This document was created to make public non-proprietary data contained in Special Conditions (including Deviations, Equivalent Safety Findings) that are part of the applicable Certification Basis as recorded in TCDS EASA.IM.A.009.

Content:

Special Conditions (SC)

B-02 (SC): Flight Envelope Protection Design	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.143
ADVISORY MATERIAL:	

SPECIAL CONDITION (SC)

Flight Envelope Protection Design

Add a new paragraph CS 25.143(k):

Normal operation:

The onset characteristics of each envelope protection feature must be smooth, appropriate to the phase of flight and type of manoeuvre and not in conflict with the ability of the pilot to satisfactorily change aeroplane flight path or attitude as needed.

The limit values of protected flight parameters must be compatible with:
aeroplane structural limits,
required safe and controllable manoeuvring of the aeroplane and
margins to critical conditions.

Unsafe flight characteristics or conditions must not result from:
dynamic manoeuvring,
airframe and system tolerances (both manufacturing and in-service), and
non-steady atmospheric conditions, in any appropriate combination and phase of flight, if this manoeuvring can produce a limited flight parameter beyond the nominal design limit value.
Note : Reference may be made to FAA Advisory Circular AC 120-41 for guidance on atmospheric conditions.

The aeroplane must respond to intentional dynamic manoeuvring within a suitable range of the parameter limit. Dynamic characteristics such as damping and overshoot must also be appropriate for the flight manoeuvre and limit parameter concerned.
When simultaneous envelope limiting is engaged, adverse coupling or adverse priority must not result.

Failure states :
EFCS (including sensor) failures must not result in a condition where a parameter is limited to such a reduced value that safe and controllable manoeuvring is no longer available. The crew must be alerted by suitable means if any change in envelope limiting or manoeuvrability is produced by single or multiple failures of the EFCS not shown to be extremely improbable.

– END –

B-03 (SC): Flight in Icing Conditions	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS-25.21(g), 25.105, 25.107, 25.121, 25.123, 25.125, 25.143(j)
ADVISORY MATERIAL:	Appendix 1 of AMC 25.21(g)

Special Condition (SC)

Note: In this Special Condition changed text compared to the wording of the actual CS-25 paragraph is highlighted by *Italic*.

1) Change CS-25.21(g)(1) to read as follows:

CS-25.21 Proof of compliance

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

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

2) Change CS-25.103 Stall speed to read as defined in CRI B-04

3) Change and replace CS-25.105(a)(2)(i) to read as follows:

CS-25.105 Take-off

(a) The take-off speeds prescribed by CS-25.107, the accelerate-stop distance prescribed by CS-25.109, the take-off path prescribed by CS-25.111, and the take-off distance and take-off run prescribed by CS-25.113, must be determined and the net take-off flight path prescribed by CS-25.115, must be determined in the selected configuration for take-off at each weight, altitude and ambient temperature within the operational limits selected by the applicant -

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

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

4) Change CS-25.107(c) (g) and add CS-25.107(c’) (g’) to read as follows:

CS-25.107 Take-off speeds

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

(1) V_{2MIN};
(2) V_R plus the speed increment attained (in accordance with CS 25.111(c)(2)) before reaching a height of 11 m (35 ft) above the takeoff surface; and
(3) A speed that provides the manoeuvring capability specified in CS 25.143(h).

(c') in icing conditions with the "Take-off ice" accretion defined in Appendix C, V_2 may not be less than –
(1) the V_2 speed determined in non-icing conditions
(2) A speed that provides the manoeuvring capability specified in CS 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 CS 25.121(c), but may not less than
(1) 1.18 V_{SR}; and
(2) A speed that provides the manoeuvring capability specified in CS 25.143(h).

(g') in icing conditions with the "Final take-off ice" accretion defined in Appendix C,, V_{FTO}, may not less than
(1) the V_{FTO} speed determined in non-icing conditions
(2) A speed that provides the manoeuvring capability specified in CS 25.143(h).

5) Change CS-25.121(b)(2)(ii)(A), CS-25.121(c)(2)(ii)(A), CS-25.121(d)(2)(ii), replace by new paragraph CS-25.121(b)(2)(ii)(A), CS-25.121(c)(2)(ii)(A), CS-25.121(d)(2)(ii), to read as follows:

CS-25.121 Climb: one-engine inoperative:

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

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

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

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

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

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

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

(A) *The VFTO speed scheduled in non-icing conditions does not provide the manoeuvring capability specified in CS-25.143(h) for the en-route configuration; or*

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

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

(ii) In icing condition with the approach Ice accretion defined in Appendix C, *in a configuration corresponding to the normal all-engines-operating procedure in which V_{MIN1G} for this configuration does not exceed 110% of the V_{MIN1G} for the related all-engines-operating landing configuration in icing, with a climb speed established with normal landing procedures, but not more than 1.4 V_{SR} (V_{SR} determined in non-icing conditions).*

6) Change CS-25.123 (b)(2)(i) to read as follows:

CS-25.123 En-route flight paths :

(b) The one-engine-inoperative net flight path data must represent the actual climb performance diminished by a gradient of climb of 1·1% for two-engined aeroplanes, 1·4% for three-engined aeroplanes, and 1·6% for four engined aeroplanes.

(1) In non-icing conditions; and

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

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

(ii) [UNCHANGED]

7) Delete CS-25.125(b)(2)(ii)(B) and replace it by CS-25.125(b)(2)(ii)(C) to read as follows:

CS-25.125 Landing

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

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

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

(i) In non-icing conditions, V_{REF} may not be less than:
(A) $1.23V_{SR0}$;
(B) V_{MCL} established under CS-25.149(f); and
(C) A speed that provides the manoeuvring capability specified in CS-25.143(h).

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

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

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

8) Change CS-25.143(j) to read as follows:

Controllability and Manoeuvrability
CS-25.143 General

(j) For flight in icing conditions before the ice protection system has been activated and is performing its intended function, it must be demonstrated in flight with the most critical of the ice accretion(s) defined in Appendix C part II(e) and Appendix O part II(d), as applicable, in accordance with CS 25.21(g), that:

(1) The aeroplane is controllable in a pull-up manoeuvre up to 1.5 g load factor *or lower if limited by AOA protection*; and

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

9) Change CS-25.207 Stall warning to read as defined in CRI B-02

Appendix B

Interpretative Material

Note: In the below Interpretative Material changed text compared to the wording of the actual CS-25 AMC is highlighted in *Italic*.

AMC 25.21(g) Performance and Handling Characteristics in Icing Conditions Contained in Appendix C, of CS-25

6 Acceptable Means of Compliance – Flight Test Programme modified as defined below:

- *6.2 Stall Speed (CS-25.103) : not applicable REFER to IM B-02*

- 6.4 *Take-off Path (CS-25.111).* If *V_2 speed scheduled in icing conditions is greater than V_2 in non-icing conditions* take-off demonstrations should be repeated to substantiate the speed schedule and distances for take-off in icing conditions. The effect of the take-off speed increase, thrust loss, and drag increase on the take-off path may be determined by a suitable analysis.

- Shift 6.9.4.3 (c).(iii) to 6.9.4.3 (d) and change as follows :

  (d) Conduct steady heading sideslips to full rudder authority, 801 N. (*180* lbf) rudder force or full lateral control authority (whichever comes first), with highest lift landing configuration, trim at estimated $1.23V_{SR}$ or the minimum AFM speed, and power or thrust for -3° flight path angle.

- Change 6.9.5.1 as follows :

  6.9.5.1 Where the ice protection system is activated as described in paragraph A1.2.3.*4*.a of Appendix 1 of this AMC, paragraphs 6.9.1, 6.9.2 and 6.9.4 of this AMC are applicable with the ice accretion prior to normal system operation.

- Change 6.9.5.2 as follows :

  6.9.5.2 Where the ice protection system is activated as described in paragraphs A1.2.3.*4*.b, c, d or e of Appendix 1 of this AMC, it is acceptable to demonstrate adequate controllability with the ice accretion prior to normal system operation, as follows:

  a. In the configurations listed below, trim the aeroplane at the specified speed. Conduct pull up to 1.5g *or lower if limited by AOA protections* and pushover to 0.5g without longitudinal control force reversal.

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

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

- Change 6.10.2 (c) as follows :

  6.10.2 Acceptable Test Programme. The following represents an acceptable test programme for compliance with CS-25.145(a):

  a. "Holding ice."

  b. Medium to light weight, aft centre of gravity position, symmetric fuel loading.

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

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

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

- *6.17 Stall Demonstration (CS-25.201): Not applicable REFER to CRI B-02*

- *6.18 Stall Warning (CS-25.207): Not applicable REFER to CRI B-02*

- 6.21 Natural Icing Conditions.

  Change ice accretion Tables 3 & 4 as follows:

TABLE 3: Holding Scenario - Manoeuvres

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

TABLE 4: Approach/Landing Scenario - Manoeuvres

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

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

- Change 6.22.2 d) as follows :

  6.22 Failure Conditions (CS-25.1309). - Acceptable Test Programme

  d. In the configurations listed below, trim the aeroplane at *the Minimum AFM speed*. Decrease speed to *minimum steady achievable speed*, plus 1 second, and demonstrate prompt recovery using the same test technique as for the non-contaminated aeroplane. Natural stall warning is acceptable for the failure case.

     i. High lift devices retracted configuration: Straight/Power Off.
     ii. Landing configuration: Straight/Power Off.

– END –

B-04 (SC): Stalling and Scheduled Operating Speeds	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.103, 25.143 (h), 25.145, 25.201, 25.203, 25.207, 25.1323
ADVISORY MATERIAL:	--

Special Condition (SC)

Appendix A

Stalling and Scheduled Operating Speeds

0 – Foreword

In the following paragraphs, “In icing conditions” means with the ice accretions (relative to the relevant flight phase) as defined in CS 25 amendment 7 Appendix C

1 - Definitions

This Special Condition addresses novel features of the Bombardier C Series and uses terminology that does not appear in CS 25.

The following definitions shall apply:

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

- Alpha-floor system: Not applicable.

- Alpha-limit: The maximum angle of attack at which the aeroplane stabilises 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 aeroplane configuration under consideration with the high incidence protection system operating. See section 3 of this Special Condition.

- V_{MIN1G}: V_{MIN} corrected to 1g conditions. See section 3 of this Special Condition. It is the minimum calibrated airspeed at which the aeroplane 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

Those paragraphs of CS 25 quoted in reference may be amended in accordance with this Special Condition provided that acceptable capability and reliability of the high incidence protection system can be established by flight test, simulation, and analysis as appropriate. The capability and reliability required are as follows:

1- It shall not be possible during pilot induced manoeuvres to encounter a stall and handling characteristics shall be acceptable, as required by section 5 of this Special Condition.

2- The aeroplane shall be protected against stalling due to the effects of wind-shears and gusts at low speeds as required by section 6 of this Special Condition.

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 CS 25.1309.

3 - Minimum Steady Flight Speed and Reference Stall Speed

Delete existing CS-25.103 and replace as follows:

CS 25.103: Minimum steady flight speed and Reference stall speed

(a) The minimum steady flight speed, V_{MIN}, is the final stabilised calibrated airspeed obtained when the aeroplane is decelerated until the longitudinal control is on its stop in such a way that the entry rate does not exceed 1 knot per second. (See Interpretative Material IM B-1, paragraph 3)

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

(1) The high incidence protection system operating normally.

(2) Idle thrust

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

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

(5) The most unfavourable centre of gravity allowable; and

(6) The aeroplane trimmed for straight flight at a speed selected by the applicant, but not less than the greater of 1.13 V_{SR} or the minimum trim speed, and not greater than 1.3 V_{SR}.

(c) The one-g minimum steady flight speed, V_{MIN1G}, is the minimum calibrated airspeed at which the aeroplane can develop a lift force (normal to the flight path) equal to its weight, whilst at an angle of attack not greater than that at which the minimum steady flight speed of sub-paragraph (a) was determined. It must be determined in icing and non-icing conditions.

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

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

Where

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

n_{ZW} = Load factor normal to the flight path at $V_{C_{L_{MAX}}}$

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 aeroplane 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 centre of gravity position that results in the highest value of reference stall speed;

(5) The aeroplane trimmed for straight flight at a speed selected by the applicant, but not less than the greater of 1.13 V_{SR} or the minimum trim speed, and not greater than 1.3 V_{SR};

(6) Not applicable.

(7) The High Incidence Protection System adjusted, at the option of the applicant, to allow higher incidence than is possible with the normal production system.

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

4 - Stall Warning

Delete existing CS 25.207 and replace as follows:

4.1 Normal operation

If the conditions of paragraph 2 are satisfied, equivalent safety to the intent of CS 25.207, Stall Warning, shall be considered to have been met without provision of an additional, unique warning device.

4.2 High Incidence Protection System Failure

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

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

(b) Stall warning must also be provided in each abnormal configuration of the high lift devices that is likely to be used in flight following system failures.

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

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

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

(1) In power off straight deceleration not exceeding one knot per second to a speed 5 knots or 5 per cent CAS, whichever is greater, below the warning onset.

(2) In turning flight stall deceleration at entry rates up to 3 knots per second when recovery is initiated not less than one second after the warning onset.

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

(f) An aeroplane is considered stalled when the behaviour of the aeroplane gives the pilot a clear and distinctive indication of an acceptable nature that the aeroplane 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

Delete existing CS 25.201, 203 and replace as follows:

5.1 High Incidence Handling Demonstrations

CS 25.201: High incidence handling demonstration in icing and non-icing conditions

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

(1) The high incidence protection system operating normally.

(2) Initial power conditions of:

I: Power off

II: The power necessary to maintain level flight at 1.5 VSR1, where VSR1 is the reference stall speed with flaps in approach position, the landing gear retracted and maximum landing weight. (See Interpretative Material IM B-02 paragraph 5)

(3) Not applicable.

(4) Flaps, landing gear and deceleration devices in any likely combination of positions (see Interpretative Material IM B-02 paragraph 6).

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

(6) The aeroplane trimmed for straight flight at a speed selected by the applicant, but not less than the greater of 1.13 V_{SR} or the minimum trim speed, and not greater than 1.3 V_{SR}.

(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 one knot per second until the control reaches the stop (see Interpretative Material IM B-02 paragraph 3)

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

(3) Manoeuvres with increased deceleration rates

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

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

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

With the ice accretion prior to operation of the normal anti-ice system, the requirement must also be met in deceleration at 1kt/s up to full back stick.

5.2 <u>Characteristics in High Incidence Manoeuvres</u>

CS 25.203: Characteristics in High Incidence
(see Interpretative Material IM B-02 paragraph 7)

In icing and non-icing conditions:

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

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

(2) There shall not be any uncommanded nose-down pitching, which would be indicative of stall. However reasonable attitude changes associated with stabilizing the incidence at Alpha limit as the longitudinal control reaches the stop would be acceptable. (See Interpretative Material IM B-02 paragraph 7.3)

(3) There shall 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 manoeuvre.

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

(b) In manoeuvres with increased rates of deceleration some degradation of characteristics is acceptable, associated with a transient excursion beyond the stabilized Alpha-limit. However the aeroplane 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 manoeuvre.

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

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

5.3 <u>Characteristics up to maximum lift angle of attack</u>

(a) In non-icing conditions:

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

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

(2) Not applicable.

(3) Engines idling

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

(5) The aeroplane trimmed for straight flight at a speed selected by the applicant, but not less than the greater of 1.13 V_{SR} or the minimum trim speed, and not greater than 1.3 V_{SR}.

(b) In icing conditions:

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

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

(2) Not applicable.

(3) Engines idling

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

(5) The aeroplane trimmed for straight flight at a speed selected by the applicant, but not less than the greater of 1.13 V_{SR} or the minimum trim speed, and not greater than 1.3 V_{SR}.

(c) During the manoeuvres used to show compliance with paragraphs (a) and (b) above, the aeroplane 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 manoeuvre.

6 – <u>Atmospheric Disturbances</u>

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 shall be demonstrated in non-icing and icing conditions.

7 – Not applicable

8 – Proof of compliance

Add the following paragraph 25.21 (b):

(b) The flying qualities will be evaluated at the most unfavourable CG position.

9– Change CS 25.145 (a), CS 25.145 (b) (6) and CS 25.1323(d) as follows:

CS 25.145 (a)	V_{MIN} in lieu of “stall identification”
CS 25.145 (b) (6)	V_{MIN} in lieu of V_{SW}
CS 25.1323 (d)	“From 1.23 V_{SR} to V_{MIN}” in lieu of “1.23 V_{SR} to stall warning speed” and “speeds below V_{MIN}” in lieu of “speeds below stall warning”

Appendix B

Interpretative Material

Stalling and Scheduled Operating Speeds

1 – Introduction

This Interpretative Material expands various aspects of Special Condition B-02 and replaces the CS 25 AMC's that are no longer applicable due to the amendments introduced by this Special Condition.

2 – Alpha protection tolerances

Flight testing may be made with nominal AOA protection system settings unless tolerances are such as to produce significant changes in performance determination and handling qualities, in which case the most adverse settings within the tolerance band should be used.

3 - Minimum Steady Flight Speed Entry Rate

(See CS 25.103(a) and CS 25.203(a) as amended by paragraphs 3 and 5.2 of Special Condition B-02)

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

$$\text{Entry rate} = \frac{1.15\ V_{MIN}\ 1g - 1.05\ V_{MIN}\ 1g}{\text{Time to decelerate from } 1.15\ V_{MIN1G} \text{ to } 1.05\ V_{MIN1G}} \text{ (knot CAS/sec)}$$

4 - Manoeuvring Capabilities at Scheduled Operating Speeds

RESERVED

5 – Power Setting for power-on Handling to High Incidence

(See CS 25.201(a) (2) as amended by paragraph 5.1 of Special Condition B-02)

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

6 - Position of Deceleration Devices During Handling to High Incidence

(See CS 25.201 as amended by paragraph 5.1 of Special Condition B-02)

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

7 - Characteristics During High Incidence Manoeuvres

(See CS 25.203, as amended by paragraph 5.2 of Special Condition B-02)

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

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

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

8 - Atmospheric Disturbances

(See paragraph 6 of Special Condition B-02)

In establishing compliance with paragraph 6 of Special Condition B-02, the high incidence protection system shall be assumed to be operating normally. Simulator studies and analyses may be used but will need to be validated by limited flight testing to confirm handling qualities, at critical loadings, up to the maximum incidence shown to be reached by such studies and analyses.

9 - Not applicable.

– END –

B-09 (SC): Static Directional, Lateral and Longitudinal Stability and Low Energy Awareness	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.171, 25.173, 25.175, 25.177, SC B-02
ADVISORY MATERIAL:	--

Special Condition (SC)

Appendix A

Special Condition

1. Replace CS 25.171 by the following :

   "The aircraft must be shown to have suitable lateral, directional and longitudinal stability in any condition normally encountered in service, including the effects of atmospheric disturbances.

   The aircraft, fitted with flight control laws presenting neutral static longitudinal stability significantly below the normal operating speeds, must provide adequate awareness to the pilot of a low energy state."

2. Remove CS 25.173

3. Remove CS 25.175

4. Remove CS 25.177 (b)

5. Replace CS 25.177(c) by the following:

   In straight, steady sideslips over the range of sideslip angles appropriate to the operation of the aeroplane, but not less than those obtained with one-half of the available rudder control input or a rudder control force of 801 N (180 lbf), the rudder control movements and forces must be substantially proportional to the angle of sideslip in a stable sense; and the factor of proportionality must lie between limits found necessary for safe operation. This requirement must be met for the configurations and speeds specified in sub-paragraph (a) of this paragraph. (see AMC 25.177 (c)).

Appendix B

Interpretative Material

I. Lateral-directional stability

Positive static directional stability is defined as the tendency to recover from a skid with the rudder free. Positive static lateral stability is defined as the tendency to raise the low wing in a sideslip with the aileron controls free. These control criteria are intended to accomplish the following:

1. Provide additional cues of inadvertent sideslips and skids through control force changes.
2. Ensure that short periods of unattended operation do not result in any significant changes in yaw or bank angle.
3. Provide predictable roll and yaw response.
4. Provide acceptable level of pilot attention (workload) to attain and maintain a co-ordinated turn.

A suitable lateral-directional stability must allow to achieve the same goal. In the absence of positive lateral stability, the curve of lateral surface deflection against sideslip angle should be in a conventional sense, and reasonably in harmony with rudder deflection during the sideslip.

II. Longitudinal stability and low energy awareness

1. General

The aeroplane's static longitudinal stability and energy awareness characteristics shall be evaluated by flight and simulator tests. Control laws that result in neutral static stability throughout most of the operational flight envelope may be accepted in principle subject to:

- adequate speed control without excessive pilot workload
- suitable longitudinal behaviour in turbulence
- acceptable high and low speed protection
- provision of adequate cues to the pilot of significant speed excursions beyond VMO/MMO, and of low energy situations.

2. Longitudinal stability

a. Accurate speed control shall be achievable without excessive pilot workload in the full range of operating speeds including low speeds (scheduled speeds at take-off and landing with or without engine failed) and high speeds for each configuration including VMO/MMO.

b. Since conventional relationships between stick forces and control surface displacements do not apply to a manoeuvre demand control system, longitudinal static stability characteristics shall be determined on the basis of the aeroplane's response to disturbances rather than on the basis of stick force versus speed gradients.

c. Outside the normal flight envelope adequate high or low speed cues may be provided by a strong positive stability gradient. A force gradient of 1 lb for each 6 knots, applied through the side-stick shall be considered as providing this strong stability.

3. Low energy awareness

   Although stability cues and protection systems may be adequate at high altitude, past experience has shown that additional attention is required at low altitude. Adequate cues shall be available to the pilot to ensure that the aircraft retains sufficient energy to recover from low power and/or low speed situations when close to the ground.

   Such low energy cues may be provided by an appropriate warning with the following characteristics:

   a. it should be unique, unambiguous, and unmistakable.
   b. it should be active at appropriate altitudes and in appropriate configurations (i.e. at low altitude, in the approach and landing configurations).
   c. it should be sufficiently timely to allow recovery to a stabilized flight condition inside the normal flight envelope while maintaining the desired flight path and without entering the flight controls angle-of-attack protection mode.
   d. it should not be triggered during normal operation, including operation in moderate turbulence for recommended manoeuvres at recommended speeds.
   e. it should not be cancellable by the pilot other than by achieving a higher energy state.
   f. there should be an adequate hierarchy among the various warnings so that the pilot is not confused and led to take inappropriate recovery action if multiple warnings occur.

   Global energy awareness and non-nuisance of low energy cues shall be evaluated by simulator and flight tests in the whole take-off and landing altitude range for which certification is requested, in all relevant combinations of weight, center of gravity position, configuration, airbrakes position, and available thrust, including reduced and derated take-off thrust operations and engine failure cases. A sufficient number of tests shall be conducted, allowing the level of energy awareness and the effects of energy management errors to be assessed.

– END –

C-11 (SC): Automatic Braking System Structural Loads	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.125, 25.305, 25.473, 25.479(c)(2), 25.481, 25.493, 25.571, 25.723, 25.1529, 25.1585
ADVISORY MATERIAL:	--

Special Condition (SC)

Appendix A

Special Condition

In addition to the requirements of CS 25.493, a landing pitchover condition must be addressed that takes into account the effect of the automatic braking system. The aeroplane is assumed to be at the design maximum landing weight, or at the maximum weight allowed with the automatic braking system on. The aeroplane is assumed to land in a tail-down attitude, in accordance with Figure 3 of CS-25 Book 1 Appendix A, at the speeds defined by CS 25.481 and with the horizontal reaction ‘D_M’ applied at the ground contact point. Following main gear contact, the aeroplane is assumed to rotate about the main gear wheels at the highest pitch rate allowed by the automatic braking system. This is considered a limit load condition from which ultimate loads must also be determined. Loads must be determined for critical fuel and payload distributions and centers of gravity. Nose gear loads, as well as airframe loads must be determined. The aeroplane must support these loads as described in CS 25.305(a), (b), (c) and CS 25.571(b)(6).

– END –

D-03 (SC): In-Flight Fire – Composite and Unusual Construction	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.856(a)
ADVISORY MATERIAL:	

Special Condition (SC)

Appendix A

Special Condition

It must be demonstrated that the use of new structural materials does not introduce any additional in-flight fire risks (e.g. reduced flame propagation resistance, emission of hazardous quantities of toxic products into occupied areas) that would not be present if the structure were of conventional aluminium alloy.

– END –

D-09 (SC): Control Surface Position Awareness / Electronic Flight Control Systems	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.671, 25.672
ADVISORY MATERIAL:	AMC 25.671, 25.672, Aviation Rulemaking Advisory Committee (ARAC) Flight Control Harmonisation Working Group (FCHWG) Report 25.671 & 25.672 dated 17 May 2002

Special Condition (SC)

Appendix A

Special Condition

In addition to current CS 25.671 paragraph, the following conditions are applicable:

1. The flight control system shall be designed to continue to operate and must not hinder aircraft recovery from any attitude.

2. The system design must ensure that the flight crew is made suitably aware whenever the primary control means nears the limit of control authority.

3. If the design of the flight control system has multiple modes of operation, a means must be provided to indicate to the crew any mode that significantly changes or degrades the normal handling or operational characteristics of the aeroplane.

Appendix B

Interpretative Material

A. Definition

Jam. A failure or event such that a control surface, pilot control, or component is fixed in one position:

1 If the control surface or pilot control is fixed in position due to a physical interference, it is addressed under CS 25.671(c)(3). Causes may include corroded bearings, interference with a foreign or loose object, control system icing, seizure of an actuator, or a disconnect that results in a jam by creating an interference. Jams of this type must be assumed to occur and should be evaluated at positions up to and including the normally encountered positions defined below.

2 All other failures that result in a fixed control surface, pilot control, or component are addressed under CS 25.671(c)(1) and 25.671(c)(2), as appropriate. Depending on system architecture and the location of the failure, some jam failures may not always result in a fixed surface or pilot control; for example, a jammed valve could result in a surface runaway.

B. Determination of Control System Jam Positions – CS 25.671(c)(3)

The flight phases required by CS 25.671 can be encompassed by three flight phases: take-off, in-flight (climb, cruise, normal turns, descent, and approach) and landing.

Take-off is considered to be the time period between brake release and 35 ft. In-flight is considered to be from 35 ft following a take-off to 50 ft prior to landing including climb, cruise, normal turns, descent, and approach.

CS 25.671(c)(3) requires that the aeroplane be capable of landing with a flight control jam and that the aeroplane be evaluated for jams in the landing configuration. However, for the evaluation of jams which occur just prior to landing, proximity to the ground need not to be considered for the transient condition. Given that some amount of time and altitude is necessary in order to recover from any significant flight control jam, there is no practical means by which such a recovery could be demonstrated all the way to touchdown. The potential delay in accomplishing a recovery could be on the order of 5 seconds. For a jam at a control deflection corresponding to 0.8 g, a recovery may not be possible below approximately 200' even with a state of the art control system. While it is recognised that this means that a specific hazard is not addressed (a control jam that occurs, or is recognised, just before landing), this hazard is mitigated for the following reasons. First, the landing phase represents a limited exposure window in which a jam could occur. Second, successful operation of the controls throughout the flight minimises the likelihood of a jam suddenly appearing during the landing phase. Also, some sources of jamming such as icing are not prevalent in the landing phase. Third, a certain level of recovery capability will be ensured through compliance with this interpretative material such that if a jam does occur during landing, the crew will have a reasonable chance of landing safely.

Only the aeroplane rigid body modes need to be considered when evaluating the aircraft response to manoeuvres and continued safe flight to landing.

It is assumed that if the jam is detected prior to V_1, the take-off will be rejected.

Although 1 in 1000 operational take-offs is expected to include crosswinds up to 25 knots, the short exposure time associated with a control surface jam occurring between V_1 and VLOF allows usage of a less conservative crosswind magnitude when determining normally encountered lateral and directional control positions. Given that lateral and directional controls are continuously used to maintain runway centreline in a crosswind take-off, and control inputs greater than that necessary at V_1 will occur at speeds below V_1, any jam in these control axes during a crosswind take-off will normally be detected prior to V_1. Considering the control jam failure rate of approximately 10^{-6} to 10^{-7} per flight hour combined with the short exposure time between V_1 and VLOF, a reasonable crosswind level for determination of jammed lateral or directional control positions during take-off is 15 knots.
The jam positions to be considered in showing compliance include any position up to the maximum position determined by the following manoeuvres. The manoeuvres and conditions described here are only to provide the control surface deflection to evaluate continued safe flight and landing capability, and are not to represent flight test manoeuvres for such an evaluation.

1 Jammed Lateral Control Positions.

(i) Take-off: The lateral control position for wings-level at V_1 in a steady crosswind of 15 knots (at a height of 10 meters above the take-off surface). Variations in wind speed from a 10 meter height can be obtained using the following relationship:

$$V_{alt} = V_{10meters} * (H_{desired}/10.0)^{1/7}$$

Where:

$V_{10meters}$	=	Wind speed at 10 meters AGL (knots)
V_{alt}	=	Wind speed at desired altitude (knots)
$H_{desired}$	=	Desired altitude for which wind speed is sought (Meters AGL), but not lower than 1.5m (5 ft)

(ii) In-flight: The lateral control position to sustain a 12 deg/sec steady roll rate from $1.23V_{SR1}(1.3V_S)$ to V_{MO}/M_{MO} or V_{fe}, as appropriate, but not greater than 50% of the control input.

Note: If the flight control system augments the pilot's input, then the maximum surface deflection to achieve the above manoeuvres should be considered.

2 Jammed Longitudinal Control Positions.

(i) Take-off: Three longitudinal control positions should be considered:

(1) Any control position from that which the controls naturally assume without pilot input at the start of the take-off roll to that which occurs at V_1 using the manufacturer's recommended procedures.

Note: It may not be necessary to consider this case if it can be demonstrated that the pilot is aware of the jam before reaching V_1 (for example, through a manufacturer's recommended AFM procedure).

(2) The longitudinal control position at V_1 based on the manufacturers recommended procedures including consideration for any runway condition for which the aircraft is approved to operate.

(3) Using the manufacturers recommended procedures, the peak longitudinal control position to achieve a steady aircraft pitch rate of the lesser of 5 deg/sec or the pitch rate

necessary to achieve the speed used for all-engines-operating initial climb procedures (V_2+XX) at 35 ft.

(ii) In-flight: The maximum longitudinal control position is the greater of :

(1) The longitudinal control position required to achieve steady state normal accelerations from 0.8g to 1.3g at speeds from $1.23V_{SR1}(1.3V_S)$ to V_{MO}/M_{MO} or V_{fe}, as appropriate.

(2) The peak longitudinal control position commanded by the autopilot and/or stability augmentation system in response to atmospheric discrete vertical gust defined by 15 fps from sea level to 20,000 ft.

3 Jammed Directional Control Positions.

(i) Takeoff: The directional control position for takeoff at V_1 in a steady crosswind of 15 knots (at a height of 10 meters above the takeoff surface). Variations in wind speed from a height of 10 meters can be obtained using the following relationship:

$$V_{alt} = V_{10meters} * (H_{desired}/10.0)^{1/7}$$

Where:

$V_{10meters}$	=	Wind speed at 10 meters AGL (knots)
V_{alt}	=	Wind speed at desired altitude (knots)
$H_{desired}$	=	Desired altitude for which wind speed is sought (Meters AGL), but not lower than 1.5m (5 ft)

(ii) In-flight: The directional control position is the greater of:

(1) The peak directional control position commanded by the autopilot and/or stability augmentation system in response to atmospheric discrete lateral gust defined by 15 fps from sea level to 20,000 ft.

(2) Maximum rudder angle required for lateral/directional trim from $1.23V_{SR1}(1.3V_S)$ to the maximum all engines operating airspeed in level flight with climb power, but not to exceed V_{MO}/M_{MO} or V_{fe} as appropriate. While more commonly a characteristic of propeller aircraft, this addresses any lateral/directional asymmetry that can occur in flight with symmetric power.

4 Control Tabs, Trim Tabs, and Trimming Stabilisers

Any tabs installed on control surfaces are assumed jammed in the position associated with the normal deflection of the control surface on which they are installed.

Trim tabs and trimming stabilisers are assumed jammed in the positions associated with the manufacturer's recommended procedures for tak-eoff and that are normally used throughout the flight to trim the aircraft from $1.23V_{SR1}(1.3V_S)$ to V_{MO}/M_{MO} or V_{fe}, as appropriate.

5 Speed Brakes

Speed brakes are assumed jammed in any position for which they are approved to operate during flight at any speed from $1.23V_{SR1}(1.3V_S)$ to V_{MO}/M_{MO} or V_{fe}, as appropriate. Asymmetric extension and retraction of the speed brakes should be considered. Roll spoiler jamming (asymmetric spoiler panel) is addressed under paragraph (1).

6 High Lift Devices

Leading edge and trailing edge high lift devices are assumed to jam in any position for take-off, climb, cruise, approach, and landing. Skew of high lift devices or asymmetric extension and retraction should be considered; CS 25.701 contains a requirement for flap mechanical interconnection unless the aircraft has safe flight characteristics with the asymmetric flap positions not shown to be extremely improbable.

7 Load Alleviation Systems.

(i) Gust Load Alleviation Systems At any airspeed between $1.23V_{SR1}(1.3V_S)$ to V_{MO}/M_{MO} or V_{fe}, as appropriate, the control surfaces are assumed to jam in the maximum position commanded by the gust load alleviation system in response to a discrete atmospheric gust with the following reference velocities:

(1) 15 fps (EAS) from sea level to 20,000 ft (vertical gust),

(2) 15 fps (EAS) from sea level to 20,000 ft (lateral gust).

(ii) Manoeuvre Load Alleviation Systems. At any airspeed between $1.23V_{Sr1}(1.3V_{Smin})/V_{ref}$ to $V_{MO}/M_{MO}/V_{fe}$ the control surfaces are assumed to jam in the maximum position commanded by the manoeuvre load alleviation system during a pull-up manoeuvre to 1.3g or a pushover manoeuvre to 0.8g.

C. Compliance to SC D-16 (1) Abnormal attitude.

Compliance should be shown by evaluation of the closed loop flight control system. This evaluation is intended to ensure that there are no features or unique characteristics (including numerical singularities) which would restrict the pilot's ability to recover from any attitude. It is not the intent of this rule or guidance material to limit the use of envelope protection features or other systems that augment the control characteristics of the aircraft.

D. Compliance to SC D-16 (2) Limit of control authority

SC D-16 requires suitable annunciation to be provided to the flight crew when a flight condition exists in which near-full control authority (not pilot-commanded) is being used. Suitability of such a display must take into account that some pilot-demanded manoeuvres (e.g., rapid roll) are necessarily associated with intended full performance, which may saturate the surface. Therefore, simple alerting systems, which would function in both intended and unexpected control-limiting situations, must be properly balanced between needed crew-awareness and nuisance alerting. Nuisance alerting should be minimised. The term suitable indicates an appropriate balance between nuisance and necessary operation.
Depending on the application, suitable annunciations may include cockpit control position, annunciator light, or surface position indicators. Furthermore, this requirement applies at limits of control authority, not necessarily at limits of any individual surface travel.

E. Compliance to SC D-16 (3) Submodes of operation

Some systems, EFCS in particular, may have submodes of operation not restricted to being either on or off. The means provided to the crew to indicate the current submode of operation may be different from the classic "failure warning."

– END –

D-13 (SC): High Altitude Operation / High Cabin Heat Load	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.831, CS 25.841, CS 25.903, CS 25.1309
ADVISORY MATERIAL:	AMC 20-128A, AMC 25.1309, INT/POL/25/16

Special Condition (SC)

Appendix A

Special Condition

A - PRESSURE VESSEL INTEGRITY

For the damage tolerance evaluation, in addition to the damage sizes critical for residual strength, the damage sizes critical for depressurisation decay must be considered, taking also into account the (normal) unflawed pressurised cabin leakage rate. The resulting leakage rate must not result in the cabin altitude exceeding the cabin altitude time history shown in Figure 4.

B - VENTILATION

In lieu of the requirements of CS 25.831(a), the ventilation system must be designed to provide a sufficient amount of uncontaminated air to enable the crew members to perform their duties without undue discomfort and fatigue and to provide reasonable passenger comfort during normal operating conditions and also in the event of any probable failure of any system which could adversely affect the cabin ventilating air. For normal operations, crew members and passengers must be provided with at least 0.25 kg/min (0.55 lb/min) of fresh air per person or the equivalent in filtered, recirculated air based on the volume and composition at the corresponding cabin pressure altitude of not more than 8000 ft.

The supply of fresh air in the event of the loss of one source, should not be less than 0.18 kg/min (0.4 lb/min) per person for any period exceeding five minutes. However, reductions below this flow rate may be accepted provided that the compartment environment can be maintained at a level which is not hazardous to the occupant (text of the AMC 25.831(a) of CS 25).

C - AIR CONDITIONNING

In addition to the requirements of CS 25.831, paragraphs (b) through (e), the cabin cooling system must be designed to meet the following conditions during flight above 15 000 ft mean sea level (MSL):

After any probable failure, the cabin temperature-time history may not exceed the values shown in Figure 1.

After any improbable failure, the cabin temperature-time history may not exceed the values shown in Figure 2.

Other temperatures standards could be accepted by the EASA if they provide an equivalent level of safety.

D - PRESSURISATION

In addition to the requirements of CS 25.841, the following apply:

1. The pressurisation system, which includes for this purpose bleed air, air conditioning and pressure control systems, must prevent the cabin altitude from exceeding the cabin altitude-time history shown in Figure 3 after each of the following:
   a) Any probable double failure in the pressurisation system (CS 25.1309 may be applied).
   b) Any single failure in the pressurisation system combined with the occurrence of a leak produced by a complete loss of a door seal element, or a fuselage leak through an opening having an effective area 2.0 times the effective area which produces the maximum permissible fuselage leak rate approved for normal operation, whichever produces a more severe leak.

2. The cabin altitude-time history may not exceed that shown in Figure 4 after each of the following:
   a) The pressure vessel opening or duct failure resulting from probable damage (failure effect) while under maximum operating cabin pressure differential due to a tyre burst, loss of antennas or stall warning vanes, or any probable equipment failure (bleed air, pressure control, air conditioning, electrical source(s) ...) that affects pressurisation.
   b) Complete loss of thrust from engines.

3. In showing compliance with paragraph D.1 and D.2 of this special condition, it may be assumed that an emergency descent is made by an approved emergency procedure. A 17-seconds crew recognition and reaction time must be applied between cabin altitude warning and the initiation of emergency descent.

   For flight evaluation of the rapid descent, the test article must have the cabin volume representative of what is expected to be normal

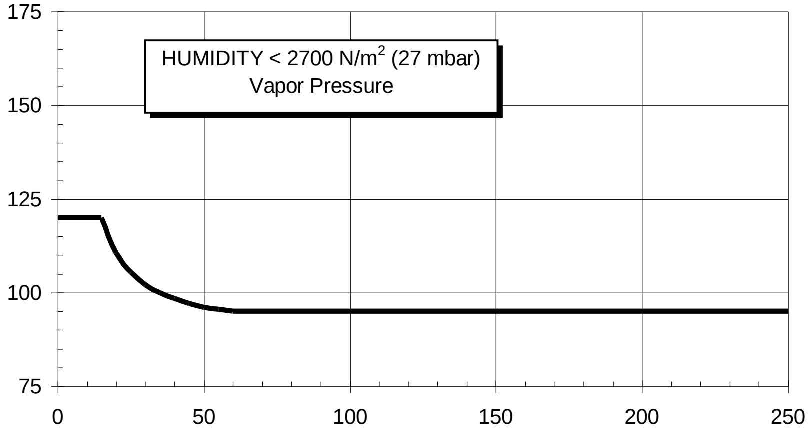
4. Engine rotor failures must be assessed according to the requirements of CS 25.903(d)(1).

   According to AMC 20-128A, consideration must be given to the practicability and feasibility of minimising the depressurisation effects, assessing each aircraft configuration on a case-by-case basis, and taking into account the practices in the industry for each configuration.

E - OXYGEN SUPPLY

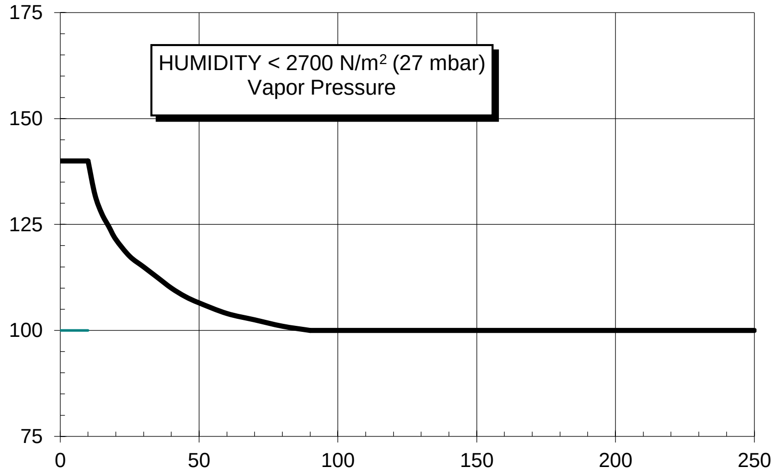
AFM procedure must be introduced to require that when operating at flight altitudes above flight level 410, one pilot at the controls of the airplane shall at all times wear and use an oxygen mask secured, sealed, and supplying oxygen. If certification for operation above 41,000 feet without equipment donned is intended, the applicant must substantiate that if a rapid depressurization occurs, the crew can recognize it and don equipment quickly enough to prevent unacceptable levels of hypoxia.

TEMPERATURE (°F)



TIME - MINUTES
TIME - TEMPERATURE RELATIONSHIP
FIGURE 1

TEMPERATURE (°F)



TIME - MINUTES
TIME - TEMPERATURE RELATIONSHIP
FIGURE 2

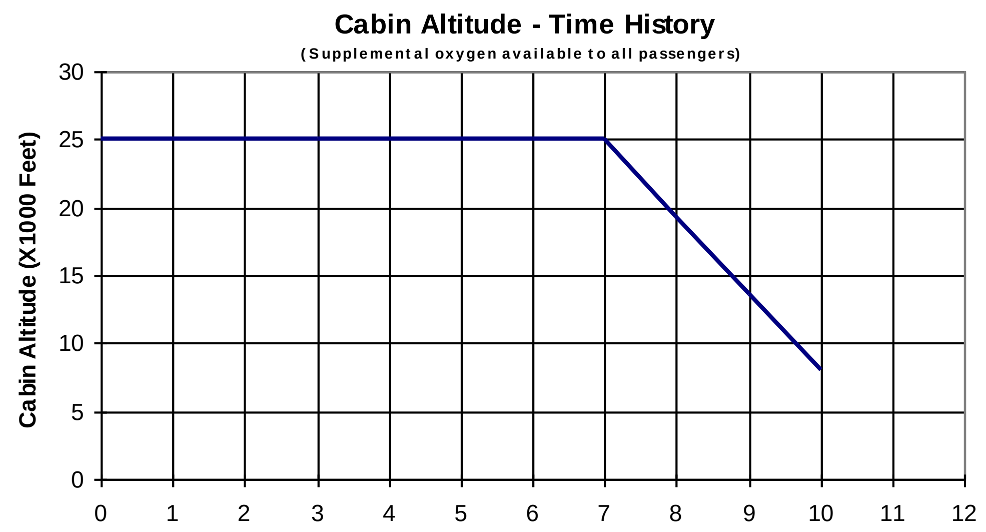


Figure 3

NOTE: For figure 3, time starts at the moment cabin altitude exceeds 8,000 feet during depressurization. If depressurization analysis shows that the cabin altitude limit of this curve is exceeded, the following alternate limitations apply: After depressurization, the maximum cabin altitude exceedence is limited to 30,000 feet. The maximum time the cabin altitude may exceed 25,000 feet is 2 minutes; time starting when the cabin altitude exceeds 25,000 feet and ending when it returns to 25,000 feet.

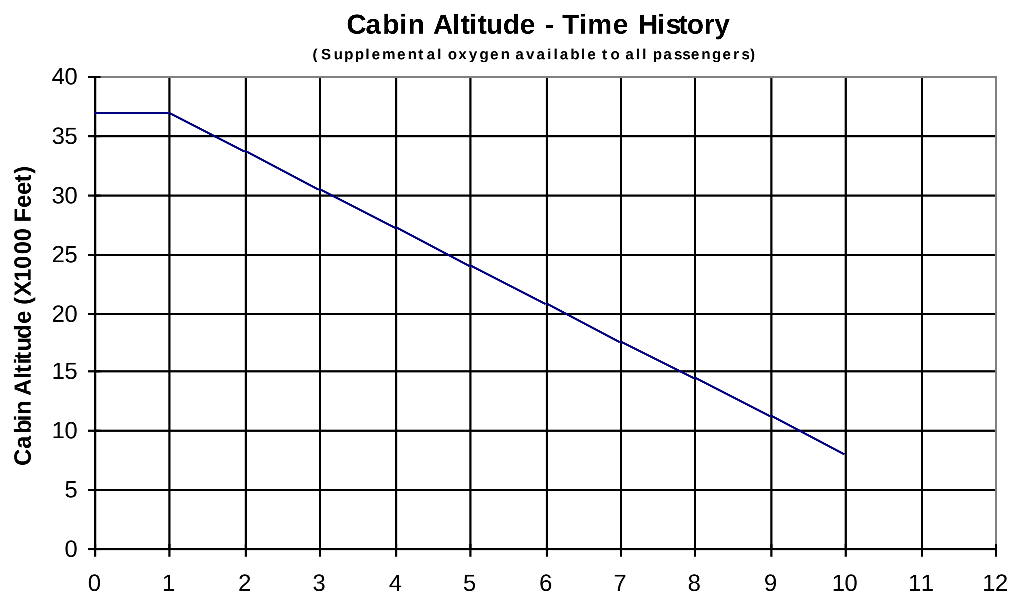


Figure 4

NOTE: For figure 4, time starts at the moment cabin altitude exceeds 8,000 feet during depressurization. If depressurization analysis shows that the cabin altitude limit of this curve is exceeded, the following alternate limitations apply: After depressurization, the maximum cabin altitude exceedence is limited to 40,000 feet. The maximum time the cabin altitude may exceed 25,000 feet is 2 minutes; time starting when the cabin altitude exceeds 25,000 feet and ending when it returns to 25,000 feet.

– END –

D-21 (SC): Side Facing Seats and Inflatable Passenger Restraints	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.562(a), 25.785(b)
ADVISORY MATERIAL:	FAA Policy No: PS-ANM-25-03-R1

Special Condition (SC)

Appendix A

Side Facing Seats (at 90° angle) and Associated Inflatable Passenger Restraints

I. Special Conditions in addition to CS 25.562, and 25.785 for side facing seats/divans

1. Additional requirements applicable to tests or rational analysis conducted to show compliance with CS 25.562 and 25.785 for side-facing seats:

   a) The longitudinal test(s) conducted in accordance with CS 25.562(b)(2) to show compliance with the seat-strength requirements of CS 25.562(c)(7) and (8), and these special conditions must have an ES-2re anthropomorphic test dummy (ATD) (49 CFR part 572 subpart U) or equivalent, or a Hybrid-II ATD (49 CFR part 572, subpart B as specified in CS 25.562) or equivalent, occupying each seat position and including all items contactable by the occupant (e.g., armrest, interior wall, or furnishing) if those items are necessary to restrain the occupant. If included, the floor representation and contactable items must be located such that their relative position, with respect to the center of the nearest seat place, is the same at the start of the test as before floor misalignment is applied. For example, if floor misalignment rotates the centerline of the seat place nearest the contactable item 8 degrees clockwise about the aircraft x-axis, then the item and floor representations must be rotated by 8 degrees clockwise also to maintain the same relative position to the seat place, as shown in Figure 1. Each ATD's relative position to the seat after application of floor misalignment must be the same as before misalignment is applied. To ensure proper loading of the seat by the occupants, the ATD pelvis must remain supported by the seat pan, and the restraint system must remain on the pelvis and shoulder of the ATD until rebound begins. No injury-criteria evaluation is necessary for tests conducted only to assess seat-strength requirements.

   b) The longitudinal test(s) conducted in accordance with CS 25.562(b)(2), to show compliance with the injury assessments required by CS 25.562(c) and these special conditions, may be conducted separately from the test(s) to show structural integrity. In this case, structural-assessment tests must be conducted as specified in paragraph 1a, above, and the injury-assessment test must be conducted without yaw or floor misalignment. Injury assessments may be accomplished by testing with ES-2re ATD (49 CFR part 572 subpart U) or equivalent at all places. Alternatively, these assessments may be accomplished by multiple tests that use an ES-2re at the seat place being evaluated, and a Hybrid-II ATD (49 CFR part 572, subpart B, as specified in CS 25.562) or equivalent used in all seat places forward of the one being assessed, to evaluate occupant interaction. In this case, seat places aft of the one being assessed may be unoccupied. If a seat installation includes adjacent items that are contactable by the occupant, the injury potential of that contact must be assessed. To make this assessment, tests may be conducted that include the actual item, located and attached in a representative fashion. Alternatively, the injury potential may be assessed by a combination of tests with items having the same geometry as the actual item, but having stiffness characteristics that would create the worst case for injury (injuries due to both contact with the item and lack of support from the item).

c) If a seat is installed aft of structure (e.g., an interior wall or furnishing) that does not have a homogeneous surface contactable by the occupant, additional analysis and/or test(s) may be required to demonstrate that the injury criteria are met for the area which an occupant could contact. For example, different yaw angles could result in different injury considerations and may require additional analysis or separate test(s) to evaluate.

d) To accommodate a range of occupant heights (5th percentile female to 95th percentile male), the surface of items contactable by the occupant must be homogenous 7.3 inches (185 mm) above and 7.9 inches (200 mm) below the point (center of area) that is contacted by the 50th percentile male size ATD's head during the longitudinal test(s) conducted in accordance with paragraphs a, b, and c, above. Otherwise, additional head injury criteria (HIC) assessment tests may be necessary. Any surface (inflatable or otherwise) that provides support for the occupant of any seat place must provide that support in a consistent manner regardless of occupant stature. For example, if an inflatable shoulder belt is used to mitigate injury risk, then it must be demonstrated by inspection to bear against the range of occupants in a similar manner before and after inflation. Likewise, the means of limiting lower-leg flail must be demonstrated by inspection to provide protection for the range of occupants in a similar manner.

e) For longitudinal test(s) conducted in accordance with CS 25.562(b)(2) and these special conditions, the ATDs must be positioned, clothed, and have lateral instrumentation configured as follows:

(1) ATD positioning:
Lower the ATD vertically into the seat while simultaneously (see Figure 2 for illustration):

a) Aligning the mid-sagittal plane (a vertical plane through the midline of the body; dividing the body into right and left halves) with approximately the middle of the seat place.

b) Applying a horizontal x-axis direction (in the ATD coordinate system) force of about 20 lb (89 N) to the torso at the intersection of the midsagittal plane and the bottom rib of the ES-2re or lower sternum of the Hybrid-II at the midsagittal plane, to compress the seat back cushion.

c) Keeping the upper legs nearly horizontal by supporting them just behind the knees.

Once all lifting devices have been removed from the ATD:

d) Rock it slightly to settle it in the seat.

e) Separate the knees by about 4 inches (100 mm)

f) Set the ES-2re's head at approximately the midpoint of the available range of z-axis rotation (to align the head and torso midsagittal planes).

g) Position the ES-2re's arms at the joint's mechanical detent that puts them at approximately a 40 degree angle with respect to the torso. Position the Hybrid-II ATD hands on top of its upper legs.

h) Position the feet such that the centerlines of the lower legs are approximately parallel to a lateral vertical plane (in the aircraft coordinate system).

(2) ATD clothing:

Clothe each ATD in form-fitting, mid-calf-length (minimum) pants and shoes (size 11E) weighing about 2.5 lb (1.1 Kg) total. The colour of the clothing should be in contrast to the colour of the restraint system. The ES-2re jacket is sufficient for torso clothing, although a form-fitting shirt may be used in addition if desired.

(3) ES-2re ATD lateral instrumentation:

The rib-module linear slides are directional, i.e., deflection occurs in either a positive or negative ATD y-axis direction. The modules must be installed such that the moving end of the rib module is toward the front of the aircraft. The three abdominal-force sensors must be installed such that they are on the side of the ATD toward the front of the aircraft.

f) The combined horizontal/vertical test, required by CS 25.562(b)(1) and these special conditions, must be conducted with a Hybrid II ATD (49 CFR part 572 subpart B as specified in CS 25.562), or equivalent, occupying each seat position.

g) Restraint systems:

(1) If inflatable restraint systems are used, they must be active during all dynamic tests conducted to show compliance with CS 25.562.

(2) The design and installation of seat-belt buckles must prevent unbuckling due to applied inertial forces or impact of the hands/arms of the occupant during an emergency landing.

2. Additional performance measures applicable to tests and rational analysis conducted to show compliance with CS 25.562 and 25.785 for side-facing seats:

a. Body-to-body contact: Contact between the head, pelvis, torso, or shoulder area of one ATD with the adjacent-seated ATD's head, pelvis, torso, or shoulder area is not allowed. Contact during rebound is allowed.

b. Thoracic: The deflection of any of the ES-2re ATD upper, middle, and lower ribs must not exceed 1.73 inches (44 mm). Data must be processed as defined in Federal Motor Vehicle Safety Standards (FMVSS) 571.214.

c. Abdominal: The sum of the measured ES-2re ATD front, middle, and rear abdominal forces must not exceed 562 lbs (2,500 N). Data must be processed as defined in FMVSS 571.214.

d. Pelvic: The pubic symphysis force measured by the ES-2re ATD must not exceed 1,350 lbs (6,000 N). Data must be processed as defined in FMVSS 571.214.

e. Leg: Axial rotation of the upper-leg (femur) must be limited to 35 degrees in either direction from the nominal seated position.

f. Neck: As measured by the ES-2re ATD and filtered at CFC 600 as defined in SAE J211:

1) The upper-neck tension force at the occipital condyle (O.C.) location must be less than 405 lb (1,800 N).

2) The upper-neck compression force at the O.C. location must be less than 405 lb (1,800 N).

3) The upper-neck bending torque about the ATD x-axis at the O.C. location must be less than 1,018 in-lb (115 Nm).

4) The upper-neck resultant shear force at the O.C. location must be less than 186 lb (825 N).

g. Occupant (ES-2re ATD) retention: The pelvic restraint must remain on the ES-2re ATD's pelvis during the impact and rebound phases of the test. The upper-torso restraint straps (if present) must remain on the ATD's shoulder during the impact. Alternatively to this requirement, for instances where the pelvic restraint moves off the pelvis during the rebound phase of the test, a

250 lbs restraint tension load limit may be used to establish an alternative compliance, provided the following requirements are met:

1. A clear indication of when the restraint moves above the pelvis. Loose clothing can make it difficult to determine where the top of the pelvis is, and in turn make it hard to discern exactly when the restraint moved above it. This can be improved by marking the top of the pelvis clearly and by positioning the cameras so that the position of the restraint, relative to the top of the pelvis can be observed throughout the test.

2. Measurement of the restraint tension during the time when the restraint moves above the pelvis. The webbing transducer should be placed to measure the total tension in the forward restraint segment. If a split (combined body-centered and conventional) leading restraint is used, the tension should be measured in the common section so that it reflects the contribution of each segment. Since this placement typically produces contact between the ATD and the transducer, it is important to use a webbing transducer that is not sensitive to contact.

3. Useful video and pelvic restraint load data must be recorded until significant ATD rebound motion stops. Extra recording time is necessary because submarining usually occurs later in the test than other injury criteria maximums.

h. Occupant (ES-2re ATD) support:

1) Pelvis excursion: The load-bearing portion of the bottom of the ATD pelvis must not translate beyond the edges of its seat's bottom seat-cushion supporting structure.

2) Upper-torso support: The lateral flexion of the ATD torso must not exceed 40 degrees from the normal upright position during the impact.

12

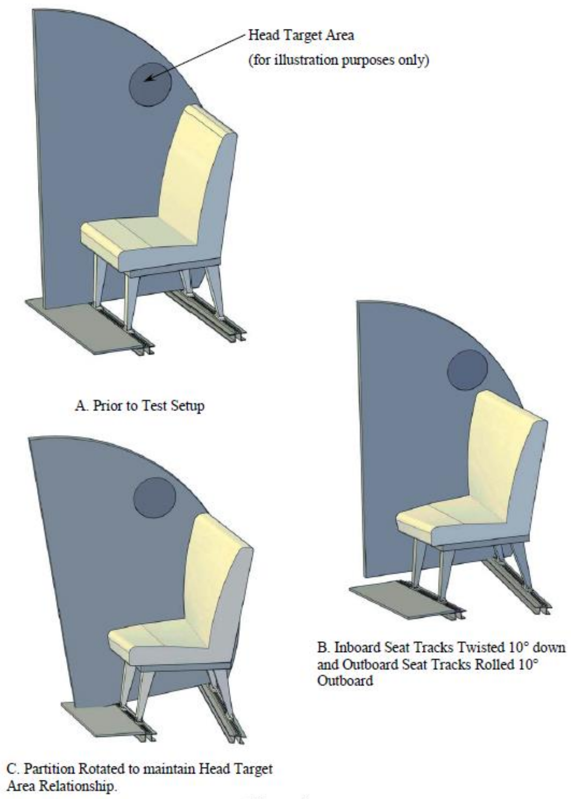


Figure 1

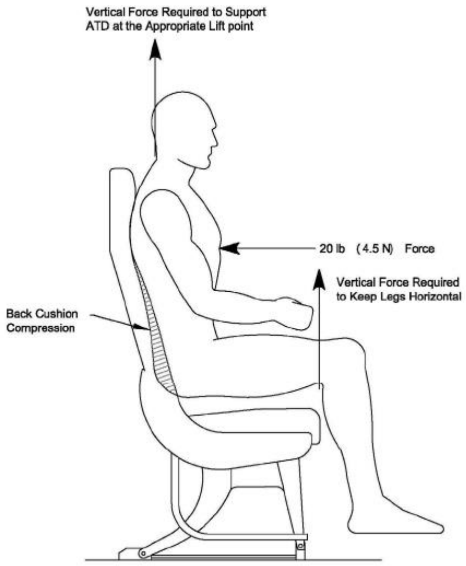


Figure 2

II. <u>Special Conditions for seat place(s) equipped with inflatable passenger restraint</u>

1. For seats with automatically deploying safety systems, show that any automatically deploying safety system will deploy and provide protection under crash conditions where it is necessary to prevent serious injury. The means of protection must take into consideration a range of stature from a 2-year-old child to a 95th percentile male. The automatically deploying safety system must provide a consistent approach to energy absorption throughout that range of occupants. When the seat system includes an automatically deploying safety system, that system must be included in each of the certification tests as it would be installed in the airplane. In addition, the following situations must be considered:

   a. The seat occupant is holding an infant.

   b. The seat occupant is a pregnant woman.

2. All automatically deploying safety systems must provide adequate protection for each occupant regardless of the number of occupants of the seat assembly, considering that unoccupied seats may have active automatically deploying safety systems installed.

3. The design must prevent all automatically deploying safety systems from being either incorrectly buckled or incorrectly installed, such that the automatically deploying safety system would not properly deploy. Alternatively, it must be shown that such deployment is not hazardous to the occupant, and will provide the required injury protection.

4. It must be shown that all automatically deploying safety system are not susceptible to inadvertent deployment as a result of wear and tear, or inertial loads resulting from in-flight or ground manoeuvres (including gusts and hard landings), and other operating and environmental conditions (vibrations, moisture, etc.) likely to occur in service.

5. Deployment of any automatically deploying safety system must not introduce injury mechanisms to the seated occupant, or result in injuries that could impede rapid egress. This assessment should include an occupant whose belt is loosely fastened.
6. It must be shown that inadvertent deployment of any automatically deploying safety system, during the most critical part of the flight, will either meet the requirement of CS 25.1309(b) or not cause a hazard to the airplane or its occupants.
7. It must be shown that any automatically deploying safety system will not impede rapid egress of occupants 10 seconds after airbag deployment.
8. All automatically deploying safety system must be protected from lightning and high-intensity radiated fields (HIRF). The threats to the airplane specified in existing regulations regarding lighting, CS 25.1316, and HIRF, CS 25.1317, are incorporated by reference for the purpose of measuring lightning and HIRF protection.
9. All automatically deploying safety system must function properly after loss of normal aircraft electrical power, and after a transverse separation of the fuselage at the most critical location. A separation at the location of the automatically deploying safety system does not have to be considered.
10. It must be shown that automatically deploying safety systems will not release hazardous quantities of gas or particulate matter into the cabin.
11. All automatically deploying safety system installation must be protected from the effects of fire such that no hazard to occupants will result.
12. A means must be available for a crewmember to verify the integrity of all automatically deploying safety system prior to each flight, or it must be demonstrated to reliably operate between inspection intervals. The EASA considers that the loss of an automatically deploying safety system deployment function alone (i.e., independent of the conditional event that requires the automatically deploying safety system deployment) is a major-failure condition.
13. The inflatable material may not have an average burn rate of greater than 2.5 inches/minute when tested using the horizontal flammability test defined in part 25, Appendix F, part I, paragraph (b)(5).
14. Any automatically deploying safety system, once deployed, must not adversely affect the emergency-lighting system (i.e., block floor proximity lights to the extent that the lights no longer meet their intended function).

Note: The special conditions in Chapter II above are meant to apply to restraint mounted airbags for side facing seats, however they have been generalized to any automatically deploying safety system triggered by the airbag system. Some conditions, such as Special Condition II 1, may not in part or fully apply to non-inflatable systems, it is left to the design applicant to explain and justify this aspect.

– END –

E-05 (SC): Water/ Ice in Fuel System	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.951
ADVISORY MATERIAL:	--

Special Condition (SC)

Appendix A

Special Condition

The applicant shall establish that:-

- the free water (or ice) remains evenly dispersed in the fuel under all operating conditions, or
- the amount of ice that could be released as a slug must be minimised. The applicant must establish the threat(s) (quantity of ice, temperature) that can be released. The complete fuel system (including the engine) must be shown to be tolerant to such sudden release of ice, without significant adverse effect(s) on the powerplant system.

In finding compliance, the following guidelines should be considered:

1) All components of the fuel system should be taken into account, including pipes and fuel tank structure. The environmental effects of component immersion in fuel, exposure to the tank ullage space and surrounding ambient air temperatures should be assessed in consideration of ice accretion and release.

2) The assessment should be performed for the most critical temperature conditions. It should at least address temperatures close to the fuel freezing point as well as temperatures likely to favour ice accretion, typically in the -20°/-10°C range.

3) Cumulative ice accretion over several flights should be minimised by design. The effect of the water sumping program as well as ground operation below 0°C should be taken into account.

4) If testing is used to establish compliance, the applicant should ensure that consistent and repeatable results are achieved.

– END –

E-11 (SC): Airworthiness standard for aircraft operations under falling and blowing snow	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.1093(b), CS 25J1093(b)
ADVISORY MATERIAL:	NPA 25E-341, NPA 2011-03

Special Condition (SC)

Appendix A

Special Condition

Add a paragraph (ii) to CS 25.1093(b)(1) to read as follows:

CS 25.1093 Air intake system de-icing and anti-icing provisions

(b) Turbine engines
(1) Each turbine engine must operate throughout the flight power range of the engine (including idling), without the accumulation of ice on the engine, inlet system components, or airframe components that would adversely affect engine operation or cause a serious loss of power or thrust (see AMC 25.1093 (b).) –
(i) Under the icing conditions specified in Appendix C.

(ii) ~~Reserved~~ In falling and blowing snow within the limitations (AFM) established for the aeroplane for such operation

Appendix B

Interpretative Material

“AMC No 2 to CS 25.1093(b) / CS 25J1193(b)

Propulsion Engine Air Intakes Falling and Blowing Snow (Acceptable Means of Compliance and Interpretative Material “

Falling and blowing snow is a weather condition, which needs to be considered for the powerplants and essential Auxiliary Power Units (APUs) of transport category airplanes. Although snow conditions can be encountered on the ground or in flight, there is little evidence that snow can cause adverse effects in flight on turbojet and turbofan engines with traditional pitot style inlets where protection against icing conditions is provided. However, service history has shown that inflight snow (and mixed phase) conditions have caused power interruptions on some turbine engines and APUs with inlets that incorporate plenum chambers, reverse flow, or particle separating design features.

For turbojet and turbofan engine with traditional pitot (straight duct) type inlets, icing conditions are generally regarded as more critical case than falling and blowing snow. For these types of inlets, compliance data for the icing requirements will be accepted for compliance to the falling and blowing snow requirements, in lieu of dedicated snow testing and/or analysis.

For non-pitot inlet types, demonstration of compliance with the falling and blowing snow ground conditions should be conducted by test and/or analysis. If acceptable powerplant operation can be shown in the following conditions, no take-off restriction on the operation of the aeroplane in snow will be necessary.

a. Visibility: 0.4 Km or less as limited by snow, provided this low visibility is only due to falling snow (i.e. no fog). This condition corresponds approximately to 1 g/m^3.

b. Temperature: -3°C to +2°C for wet (sticky) snow and -9°C to -2°C for dry snow, unless other temperatures are found to be critical (e.g. where dry snow at a lower temperature could cause runback ice where it contacts a heated surface).

c. Blowing snow: Where tests are conducted, the effects of blowing snow may be simulated by taxiing the aircraft at 15 to 25 kts, or buy using another aircraft to blow snow over the test powerplant. This condition corresponds approximately to 3 g/m^3.

d. Duration: it must be shown that there is no accumulation of snow or slush in the engine, inlet system or on airframe components, which would adversely affect engine operation during any intended ground operation. Compliance evidence should consider a duration which corresponds to the achievement of a steady state condition of accretion and (possible) shedding. Any snow shedding should be acceptable to the engine.

e. Operation: The methods for evaluating the effects of snow on the powerplant should be agreed by the Authority. All types of operation likely to be used on the ground should be considered for the test (or analysis). This should include prolonged idling and power transients consistent with taxiing and other ground manoeuvring conditions. Where any accumulation does occur, the engine should be run up to full power, to simulate takeoff conditions and demonstrate that no hazardous shedding of snow or slush occurs. Adequate means should be used to determine the presence of any hazardous snow accumulation.

f. For inflight snow (and mixed phase) conditions, some non-pitot type inlets with reverse flow particle separators have been found to accumulate snow/ice in the pocket lip (sometimes referred to as the “birdcatcher” section) just below the splitter which divides the engine compressor from the inlet bypass duct. Eventually, the buildup of snow in the pocket (which can melt and refreeze into ice) either spans across to the compressor inlet side of the splitter lip or, the snow/ice buildup is released from the pocket and breaks up whereupon some of the ice pieces can be reingested into the compressor side of the inlet. The ingestion of this snow/ice has caused momentary or permanent flameouts and in some cases, foreign object damage to the compressor.

Some airframe manufacturers have tried to correct this condition by increasing the amount and/or frequency of applied thermal heat used around the pocket, splitter, and bypass sections of the inlet. However, short of modifying the engine ice protection systems to the point of operating fully evaporative, these fixes have mostly failed to achieve acceptable results.

Airplanes with turbine engine or essential APU inlets which have plenum chambers, screens, particle separators, variable geometry, or any other feature (such as an oil cooler) which may provide a hazardous accumulation site for snow should be qualitatively evaluated for inflight snow conditions. The qualitative assessment should include:

1) A visual review of the installed engine and inlet (or drawings) to identify potential snow accumulation sites

2) Review of the engine and engine inlet ice protection systems to determine if the systems were designed to run wet, fully evaporative, or just de-ice during icing conditions

3) Unless the inlet ice protection means (e.g. thermal blanket, compressor bleed air, hot oil) operates in a fully evaporative state in and around potential inlet accumulation sites, inlet designs with reverse flow pockets exposed directly to inflight snow ingestion should be avoided."

– END –

F-04 (SC): Airborne Systems and Network Security	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	21A.16B, CS 25.1309
ADVISORY MATERIAL:	AMC 25.1309

Special Condition (SC)

Appendix A

Special Condition

a) The applicant shall ensure security protection of the systems and networks of the aircraft from any remote or local access by unauthorized sources if corruption of these systems and networks (including hardware, software, data) by an inadvertent or intentional attack would impair safety, and

b) The applicant shall ensure that the security threats to the aircraft, including those possibly caused by maintenance activity or by any unprotected connecting equipment/devices inside or outside the A/C, are identified, , assessed and risk mitigation strategies are implemented to protect the aircraft systems from all adverse impacts on safety, and

c) Appropriate procedures shall be established to ensure that the approved security protection of the aircraft's systems and networks is maintained following future changes to the Type Certificated design.

Appendix B

Interpretative Material

Aircraft systems and networks covered by 25.1309 should be assessed against potential failure caused by information security threats in order to evaluate their vulnerabilities to these threats. To do so an acceptable means is to perform a Particular Risk Analysis, called in the rest of this AMC "Network Security Assessment", that is described in section I.

As a result of this assessment, either the aircraft systems have no known vulnerabilities, or the vulnerabilities cannot be exploited by any security threat to create a Hazard of a Failure Condition that has an effect deemed unacceptable against CS 25.1309.

When vulnerabilities exist and protection mechanisms are needed to fulfil this requirement, validation and verifications of these security protection mechanisms, as described in section II, should demonstrate that the implemented mechanisms provide the expected protection against information security threats.

When required, Instruction for Continued Airworthiness as described in section III should be developed to maintain the security efficiency after the entry into service of the Aircraft.

I. AIRCRAFT SYSTEMS AND NETWORK SECURITY ASSESSMENT

As recommended in ED-79A/ARP-4754A and ED-135/ARP-4761, a Particular Risk Analysis is required when risks, as those events or influences which are outside the system(s) and item(s) concerned, but which may violate failure independence claims, may be encountered. Having identified the appropriate risks with respect to the design under consideration, each risk should be the subject of a specific study to examine and document the simultaneous or cascading effect(s) of each risk. The objective is to ensure that any safety related effects are either eliminated or the risk is shown to be acceptable.

In this context, the applicant should develop a Particular Risk Analysis dedicated to Aircraft Systems and Network Information Security, hereafter referred to as the Network Security Assessment. It should include:

1. identification and detailed definition or the information security threats, risks and vulnerabilities
2. identification of the impacted assets
3. review of the consequences on safety of the information security threat on the affected items
    a. *Note: the following documentation should be used as input, when appropriate: FHA, FMEA or PSSA*
4. review of the potential effect of the information security threats on the aircraft safety
5. Determination if the consequences are acceptable.
    a. If yes, preparation of justification for certification
    b. If no,
        i. implementation, description and justification of a protection mechanism(s),
        ii. Identification of the vulnerabilities associated with incorrect operation or loss of the protection mechanisms

6. Definition of the Security Level for all implemented protection mechanism. This security level determination should encompass:
   a. the effectiveness of the protection mechanism,
   b. the likelihood of the information security thread to occur and,
   c. the acceptability of the risk, depending on its effect to the safety.

When a system and network security rule violation may, as a result of this assessment, generate an unsafe condition, this violation should be reported timely to the crew or maintenance operators. Guidance can be found in AMC 25.1309 § 9(5) Crew and Maintenance Actions (i), (ii) and (iii).

The applicant should gain the agreement of the EASA for those assigned protection levels and their network security protection plan(s).
Guidance for performing security risk assessments for airworthiness on Aircraft Systems and Network, and for Security Level determination can be found in document ED-202/DO-326.

This Network Security Assessment should be performed for any design change which may have an effect on the Aircraft Systems and Network Security.

II. VALIDATION AND VERIFICATION OF THE AIRCRAFT SYSTEMS AND NETWORK SECURITY PROTECTION

When vulnerabilities have been identified during the Network Security Assessment, and when these vulnerabilities require the implementation of protection mechanisms, security verifications should demonstrate that Aircraft safety is not lowered by information security threats.
These security verifications should
a. establish the correct functioning of security technical features, and
b. verify the absence of unintended functionality, and
c. verify the absence of new vulnerabilities introduced by the protection mechanism.

These verifications should be performed as much as possible by security testing. Security testing addresses the aircraft system from the perspective of a potential adversary, using network access or other vulnerabilities identified in the Network Security Assessment, potentially including:
a. Network access;
b. Logical remote access where enabled; and
c. Forged data (such as malware, coherently corrupted data tables, configuration files).

In case that these verifications cannot be established through functional testing, they may be done by combinations of analysis, (security oriented) robustness testing, inspection and review.

III. INSTRUCTION AND INFORMATION FOR CONTINUED AIRWORTHINESS

The applicant should identify the network security assets and protection mechanism to be addressed by the ICA of the aircraft (for example: physical and operational security, auditing and monitoring of the security efficiency, key management procedures that are used as assumptions in the security assurance process) and develop the appropriate procedure to maintain the security efficiency after the aircraft enters commercial service.

When an in-service occurrence is reported, the applicant should consider the possibility to be originated by a system and network security rule violation and should take any required corrective action accordingly. When a system and network security rule violation has generated an unsafe condition, then information about occurrence, investigation results and recovery actions will be reported to the Agency in accordance with Part 21A.3.

The Applicant should also assess the impact of new threats not foreseen during previous Network Security Assessment, on the aircraft systems and networks. In case the assessment would identify an unacceptable hazard of Failure Condition, the Applicant should notify the Operators of the need to update the protection means.

– END –

F-05 (SC): HIRF Protection	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	21.A.16B (a)(3)
ADVISORY MATERIAL:	JAA INT/POL/25/2

Special Condition (SC)

Appendix A

Special Condition

HIRF protection

The aeroplane electrical and electronic systems, equipment, and installations considered separately and in relation to other systems must be designed and installed so that:

Each function, the failure of which would prevent the continued safe flight and landing of the aeroplane:

Is not adversely affected when the aeroplane is exposed to the Certification HIRF environment defined in Appendix 1.

Following aeroplane exposure to the Certification HIRF environment, each affected system that performs such a function automatically recovers normal operation unless this conflicts with other operational or functional requirements of that system.

Each system that performs a function, the failure of which would prevent the continued safe flight and landing of the aeroplane, is not adversely affected when the aeroplane is exposed to the normal HIRF environment defined in Appendix 1.

Each system that performs a function, the failure of which would cause large reductions in the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions, is not adversely affected when the equipment providing these functions is exposed to the equipment HIRF test levels defined in Appendix 1.

Each system that performs a function, the failure of which would reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions, is not adversely affected when the equipment providing these functions is exposed to the equipment HIRF test levels defined in Appendix 1.

APPENDIX 1

a) HIRF environments
Table I lists the Certification HIRF environment required by SC F-01 sub-paragraph (a).
Table II lists the Normal HIRF environment required by SC F-01 sub-paragraph (b).

b) Test levels for complying with SC F-01 sub-paragraph (c)
As a minimum, one of the following sets of equipment test levels shall be used:

1. From 10 kHz to 400 MHz, use conducted susceptibility tests with CW and 1 kHz square wave modulation of depth greater than 90 percent. The conducted susceptibility current shall start at 0.6 mA at 10 kHz, increasing 20 dB per frequency decade to 30 mA at 500 kHz. From 500 kHz to 400 MHz, the conducted susceptibility current shall be 30 mA. From 100 MHz to 400 MHz, use radiated susceptibility tests at 20 V/m peak, with CW and 1 kHz square wave modulation of depth greater than 90 percent. From 400 MHz to 8 GHz, use radiated susceptibility tests at 150 V/m peak with pulse modulation of 0.1 percent duty cycle with 1 kHz pulse repetition frequency. This signal should be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent. Also, from 400 MHz to 8 GHz, use radiated susceptibility tests at 28 V/m peak with 1 kHz square wave modulation of depth greater than 90 percent. This signal should be switched on and off at a rate of 1 Hz (ref. ED-14D/DO-160D, Section 20, Cat. R).

2. Or, from 10 kHz to 400 MHz, use conducted susceptibility tests with CW and 1 kHz square wave modulation of depth greater than 90 percent. The conducted susceptibility current shall start at 0.6 mA at 10 kHz, increasing 20 dB per frequency decade to 30 mA at 500 kHz. From 500 kHz to 400 MHz, the conducted susceptibility current shall be 30 mA. From 100 MHz to 400 MHz, use radiated susceptibility tests at 20 V/m peak, with CW and 1 kHz square wave modulation of depth greater than 90 percent. From 400 MHz to 8 GHz, use radiated susceptibility tests at 150 V/m peak with pulse modulation of 4 percent duty cycle with a 1 kHz pulse repetition frequency. This signal should be switched on and off at a rate of 1 Hz with a duty cycle of 50 percent (ref. ED-14D/DO-160D, Section 20, Cat. R).

3. Or, the test level to be used during equipment testing may be based on the Normal HIRF environment in Table II with allowance made for aircraft attenuation using aircraft transfer function/attenuation curves. Testing must cover the frequency band of 10 kHz to 8 GHz.

c) Test levels for complying with F-12 sub-paragraph (d)
As a minimum, the following equipment test level shall be used:

From 10 kHz to 400 MHz, use conducted susceptibility tests, starting at 0.15 mA at 10 kHz, increasing 20 dB per frequency decade to 7.5 mA at 500 kHz. From 500 kHz to 400 MHz, use conducted susceptibility tests at 7.5 mA. From 100 MHz to 8 GHz, use radiated susceptibility tests at 5 V/m (ref. ED-14D/DO-160D, Section 20, CAT T).

d) Test procedures
AC/AMJ 20.1317 Final Draft Issue (EEHWG Document WG-327 dated November 98) and EUROCAE ED-14D/RTCA Document DO-160D, Section 20 should be referred to for the applicability of tests and test details.

TABLE I

CERTIFICATION HIRF ENVIRONMENT

FREQUENCY	FIELD STRENGTH (V/m)	
	PEAK	AVERAGE
10 kHz - 100 kHz	50	50
100 kHz - 500 kHz	50	50
500 kHz - 2 MHz	50	50
2 MHz - 30 MHz	100	100
30 MHz - 70 MHz	50	50
70 MHz - 100 MHz	50	50
100 MHz - 200 MHz	100	100
200 MHz - 400 MHz	100	100
400 MHz - 700 MHz	700	50
700 MHz - 1 GHz	700	100
1 GHz - 2 GHz	2000	200
2 GHz - 4 GHz	3000	200
4 GHz - 6 GHz	3000	200
6 GHz - 8 GHz	1000	200
8 GHz - 12 GHz	3000	300
12 GHz - 18 GHz	2000	200
18 GHz - 40 GHz	600	200

TABLE II
NORMAL HIRF ENVIRONMENT

FREQUENCY	FIELD STRENGTH (V/m)	
	PEAK	AVERAGE
10 kHz - 100 kHz	20	20
100 kHz - 500 kHz	20	20
500 kHz - 2 MHz	30	30
2 MHz - 30 MHz	100	100
30 MHz - 70 MHz	10	10
70 MHz - 100 MHz	10	10
100 MHz - 200 MHz	30	10
200 MHz - 400 MHz	10	10
400 MHz - 700 MHz	700	40
700 MHz - 1 GHz	700	40
1 GHz - 2 GHz	1300	160
2 GHz - 4 GHz	3000	120
4 GHz - 6 GHz	3000	160
6 GHz - 8 GHz	400	170

8 GHz - 12 GHz	1230	230
12 GHz - 18 GHz	730	190
18 GHz - 40 GHz	600	150

– END –

F-06 (SC): Flight Instrument External Probes – Qualification in Icing Conditions	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.1309, 25.1323(h), 25.1323(i), 25.1325(b), 25.1326, 25.1419, 25.1529, ETSO C16a & C54
ADVISORY MATERIAL:	AMC 25.1323(h), 25.1323(i), 25.1325(b), 25.1093(b)(1),25.1419

Special Condition (SC)

Appendix A

Flight Instrument External Probes – Qualification in Icing Conditions

Replace CS 25.1323(i), AMC 25.1323(i) and 25.1326 by SC 1 & 2 and respective AMC's

1 Flight Instrument External Probes Heating Systems

Each Flight Instrument External Probes Systems must be heated or have an equivalent means of preventing malfunction due to icing conditions specified in CS 25 Appendix C and mixed phase / ice crystal conditions as defined in Appendix 1 of this Special Condition (see AMC in Appendix 2 of this SC)

2 Flight Instrument External Probes heat alerting systems

If a flight instrument external probe heating system is installed, an alerting system must be provided to alert the flight crew when the flight instrument external probe heating system is not operating or not functioning normally. The alerting system must comply with the following requirements:

(a) The alert provided must conform to the Caution alert indications.
(b) The alert provided must be triggered if either of the following conditions exists:
(1) The flight instrument external probe heating system is switched 'off'.
(2) The flight instrument external probe heating system is switched 'on' and any flight instrument external probe heating element is not functioning normally.
(see AMC in Appendix 2 of this SC)

Appendix 1 to Appendix A

Special Condition

Mixed Phase and Ice Crystal Icing Envelope (Deep Convective Clouds)

References

1. THE ANALYSIS OF MEASUREMENTS OF FREE ICE AND ICE/WATER CONCENTRATIONS IN THE ATMOSPHERE OF THE EQUATORIAL ZONE, IAN I. MCNAUGHTON, B.SC., DIP. R.T.C., ROYAL AIRCRAFT ESTABLISHMENT (FARNBOROUGH) TECHNICAL NOTE NO: MECH. ENG. 283

2. SNOW AND ICE PARTICLE SIZES AND MASS CONCENTRATIONS AT ALTITUDES UP TO 9 KM (30,000 FT), R. K. JECK, DOT/FAA/AR-97/66, AUGUST, 1998.

3. CLOUD MICROPHYSICAL MEASUREMENTS IN THUNDERSTORM OUTFLOW REGIONS DURING ALLIED/BAE 1997 FLIGHT TRIALS, STRAPP, J.W., P. CHOW, M. MALTBY, A.D. BEZER, A. KOROLEV, I. STOMBERG, AND J. HALLETT, *37TH AIAA AEROSPACE SCIENCES MEETING AND EXHIBIT*, JAN. 11-14, 1999, RENO, NV. AIAA 99-0498.

4. ARAC EHWG PROPOSED APPENDIX D TO 14 CFR PART 33

Ice crystal conditions associated with convective storm cloud formations exist within the CS 25 Appendix C Intermittent Maximum Icing envelope (including the extension to -40 deg C) and the Mil Standard 310 Hot Day envelope. This ice crystal icing envelope is depicted in the Figure D-1.

FAR 33 Appendix D Icing Envelope Limits

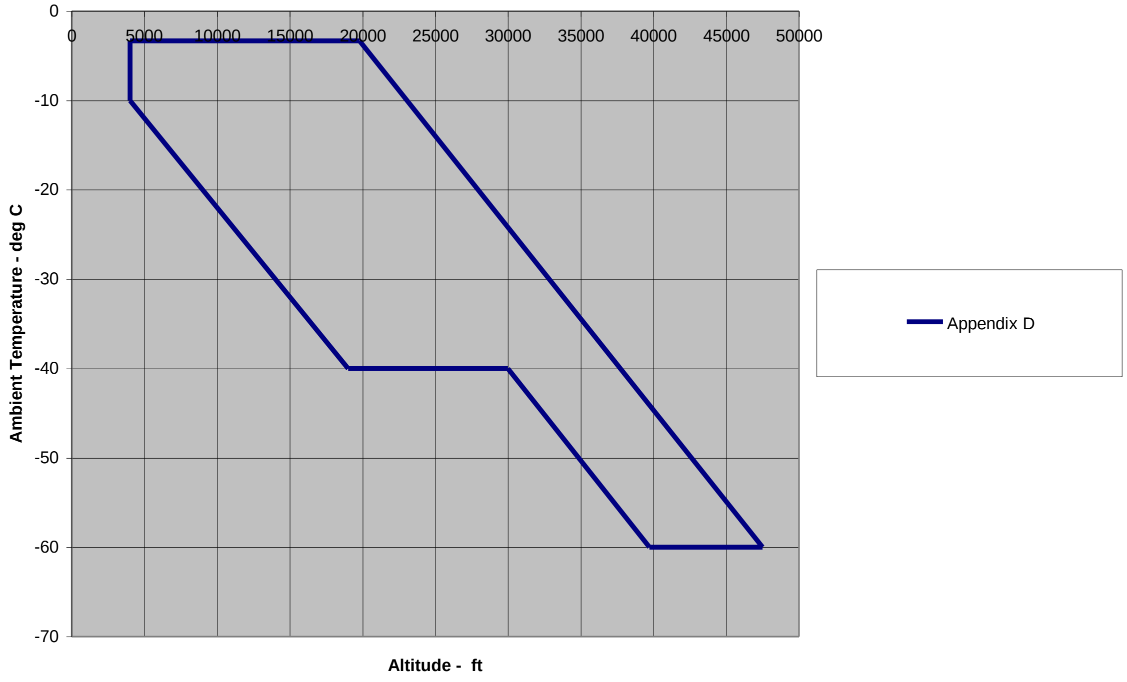


Figure D-1 Convective Cloud Ice Crystal Envelope

Within the envelope, total water content (TWC) in gms/m3 have been assessed based upon the adiabatic lapse defined by the convective rise of 90% relative humidity air from sea level to higher altitudes and scaled by a factor of 0.65 to a standard cloud length of 17.4 nautical miles. TWC is displayed for this distance over a range of ambient temperature within the boundaries of the ice crystal envelope in Figure D-2.

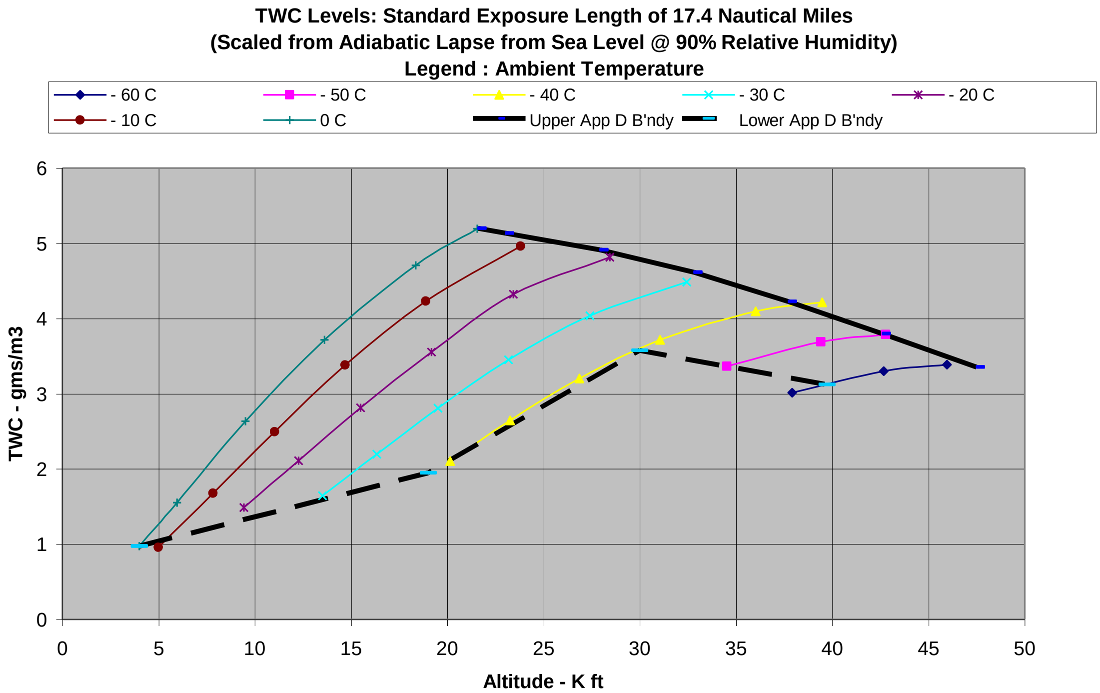


Figure D-2 Total Water Content

Ice crystal size median mass dimension (MMD) range is 50 - 200 microns (equivalent spherical size) based upon measurements near convective storm cores.

The TWC can be treated as completely glaciated except as noted in the Table D-1.

Temperature Range – deg C	Horizontal Cloud Length	LWC – gm/m3
0 to -20	</= 50 miles	</=1.0
0 to -20	Indefinite	</=0.5
< -20		0

Table D-1 Supercooled Liquid Portion of TWC

The TWC levels displayed in Figure D-2 represent TWC values for a standard exposure distance (horizontal cloud length) of 17.4 nautical miles that must be adjusted with length of icing exposure. The assessment from data measurements in References 1 supports the reduction factor with exposure length shown in Figure D-3.

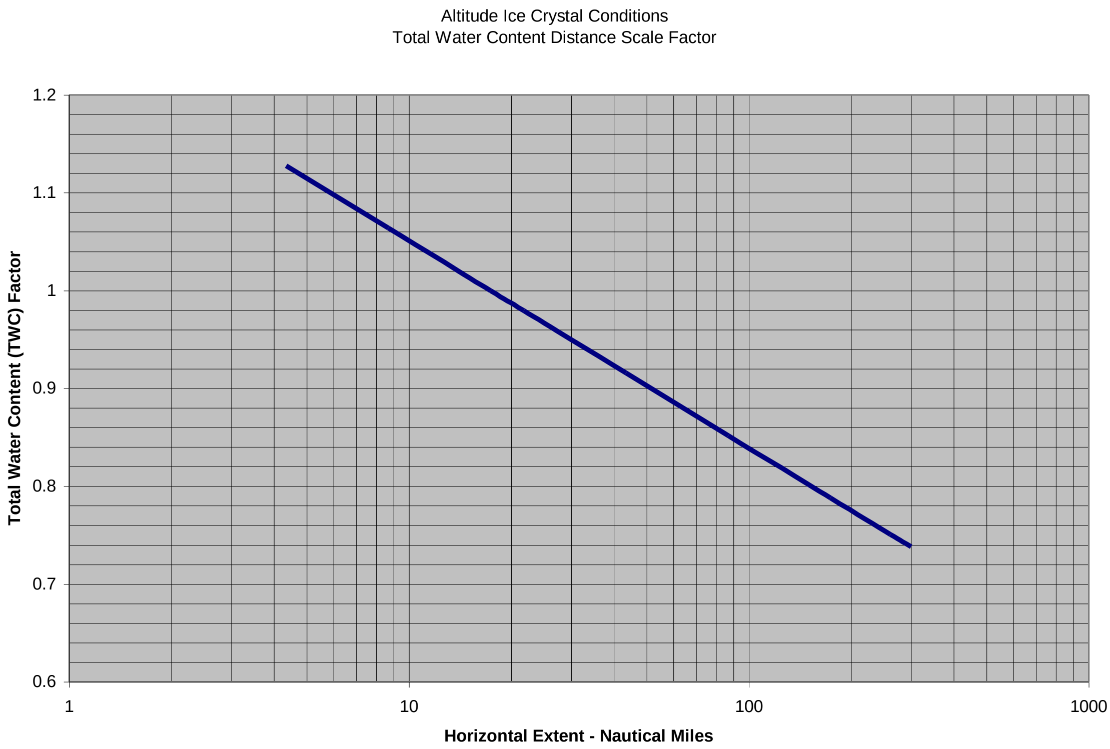


Figure D-3 Exposure Length Influence on TWC

Appendix 2 to Appendix A

Acceptable Means of Compliance

1. Nomenclature

SAT: Static Air Temperature
LWC: Liquid Water Content
MVD: Mean Volume Diameter
IWC: Ice Water Content
IMMD: Ice Median Mass Dimension
L(i): "Liquid" supercooled water conditions
M(i): Mixed phase icing conditions, contain both supercooled water and ice crystals.
G(i): Glaciated conditions are icing conditions totally composed of ice crystals.
R(i): Rain conditions

2. Test setup and Conditions to be tested

2.1. Wind Tunnels

If wind tunnel testing is proposed, all conditions must be appropriately corrected to respect the similarity relationship between actual and wind tunnel conditions (due to pressure and scale differences for example). It is the manufacturer responsibility to determine and justify the various derivations and corrections to be made to the upstream conditions in order to determine actual test conditions (local and scaled). When the tests are conducted in non-altitude conditions, the system power supply and the external aerodynamic and atmospheric conditions should be so modified as to represent the required altitude condition as closely as possible.

Icing Wind tunnel calibration shall be verified, in accordance with SAE ARP 5905, prior to the beginning of icing test campaign, and at the end of the campaign. In particular, the local liquid water concentration at the location of the probe shall comply with values required in the test specification.

2.2. Test setup

The test setup installation in the wind tunnel must be shown to be equivalent to the installation on aircraft. In particular, the probe must be installed in such a way that the heat sink capacity of the mount is equal to or greater than the aircraft installation.

Surface temperature measurements are typically made, during icing wind tunnel tests to verify thermal analyses and to allow extrapolation to conditions not reachable due to tunnel limitations.

2.3. Local conditions

The Water Content (WC) values provided in this AMC or in the Appendix 1 are upstream values, independent of the aircraft installation. Local WC values (values at the probe location) need to be derived from the upstream values according to the streamline behavior

around the aircraft. Overconcentration of the WC at the probe location may occur due to the aerodynamic effects of the fuselage in particular.
Local conditions shall be determined based on many parameters which could be :

- **Aircraft specific**
  - A/C fuselage shape
  - Probe location on A/C fuselage (X, Y, Z coordinates)
  - A/C speed and altitude (Climb, Cruise, Descent …)
- **Environmental Conditions specific**
  - Type (SD, SLD, Crystals, Rain)
  - Size (from 0 to 2000 micron)
  - Density
- **Probe specific:**
  - mast/strut length

Concerning the type and size of the particles, the local WC shall be computed considering the full distribution of the particles sizes that is actually present in the real atmosphere, even if the wind tunnel tests are then performed at a given single size (20 micron for supercooled droplets, 150 micron for ice crystals, 1000 & 2000 micron for rain drops). The local conditions may also be affected by the "bouncing effect" for solid particles or the "splashing effects" for large liquid particles.

2.4. Operational Conditions

The conditions are to be tested at several Mach and Angle of Attack (AoA) values in order to cover the operational flight envelope of the aircraft. It is the manufacturer responsibility to select and justify, for each of the conditions listed in each Cloud Matrix below, the relevant operational conditions to be tested (Mach, AoA and Mode…).

For normal operational conditions all the parameters such as weight and CG position should be considered. Other operational conditions should be considered such as the dispatch in MMEL and major failure conditions having an effect on the Mach number and / or the AoA.

It is expected that several operational conditions will be identified for each matrix condition but exhaustive testing is not intended.

2.5. Power supply

The heating power supply used during the tests shall be the minimum value expected at the probe location on the aircraft.

2.6. Test article selection

To be delivered an article has to meet an Acceptance Test Procedure (ATP) established by the equipment supplier. The ATP is a production test performed on each item to show it meets the performance specification. The performance of the ice protection system, in particular the icing tests described hereafter, are expected to be demonstrated with an equipment selected at the lowest value of the ATP with the respect to the acceptability of the heating performance.

2.7. Mode of Operation

The modes of operation of the probe are to be assessed in the two following tests. However, depending of the mode of operation of the heating systems, other intermediate modes may have to be tested (e.g. if heating power is varied as a function of the outside temperature, etc.)

Anti-icing test:

During this test, the icing protection of the probe (typically resistance heating) is assumed to be switched "on" prior to reaching freezing temperatures.

De-icing test:

During this test, the icing protection of the probe (typically resistance heating) must be "off" until 0.5 inch of ice has accumulated on the probe. For ice crystal tests in deicing mode, since no accretion is usually observed, an agreed Off period time duration shall be agreed before the test; in the past a one minute time duration without heating power has been accepted This mode need not be tested if, in all operational scenarios (including all dispatch cases), the probe heating systems are activated automatically at A/C power ON and cannot be switched to manual operation later during the flight.

2.8. Liquid (L) Conditions

The following proposed test points, are intended to provide the most critical conditions of the complete CS 25 Appendix C icing envelope, however, Critical Point Analysis (CPA) may be used to justify other values.

Stabilized conditions

Test #	SAT (°C)	Altitude Range		LWC(*) (g/m3)	Duration (min)	MVD(*) (µm)
L1	-20	0 to 22000 ft	0 to 6700m	0,22 to 0,3	15	15 to 20
L2	-30	0 to 22000 ft	0 to 6700m	0,14 to 0,2	15	15 to 20
L3	-20	4000 to 31000 ft	1200 to 9450m	1,7 to1,9	5	15 to 20
L4	-30	4000 to 31000 ft	1200 to 9450m	1 to 1,1	5	15 to 20
L5	-40	4000 to 31000 ft	1200 to 9450m	0,2 to 0,25	5	15 to 20

Table 1: Stabilized Liquid icing test conditions

(*) **Note:**

The upstream LWC values of the table are based on CS 25 Appendix C and correspond to a droplet diameter of 20µm or 15µm. Considering that the local collection efficiency is function of the MVD and the probe location with respect to the boundary layer, and that the upstream LWC value is higher for an MVD of 15 µm as compared to 20 µm, the applicant shall establish the conditions leading to the highest local LWC at probe location and test accordingly.

It is acceptable to run the tests at the highest determined local LWC but using a droplet diameter of 20 µm since most of the wind tunnel are calibrated for that value.

Cycling conditions

The cycling test conditions detailed in Table 2 below are identical to those established in AMC 25.1093 (b) section 2.4.2, and currently recommended in existing AMC 25.1323(i), 25.1325(b) and 25.1419.

A separate test should be conducted at each temperature condition of Table below, the test being made up of repetitions of either the cycle:

a. 28 km in the conditions of column (a) appropriate to the temperature, followed by 5 km in the conditions of column (b) appropriate to the temperature, for a duration of 30 minutes, or
b. 6 km in the conditions of column (a) appropriate to the temperature, followed by 5 km in the conditions of column (b) appropriate to the temperature, for a duration of 10 minutes.

Test #	SAT (°C)	Altitude Range (ft)	Altitude Range (m)	LWC (g/m³) (a)	LWC (g/m³) (b)	MVD (µm)
L6	-10	17 000	5 200	0.6	2.2	20
L7	-20	20 000	6 100	0.3	1.7	
L8	-30	25 000	7 600	0.2	1.0	

Table 2: Cycling Liquid icing test conditions

2.9. 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. The SLD concentrations between 0.2 and 0.5 g/m3 are largely covered by the Appendix C continuous concentrations (between 0.2 and 0.8 g/m3) and the Appendix C intermittent concentrations (between 0.25 and 2.9 g/m3).

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 SLD conditions.

2.10. Mixed Phase (M) and Glaciated (G) Conditions

The applicant shall propose a set of critical test points to cover adequately the Icing Environment as proposed in Appendix 1 of this CRI. The following considerations shall be taken into consideration.

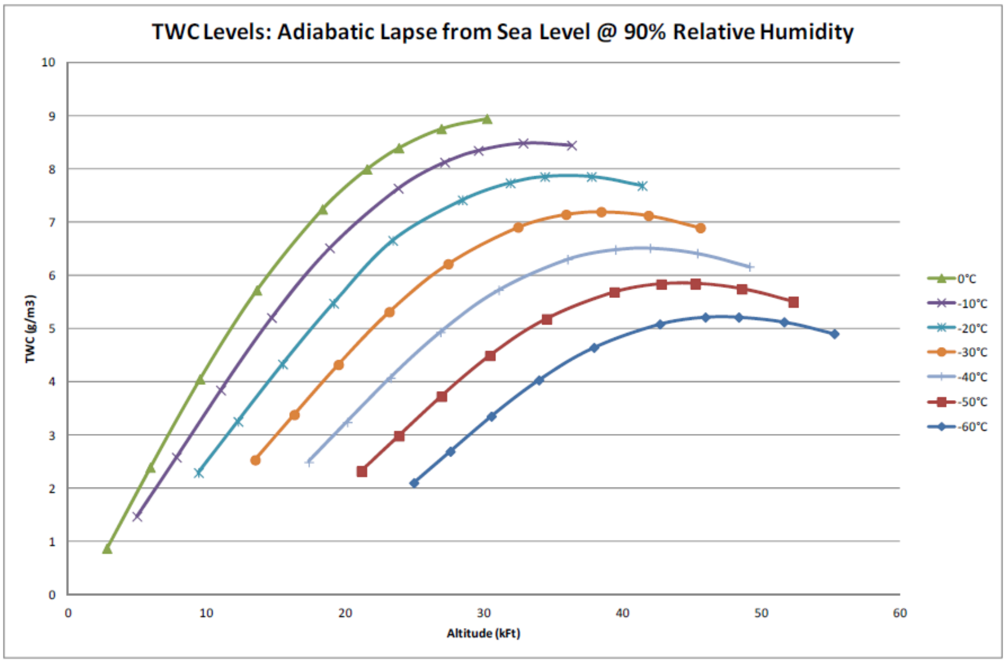
Glaciated Conditions

As indicated in the Appendix 1, the total water content (TWC) in gms/m3 have been assessed based upon the adiabatic lapse defined by the convective rise of 90% relative humidity air from sea level to higher altitudes and scaled by a factor of 0.65 to a standard cloud length of 17.4 nautical miles.

In service occurrences show that several Pitot icing events in Glaciated Conditions, above 30 000ft, are outside of the Appendix 1 domain in term of Altitude and outside air temperature. In particular, a reported event occurred at a temperature of -70°C. Testing may not be possible at such a low temperature due to simulation tool limitations however, the presence of Ice Crystals has been observed and it is anticipated that an extrapolation of existing test data at higher temperature should allow assessing the predicted performance of the probe heating down to this minimum temperature.

In addition, based on various feedback (Eurocae WG 89 in particular), EASA is of the opinion that the standard cloud of 17.4 NM and the associated average TWC concentration values provided by appendix 1 may not provide the most conservative conditions for Flight Instrument External probes testing.

The “max” or “peak” TWC concentration values should be considered instead of the “17.4 NM” values provided by the Appendix 1. These max or peak values are given in FAA document DOT/FAA/AR-09/13. They correspond to the “17.4 NM” values multiplied by a factor of 1.538 (1/0.65). The “max” concentration values (TWC) are provided below:

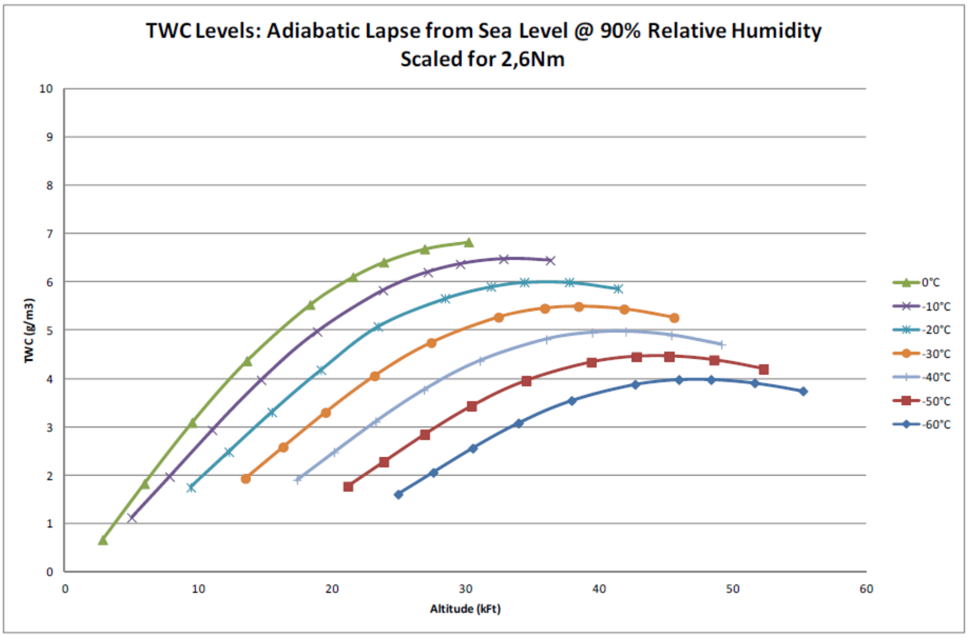


Mixed Phase Conditions

In service occurrences show several Pitot icing events in Mixed phase conditions, between 20 000 & 30 000 ft, outside of the Appendix 1 domain in term of Altitude and outside air Temperature.

Based on various feedback (Eurocae WG 89 in particular), EASA is of the opinion that the “2.6 NM” TWC concentration values should be considered instead of the “17.4 NM” values, as the CS 25 Appendix C Intermittent conditions provide data for a 2.6 NM cloud.

The “2.6 NM” values are given by the “17.4 NM” values scaled by the F factor for 2.6 NM clouds which is 1.175 and are provided below:



Ice Particles

According to the IPHWG, several methods of generating ice particles are used in testing and produce a wide range of particle sizes. Some methods of generating ice particles results in irregular shapes which are difficult to quantify in terms of mean particle diameter. The heat requirements for mixed phase icing are driven primarily by the quantity of ice collected in the probe rather than the size of the ice particles. Particles in the range of 50 to 1000 µm tend towards ballistic trajectories with collection efficiencies approaching one on conventional Pitot tubes. As such, the IPHWG determined it is acceptable to specify ice particle sizes based on the available range of ice particle generation techniques and using the IMMD consistent with draft AC 20-147 for engines.

Past experience shows that an ice crystal MMD size of 150 micron is the more practical size to be tested in wind tunnel. For mixed phase conditions, it shall be tested together with supercooled droplet MVD size of 20 micro.

Duration

For each condition a minimum of 2 minutes exposure time shall be tested. This is the minimum time needed to reach a steady state and stabilised condition.

Total Air Temperature design consideration

It is recognised that due to the intrinsic function of the total air temperature probes it may not be possible to design the temperature sensor with sufficient heating capability to ensure both adequate protection across the complete icing environment of Appendix 1 and accurate temperature measurements. In this case it may be acceptable that the temperature probe is not fully protected over a portion of the Appendix 1 icing environment provided that the malfunction of the probe within this portion and outside the portion if applicable will not prevent continued safe flight and landing. System safety assessments must include common mode failure conditions. Mitigation for potential icing related failures at the aircraft level should be accomplished as required by the Air Data System and/or by the primary data consumers, specifically, by comparing air data from multiple sources and from sources of dissimilar technologies.

2.11. Rain (R)Conditions

Test #	SAT	Altitude Range		LWC	Horizontal Extent		Droplet MVD
	(°C)	(ft)	(m)	(g/m3)	(km)	(nmi)	(µm)
R1	-2 to 0	0 to 10,000	0 to 3,000	1	100	50	500 to 1000
R2				6	5	3	
R3				15	1	0.5	

Table 3: Rain icing test conditions

2.12. Pass/fail criteria

The pass/fail criteria of a given test are as follows:

The output of the probe must quickly stabilize to the correct value (after the start of an Anti-icing test or once the icing protection is restored in a De-icing test), value which has to be agreed before the test between the manufacturer and EASA, and it must stay correct as long as the icing protection is maintained. The measurement is considered to be correct if any observed fluctuation when assessed by the manufacturer has no effect at A/C level.

In addition, for Pitot probes and especially during ice crystal or mixed conditions tests, it shall be observed that the measured pressure is not ‘frozen’(pressure signal without any noise, i.e. completely flat), which would indicate an internal blockage resulting in a captured pressure measurement.

At the conclusion of each test, the amount of water trapped in and around the probe (i.e in the line conveying the air to the electronics) shall not interfere with the output correctness, if the probe were suddenly subjected to freezing or re-freezing after melting. After each tests, any moisture accumulating in the probe connection line shall be removed and measured. A maximum of 1 gram should not be exceeded.

III. Probes heat alerting systems

If a flight instrument external probes heating system is installed, an alerting system must be provided to indicate to the flight crew when that flight instrument external probes heating system is not operating or not functioning normally. In other words, failures must be indicated to the crew if such failures have an impact on the performance of the heating system to the extent of having an “effect on operational capability or safety” (see CS 25.1309).

The setting of the information provided to the flight deck is expected to be not lower than the lowest acceptable value of the heating performance according to its performance specification and/or qualification standards.

All performances of the probe ice protection system, in particular the icing tests described in this AMC are expected to be demonstrated with equipment selected at the level of the flight deck indication of the probe.

IV. Maintenance Tasks

As part of the overall Ice and Water protection, probes usually feature drain holes to evacuate melted ice or water from the equipment. It is essential that the drain holes and more generally the probe tube are kept free of any contamination. Simple maintenance tasks of checking for probe drain holes cleanliness, with subsequent cleaning and flushing if any particle/dust/etc. is detected, are expected frequently. Inspection interval of the probes could be derived to cope with classification of the failure condition linked to the loss of speed on more than one probe. A 300 to 500 hours maintenance time interval should not be exceeded for such a check on each pitot probe.

V. Further Guidance

Further guidance can be found in the following documents:

- BS 2G135 revised “Specification for Electrically-heated pitot and pitotstatic pressure heads
- AS8006 “Minimum performance standard for pitot and pitot-static tubes”
- MIL-HDBK-310 “Global climatic data for developing Military products”

– END –

F-08 (SC): Flight Recorders, Data Link Recording	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.1301, 1457, 1459
ADVISORY MATERIAL:	ED-112, ED-93, AC 20-160

Special Condition (SC)

Appendix A
SPECIAL CONDITION

The flight recorder (Cockpit Voice Recorder or Flight Data Recorder) shall record:

(a) Data link communications related to air traffic services (ATS Communications*) to and from the aeroplane.

(b) All messages whereby the flight path of the aircraft is authorised, directed or controlled, and which are relayed over a digital data link rather than by voice communication.

(c) The minimum recording duration shall be equal to the duration of the Cockpit Voice Recorder, and the recorded data shall be time correlated to the recorded cockpit audio.

(d) To enable an aircraft operator to meet the intent of EU OPS 1.160 (4)(ii) and future Part OPS CAT.IDE.A.195(b), information shall be provided explaining how the recorded data can be converted back to the format of the original data link messages in order to determine an accurate sequence of events for the aircraft and the cockpit operation."

* **ATS communications (ATSC)** are defined by ICAO as communications related to air traffic services including air traffic control, aeronautical and meteorological information, position reporting and services related to safety and regularity of flight.

APPENDIX 2

INTERPRETATIVE MATERIAL

I- Data link recording.

Data link communications mentioned in SC F-10 include:

- Controller/Pilot Data Link Communications (CPDLC),
- Character Orientated Air Traffic Service (ATS) Applications (ARINC 623 applications of DCL, OCL, and D-ATIS).
- Automatic Dependent Surveillance-Contract (ADS-C)
- ATS Facility Notification (AFN) or Context Management (CM)

Data-link communication in this context is limited to communications between the aircraft and the air traffic services via the air traffic network.

It also will include automatic dependent surveillance (ADS) information, when defined and implemented, to be used for air traffic surveillance purposes and unless the corresponding source data is already recorded on the FDR.

In the context of this CRI, air traffic network means any network commissioned by an air traffic service provider.

In showing compliance with the above Special Condition, the data link recording process should be compliant with EUROCAE ED 112 Part IV “Minimum Operational Performance Specification for crash protected airborne recorder system”. The table A-1 in Attachment 1 is derived from the ED-112 table IV-B-1 and as amended by ICAO Annex 6 Part 1 Table A8-2 shows an acceptable list of data link message types to be recorded.

In order to be able to meet SC F-10 recording requirements for data link message, when this system is defined and implemented, Bombardier is requested to make appropriate provision for the recording of digital data link communications.

The Erasure Function of the Cockpit Voice Recording System should only be applicable to the audio parts of the recorded files under the given preconditions. Data link recording files should not be erasable with this function.

In addition the Applicant should show compliance to FAA AC 20-160 “Onboard Recording of CPDLC on Crash Survival Memory”.

ATTACHMENT 1

Application Recording Table

The following table A-1 lists the appropriate data to be recorded on board.

Table A-1 symbol:

The following symbols are used in the table A-1 to denote:

C: Complete contents recorded.
M: Information that enables correlation to any associated records stored separately from the aeroplane.
*: Applications to be recorded only as far as is practicable given the architecture of the system.

Table A-1: Definition of „Data Link Point to Point Communications“ Application

Item No.	Application Type	Application Description	Required Recording Content
1	Data link Initiation	This includes any applications used to logon to or initiate data link service. In FANS-1/A and ATN, these are ATS Facilities Notification (AFN) and Context Management (CM) respectively.	C
2	Controller/Pilot Communication	This includes any application used to exchange requests, clearances, instructions and reports between the flight crew and controllers on the ground. In FANS-1/A and ATN, this includes the CPDLC application. It also includes applications used for the exchange of oceanic (OCL) and departure clearances (DCL) as well as data link delivery of taxi clearances.	C
3	Addressed Surveillance	This includes any surveillance application in which the ground sets up contracts for delivery of surveillance data. In FANS-1/A and ATN, this includes the Automatic Dependent Surveillance (ADS-C) application Where parametric data are reported within the message they shall be recorded unless data from the same source are recorded on the FDR.	C
4	Flight Information	This includes any service used for delivery of flight information to specific aircraft. This includes, for example, D-METAR, D-ATIS, D-NOTAM and other textual data link services.	C
5	Aircraft Broadcast Surveillance	This includes Elementary and Enhanced Surveillance Systems, as well as ADS-B output data. Where parametric data sent by the aeroplane are reported within the message they shall be recorded unless data from the same source are recorded on the FDR.	M *
6	Aeronautical Operational Control Data	This includes any application transmitting or receiving data used for AOC purposes (per the ICAO definition of AOC).	M *

ICAO definitions :

ATS communications (ATSC) are defined by ICAO as communications related to air traffic services including air traffic control, aeronautical and meteorological information, position reporting and services related to safety and regularity of flight.

Aeronautical operational control (AOC) are defined by ICAO as communications required for the exercise of authority over the initiation, continuation, diversion or termination of flight for safety, regularity and efficiency reasons.

Aeronautical administrative communication (AAC) are defined by ICAO as communications used by aeronautical operating agencies related to the business aspects of operating their flights and transport services. This communication is used for a variety of purposes, such as flight and ground transportation, booking, deployment of crew and aircraft or any logistical purposes that maintain or enhance the efficiency of over-all flight operation.

Note : The airlines use the term Airline Operational Communication (AOC) for this type of communication. ICAO uses the abbreviation « AOC » for different purpose. This should not be confused with the ICAO term Aeronautical Operational Control (AOC).

ACRONYMS:

AAC	Aeronautical Administrative Communication
ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance-Broadcast
ADS-C	Automatic Dependent Surveillance-Contract
AFN	ATS Facilities Notification
AOC	Aeronautical Operational Control
ATS	Air Traffic Service
ATSC	Air Traffic Service Communication
C of A	Certificate of Airworthiness
CM	Context Management
CPDLC	Controller / Pilot Data Link Communications
CS	Certification Specification
CVR	Cockpit Voice Recorder
D-ATIS	Digital – Automatic Terminal Information Services
DCL	Departure Clearance
DL	Data Link
DLIC	Data Link Initiation Capability
ED	EUROCAE Document
ETSO	European Technical Standard Order
FDR	Flight Data Recorder
FLIPCY	Flight Path Consistency
ICAO	International Civil Aviation Organization
MASPS	Minimum Aviation System Performance Specification
OCL	Oceanic Clearances
SC	Special Condition

– END –

F-21 (SC): Data Link Services for the Single European Sky	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.1301, 25.1302, 25.1307, 25.1309, 25.1321, 25.1322, 25.1431, 25.1459, 25.1581, 25.1585
ADVISORY MATERIAL:	EUROCAE ED-120, ED-78A, ED-110B, ED-92A (Radio VDL/M2), ICAO Annex 10 Vol II & III, ICAO Doc 9776, ARINC Specification 631-5

Special Condition (SC)

Appendix A

Special Condition

A system capable of providing Data Link Services that complies with the safety, performance and interoperability standards as detailed in this Appendix A must be provided if operations are to be conducted within the airspace as defined by the Commission Regulation (EC) No 29/2009.

The following Data link services must be provided:

1.1. Data Link Initiation Capability (DLIC), to enable the exchange of the necessary information for the establishment of Data Link communications between ground and aircraft systems.

1.2. ATC Communication Management (ACM), to provide automated assistance to flight crews and air traffic controllers for conducting the transfer of ATC communications (voice and data).

1.3. ATC Clearances (ACL), to provide flight crews and air traffic controllers with the ability to conduct operational exchanges.

1.4. ATC Microphone Check (AMC), to provide air traffic controllers with the capability to send an instruction to several Data Link equipped aircraft, at the same time, in order to instruct flight crews to verify that their voice communication equipment is not blocking a given voice channel.

Safety, performance and interoperability standards
<u>1 - Data link services</u>

The following services shall comply with the interoperability requirements allocated to the airborne system as defined in the Interoperability Requirements Standard for Aeronautical Telecommunication Network Baseline 1 (ATN B1 Interop Standard), EUROCAE Document ED 110B

<u>1.1- Data Link Communications Initiation Capability (DLIC):</u>

The DLIC service shall enable the exchange of the necessary information for the establishment of Data Link communications between ground and aircraft Data Link systems.

The DLIC service shall be available to support:

a) the unambiguous association of flight data from the aircraft with flight plan data used by an ATS unit,
b) the exchange of the supported air–ground application type and version information,
c) the delivery of the addressing information of the entity hosting the application.

The exchanges between airborne and ground Data Link systems for the execution of DLIC service shall comply, as applicable to airborne systems, with:

d) operating methods, time sequence diagrams and messages for the DLIC initiation and DLIC contact functions specified in Section 4.1 of the EUROCAE Document ED 120 incl. change 1 & 2,
e) safety requirements specified in Section 4.2.2 of the EUROCAE Document ED 120 incl. change 1 & 2,
f) performance requirements specified in Section 4.3.2 of the EUROCAE Document ED 120 incl. change 1 & 2.

1.2- ATC Communications Management service (ACM):

The ACM service shall provide automated assistance to flight crews and air traffic controllers for conducting the transfer of ATC communications (voice and data) comprising:

a) the initial establishment of CPDLC with an ATS unit,
b) the transfer of CPDLC and voice for a flight from one ATS unit to the next ATS unit, or to instruct a change of voice channel within an ATS unit or sector,
c) the normal termination of CPDLC with an ATS unit.

The exchanges between airborne and ground Data Link systems for the execution of ACM service shall comply, as applicable to airborne systems , with:

d) operating methods and time sequence diagrams specified in Sections 5.1.1.1.1 to 5.1.1.1.7 and 5.1.1.2 of the EUROCAE Document ED 120 incl. change 1 & 2,
e) safety requirements specified in Section 5.1.2.3 of the EUROCAE Document ED 120 incl. change 1 & 2, excluding requirements relating to downstream clearance,
f) performance requirements for the en route phase specified in Section 5.1.3.2 of the EUROCAE Document ED 120 incl. change 1 & 2.

Note: "automated assistance" is not considered as a requirement for autotunning of voice frequency.

1.3- ATC Clearances and Information service (ACL):

The ACL service shall provide flight crews and controllers with the ability to conduct operational exchanges comprising:

a) requests and reports from flight crews to air traffic controllers,
b) clearances, instructions and notifications issued by air traffic controllers to flight crews.

The exchanges between airborne and ground Data Link systems for the execution of ACL service shall comply, as applicable to airborne systems , with:

c) operating methods and time sequence diagrams specified in Sections 5.2.1.1.1 to 5.2.1.1.4 and 5.2.1.2 of the EUROCAE Document ED 120 incl. change 1 & 2,
d) a common subset of the message elements specified in Section 5.2.1.1.5 of the EUROCAE Document ED 120 incl. change 1 & 2, as appropriate to the en route operational environment,
e) safety requirements specified in Section 5.2.2.3 of the EUROCAE Document ED 120 incl. change 1 & 2,
f) performance requirements for the en route phase specified in Section 5.2.3.2 of the EUROCAE Document ED 120 incl. change 1 & 2.

1.4- ATC Microphone Check service (AMC):

The AMC service shall provide air traffic controllers with the capability to send an instruction to several Data Link equipped aircraft, at the same time, in order to instruct flight crews to verify that their voice communication equipment is not blocking a given voice channel.

The exchanges between airborne and ground Data Link systems for the execution of AMC service shall comply, as applicable to airborne systems , with:

a) operating methods and time sequence diagrams specified in Sections 5.3.1.1.1, 5.3.1.1.2 and 5.3.1.2 of the EUROCAE Document ED 120 incl. change 1 & 2,
b) safety requirements specified in Section 5.3.2.3 of the EUROCAE Document ED 120 incl. change 1 & 2,
c) performance requirements specified in Section 5.3.3.2 of the EUROCAE document ED 120 incl. change 1 & 2.

Appendix B

Interpretative Material

This IM is applicable to airborne aspects of Data Link Services based on ATN and VDL Mode 2. The data contained herein provides acceptable means to satisfy the requirements of this CRI. This IM is not applicable to air-ground communications based on other communications protocols.

This IM addresses the airworthiness objectives and interoperability standards for the Data Link services as defined in Appendix A of this CRI:

1- Applicable regulatory and guidance materials:

The following chapter provides regulatory and guidance material:

1.1- Regulations/Requirements:
- COMMISSION REGULATION (EC) No 29/2009, DLS Implementing Rule (DLS IR),
- EASA Certification Specifications CS-25, CS-23

1.2-ICAO Documents:
- ICAO Annex 10 Vol II & III,
- ICAO Doc 9776,

1.3-Industry standards for system design (VDL Mode 2 and ATN Applications: CM & CPDLC):
- EUROCAE ED-92A, Minimum Operational Performance Specification for an airborne VDL Mode-2 System operating in the frequency range 118-136.975 Mhz, (RTCA DO-281),
- EUROCAE ED-110 Rev B: Interoperability Requirements Standards for ATN Baseline 1 (INTEROP ATN B1), (RTCA DO-280B), 2007,
- EUROCAE ED 120 +Change 1 +Change 2: Safety and Performance Requirements Standards for Air Traffic Data Link Services in Continental airspace (CONTINENTAL SPR STANDARD), (RTCA DO-290), 2007,
- ARINC 631-5, VHF Digital Link (VDL) Mode 2 Implementation Provisions,

1.4- Additional guidance material for airborne equipment qualification:
- EUROCAE ED-14F Environmental conditions and test Procedures for airborne equipment (RTCA DO-160F).
- EUROCAE ED-12B Software considerations in airborne systems and equipment certification (RTCA DO-178B).
- EUROCAE ED-80 Design assurance guidance for airborne electronic hardware (RTCA DO-254).
- EUROCAE ED-76 Standards for processing aeronautical data (RTCA DO-200A)

1.5- Additional guidance material:
- EUROCONTROL specification on Data Link Services, EUROCONTROL-SPEC-0116, Edition Number: 2.1, dated 28/Jan/2009.
- EUROCAE ED-78A: Guidelines for approval of the provision and use of Air Traffic Services supported by data communications,
- TSO-C160, VDL Mode 2 Communications Equipment.

2- Airworthiness Objectives:

This section lists the Airworthiness objectives which should be fulfilled in order to demonstrate compliance with the Special Condition.

2.1 Certification plan

The Applicant should provide a certification plan addressing the following aspects to the Agency for acceptance.

2.2- Safety, Performance and Interoperability

The Applicant should demonstrate that the installation is designed to comply with the safety, performance and interoperability criteria allocated to the airborne system as defined in EUROCAE ED-120 including change 1 & 2 and EUROCAE ED-110B.

The Applicant should produce a hazard analysis of all relevant failure conditions at the aircraft level affecting the aircraft Data Link installation and applications, proposing safety objectives. These safety objectives should be provided to EASA.

The Data Link installation should support multi-frequency operation, in compliance with ARINC Specification 631-5 (or later issue acceptable to EASA).

Note: EUROCONTROL Specification SPEC-0116 on Data Link Services provides additional guidance for the demonstration of compliance to the interoperability, performance and safety requirements of the Commission Regulation No 29/2009 and this SC.

2.3- Equipment Qualification

The Applicant should demonstrate that the equipment has been designed and developed in compliance with adequate standards as listed in §§ 1.3 and 1.4 of this Appendix.

2.4- Installation

The following design considerations should be applied to the installed Data Link system:

Compatibility:

2.4.1 The flight crew interface should be consistent with the overall crew flight deck design philosophy.

2.4.2 If the aircraft includes both FANS 1/A and ATN B1 (VDL Mode 2) Data Link systems, then messages with the same intent from two different systems should be displayed in the same way.

Flight deck annunciations:

2.4.3 Flight deck annunciations should be compatible with the overall alerting scheme of the aircraft.

2.4.4 Audible and visual indications should be given for each uplink ATS message, including those messages not displayed immediately because of lack of crew response to an earlier ATS message. Visual alerts alone may be used for non-ATS messages.

2.4.5 The status of the Data Link system should be available to the flight crew.

2.4.6 The system should indicate when message storage and/or printing is not available.

2.4.7 Annunciation of the receipt of a message during critical flight phases (e.g. take-off and landing) should be inhibited until after the critical flight phase. The criteria that define critical flight phases should be consistent with the particular flight deck philosophy and the particular Data Link services supported.

Flight deck controls:

2.4.8 Means should be provided for the flight crew to activate or deactivate each or all of the Data Link applications.

2.4.9 Means should be provided to the flight crew to know in real time the identity of the ATS provider(s) connecting with the aircraft, and the Data Link applications involved with each connection.

2.4.10 Means should be provided for the flight crew to respond to ATS messages.

2.4.11 Means should be provided for the flight crew to list, select and retrieve the most recent (e.g. ten) ATS messages received and sent by the flight crew during the flight segment. The status of each message, the time it was received or sent, should be accessible.

2.4.12 Means should be provided for the flight crew to clear uplinked messages from the display. However this capability should be protected against inadvertent deletion.

2.4.13 Means should be provided for the flight crew to create, store, retrieve, edit, delete, and send Data Link messages.

2.4.14- If a direct interface exists between the Data Link application and other onboard systems, (e.g. flight planning and navigation), a means should be provided for the flight crew to initiate the use of the data contained in the message by the other onboard system. The means provided should be separate from that used to respond to a message.

Flight deck display:

2.4.15 All messages should be displayed in a format that the flight crew can easily comprehend.

2.4.16 The flight crew should be able to read displayed messages without leaving their seats and with minimum head movement.

2.4.17.a Datalink messages from the ATS should be displayed without the need for flight crew action, and remain displayed until responded or cleared or the flight crew selects another message.

2.4.17.b An unmistakable indication/reminder that pending open messages are waiting for a response should be provided.

2.4.17.c In the case 2.4.17.a cannot be met (for example: due to Datalink messages from ATS are displayed on a shared display or on a shared display area), selection of another display format or function should not result in the loss of uplinked messages which are waiting for a response. In case the pilot is working on this display with another task and a message is uplinked, this may not interrupt the current work nor may it result in the loss of any uplinked message and/or data entered while accomplishing the other task.

Note: It is recognized that, in the first implementation phase compliant with EC Reg. No. 29/2009, the selected set of Datalink messages are not time critical and are for use in upper airspace. Furthermore, voice communication initially remains the primary means of communication with Datalink as a secondary supplementary means. Systems which do not comply with the requirement of § 2.4.17.a may be acceptable for implementations compliant to EC Reg. 29/2009, depending on the following factors:

1. The time criticality of the messaging

2. The flight phase
3. The Human-Machine Interface

It is the choice of the Applicant whether or not the implementation should be capable of being used in future envelope expansions. If the implementation is such that one or more pilot actions are needed to display the uplinked message, the implementation may only be acceptable in the future for cruise and non-time critical messaging. This restriction should be part of the limitation section in the Airplane Flight Manual, see also § 2.7 of this appendix B. Installations sharing a multi-function display for the presentation of data link messages, as described in § 2.4.17.c above, may be limited to cruise flight phase and non-time critical applications, see also § 2.7 of this appendix B.

2.4.18 ATS messages should be displayed so that messages are distinguishable from each other. The status of each message (i.e. source, time sent, open/closed) should be displayed together with the message.

2.4.19 When the Data Link system is sharing a display and /or input devices with other aircraft functions (e.g. via MCDU), appropriate prioritisation of tasks and information display should be assured.

Note: If more functions are channelled through one device it may be impossible to add the data link function without using a second, similar device. This may also have consequences for the Minimum Equipment list and the required dispatch configuration.

2.4.20 If a message intended for visual display is greater than the available display area and only part of the message is displayed, a visual indication shall be provided to the pilot to indicate the presence of remaining message. The flight crew should not be allowed to respond or clear the message until the entire message was displayed.

Flight deck Printer:

2.4.21 A flight deck printer may be used as a means of storing data communications messages received or sent during flight. It should satisfy integrity and interface design criteria appropriate for this purpose.

2.5- Recording of Data Link messages on airborne recorders

Data Link recording on airborne recorders will be required by future EASA Operational Rule for specific categories of aircraft (i.e. aircraft which are currently required to have voice communications recorded on a CVR).

Applicants are therefore encouraged to implement on aircraft Datalink Recording concurrently with the installation of Datalink Services (DLS). In cases where this requires considerable development and redesign efforts, the Applicant should establish adequate mitigation means or acceptable operational procedures, to be applied until such time that Datalink Recording has been implemented.

Datalink Recording is covered under a separate Special Condition CRI.

2.6- Certification Testing

A test plan including interoperability demonstration should be provided to EASA for acceptance.

For further guidance refer to Appendix C (Guidelines and additional information on interoperability testing).

2.7- Aircraft Flight Manual

The Aircraft Flight Manual or Aircraft Flight Manual Supplement should contain the following statement:

> *"The aircraft data link system has been demonstrated to comply with the applicable safety, performance and interoperability requirements for continental ATN B1 Data Link using VDL Mode-2."*

The AFM/AFMS should also contain a clear statement expressing the compliance to support multi-frequency operation as defined in ARINC Specification 631-5.

The AFM/AFMS should also contain in the limitations section a clear statement that Datalink installation is only intended to be used in cruise flight phase and for non-critical messaging.

Examples for Aircraft Flight Manual or Aircraft Flight Manual Supplement entries are provided below:

> *"This CPDLC installation is limited to providing a supplementary means of communication; voice shall remain the primary means of communication. CPDLC shall only be used for routine datalink exchanges during en-route operations in upper airspace."*
> *"The aircraft ATC Data Link system does support multi-frequency operation as defined in ARINC Spec. 631-5."*
> *"This AFM entry does not, by itself, constitute an operational approval where such an approval is required."*

2.8- (Master) Minimum Equipment List MMEL/MEL

Considerations should be given to MMEL/MEL aspects of the installation.

Appendix C

Guidelines and additional information on interoperability testing

The EUROCONTROL specification on Data Link Services (EUROCONTROL-SPEC-0116, Edition Number: 2.1, dated 28/Jan/2009) provides the definition of continental Data Link services in European Airspace.

The Applicant may propose different test plans to the ones included in the documents from Eurocontrol.

Testing demonstrations could be based in two main steps:

- Equipment testing (done by equipment manufacturer) using adequate simulation testing tools.
- System testing, at system test bench and/or at aircraft test level (either on ground or flight).

The Applicant may reuse qualification testing data from the avionics manufacturer, provided that full and unrestricted access to the compliance data is established and maintained. However, the Applicant remains responsible for all test data used in the course of compliance demonstration.

Guidance material from Eurocontrol available at Link 2000+ Programme Websites:

http://www.eurocontrol.int/link2000/public/subsite_homepage/homepage.html

http://www.eurocontrol.int/link2000/public/site_preferences/display_library_list_public.html

- LINK2000+/ATC DATA LINK OPERATIONAL GUIDANCE, Version 5.1, Date: 01 March 2010
- LINK 2000+ Guidance to Airborne Implementers, Version 1.1, Date: 09 December 2009
- LINK2000+/FLIGHT CREW DATA LINK OPERATIONAL GUIDANCE Version 4.0, Date: 30 June 2009
- LINK2000+ Programme, Generic Interop Test Plan for Avionics - Part 1, Upper Layers and CM/CPDLC applications, Version 2.3, Date : 15th June 2010

Appendix D
Acronyms

A/C	Aircraft
ACL	ATC Clearance
ACM	ATC Communication Management
ACNS	Airborne systems for Communication, Navigation and Surveillance
AFM	Airplane Flight Manual
AFMS	Airplane Flight Manual Supplement
AMC	Acceptable Means of Compliance
AMC	ATC Microphone Check
ARINC	Aeronautical Radio Incorporated
ATC	Air Traffic Control
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic System
CEH	Complex Electronic Hardware
CM	Communication Management
CPDLC	Controller Pilot Data Link Communication
CRI	Certification Review Item
CS	Certification Specification
DLIC	Data Link Initiation Capability
DLS	Data Link Service
DLS IR	DLS Implementing Rule
EASA	European Aviation Safety Agency
EC	European Commission
ED	EUROCAE Document
FANS	Future Air Navigation System
FL	Flight Level
ICAO	International Civil Aviation Organisation
IM	Interpretative Material
INTEROP	Interoperability
M2	Mode 2
Mhz	Mega Hertz
MMEL	Master Minimum Equipment List
RTCA	Radio Technical Commission for Aeronautics
SC	Special Condition
SES	Single European Sky
SPEC	Specification
VDL	VHF Digital Link
VHF	Very High Frequency

– END –

F-25 (SC): Rechargeable Lithium battery installations	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.601, 25.863, 25.1353
ADVISORY MATERIAL:	--

Special Condition (SC)

Appendix A

Special Condition

Rechargeable Li-Batteries

In lieu of the requirements of CS 25.1353(c) the following applies:

a. Lithium batteries and battery installations must be designed and installed as follows:

1) Safe cell temperatures and pressures must be maintained during any probable charging or discharging condition, or during any failure of the charging or battery monitoring system not shown to be extremely remote. The Li battery installation must be designed to preclude explosion in the event of those failures.

2) Li batteries must be designed to preclude the occurrence of self-sustaining, uncontrolled increases in temperature or pressure.

3) No explosive or toxic gasses emitted by any Li battery in normal operation or as the result of any failure of the battery charging or monitoring system, or battery installation not shown to be extremely remote, may accumulate in hazardous quantities within the aeroplane.

4) Li battery installations must meet the requirements of CS 25.863(a) through (d).

5) No corrosive fluids or gasses that may escape from any Li battery may damage surrounding aeroplane structures or adjacent essential equipment.

6) Each Li battery installation must have provisions to prevent any hazardous effect on structure or essential systems that may be caused by the maximum amount of heat the battery can generate during a short circuit of the battery or of its individual cells.

7) Li battery installations must have a system to control the charging rate of the battery automatically so as to prevent battery overheating or overcharging, and,

   (i) A battery temperature sensing and over-temperature warning system with a means for automatically disconnecting the battery from its charging source in the event of an over-temperature condition or,

   (ii) A battery failure sensing and warning system with a means for automatically disconnecting the battery from its charging source in the event of battery failure.

8) Any Li battery installation whose function is required for safe operation of the aeroplane, must incorporate a monitoring and warning feature that will provide an indication to the appropriate flight

crewmembers, whenever the capacity and SOC of the batteries have fallen below levels considered acceptable for dispatch of the aeroplane.

9) The Instructions for Continued Airworthiness must contain maintenance procedures for Lithium-ion batteries in spares storage to prevent the replacement of batteries whose function is required for safe operation of the aeroplane, with batteries that have experienced degraded charge retention ability or other damage due to prolonged storage at low SOC.

b. Compliance with the requirements of this Special Condition must be shown by test or, with the concurrence of EASA, by analysis.

DO 311 for large batteries or DO 347 for small and medium batteries is an acceptable means of compliance with this requirements.

– END –

F-26 (SC): Non-Rechargeable Lithium battery installations	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.601, 25.863, 25.1353(c)
ADVISORY MATERIAL:	

Special Condition (SC)

Appendix A

Special Condition

Non-Rechargeable Li-Batteries

In lieu of the requirements of CS 25.1353(c) (1) through (c)(4), non-rechargeable Lithium batteries and battery installations must comply with the following special conditions:

1. Be designed so that safe cell temperatures and pressures are maintained under all foreseeable operating conditions to preclude fire and explosion.
2. Be designed to preclude the occurrence of self-sustaining, uncontrolled increases in temperature or pressure.
3. Not emit explosive or toxic gases in normal operation, or as a result of its failure, that may accumulate in hazardous quantities within the airplane.
4. Must meet the requirements of CS 25.863(a) through (d).
5. Not damage surrounding structure or adjacent systems, equipment or electrical wiring of the airplane from corrosive fluids or gases that may escape and that may cause a major or more severe failure condition.
6. Have provisions to prevent any hazardous effect on airplane structure or essential systems caused by the maximum amount of heat it can generate due to any failure of it or its individual cells.
7. Have a means to detect its failure and alert the flight crew in case its failure affects safe operation of the aircraft.
8. Have a means for the flight crew or maintenance personnel to determine the battery charge state if its function is required for safe operation of the airplane.

Note 1: A battery system consists of the battery and any protective, monitoring and alerting circuitry or hardware inside or outside of the battery. It also includes vents (where necessary) and packaging. For the purpose of this special condition, a battery and battery system are referred to as a battery.
Note 2: These special conditions apply to all non-rechargeable lithium battery installations in lieu of CS 25.863 and 25.1353(b)(1) through (b)(4). Section 25.1353(b)(1) through (b)(4) will remain in effect for other battery installations.
Note 3: For Very Small Non-rechargeable Lithium Batteries (equal or less than 2 Watt-hour of energy), an acceptable MoC with this Special Conditions is showing these batteries compliant with Underwriters Laboratories (UL) 1642 or UL 2054..
Note 4: For the purpose of SCs 7 and 8, “safe operation of the airplane” is defined as continued safe flight and landing following failures or other non-normal conditions. The following are examples of devices with batteries that are not required for safe operation of the airplane: emergency locator transmitters,

underwater locator beacons, seat belt air bag initiators and flashlights. A backup flight instrument with a non-rechargeable lithium battery is an example that would be required for safe operation of the airplane.
Note 5: Due to a missing more appropriate standard at the issuance of this CRI, ETSO-C142a + Risk assessment at A/C level is an acceptable MoC to the SC contained in this CRI. When a more adequate standard will be available, EASA will review the acceptable MoC.

– END –

F-30 (SC): Synthetic Vision on Head Up Display	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.773, 25.777, 25.1301, 25.1302, 25.1303, 25.1309, 25.1316, 25.1321, 25.1322, 25.1329, 25.1381, 25.1459(e), 25.1541, 25.1581, 25.1583, 25.1585
ADVISORY MATERIAL:	AMC 25-11, AMC 25.1302, AMC 25.1309, AMC 25.1322, AMC 25.1329, ED-179B, ED-79A, SAE AS 8055

Special Condition (SC)

Appendix A

Special Condition

SVS in HUD - Pilot's compartment view

The following special condition applies under the provision of Part 21A.16B to provide the unique pilot compartment view requirements for the SVS installation:

1. SVS imagery on the HUD must not degrade the safety of flight or interfere with the effective use of outside visual references for required pilot tasks during any phase of flight in which it is to be used.

2. Appropriate limitations must be stated in the Operating Limitations section of the Airplane Flight Manual. Associated Normal, Abnormal and Emergency procedures must be incorporated in the Airplane Flight Manual

Appendix B

Means of Compliance

SVS in HUD

Depending on the intended function as defined by the applicant, EASA proposes to use the applicable sections of EUROCAE document ED-179B titled “MINIMUM AVIATION SYSTEM PERFORMANCE STANDARDS (MASPS) For ENHANCED VISION SYSTEMS, SYNTHETIC VISION SYSTEMS, COMBINED VISION SYSTEMS And ENHANCED FLIGHT VISION SYSTEMS”, as published in September 2011.

A compliance matrix with respect to applicable sections of ED-179B should be provided by the applicant and any deviation should be highlighted.

In addition to ED-179B, the following criteria are proposed by EASA:

a) Image Characteristics

As stated in section 2.1.1.1.1.2 of ED179B, the recommendations made in design standards SAE AS 8055, SAE ARP 5288 and SAE ARP 5287 at the latest revision should be applied.

b) Installation

(i) Cockpit Integration. To the greatest extent practicable, the SVS controls should be integrated with other controls, to minimize the crew workload associated with SVS operation and to ensure flight crew awareness of engaged flight guidance modes.

(ii) Conformal Display. The HUD symbology is conformal. This may not be the case of the SVS image e.g. because of the inaccuracy of the A/C position. Therefore, the conformality of the SVS display should be evaluated and demonstrated to be adequate for the intended function, for all foreseeable operation conditions (including engine out condition) and phases of flight where the use of the system is expected.

c) System Requirements

(i) Safety Assessment

The criticality of the SVS system’s function to display imagery, including the potential to display hazardously misleading information, should be assessed according to CS 25.1309, AMC 25-11 paragraph 21, and AMC 25.1309. All assumptions and alleviating flight crew actions that are considered in the SVS safety analysis should be validated during testing for incorporation in the AFM limitation section, procedures section or for inclusion in type-specific training.

The Functional Hazard Assessments given in ED-179B are only provided as an example for information and the actual failure conditions and hazard classifications may differ depending on the actual design, the intended function and the associated flight crew procedures. No credit can be claimed for the hazard classifications and criticalities mentioned in ED-179B.

The safety analysis should show that the integrated system, consisting of the HUD components and SVS components, meets critical signal integrity requirements for the airplane, HUD and SVS. System and subsystem malfunctions which are not shown to be extremely improbable should be demonstrated in a simulation or in flight. The malfunction annunciation and fault detection schemes should demonstrate operation to the designed level of integrity.

(d) Testing Requirements

Testing should include all phases of flight for which the applicant seeks approval of the system. In particular each applicable type of approach should be part of the demonstration: E.g. visual, Cat1, FMS (VNAV and VGP), Cat1, Cat2, HUD3, circle-to-land. Evaluation should also cover the different HUD configurations relevant for these approaches: e.g. with and without path reference angle, with and without flight director, with and without declutter.

(e) Human factor considerations related to the intended function

The use of the SVS on the HUD is a novel concept and this should be taken into account when showing compliance to CS 25.1302.

(f) TAWS on HUD/SVS

(i) Symbology description

The applicant should provide a description showing how each TAWS alert is annunciated (HUD, head-down, aural, …).

(ii) Human factor evaluation

The display of a brighter and solid area for TAWS alerts on the HUD monochrome format may impair the pilot ability to view the outside terrain, both behind the alert area (obscuration) and around it (dazzling).

In addition, the display of the highlighted threatening terrain in the primary field of view may induce lateral evasive manoeuvre.

The applicant should demonstrate, through human factor evaluations, that the crew is able to properly react to the alert, and that the resulting manoeuvre is unchanged compared to the head-down display.

(iii) Consistency of data

The databases and algorithms used for SVS terrain display, terrain shading for alerts and for alert computation may be different. The applicant should address the potential inconsistent alert areas between head-up and head-down, or between terrain relief and alert area. In particular, the classification of the TAWS function failure conditions may have to be re-evaluated to consider the risk that the crew may engage in lateral manoeuvre as described above in (ii).

(iv) Level of alerts

Considering that the HUD is a monochrome devices, the HUD should emphasise the different level of TAWS alerts (caution and warning) with the appropriate use of attention-getting properties such as flashing, outline boxes, brightness, size, and/or location to compensate for the lack of colour coding. The philosophy adopted to translate caution and warnings to the monochrome HUD should also be applied to the TAWS alerts.

– END –

F-31 (SC): Enhanced Flight Vision System with operational credit	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.773, 25.777, 25.1301, 25.1302, 25.1303, 25.1309, 25.1316, 25.1321, 25.1322, 25.1329, 25.1381, 25.1459(e), 25.1541, 25.1581, 25.1583, 25.1585
ADVISORY MATERIAL:	AMC 25-11, AMC 25.1302, AMC 25.1309, AMC 25.1322, AMC 25.1329, ED-179B, ED-79A, SAE AS 8055

Special Condition (SC)

Appendix A

Pilot’s compartment view with Enhanced Flight Vision System

The following special condition applies under the provision of Part 21A.16B to provide the unique pilot compartment view requirements for the EFVS installation:

1. EFVS imagery on the HUD must not degrade the safety of flight or interfere with the effective use of outside visual references for required pilot tasks during any phase of flight in which it is to be used.

2. To avoid unacceptable interference with the safe and effective use of the pilot compartment view, the EFVS device must meet the following requirements:

   a) EFVS design must minimize adverse display characteristics or artefacts (e.g. noise, “burlap” overlay, running water droplets) that obscure the desired image of the scene, impair the pilot’s ability to detect and identify visual references, mask flight hazards, distract the pilot, or otherwise degrade task performance or safety.

   b) Control of EFVS display brightness must be sufficiently effective, in dynamically changing background (ambient) lighting conditions, to prevent full or partial blooming of the display that would distract the pilot, impair the pilot’s ability to detect and identify visual references, mask flight hazards, or otherwise degrade task performance or safety. If automatic control for image brightness is not provided, it must be shown that a one-time manual setting is satisfactory.

   c) A readily accessible control must be provided that permits the pilot to immediately deactivate and reactivate display of the EFVS image on demand.

   d) The EFVS image on the HUD must not impair the pilot's use of guidance information or degrade the presentation and pilot awareness of essential flight information displayed on the HUD, such as alerts, airspeed, flight path, attitude, altitude and direction, approach guidance, wind shear guidance, TCAS resolution advisories, unusual attitude recovery cues.

   e) The EFVS image and the HUD symbols, which are spatially referenced to the pitch scale, outside view and image, must be scaled and aligned (i.e. conformal) to the external scene and, when considered singly or in combination, must not be misleading, cause pilot confusion, or increase workload. There may be airplane attitudes or cross-wind conditions which cause certain symbols, such as the zero-pitch line or flight path vector, to reach field of view limits such that they cannot be positioned conformably with the image and external scene. In such cases, these symbols may be displayed, but with an altered appearance which makes the pilot aware that they are no longer displayed conformably (for example, "ghosting").

   f) A HUD system used to display EFVS images must, if previously certified, continue to meet all of the requirements of the original approval.

3. The safety and performance of the pilot tasks associated with the use of the pilot compartment view must not be degraded by the display of the EFVS image. Pilot tasks which must not be degraded by the EFVS image include:

   a) Detection, accurate identification and manoeuvring, as necessary, to avoid traffic, terrain, obstacles, and other hazards of flight.

   b) Accurate identification and utilization of visual references required for every task relevant to the phase of flight.

4. Appropriate limitations must be stated in the Operating Limitations section of the Airplane Flight Manual. Associated limitations and Normal, Abnormal and Emergency procedures must be defined and incorporated in the Airplane Flight Manual.

Appendix B

Means of Compliance

Enhanced Flight Vision System

Depending on the intended function as defined by the Applicant, EASA proposes to use the applicable sections of EUROCAE document ED-179B titled "MINIMUM AVIATION SYSTEM PERFORMANCE STANDARDS (MASPS) For ENHANCED VISION SYSTEMS, SYNTHETIC VISION SYSTEMS, COMBINED VISION SYSTEMS And ENHANCED FLIGHT VISION SYSTEMS", as published in September 2011.

It should be noted that the EVS sections of ED-179B apply to the use of the system without operational credit and EFVS sections to the use with operational credit. In particular, when seeking operational credit with EFVS, sections 1.3, 2.2, 3.2 and 4.1 become applicable.

A compliance matrix with respect to applicable sections of ED-179B should be provided by the applicant and any deviation should be highlighted.

In addition to ED-179B, the following criteria are proposed by EASA:

a) Image Characteristics

As stated in ED-179B section 2.2.3.3, the recommendations made in design standards SAE AS 8055, SAE ARP 5288 and SAE ARP 5287 should be applied. Furthermore, standards of ED-179B section 3.2.3 should be followed.

In addition, the following recommendation regarding Image controls should be followed:

Controls for image and symbology display parameters such as brightness, sensor gain, contrast, should provide independent adjustment for the image and symbology. For parameters that need adjustment for changes in ambient light levels, and other dynamic environmental conditions, if automatic control for these adjustments is not provided, it should be shown that a one-time manual setting is satisfactory.

When the brightness level is altered, the relative luminance of the imagery should vary smoothly. There shall be no objectionable brightness transients when transitioning between manual and automatic control, if applicable.

b) Installation.

As regards to installation, the standards of ED-179B section 3.2.4 (EFVS Aircraft Interface) should be applied.

In addition, the following recommendation regarding Cockpit integration should be applied:

To the greatest extent practicable, the EFVS controls should be integrated with other controls, to minimize the crew workload associated with EFVS operation and to ensure flight crew awareness of engaged flight guidance modes.

c) System Requirements

(i) Safety Assessment

The criticality of the EFVS system's function to display imagery, including the potential to display hazardously misleading information, should be assessed according to CS 25.1309, AMC 25-11 paragraph 21, and AMC 25.1309. All assumptions and alleviating flight crew actions that are considered in the EFVS safety analysis should be validated during testing for incorporation in the AFM limitation section, procedures section or for inclusion in type-specific training.

The Functional Hazard Assessment given in Appendix C of ED-179B is only provided as an example for information and the actual failure conditions and hazard classifications may differ depending on the actual design, the intended function and the associated flight crew procedures. The use of this Appendix C is therefore not recommended and no credit can be claimed for the hazard classifications and criticalities mentioned in it.

The safety analysis should show that the integrated system, consisting of the HUD components and EFVS components, meets critical signal integrity requirements for the airplane, HUD and EFVS. System and subsystem malfunctions which are not shown to be Extremely Improbable should be demonstrated in a simulation or in flight. The malfunction annunciation and fault detection schemes should demonstrate operation to the designed level of integrity.

The Safety Assessment should also address failures of one or more sensors and the acceptability of colour visibility with a degraded multi-sensory image will have to be evaluated. Latent sensor failures have to be considered.

(ii) Recording

The EFVS and its design specificities (e.g. multi-sensor characteristics) should be taken into account when showing compliance to CS 25.1459(e). As a minimum, a discrete signal, indicating when the EFVS image is displayed, should be recorded in addition to the “HUD in use” parameter. This recommendation complements thestandard of ED-179B section 3.2.4.2.

(iii) Vertical Guidance

For approach operations with EFVS it is recommended to provide vertical guidance information of adequate accuracy and integrity.

(iv) Decision Height Determination

A radio altimeter with display at each pilot’s station may be required for operations with minima based on actual height or may be provided to enhance situational awareness.

(v) Co-Pilot’s Repeater Display

An additional view of the EFVS image for the pilot not-flying (PNF) is needed to address multi-pilot philosophy (operations in RVRs below 550m will require two pilots operation). It enables the PNF to be kept in the ‘loop’ and crew resource management will not break down. The PNF can be isolated from the information necessary for monitoring flight progress and decision making if the flying pilot is the only one that would have access to the EFVS image. This recommendation complements information provided by ED-179B section 2.2.3.8 and 3.2.5.4. For information, this guidance is also present in Air Operations regulation (ED 965/2012) through GM1 SPA.LVO.100(f) Low visibility operations.

<u>(d) Testing Requirements</u>

As regards to testing requirements, the standards of ED-179B section 4.1 (PERFORMANCE DEMONSTRATION FOR EVS/SVS/CVS AND EFVS APPROVED TO 100 FEET ABOVE THRESHOLD ELEVATION (THRE)) should be applied. In particular for flight testing, ED-179B Appendix G “Sample EFVS Flight Test Plan” should be followed.

Besides, testing should include all phases of flight for which the applicant seeks approval of the system. In particular, each applicable type of approach should be part of the demonstration: E.g. visual, Cat1, FMS (VNAV and VGP), Cat1, Cat2, HUD3, circle-to-land. Evaluation should also cover the different HUD configurations relevant for these approaches: e.g. with and without path reference angle, with and without flight director, with and without declutter.

(e) Human factor considerations related to the intended function

Although the use of the EFVS for operational credit below the published minima is by itself not considered a novel concept, the new HUD in combination with the new multi-sensor system is considered to be novel and this should be taken into account when showing compliance to CS 25.1302.

Miscellaneous: fairing substantiation

The location, attachment and shape of the camera fairing should be appropriately substantiated in accordance with the BD-700-2A12/-2A13 certified flight envelope. At least the following aspects should be addressed: aircraft performance (drag), high speed (VFc/MFc) and low speed characteristics (Stall Warning), anemometry impact (RVSM), icing conditions (including failure of the heating system).

-END-

F-41 (SC): Therapeutic Oxygen System	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.1445
ADVISORY MATERIAL:	

Special Condition (SC)

Appendix A
Special Conditions

For the type certification of the Bombardier BD-700-2A12 (Global 7000) aeroplane model, the following Special Condition is provided in addition to the applicable requirements of CS-25:

- When oxygen is supplied for both passenger supplemental oxygen and therapeutic (discretionary/first-aid) oxygen from a common source of supply, there must be a means to separately reserve the minimum supply required for passenger supplemental oxygen.

-END-

Equivalent Safety Findings (ESF)

B-12 (ESF): Out of Trim	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.161(c)(1)
ADVISORY MATERIAL:	

Equivalent Safety Findings (ESF)

Appendix A

Equivalent Safety Finding Applicable to Global 7000/8000

The intent of CS 25.161(c)(1) is satisfied by demonstrating stick free longitudinal trim at the appropriate operation speeds for the conditions specified in CS 25.161(c)(1). For the flaps retracted this would correspond to the final take-off speed (Vfto) and the all engine operating take-off speed with flaps in the take-off position.

– END –

D-06 (ESF): Pilot Compartment View – Hydrophobic Coatings	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.773(b)(4)(i)
ADVISORY MATERIAL:	--

Equivalent Safety Findings (ESF)

Appendix A

Equivalent Safety Finding

As the hydrophobic coating cannot be defined as a system, an analysis based on CS 25.1309 is not possible to demonstrate compliance with CS 25.773(b)(4)(i).

Therefore the applicant is requested to demonstrate equivalent safety to CS 25.773(b)(4)(i).

This demonstration should at least address the following considerations:
(a) Effectiveness of the hydrophobic coating under the precipitation conditions of CS 25.773(b)(1);
(b) Behaviour of the hydrophobic coating over time (long term degradation due to ageing, aerodynamic erosion, thermal effects, exposure to water and chemicals, etc.);
(c) Degradation of the coating due to single exposure events, such as hail, volcanic ash, windblown sand, etc.
(d) Instructions for Continued Airworthiness to properly maintain and inspect the hydrophobic coating.

– END –

D-22 (ESF): APU Access Door	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.783
ADVISORY MATERIAL:	Interpretative Material D-20, AMC 25.783

Equivalent Safety Findings (ESF)

Appendix A

Equivalent Safety Finding

The following compensating factors shall be met to allow an equivalent safety finding:

- The doors shall require access via a platform, such that they may only be opened and closed by qualified maintenance personnel, for the purpose of performing maintenance.
- The doors shall not close unless closed in the correct sequence.
- The correct closing and latching shall be easily determined via tactile means.
- The doors shall hang open under gravity if not properly closed and latched.
- There shall be no reported incidents of open doors that possess similar compensating factors on any applicant's program.

– END –

D-23 (ESF): Access Panel Doors	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.783(h)(2)
ADVISORY MATERIAL:	Interpretative Material D-20, AMC 25.783

Equivalent Safety Findings (ESF)

Appendix A

Equivalent Safety Finding

The following compensating factors shall be met to allow an equivalent safety finding to CS 25.783(h)(2):

1. Multiple latching elements are required that are not subject to backdriving loads and therefore do not lead to driving the device to unlatch.

2. The door shall remain attached to the aircraft in case of one open latch considering aerodynamic loads.

3. An amber CAS message is required in the cockpit during parking and taxi phases
4. The correct closing and latching shall be easily determined via tactile means.
5. There shall be no possibility of inadvertent opening by persons in flight.
6. There shall be no reported incidents of open doors that possess similar compensating factors on any applicant's program at the time of compliance demonstration.

– END –

D-24 (ESF): Fuel Tank Expansion	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.671(c)(2), 25.1309
ADVISORY MATERIAL:	AMC 25.671, 25.1309, FCHWG §25.671 ARAC recommendation

Equivalent Safety Findings (ESF)

Appendix A

Fuel Tank Expansion

In lieu of paragraph 25.671(c)(2), the following, as proposed in the ARAC recommendation, applies:

"(c) The airplane must be shown by analysis, test, or both, to be capable of continued safe flight and landing after any of the following failures, including jamming, in the flight control system and surfaces (including trim, lift, drag, and feel systems) within the normal flight envelope, without requiring exceptional piloting skill or strength. Probable failures must have only minor effects and must be capable of being readily counteracted by the pilot.

(2) Any combination of failures not shown to be extremely improbable. Furthermore, in the presence of any single failure in the flight control system, any additional failure states that could prevent continued safe flight and landing shall have a combined probability of less than 1 in 1000. This paragraph excludes failures of the type defined in (c)(3)."

Definitions

- Latent = dormant = hidden
- A failure is latent until it is made known to the flight crew or maintenance personnel.
- A significant latent failure is one, which would in combination with one or more specific failures, or events result in a Hazardous or Catastrophic Failure Condition (AMC 25.1309 5.o).

Since it is not evident that the above is sufficient to provide an ESF to the existing CS25.671(c)(2), the following approach and additional criteria shall also be met.

The objective is to obtain a design with a minimum number of significant latent failures. Each significant latent failure should be highlighted in the system safety assessment, subject to review by the Authorities.

1) Double failures, with either one or both latent, that can lead to a Catastrophic Failure Condition shall be avoided in system design.
2) Latent failures contributing to Hazardous or Catastrophic repercussions should be avoided in system design.
3) "The use of periodic maintenance or flight crew checks to detect significant latent failures when they occur is undesirable and should not be used in lieu of practical and reliable failure monitoring and indications", as per AMC 25.1309 9.c.6.

4) It is recognised that, on occasion, there may be no possibility to comply with the above criteria 1) and 2). In such cases:
   a) The deviation shall be recorded and justified in the PSSA/SSA and reviewed during the design review process for acceptance,
   b) Acceptance should be based on both previous experience and sound engineering judgement and shall assess:
      i) the failure rates and service history of each component,
      ii) the inspection type and interval for any component whose failure would be latent, and
      iii) any possible common cause of cascading failure modes.
   c) The integrity of the evident part of the significant failure condition shall meet a minimum standard:
      i) For Catastrophic failure combinations comprising only one evident failure, the probability per flight hour of the evident part should be <= 10-5/Fh, and
      ii) For Hazardous failure combinations comprising only one evident failure, the probability per flight hour of the evident part should be <= 10-4/Fh.
   d) In addition, a Specific Risk calculation should be considered in accepting the presence of a latent failure. For each combination composed of one active failure and latent failures and leading to a Catastrophic Failure Condition:
      i) The probability of the latent part of the combination (e.g. “Sum of the products of the failure rates multiplied by the exposure time” of any latent failure) must be equal or less than $1x10^{-3}$ (=1/1000) on average.
   e) The periodic maintenance checks, which may result from the compliance to this Specific Risk criterion (d), will be considered as CMR candidates, in addition to the CMR Candidates already selected for compliance to CS 25.1309.

– END –

D-27 (ESF): Class B Baggage Compartment	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.857(b)(1)
ADVISORY MATERIAL:	AMC 25.855, 25.857

Equivalent Safety Finding (ESF)

Class B Baggage Compartment

Appendix A

Equivalent Safety Finding
Class B Baggage Compartment

The applicant proposes a 200 ft^3 Class B baggage compartment which exceeds the 52” radius criterion contained in the related CS 25 guidance material (ref. AMC to CS 25.855 and 25.857).

The primary means to fight a baggage compartment fire is a built in Halon 1301 compartment flooding system.

As such, the design will not meet the requirement that “*a crewmember standing at any one access point and without stepping into the compartment”* will be able to *“extinguish a fire occurring in any part of the compartment using a hand fire extinguisher”* (ref. CS25.857(b)(1)).

In order to demonstrate that the level of safety provided by this design is equivalent to that afforded by strict compliance to CS 25.857(b)(1), it must be substantiated that:

(1) the built in agent discharge system design and capacity will achieve and maintain in the baggage compartment effective fire extinguishing conditions for a duration commensurate with the time needed for a crewmember to prepare for and achieve (2) below;

(2) conditions (e.g. visibility, access) in the baggage compartment after discharge of the built-in system will be such that a crew member will be able to enter the compartment and ensure that a fire is extinguished. This can include, if required, additional agent application with a handheld extinguisher;

(3) the means to discharge the built-in system can be actuated from either pilot station, and at the access point to the baggage compartment;

(4) there is a means to prevent activation of the built-in system whenever the baggage compartment door is open;

(5) the built-in system activation means at the access point to the baggage compartment is designed to minimise the risk of inadvertent operation by a passenger, and;

(6) appropriate AFM procedures and associated training material are developed to cover all operational aspects of the baggage compartment built-in agent discharge system, by the crew, following detection of a fire in the baggage compartment.

In the context of (1) above, “effective fire extinguishing conditions” means there is no evidence of reignition for a period of thirty (30) minutes after the access door has been opened.

– END –

D-28 (ESF): Lavatory Ashtray	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.853 (g) Amendment 19
ADVISORY MATERIAL:	--

Equivalent Safety Findings (ESF)

Lavatory Ashtray

Appendix A

Equivalent Safety Finding
Lavatory Ashtray

EASA agrees that no ashtray needs to be installed inside each lavatory of the Global 7000/8000, as required by CS 25.853(g) provided that all the following criteria are met:

1) The cabin length must be lower than 18.29 m (60 ft).

2) The maximum passenger capacity must be 19 or less.

3) Each lavatory must be equipped with a smoke detector system or equivalent meeting the requirements of CS 25.854(a).

4) In addition to the placards and signs required by CS 25.791(a) and (d), the lavatory will be equipped with a continuously illuminated “No Smoking” passenger information sign.

5) A pre-flight briefing will be provided to the cabin occupants and will include the statement that smoking is prohibited in the lavatories.

– END –

D-29 (ESF): 'No smoking' placards	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.791 (d) Amendment 19
ADVISORY MATERIAL:	--

Equivalent Safety Findings (ESF)

Appendix A

Equivalent Safety Finding
'No smoking' placards

EASA agrees that the installation of 'No smoking' placards for lavatories of the Global 7000/8000 does not need to comply with CS 25.791(d) provided that all the following criteria are met:

1) The cabin length must be lower than 18.29 m (60 ft).

2) The maximum passenger capacity must be 19 or less.

3) Each lavatory must be equipped with a smoke detector system or equivalent meeting the requirements of CS 25.854(a).

4) The lavatory will be equipped with a continuously illuminated "No Smoking" passenger information sign.

5) A pre-flight briefing will be provided to the cabin occupants and will include the statement that smoking is prohibited in the lavatories.

6) Lavatories must have "No Smoking" or "No Smoking in Lavatory" placards conspicuously located on or adjacent to each side of the entry door.

7) The "no smoking in lavatory" placards will have red letters at least 0.18 inch high on a background white at least 0.38 inches high.

– END –

E-18 (ESF): Fuel Filter Location	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.997
ADVISORY MATERIAL:	--

Equivalent Safety Findings (ESF)

Fuel Filter Location

Appendix A

The following compensating factors shall be met to allow an equivalent safety finding to CS 25.997:

The design of the engine shall include a strainer upstream the engine driven positive displacement pump that:

1. is in compliance with CS 25.997(a)(b)(c)
2. includes a bypass,
3. has a delta pressure monitoring for indication of impending bypass and bypass to the flight crew via CAS messaging, as required by CS 25.1305(c)(6).

– END –

E-19 (ESF): Thrust Reverser Actuation System (TRAS) zone adjacent to designated fire zone	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.1182(a), 25.1103(b), 25.1165(e), 25.1183, 25.1185(c), 25.1187, 25.1189, 25.1195, 25.1197, 25.1199, 25.1201, 25.1203
ADVISORY MATERIAL:	--

Equivalent Safety Findings (ESF)

Thrust Reverser Actuation System (TRAS) zone adjacent to designated fire zone

Appendix A

Equivalent Safety Finding

Thrust Reverser Actuation System (TRAS) zone adjacent to designated fire zone

The following compensating factors shall be met to allow an equivalent safety finding to CS 25.1182(a) pertaining to TRAS zone adjacent to designated fire zone:

1) Zone Isolation & Segregation from Adjacent Zones.
The TRAS Compartment shall be isolated from the engine fan cowl fire zone by a firewall compliant with CS 25.1191 and that is located at the forward bulkhead of the thrust reverser assembly.

2) Minimization of Potential Ignition Sources.
In the normal inflight configuration (i.e. thrust reverser doors are stowed), electrical current shall not flow through TRAS component solenoid control wires. The excitation currents supplied to TRAS sensors shall be low enough not to be considered a source of ignition.

Electrical harnesses shall be insulated with a self-extinguishing material.

Failure of a thrust reverser electrical harness or connector shall not result in opening of the TRAS Isolation control valve or pressurization of the TRAS components and shall not cause inflight deployment of the thrust reverser.

Electrical components of the TRAS compartment shall be qualified as explosion proof.

In the event of a fan compartment fire the maximum surface temperatures of the fan compartment firewall bordering the TRAS compartment shall be below the auto-ignition temperature of hydraulic fluid.

The maximum surface temperatures in the TRAS compartment, under all normal operating conditions and failure conditions shall be below the auto-ignition temperature of hydraulic fluid.

3) Flammable Fluid Sources, Leakage and Drainage.

The TRAS shall not be pressurized in flight.

There shall be no fuel, engine oil or other flammable fluid sources in the TRAS compartment.

4) Service Experience.
Previous service experience of thrust reverser with similar design of the nacelle and aircraft manufacturers shall not reveal any in-service fire event report.

– END –

E-21 (ESF): Powerplants Fire Extinguishing System Bottle Sharing	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.851(b), 25.857, 25.1195(b), 25.1309
ADVISORY MATERIAL:	

Ref: TCCA BD-700-2A12 IP-11 Powerplants Fire Extinguishing System Bottle Sharing, edition 2 dated 10 May 2018

– END –

F-34 (ESF): Non-magnetic Standby Compass	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.1303(a)(3), 25.1327 (b), and 25.1547
ADVISORY MATERIAL:	AMC 25.1327

Equivalent Safety Findings (ESF)

Non-magnetic Standby Compass

Appendix A

Equivalent Safety Finding
to CS 25.1303(a)(3), CS 25.1327, and CS 25.1547 on direction indicator
(non-stabilised magnetic compass)

1) Independency from the primary and standby system (source and display of heading information) should be established in all foreseeable operating conditions. In normal conditions, each PFD uses the on side source for heading, and other sources may be used both as a backup to the PFD sources and to the electronic standby direction indicator. Hence, required independency may be compromised in the event that the same heading source is selected for the electronic standby direction indicator and on one PFD;

2) The applicant to provide assessment that the reliability of the electronic standby direction indicator is commensurate with the identified hazard level.

3) Additional availability assessments should be provided;

   a) Direction indication should be available immediately following the loss of the primary dedicated navigation (heading data) source without additional crewmember action, and after any single failure or combination of failures. The alternative magnetic heading source must provide availability at least equivalent to the availability level offered by a traditional non-stabilized magnetic direction indicator.
   b) Direction indication should not be adversely affected following a power interruption.

   c) Operation during and after exposure to HIRF environment should be established.

   d) Operation after exposure to indirect effect of lightning should be established.

– END –

F-38 (ESF): Minimum Mass Flow of Supplemental Oxygen	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25. 1443(c)
ADVISORY MATERIAL:	

Ref: TCCA BD-700-2A12 OS-104 Passenger Cabin Minimum Mass Flow of Supplemental Oxygen – Equivalent Safety Finding, edition 1 dated 18 August 2016

– END –

F-40 (ESF): Maximum Allowable Overlapping Intensities on Position Lights	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS ACNS.E.TAWS.030 (b)(3), (b)(4), (e)
ADVISORY MATERIAL:	--

Equivalent Safety Findings (ESF)

Maximum Allowable Overlapping Intensities on Position Lights

Appendix A
Equivalent Safety Finding

The following design features minimize the potential for confusion by an observer in another aircraft regarding the orientation and direction of travel of the Global 7000 airplane:

1. The main beam intensity of the position lights is significantly higher than the requirements as stated in 25.1391 and 25.1393.

2. The size/location of the viewing angles at which the exceeding overlapping intensities can be observed (above and below the horizontal plane);and

3. The ratio between the main beam and the overlapping beam exceeds ratios allowed by current certification rules (Positive ratios for angles between -70 and +70 Degrees).

4. A trained observer could not visually distinguish between a position light system producing the overlap intensities described above, and one without the exceeding overlaps.

– END –

G-02 (ESF): Green Arc for Powerplant Instrument	
APPLICABILITY:	Bombardier BD-700-2A12
REQUIREMENTS:	CS 25.1549(b)
ADVISORY MATERIAL:	AMC 25.1549

Equivalent Safety Findings (ESF)

Green Arc for Powerplant Instrument

Appendix A

Equivalent Safety Finding

The following compensating factors shall be met to allow an equivalent safety finding to CS 25.1549(b):

a) The engine parameters are provided in the format of computerized analogue dial and pointer (needle) with a box displaying the numerical value.

b) The colour of the pointer, the box and the numerical values are adapted to the indication:

   1. green for normal operating range and

   2. red when parameter is outside the operating range.

c) In the event that the engine data being transmitted for display becomes invalid, the colour of the parameter shall be else than red or green and the numerical value shall be replaced by dashes.

d) All the non-normal indication of N1 or ITT shall be accompanied by a relevant CAS message, Master Caution annunciator and aural warning.

– END –

Acronyms and Abbreviations

TCDS	Type Certificate Data Sheet
SC	Special Condition
DEV	Deviation
ESF	Equivalent Safety Finding

– END –