative to Appendix O icing conditions, the ice protection system for a new or derivative aeroplane, and the related equipment or components comprising the system, should demonstrate a reliability level consistent with a Functional Hazard Assessment (FHA) as per CS 25.1309(b). The classification and assessment of failure conditions need only consider the effects of Appendix C icing conditions.

5.4 Ice or Icing Conditions Detection

If the new or derivative model being certified has similar ice and/or icing conditions detection means as the reference fleet, including installation and operational considerations (e.g. flight crew procedures), then a comparative analysis may be used to show compliance with Appendix O-related certification specifications.

If the applicant chooses to introduce a new ice and/or icing conditions detection technology and show compliance at the aeroplane level based on a reference fleet with unrestricted operations, and the applicant is seeking certification by comparative analysis for unrestricted operations in SLD icing conditions for the new or derivative model per CS 25.1420(a)(3), the new ice and/or icing conditions detection technology should be installed and operate in a manner that results in equivalent ice and/or icing conditions detection performance. This may include additional qualification to the icing conditions represented by Appendix C.

If the certification option chosen requires a differentiation between icing conditions (CS 25.1420(a)(1) or (a)(2)), then either the reference fleet should have demonstrated the ability to detect that the aeroplane is operating in conditions that exceed the conditions selected for certification (i.e. for CS 25.1420(a)(1), any Appendix O icing conditions; and for CS 25.1420(a)(2), the icing conditions that are beyond the selected portion of Appendix O), or the ice and/or icing conditions detection means should be substantiated for detection of the applicable Appendix O icing conditions at the aeroplane level.

If the reference fleet has achieved the required number of flights to enable the use of a comparative analysis to show compliance with the CS-25 certification specifications relative to Appendix O, then Appendix C may be used to show compliance with the certification specifications related to ice accretions before the ice protection system has been activated and is performing its intended function (e.g. CS 25.1419(e), CS 25.143(j) and CS 25.207(h)).

5.5 Unprotected Components

For systems that are required to operate in Appendix O icing conditions but do not require ice protection provisions, for example the Autopilot (CS 25.1329), wing illumination lights (CS 25.1403), unprotected environmental control system (ECS) intakes (CS 25.1420), etc., a comparative analysis may be used if design features are shown to be similar to those of the reference fleet.

5.6 Ice Accretion and Ice Shedding Sources

If a comparative analysis is used as the means of compliance with the CS-25 certification specifications relative to Appendix O icing conditions, certification ice shapes/ice data determined for Appendix C icing conditions are acceptable without additional Appendix O considerations. The locations where ice accretions may occur on the new or derivative model should be reviewed and compared to those of the reference fleet. The following aspects should be considered:

i. An analysis showing that, in Appendix C icing conditions, the propulsion system and APU installation are such that the geometry and water catch of potential sources of ice shedding are similar to those used to establish the reference fleet history database.

ii. A comparison of the location of, or the methodology for locating, flight instrument external probes to assure that the effect of airframe ice accretion forward of the probes will be comparable for the new or derivative model with that of the reference fleet relative to safe flight in the icing conditions of Appendix C.

iii. For aeroelastic analyses, performance of an analysis showing ice accretion consistency (location and volume), defined using the icing conditions of Appendix C.

5.7 Aeroplane Performance and Handling Characteristics

The comparative analysis should substantiate that the effects of ice accretion and the agreed key parameters of the new or derivative model are comparable to those of the reference fleet. The applicant should substantiate by analysis, test, or a combination of both, that the new or derivative aeroplane will have similar margins to those of the reference fleet for flight in the icing conditions of Appendix C.

The following paragraphs provide guidance on how to achieve the above:

- Aeroplane performance,
- Aeroplane controllability and manoeuvrability,
- Aeroplane trim,
- Aeroplane stability,
- Aeroplane stalls.

5.7.1 Performance

The effects on aeroplane performance of the certification ice shapes/ice shape data determined for flight in the icing conditions of Appendix C for the new or derivative model should be comparable to those of the reference fleet. A comparison of ice accretion effects on lift and drag may be used in this analysis.

If comparable effects to those of the reference fleet cannot be shown, then the applicant should show how margins similar to those of the reference fleet are restored for the new or derivative model by other means that compensate for the effect (e.g. airspeed increase, sizing criteria, or other aeroplane limitations).

5.7.2 Controllability and Manoeuvrability

The effectiveness of the control surfaces and the control forces for the new or derivative model, with the certification ice shapes/ice shape data for flight in the icing conditions of Appendix C, should be comparable to those of the reference fleet. If critical Appendix C ice shapes affect the control surface effectiveness or control forces in a manner which may be different to that of the reference fleet, then the applicant should show how the control effectiveness and forces are retained.

The manoeuvrability associated with the certification ice shapes/ice shape data determined for the icing conditions of Appendix C should be comparable to those of the aeroplanes which comprise the reference fleet. If critical Appendix C ice shapes affect manoeuvrability in a manner which may be different to that of the reference fleet, then the applicant should show how the margins are retained (speed increase, etc.).

5.7.3 Trim

In addition to showing that trim capability for the new or derivative model, with the certification ice shapes/ice shape data for flight in the icing conditions of Appendix C, is comparable to that of the reference fleet, the margins between the required trim in the most critical conditions and the trim capability in Appendix C icing conditions should be comparable to those of the reference fleet.

5.7.4 Stability

The aeroplane stability associated with the certification ice shapes/ice shape data determined for the icing conditions of Appendix C should be comparable to those of the reference fleet. If this cannot be shown, then the applicant should show how similar stability margins are retained (speed increase, sizing criteria, other aircraft limitations, etc).

5.7.5 Stalls

a. Stall warning and protection features

Stall warning, stall protection, and/or airspeed awareness methods, devices, and/or systems as applicable should be shown by comparative analysis to be similar in function or improved relative to those of the reference fleet.

b. Stall warning margins

Stall warning margins established with the certification ice shapes/ice shape data associated with flight in the icing conditions of Appendix C should be comparable to those of the reference fleet.

c. Stall characteristics

The stall characteristics demonstrated by the new or derivative model with the certification ice shapes/ice shape data for flight in the icing conditions of Appendix C should be comparable to those of the reference fleet.

d. Aeroplane with Flight Envelope Protection

It should be shown that the new or derivative aeroplane and the reference fleet aeroplane(s) high angle-of-attack protection systems have a comparable ability to accommodate any reduction in stalling angle of attack with the certification ice shapes/ice shape data for flight in the icing conditions of Appendix C relative to the clean aeroplane.

The high angle-of-attack characteristics demonstrated with the certification ice shapes/ice shape data for flight in the icing conditions of Appendix C should be comparable to those of the reference fleet.

5.8 Aeroplane Fight Manual Information

If the certification option chosen for the new or derivative model being certified (CS 25.1420(a)(1), (a)(2), or (a)(3)) is consistent with the operation of the reference fleet, then the information to be provided in the AFM may be based on that provided in the reference fleet AFM(s) or other operating manual(s) furnished by the TC holder.

5.9 Additional Considerations — Augmenting Comparative Analysis

In addition to the use of design features and/or margins, to substantiate a new or derivative design by comparative analysis, the applicant may augment the comparative analysis with other methodologies (e.g. test, analysis or a combination thereof). The new methodologies should be agreed with the Agency.

Amend AMC 25.1435 as follows:

AMC 25.1435

Hydraulic Systems -— Design, Test, Analysis and Certification

(…)

2. RELATED REGULATORY MATERIAL AND COMPLEMENTARY DOCUMENTS

(a) Related Certification Specifications

(…)

CS 25.729 Extending and Rretracting mechanisms

AMC — SUBPART G

Correct AMC 25.1593 as follows:

AMC 25.1593

Exposure to volcanic cloud hazards

(…)

[Amdt No: 25/~~20~~13]

AMC — APPENDICES

Correct AMC to Appendix Q as follows:

AMC to Appendix Q

(SAL) 25.5 Safe operational and flight characteristics

(…)

[Amdt No: 25/~~20~~13]

Note: Page numbering is corrected as follows: 2-App Q~~N~~-1