European Aviation Safety Agency

Certification Specifications for Large Aeroplanes

CS-25

Amendment 4
27 December 2007

CONTENTS (general layout)

CS–25

LARGE AEROPLANES

PREAMBLE

CS-25 Amendment 1 ***Effective: 12/12/2005***

The following is a list of paragraphs affected by this amendment.

Contents

- The title of Subpart J is amended (NPA 10/2004)
- The title of Appendix K is amended (NPA 11/2004)
- A new reference to Appendix L is added (NPA 11/2004)

Book 1

Subpart B

• CS 25.251 (a) and (b)	Amended (NPA 11/2004)

Subpart C

• CS 25.301(b)	Amended (NPA 02/005)
• CS 25.302	Created (NPA 11/2004)
• CS 25.305	Amended by adding sub-paragraphs (e) and (f) ((NPA 11/2004))
• CS 25.307	Amended (NPA 11/2004)
• CS 25.341	Amended (NPA 11/2004)
• CS 25.343(b)(1)(ii)	Amended (NPA 11/2004)
• CS 25.345(c)(2)	Amended (NPA 11/2004)
• CS 25.371	Amended (NPA 11/2004)
• CS 25.373 (a)	Amended (NPA 11/2004)
• CS 25.391	Amended (NPA 11/2004)
• CS 25.427	Amended by adding sub-paragraph (d) (NPA 11/2004)

Subpart D

• CS 25.613	Amended (NPA 11/2004)
• CS 25.621	Replaced (NPA 08/2004)
• CS 25.629	Amended (NPA 11/2004)

Subpart E

• CS 25.901(c)	Amended (NPA 13/2004)
• CS 25.933 (a)(1)	Amended (NPA 13/2004)
• CS 25.981	Replaced (NPA 10/2004)
• CS 25.1141 (f)	Amended (NPA 13/2004)
• CS 25.1189	Amended (NPA 13/2004)

Subpart F

• CS 25.1436(b)(7)	Amended to refer to Appendix L (NPA 11/2004)

Subpart G

• CS 25.1517	Amended (NPA 11/2004)
• CS 25.1522	Deleted. (NPA 10/2004)
• CS 25.1583(b)(1)	Amended by removing reference to CS 25.1522 (NPA 10/2004)

Subpart J

• Sub-part J	Replaced entirely (NPA 10/2004)
• CS 25J1189	Amended by adding reference to AMC 25.1189 (NPA 13/2004

Appendices

• Appendix K	Replaced entirely (NPA 11/2004)
• Appendix L	Old Appendix K renumbered (NPA 11/2004)

Book 2

Introduction	Amended to reflect changes introduced by Amendment 1

<u>AMC - Subpart C</u>

• AMC 25.301(b)	Amended (sub-paragraph (b) deleted) and renumbered as AMC No 1 to CS 25.301(b) (NPA 02/2005)
• AMC No.2 to CS 25.301(b)	Created (NPA 02/2005)
• AMC 25.307	Replaced (NPA 11/2004)
• AMC 25.341	Amended (NPA 11/2004)

<u>AMC - Subpart D</u>

• AMC 25.613	Created (NPA 11/2004)
• AMC 25.621	Created (NPA 08/2004)
• AMC 25.621(c)	Created (NPA 08/2004)
• AMC 25.621(c)(1)	Created (NPA 08/2004)
• AMC 25.629	Created (NPA 11/2004)

<u>AMC - Subpart E</u>

• AMC 25.901(c)	Created (NPA 13/2004)
• AMC 25.933 (a)(1)	Created (NPA 13/2004)
• AMC 25.981(a)	Created (NPA 10/2004)
• AMC 25.981(c)	Created (NPA 10/2004)
• AMC 25.1189	Created (NPA 13/2004)

<u>AMC- Subpart J</u>

• Existing AMC to subpart J	Deleted entirely (NPA 10/2004)
• AMC 25J901(c)(2)	Created (NPA 10/2004)
• AMC 25J901(c)(4)	Created (NPA 10/2004)
• AMC 25J943	Created (NPA 10/2004)
• AMC 25J955(a)(2)(iii)	Created (NPA 10/2004)
• AMC 25J991	Created (NPA 10/2004)
• AMC 25J1041	Created (NPA 10/2004)
• AMC 25J1093(b)	Created (NPA 10/2004)
• AMC 25J1195(b)	Created (NPA 10/2004)

CS-25 Amendment 2 ***Effective: 02/10/2006***

The following is a list of paragraphs affected by this amendment.

Book 1

<u>Subpart B</u>

• CS 25.101 (b)(2)	Corrected

<u>Subpart C</u>

• CS 25.399 (a)(1)	Corrected

<u>Subpart D</u>

• CS 25.735(f)(2)	Corrected
• CS 25.745(c)	Corrected

<u>Subpart F</u>

• CS 25.1301(c)	Corrected
• CS 25.1365(a)	Corrected

- CS 25.1423 Corrected
- CS 1435(b)(2) Corrected

Subpart G

- CS 25.1591 replaced entirely (NPA 14/2004)

Appendix F

- Part II, (a)(3) Corrected

Appendix J

- Introductory sentence Corrected

Book 2

AMC - Subpart C

- AMC 25.335(b)(2), 2 Title corrected
- AMC 25.415, 2 Title corrected
- AMC 25.491, 2 Title corrected
- AMC 25.571(a),(b) and (e), 3.2.2 a Corrected

AMC - Subpart D

- AMC 25.703, 2 Title corrected
- AMC 25.703, 3 a. Corrected
- AMC 25.703, 3. b. (2) Corrected
- AMC 25.703, 5. b. (4) Corrected
- AMC 25.723, 2 Title corrected
- AMC 25.735, 2. a. Corrected
- AMC 25.735, 2. b. (ii) Corrected
- AMC 25.735, 2.b. (vi) Corrected
- AMC 25.735, 4.a.(1)(e) Corrected
- AMC 25.785(d) Designation of this AMC corrected

AMC - Subpart F

- AMC 25.1309, 3.a.(3) Corrected
- AMC 25.1309, 3.a.(4) Corrected
- AMC 25.1309, 3.b.(2) Corrected
- AMC 25.1309, section 7 heading Corrected
- AMC 25.1322, 2 Title corrected
- AMC 25.1322, 2.1 Corrected
- AMC 25.1435, 2.(b) Corrected
- AMC 25.1457 Corrected

AMC - Subpart G

- AMC 25.1581, 6. (b) (6) (i) Corrected
- AMC 25.1581, APPX 1, 6. b. (1) Corrected
- AMC 25.1583(k), a. and b. Cross-references to CS 25.1591 amended (NPA 14/2004)
- AMC 25.1591 Created (NPA 14/2004)

GENERAL AMC

- AMC 25-11, 3 Title corrected
- AMC 25-11, 3 a. Corrected
- AMC 25-11, 3 b. Corrected
- AMC 25-11, 3 d. (1) Corrected
- AMC 25-11, 4 a. (1) Corrected
- AMC 25-11, 4 a. (2) Corrected
- AMC 25-11, 4 b. (2) (ii) Corrected

• AMC 25-11, 7 b. (1))	Corrected
• AMC 25-13, 2	Title corrected
• AMC 25-19, 2	Title corrected
• AMC 25-19, 3 b.	Corrected
• AMC 25-19, section 6 intro	Corrected
• AMC 25-19, section 7 intro and a.	Corrected
• AMC 25-19, section 8 intro	Corrected

CS-25 Amendment 3 ***Effective: 19/09/2007***

The following is a list of paragraphs affected by this amendment.

Book 1

Subpart B

• CS 25.21(g)	Created (NPA 16/2004)
• CS 25.103(b)(3)	Amended (NPA 16/2004)
• CS 25.105(a)	Amended (NPA 16/2004)
• CS 25.107(c)(3)	Amended (NPA 16/2004)
• CS 25.107(g)(2)	Amended (NPA 16/2004)
• CS 25.107(h)	Created (NPA 16/2004)
• CS 25.111(c)(3)(iii)	Amended (NPA 16/2004)
• CS 25.111(c)(4)	Amended (NPA 16/2004)
• CS 25.111(c)(5)	Amended (NPA 16/2004)
• CS 25.119	Amended (NPA 16/2004)
• CS 25.119(a)	Amended (NPA 16/2004)
• CS 25.119(b)	Amended (NPA 16/2004)
• CS 25.121(b)	Amended (NPA 16/2004)
• CS 25.121(c)	Amended (NPA 16/2004)
• CS 25.121(d)	Amended (NPA 16/2004)
• CS 25.123(a)	Amended (NPA 16/2004)
• CS 25.123(b)	Amended (NPA 16/2004)
• CS 25.125(a)	Amended (NPA 16/2004)
• CS 25.125(b)	Redesignated as CS 25.125(c) (NPA 16/2004)
• CS 25.125(b)	Created (NPA 16/2004)
• CS 25.125(c)	Redesignated as CS 25.125(d) (NPA 16/2004)
• CS 25.125(d)	Redesignated as CS 25.125(e) (NPA 16/2004)
• CS 25.125(e)	Redesignated as CS 25.125(f) (NPA 16/2004)
• CS 25.125(f)	Redesignated as CS 25.125(g) (NPA 16/2004)
• CS 25.143(c)	Amended and redesignated as CS 25.143(d) (NPA 16/2004)
• CS 25.143(c)	Created (NPA 16/2004)
• CS 25.143(d)	Amended and redesignated as CS 25.143(e) (NPA 16/2004)
• CS 25.143(e)	Amended and redesignated as CS 25.143(f) (NPA 16/2004)
• CS 25.143(f)	Amended and redesignated as CS 25.143(g) (NPA 16/2004)
• CS 25.143(g)	Redesignated as CS 25.143(h) (NPA 16/2004)
• CS 25.143(i)	Created (NPA 16/2004)
• CS 25.143(j)	Created (NPA 16/2004)
• CS 25.207(b)	Amended (NPA 16/2004)
• CS 25.207(e)	Amended and Redesignated as CS 25.207(f) (NPA 16/2004)
• CS 25.207(e)	Created
• CS 25.207(f)	Amended and Redesignated as CS 25.207(g) (NPA 16/2004)
• CS 25.207(h)	Created (NPA 16/2004)
•	
• CS 25.237(a)	Amended (NPA 16/2004)

• CS 25.253(b)	Amended (NPA 16/2004)
• CS 25.253(c)	Created (NPA 16/2004)

<u>Subpart C</u>

• CS 25.405(b)	Formula corrected

<u>Subpart D</u>

• CS 25.721	Amended (NPA 21/2005)
• CS 25.773(b)(1)(ii)	Amended ((NPA 16/2004)
• CS 25.811(g)	Amended (NPA 04/2006)
• CS 25.812	Amended (NPA 04/2006)
• CS 25.855(c)	Amended (NPA 04/2006)
• CS 25.857(d)	Deleted (NPA 04/2006)
• CS 25.858	Amended (NPA 04/2006)

<u>Subpart E</u>

• CS 25.901(b)(1)(ii)	Corrected
• CS 25.905	Corrected
• CS 25.907	Corrected
• CS 25.941(c)	Amended (NPA 16/2004)
• CS 25.963	Amended (NPA 21/2005)
• CS 25.994	Amended (NPA 21/2005)

<u>Subpart F</u>

• CS 25.1302	Created (NPA 15/2004)
• CS 25.1419	Amended (NPA 16/2004)

<u>Subpart J</u>

• CS 25J994	Amended (NPA 21/2005)

<u>Appendix C</u>

• Appendix C	Introduction of Part I Title (NPA 16/2004)
• Part I paragraph (c)	Created (NPA 16/2004)
• Part II	Created (NPA 16/2004)

Book 2

<u>AMC - Subpart B</u>

• AMC 25.21(g)	Created (NPA 16/2004)
• AMC 25.119(a)	Amended and redesignated as AMC 25.119 (NPA 16/2004)
• AMC 25.121(b)(1)	Redesignated as AMC 25.121(b)(1) (i) (NPA 16/2004)
• AMC 25.125(a)(3)	Redesignated as AMC 25.125(b)(3) (NPA 16/2004)
• AMC 25.125(b)	Redesignated as AMC 25.125(c) (NPA 16/2004)
• AMC 25.125(b)(2)	Amended and redesignated as AMC 25.125(c)(2)(NPA 16/2004)
• AMC 25.143(c)	Amended and redesignated as AMC 25.143(d) (NPA 16/2004)
• AMC No.1 to 25.143(f)	Redesignated as AMC No.1 to 25.143(g) (NPA 16/2004)
• AMC No.2 to 25.143(f)	Amended and redesignated as AMC No.2 to 25.143(g) (NPA 16/2004)
• AMC 25.143(g)	Amended and redesignated as AMC 25.143(h) (NPA 16/2004)

AMC - Subpart D

• AMC 25.812(b)(1)	Created (NPA 04/2006)
• AMC 25.812(b)(2)	Created (NPA 04/2006)
• AMC 25.812(e)(2)	Created (NPA 04/2006)

AMC - Subpart E

• AMC 25.963(d)	Replaced (NPA 21/2005)
• AMC 25.963(e)	Created (NPA 21/2005)
• AMC 25.963(g)	Revoked (NPA 21/2005)

AMC - Subpart F

• AMC 25.1302	Created (NPA 15/2004)
• AMC 25.1329	Cross-references amended (NPA 16/2004)
• AMC 25.1360(a)	Title corrected
• AMC 25.1360(b)	Title corrected

CS-25 Amendment 4 ***Effective: 27/12/2007***

The following is a list of paragraphs affected by this amendment.

Book 1

Subpart D

• CS 25.729	Amended (NPA 02/2006)
• CS 25.773	Amended (NPA 02/2006)
• CS 25.783	Amended (NPA 02/2006)
• CS 25.807	Amended (NPA 02/2006)
• CS 25.809	Amended (NPA 02/2006)
• CS 25.810	Amended (NPA 02/2006)
• CS 25.820	Created (NPA 02/2006)
• CS 25.851	Amended (NPA 02/2006)

Subpart F

• CS 25.1329	Replaced entirely (NPA 18/2006)
• CS 25.1335	Deleted (NPA 18/2006)
• CS 25.1439	Amended (NPA 02/2006)
• CS 25.1453	Amended (NPA 02/2006)

Appendix F

• Part II paragraph (f)4	Corrected (NPA 18/2006)

Book 2

AMC - Subpart D

• AMC 25.25.729	Created (NPA 02/2006)
• AMC 25.25.773	Created (NPA 02/2006)
• AMC 25.773(b)(1)(ii)	Deleted (NPA 02/2006)
• AMC 25.25.783	Created (NPA 02/2006)
• AMC 25.851(b)	Created (NPA 02/2006)

AMC - Subpart F

- AMC 25.1309 (4) Corrected
- AMC 25.1329 Replaced by AMC Nos 1 and 2 to CS 25.1329
- AMC No. 1 to CS 25.1329 Created (NPA 18/2006)
- AMC No. 2 to CS 25.1329 Created (NPA 18/2006)
- AMC 25.1439(b)(5) Deleted (NPA 02/2006)
- AMC 25.1453 Deleted (NPA 02/2006)

EASA Certification Specifications
for
Large Aeroplanes

CS-25
Book 1

Airworthiness Code

CS–25 BOOK 1

SUBPART A – GENERAL

CS 25.1 Applicability

(a) This Airworthiness Code is applicable to turbine powered Large Aeroplanes.

CS-25 BOOK 1

SUBPART B – FLIGHT

GENERAL

CS 25.20 Scope

(a) The requirements of this Subpart B apply to aeroplanes powered with turbine engines –

(1) Without contingency thrust ratings, and

(2) For which it is assumed that thrust is not increased following engine failure during take-off except as specified in sub-paragraph (c).

(b) In the absence of an appropriate investigation of operational implications these requirements do not necessarily cover –

(1) Automatic landings.

(2) Approaches and landings with decision heights of less than 60 m (200 ft).

(3) Operations on unprepared runway surfaces.

(c) If the aeroplane is equipped with an engine control system that automatically resets the power or thrust on the operating engine(s) when any engine fails during take-off, additional requirements pertaining to aeroplane performance and limitations and the functioning and reliability of the system, contained in Appendix I, must be complied with.

CS 25.21 Proof of compliance

(a) Each requirement of this Subpart must be met at each appropriate combination of weight and centre of gravity within the range of loading conditions for which certification is requested. This must be shown –

(1) By tests upon an aeroplane of the type for which certification is requested, or by calculations based on, and equal in accuracy to, the results of testing; and

(2) By systematic investigation of each probable combination of weight and centre of gravity, if compliance cannot be reasonably inferred from combinations investigated.

(b) Reserved

(c) The controllability, stability, trim, and stalling characteristics of the aeroplane must be shown for each altitude up to the maximum expected in operation.

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

(e) If compliance with the flight characteristics requirements is dependent upon a stability augmentation system or upon any other automatic or power-operated system, compliance must be shown with CS 25.671 and 25.672.

(f) In meeting the requirements of CS 25.105(d), 25.125, 25.233 and 25.237, the wind velocity must be measured at a height of 10 metres above the surface, or corrected for the difference between the height at which the wind velocity is measured and the 10-metre height.

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

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

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

[Amdt. No.:25/3]

CS 25.23 Load distribution limits

(a) Ranges of weights and centres of gravity within which the aeroplane may be safely operated must be established. If a weight and centre of gravity combination is allowable only within certain load distribution limits (such as spanwise) that could be inadvertently exceeded, these limits and the corresponding weight and centre of gravity combinations must be established.

(b) The load distribution limits may not exceed –

(1) The selected limits;

(2) The limits at which the structure is proven; or

(3) The limits at which compliance with each applicable flight requirement of this Subpart is shown.

CS 25.25 Weight Limits

(a) *Maximum weights.* Maximum weights corresponding to the aeroplane operating conditions (such as ramp, ground taxi, take-off, en-route and landing) environmental conditions (such as altitude and temperature), and loading conditions (such as zero fuel weight, centre of gravity position and weight distribution) must be established so that they are not more than –

(1) The highest weight selected by the applicant for the particular conditions; or

(2) The highest weight at which compliance with each applicable structural loading and flight requirement is shown.

(3) The highest weight at which compliance is shown with the noise certification requirements .

(b) *Minimum weight.* The minimum weight (the lowest weight at which compliance with each applicable requirement of this CS–25 is shown) must be established so that it is not less than –

(1) The lowest weight selected by the applicant;

(2) The design minimum weight (the lowest weight at which compliance with each structural loading condition of this CS–25 is shown); or

(3) The lowest weight at which compliance with each applicable flight requirement is shown.

CS 25.27 Centre of gravity limits

The extreme forward and the extreme aft centre of gravity limitations must be established for each practicably separable operating condition. No such limit may lie beyond –

(a) The extremes selected by the applicant;

(b) The extremes within which the structure is proven; or

(c) The extremes within which compliance with each applicable flight requirement is shown.

CS 25.29 Empty weight and corresponding centre of gravity

(a) The empty weight and corresponding centre of gravity must be determined by weighing the aeroplane with –

(1) Fixed ballast;

(2) Unusable fuel determined under CS 25.959; and

(3) Full operating fluids, including –

(i) Oil;

(ii) Hydraulic fluid; and

(iii) Other fluids required for normal operation of aeroplane systems, except potable water, lavatory pre-charge water, and fluids intended for injection in the engine.

(b) The condition of the aeroplane at the time of determining empty weight must be one that is well defined and can be easily repeated.

CS 25.31 Removable ballast

Removable ballast may be used in showing compliance with the flight requirements of this Subpart.

CS 25.33 Propeller speed and pitch limits

(a) The propeller speed and pitch must be limited to values that will ensure –

(1) Safe operation under normal operating conditions; and

(2) Compliance with the performance requirements in CS 25.101 to 25.125.

(b) There must be a propeller speed limiting means at the governor. It must limit the maximum possible governed engine speed to a value not exceeding the maximum allowable rpm.

(c) The means used to limit the low pitch position of the propeller blades must be set so that the engine does not exceed 103% of the maximum allowable engine rpm or 99% of an approved maximum overspeed, whichever is greater, with –

(1) The propeller blades at the low pitch limit and governor inoperative;

(2) The aeroplane stationary under standard atmospheric conditions with no wind; and

(3) The engines operating at the maximum take-off torque limit for turbopropeller engine-powered aeroplanes.

PERFORMANCE

CS 25.101 General
(See AMC 25.101)

(a) Unless otherwise prescribed, aeroplanes must meet the applicable performance requirements of this Subpart for ambient atmospheric conditions and still air.

(b) The performance, as affected by engine power or thrust, must be based on the following relative humidities:

(1) 80%, at and below standard temperatures; and

(2) 34%, at and above standard temperatures plus 28ºC (50ºF).

Between these two temperatures, the relative humidity must vary linearly.

(c) The performance must correspond to the propulsive thrust available under the particular ambient atmospheric conditions, the particular flight condition, and the relative humidity specified in sub-paragraph (b) of this paragraph. The available propulsive thrust must correspond to engine power or thrust, not exceeding the approved power or thrust, less –

(1) Installation losses; and

(2) The power or equivalent thrust absorbed by the accessories and services appropriate to the particular ambient atmospheric conditions and the particular flight condition. (See AMCs No 1 and No 2 to CS 25.101(c).)

(d) Unless otherwise prescribed, the applicant must select the take-off, en-route, approach, and landing configuration for the aeroplane.

(e) The aeroplane configurations may vary with weight, altitude, and temperature, to the extent they are compatible with the operating procedures required by sub-paragraph (f) of this paragraph.

(f) Unless otherwise prescribed, in determining the accelerate-stop distances, take-off flight paths, take-off distances, and landing distances, changes in the aeroplane's configuration, speed, power, and thrust, must be made in accordance with procedures established by the applicant for operation in service.

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

(h) The procedures established under sub-paragraphs (f) and (g) of this paragraph must –

(1) Be able to be consistently executed in service by crews of average skill,

(2) Use methods or devices that are safe and reliable, and

(3) Include allowance for any time delays in the execution of the procedures, that may reasonably be expected in service. (See AMC 25.101(h)(3).)

(i) The accelerate-stop and landing distances prescribed in CS 25.109 and 25.125, respectively, must be determined with all the aeroplane wheel brake assemblies at the fully worn limit of their allowable wear range. (See AMC 25.101(i).)

[Amdt. No.:25/2]

CS 25.103 Stall speed

(a) 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} is expressed as:

$$V_{SR} \geq \frac{V_{CLMAX}}{\sqrt{n_{zw}}}$$

where –

V_{CLMAX} =Calibrated airspeed obtained when the loadfactor-corrected lift coefficient $\left(\frac{n_{zw}W}{qS}\right)$ is first a maximum during the manoeuvre prescribed in sub-paragraph (c) of this paragraph. In addition, when the manoeuvre is limited by a device that abruptly pushes the nose down at a selected angle of attack (e.g. a stick pusher), V_{CLMAX} may not be less than the speed existing at the instant the device operates;

n_{zw} =Load factor normal to the flight path at V_{CLMAX};

W =Aeroplane gross weight;

S =Aerodynamic reference wing area; and

q =Dynamic pressure.

(b) V_{CLMAX} is determined 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) Propeller pitch controls (if applicable) in the take-off position;

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

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

(5) The centre of gravity position that results in the highest value of reference stall speed; and

(6) The aeroplane trimmed for straight flight at a speed selected by the applicant, but not less than 1·13 V_{SR} and not greater than 1·3 V_{SR}.

(c) Starting from the stabilised trim condition, apply the longitudinal control to decelerate the aeroplane so that the speed reduction does not exceed 0.5 m/s^2 (one knot per second). (See AMC 25.103(b) and (c)).

(d) In addition to the requirements of sub-paragraph (a) of this paragraph, when a device that abruptly pushes the nose down at a selected angle of attack (e.g. a stick pusher) is installed, the reference stall speed, V_{SR}, may not be less than 3,7 km/h (2 kt) or 2%, whichever is greater, above the speed at which the device operates.

[Amdt. No.:25/3]

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, the take-off distance and take-off run prescribed by CS 25.113, and the net take-off flight path prescribed by CS 25.115, must be determined in the selected configuration for take-off at each weight, altitude, and ambient temperature within the operational limits selected by the applicant –

(1) In non-icing conditions; and

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

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

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

(b) No take-off made to determine the data required by this paragraph may require exceptional piloting skill or alertness.

(c)The take-off data must be based on:

(1) Smooth, dry and wet, hard-surfaced runways; and

(2) At the option of the applicant, grooved or porous friction course wet, hard-surfaced runways.

(d) The take-off data must include, within the established operational limits of the aeroplane, the following operational correction factors:

(1) Not more than 50% of nominal wind components along the take-off path opposite to the direction of take-off, and not less than 150% of nominal wind components along the take-off path in the direction of take-off.

(2) Effective runway gradients.

[Amdt. No.:25/3]

CS 25.107 Take-off speeds

(a) V_1 must be established in relation to V_{EF} as follows:

(1) V_{EF} is the calibrated airspeed at which the critical engine is assumed to fail. V_{EF} must be selected by the applicant, but may not be less than V_{MCG} determined under CS 25.149 (e).

(2) V_1, in terms of calibrated airspeed, is selected by the applicant; however, V_1 may not be less than V_{EF} plus the speed gained with the critical engine inoperative during the time interval between the instant at which the critical engine is failed, and the instant at which the pilot recognises and reacts to the engine failure, as indicated by the pilot's initiation of the first action (e.g. applying brakes, reducing thrust, deploying speed brakes) to stop the aeroplane during accelerate-stop tests.

(b) V_{2MIN}, in terms of calibrated airspeed, may not be less than –

(1) 1·13 V_{SR} for –

(i) Two-engined and three-engined turbo-propeller powered aeroplanes; and

(ii) Turbojet powered aeroplanes without provisions for obtaining a significant reduction in the one-engine-inoperative power-on stall speed;

(2) 1·08 V_{SR} for –

(i) Turbo-propeller powered aeroplanes with more than three engines; and

(ii) Turbojet powered aeroplanes with provisions for obtaining a significant reduction in the one-engine-inoperative power-on stall speed: and

(3) 1·10 times V_{MC} established under CS 25.149.

(c) 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 take-off surface; and

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

(d) V_{MU} is the calibrated airspeed at and above which the aeroplane can safely lift off the ground, and continue the take-off. V_{MU} speeds must be selected by the applicant throughout the range of thrust-to-weight ratios to be certificated. These speeds may be established from free air data if these data are verified by ground take-off tests. (See AMC 25.107(d).)

(e) V_R, in terms of calibrated air speed, must be selected in accordance with the conditions of sub-paragraphs (1) to (4) of this paragraph:

(1) V_R may not be less than –

(i) V_1;

(ii) 105% of V_{MC};

(iii) The speed (determined in accordance with CS 25.111(c)(2)) that allows reaching V_2 before reaching a height of 11 m (35 ft) above the take-off surface; or

(iv) A speed that, if the aeroplane is rotated at its maximum practicable rate, will result in a V_{LOF} of not less than-

(A) 110% of V_{MU} in the all-engines-operating condition, and 105% of V_{MU} determined at the thrust-to-weight ratio corresponding to the one-engine-inoperative condition; or

(B) If the V_{MU} attitude is limited by the geometry of the aeroplane (i.e., tail contact with the runway), 108% of V_{MU} in the all-engines-operating condition and 104% of V_{MU} determined at the thrust-to-weight ratio corresponding to the one-engine-inoperative condition. (See AMC 25.107(e)(1)(iv).)

(2) For any given set of conditions (such as weight, configuration, and temperature), a single value of V_R, obtained in accordance with this paragraph, must be used to show compliance with both the one-engine-inoperative and the all-engines-operating take-off provisions.

(3) It must be shown that the one-engine-inoperative take-off distance, using a rotation speed of 9.3 km/h (5 knots) less than V_R established in accordance with sub-paragraphs (e)(1) and (2) of this paragraph, does not exceed the corresponding one-engine-inoperative take-off distance using the established V_R. The take-off distances must be determined in accordance with CS 25.113(a)(1). (See AMC 25.107(e)(3).)

(4) Reasonably expected variations in service from the established take-off procedures for the operation of the aeroplane (such as over-rotation of the aeroplane and out-of-trim conditions) may not result in unsafe flight characteristics or in marked increases in the

scheduled take-off distances established in accordance with CS 25.113(a). (See AMC No. 1 to CS25.107 (e) (4) and AMC No. 2 to CS25.107 (e) (4).)

(f) V_{LOF} is the calibrated airspeed at which the aeroplane first becomes airborne.

(g) 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).

(h) In determining the take-off speeds V_1, V_R, and V_2 for flight in icing conditions, the values of V_{MCG}, V_{MC}, and V_{MU} determined for non-icing conditions may be used.

[Amdt. No.:25/3]

CS 25.109 Accelerate-stop distance

(a) (See AMC 25.109(a) and (b).) The accelerate-stop distance on a dry runway is the greater of the following distances:

(1) The sum of the distances necessary to –

(i) Accelerate the aeroplane from a standing start with all engines operating to V_{EF} for take-off from a dry runway;

(ii) Allow the aeroplane to accelerate from V_{EF} to the highest speed reached during the rejected take-off, assuming the critical engine fails at V_{EF} and the pilot takes the first action to reject the take-off at the V_1 for take-off from a dry runway; and

(iii) Come to a full stop on a dry runway from the speed reached as prescribed in sub-paragraph (a)(1)(ii) of this paragraph; plus

(iv) A distance equivalent to 2 seconds at the V_1 for take-off from a dry runway.

(2) The sum of the distances necessary to –

(i) Accelerate the aeroplane from a standing start with all engines operating to the highest speed reached during the rejected take-off, assuming the pilot takes the first action to reject the take-off at the V_1 for take-off from a dry runway; and

(ii) With all engines still operating, come to a full stop on a dry runway from the speed reached as prescribed in sub-paragraph (a)(2)(i) of this paragraph; plus

(iii) A distance equivalent to 2 seconds at the V_1 for take-off from a dry runway.

(b) (See AMC 25.109(a) and (b).) The accelerate-stop distance on a wet runway is the greater of the following distances:

(1) The accelerate-stop distance on a dry runway determined in accordance with sub-paragraph (a) of this paragraph; or

(2) The accelerate-stop distance determined in accordance with sub-paragraph (a) of this paragraph, except that the runway is wet and the corresponding wet runway values of V_{EF} and V_1 are used. In determining the wet runway accelerate-stop distance, the stopping force from the wheel brakes may never exceed:

(i) The wheel brakes stopping force determined in meeting the requirements of CS 25.101(i) and sub-paragraph (a) of this paragraph; and

(ii) The force resulting from the wet runway braking coefficient of friction determined in accordance with sub-paragraphs (c) or (d) of this paragraph, as applicable, taking into account the distribution of the normal load between braked and unbraked wheels at the most adverse centre of gravity position approved for take-off.

(c) The wet runway braking coefficient of friction for a smooth wet runway is defined as a curve of friction coefficient versus ground speed and must be computed as follows:

(1) The maximum tyre-to-ground wet runway braking coefficient of friction is defined as (see Figure 1):

where:

Tyre Pressure = maximum aeroplane operating tyre pressure (psi)

$\mu_{t/gMAX}$ = maximum tyre-to-ground braking coefficient

V = aeroplane true ground speed (knots); and

Linear interpolation may be used for tyre pressures other than those listed.

Tyre Pressure (psi)	Maximum Braking Coefficient (tyre-to-ground)
50	$\mu_{t/gMAX} = -0\cdot0350\left(\frac{V}{100}\right)^3 + 0\cdot306\left(\frac{V}{100}\right)^2 - 0\cdot851\left(\frac{V}{100}\right) + 0\cdot883$
100	$\mu_{t/gMAX} = -0\cdot0437\left(\frac{V}{100}\right)^3 + 0\cdot320\left(\frac{V}{100}\right)^2 - 0\cdot805\left(\frac{V}{100}\right) + 0\cdot804$
200	$\mu_{t/gMAX} = -0\cdot0331\left(\frac{V}{100}\right)^3 + 0\cdot252\left(\frac{V}{100}\right)^2 - 0\cdot658\left(\frac{V}{100}\right) + 0\cdot692$
300	$\mu_{t/gMAX} = -0\cdot0401\left(\frac{V}{100}\right)^3 + 0\cdot263\left(\frac{V}{100}\right)^2 - 0\cdot611\left(\frac{V}{100}\right) + 0\cdot614$

Figure 1

(2) (See AMC 25.109(c)(2) The maximum tyre-to-ground wet runway braking coefficient of friction must be adjusted to take into account the efficiency of the anti-skid system on a wet runway. Anti-skid system operation must be demonstrated by flight testing on a smooth wet runway and its efficiency must be determined. Unless a specific anti-skid system efficiency is determined from a quantitative analysis of the flight testing on a smooth wet runway, the maximum tyre-to-ground wet runway braking coefficient of friction determined in sub-paragraph (c)(1) of this paragraph must be multiplied by the efficiency value associated with the type of anti-skid system installed on the aeroplane:

Type of anti-skid system	Efficiency value
On-off	0·30
Quasi-modulating	0·50
Fully modulating	0·80

(d) At the option of the applicant, a higher wet runway braking coefficient of friction may be used for runway surfaces that have been grooved or treated with a porous friction course material. For grooved and porous friction course runways,

(1) 70% of the dry runway braking coefficient of friction used to determine the dry runway accelerate-stop distance; or

(2) (See AMC 25.109(d)(2).) The wet runway braking coefficient of friction defined in sub-paragraph (c) of this paragraph, except that a specific anti-skid efficiency, if determined, is appropriate for a grooved or porous friction course wet runway and the maximum tyre-to-ground wet runway braking coefficient of friction is defined as (see Figure 2):

where:

Tyre Pressure = maximum aeroplane operating tyre pressure (psi)

$\mu_{t/gMAX}$ = maximum tyre-to-ground braking coefficient

V = aeroplane true ground speed (knots); and

Linear interpolation may be used for tyre pressures other than those listed.

Tyre Pressure(psi)	Maximum Braking Coefficient (tyre-to-ground)
50	$\mu_{t/gMAX} = 0\cdot147\left(\frac{V}{100}\right)^5 - 1\cdot05\left(\frac{V}{100}\right)^4 + 2\cdot673\left(\frac{V}{100}\right)^3 - 2\cdot683\left(\frac{V}{100}\right)^2 + 0\cdot403\left(\frac{V}{100}\right) + 0\cdot859$
100	$\mu_{t/gMAX} = 0\cdot1106\left(\frac{V}{100}\right)^5 - 0\cdot813\left(\frac{V}{100}\right)^4 + 2\cdot13\left(\frac{V}{100}\right)^3 - 2\cdot20\left(\frac{V}{100}\right)^2 + 0\cdot317\left(\frac{V}{100}\right) + 0\cdot807$
200	$\mu_{t/gMAX} = 0\cdot0498\left(\frac{V}{100}\right)^5 - 0\cdot398\left(\frac{V}{100}\right)^4 + 1\cdot14\left(\frac{V}{100}\right)^3 - 1\cdot285\left(\frac{V}{100}\right)^2 + 0\cdot140\left(\frac{V}{100}\right) + 0.701$
300	$\mu_{t/gMAX} = 0\cdot0314\left(\frac{V}{100}\right)^5 - 0\cdot247\left(\frac{V}{100}\right)^4 + 0\cdot703\left(\frac{V}{100}\right)^3 - 0\cdot779\left(\frac{V}{100}\right)^2 - 0\cdot00954\left(\frac{V}{100}\right) + 0\cdot614$

Figure 2

(e) Except as provided in sub-paragraph (f)(1) of this paragraph, means other than wheel brakes may be used to determine the accelerate-stop distance if that means –

(1) Is safe and reliable;

(2) Is used so that consistent results can be expected under normal operating conditions; and

(3) Is such that exceptional skill is not required to control the aeroplane.

(f) The effects of available reverse thrust –

(1) Must not be included as an additional means of deceleration when determining the accelerate-stop distance on a dry runway; and

(2) May be included as an additional means of deceleration using recommended reverse thrust procedures when determining the accelerate-stop distance on a wet runway, provided the requirements of sub-paragraph (e) of this paragraph are met. (See AMC 25.109(f).)

(g) The landing gear must remain extended throughout the accelerate-stop distance.

(h) If the accelerate-stop distance includes a stopway with surface characteristics substantially different from those of the runway, the take-off data must include operational correction factors for the accelerate-stop distance. The correction factors must account for the particular surface characteristics of the stopway and the variations in these characteristics with seasonal weather conditions (such as temperature, rain, snow and ice) within the established operational limits.

(i) A flight test demonstration of the maximum brake kinetic energy accelerate-stop distance must be conducted with not more than 10% of the allowable brake wear range remaining on each of the aeroplane wheel brakes.

CS 25.111 Take-off path
(See AMC 25.111)

(a) The take-off path extends from a standing start to a point in the take-off at which the aeroplane is 457 m (1500 ft) above the take-off surface, or at which the transition from the take-off to the en-route configuration is completed and V_{FTO} is reached, whichever point is higher. In addition –

(1) The take-off path must be based on the procedures prescribed in CS 25.101(f);

(2) The aeroplane must be accelerated on the ground to VEF, at which point the critical engine must be made inoperative and remain inoperative for the rest of the take-off; and

(3) After reaching V_{EF}, the aeroplane must be accelerated to V_2.

(b) During the acceleration to speed V_2, the nose gear may be raised off the ground at a speed not less than V_R. However, landing gear retraction may not be begun until the aeroplane is airborne. (See AMC 25.111(b).)

(c) During the take-off path determination in accordance with sub-paragraphs (a) and (b) of this paragraph –

(1) The slope of the airborne part of the take-off path must be positive at each point;

(2) The aeroplane must reach V_2 before it is 11 m (35 ft) above the take-off surface and must continue at a speed as close as practical to, but not less than V_2 until it is 122 m (400 ft) above the take-off surface;

(3) At each point along the take-off path, starting at the point at which the aeroplane reaches 122 m (400 ft) above the take-off surface, the available gradient of climb may not be less than –

(i) 1·2% for two-engined aeroplanes;

(ii) 1·5% for three-engined aeroplanes; and

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

(4) The aeroplane configuration may not be changed, except for gear retraction and automatic propeller feathering, and no change in power or thrust that requires action by the pilot may be made, until the aeroplane is 122 m (400 ft) above the take-off surface; and

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

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

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

(d) The take-off path must be determined by a continuous demonstrated take-off or by synthesis from segments. If the take-off path is determined by the segmental method –

(1) The segments must be clearly defined and must relate to the distinct changes in the configuration, power or thrust, and speed;

(2) The weight of the aeroplane, the configuration, and the power or thrust must be constant throughout each segment and must correspond to the most critical condition prevailing in the segment;

(3) The flight path must be based on the aeroplane's performance without ground effect; and

(4) The take-off path data must be checked by continuous demonstrated take-offs up to the point at which the aeroplane is out of ground effect and its speed is stabilised, to ensure that the path is conservative to the continuous path.

The aeroplane is considered to be out of the ground effect when it reaches a height equal to its wing span.

(e) Not required for CS–25.

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CS 25.113 Take-off distance and take-off run

(a) Take-off distance on a dry runway is the greater of –

(1) The horizontal distance along the take-off path from the start of the take-off to the point at which the aeroplane is 11 m (35 ft) above the take-off surface, determined under CS 25.111 for a dry runway; or

(2) 115% of the horizontal distance along the take-off path, with all engines operating, from the start of the take-off to the point at which the aeroplane is 11 m (35 ft) above the take-off surface, as determined by a procedure consistent with CS 25.111. (See AMC 25.113(a)(2), (b)(2) and (c)(2).)

(b) Take-off distance on a wet runway is the greater of –

(1) The take-off distance on a dry runway determined in accordance with sub-paragraph (a) of this paragraph; or

(2) The horizontal distance along the take-off path from the start of the take-off to the point at which the aeroplane is 4,6 m (15 ft) above the take-off surface, achieved in a manner consistent with the achievement of V_2 before reaching 11 m (35 ft) above the take-off surface, determined under CS 25.111 for a wet runway. (See AMC 113(a)(2), (b)(2) and (c)(2).)

(c) If the take-off distance does not include a clearway, the take-off run is equal to the take-off distance. If the take-off distance includes a clearway –

(1) The take-off run on a dry runway is the greater of –

(i) The horizontal distance along the take-off path from the start of the take-off to a point equidistant between the point at which V_{LOF} is reached and the point at which the aeroplane is 11 m (35 ft) above the take-off surface, as determined under CS 25.111 for a dry runway; or

(ii) 115% of the horizontal distance along the take-off path, with all engines operating, from the start of the take-off to a point equidistant between the point at which V_{LOF} is reached and the point at which the aeroplane is 11 m (35 ft) above the take-off surface, determined by a procedure consistent with CS 25.111. (See AMC 25.113(a)(2), (b)(2) and (c)(2).)

(2) The take-off run on a wet runway is the greater of –

(i) The horizontal distance along the take-off path from the start of the take-off to the point at which the aeroplane is 4,6 m (15 ft) above the take-off surface, achieved in a manner consistent with the achievement of V_2 before reaching 11 m (35 ft) above the take-off surface, determined under CS 25.111 for a wet runway; or

(ii) 115% of the horizontal distance along the take-off path, with all engines operating, from the start of the take-off to a point equidistant between the point at which V_{LOF} is reached and the point at which the aeroplane is 11 m (35 ft) above the take-off surface, determined by a procedure consistent with CS 25.111. (See AMC 25.113(a)(2).)

CS 25.115 Take-off flight path

(a) The take-off flight path must be considered to begin 11 m (35 ft) above the take-off surface at the end of the take-off distance determined in accordance with CS 25.113 (a) or (b) as appropriate for the runway surface condition.

(b) The net take-off flight path data must be determined so that they represent the actual take-off flight paths (determined in accordance with

CS25.111 and with sub-paragraph (a) of this paragraph) reduced at each point by a gradient of climb equal to –

(1) 0·8% for two-engined aeroplanes;

(2) 0·9% for three-engined aeroplanes; and

(3) 1·0% for four-engined aeroplanes.

(c) The prescribed reduction in climb gradient may be applied as an equivalent reduction in acceleration along that part of the take-off flight path at which the aeroplane is accelerated in level flight.

CS 25.117 Climb: general

Compliance with the requirements of CS 25.119 and 25.121 must be shown at each weight, altitude, and ambient temperature within the operational limits established for the aeroplane and with the most unfavourable centre of gravity for each configuration.

CS 25.119 Landing climb: all-engines-operating

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

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

(b) In icing conditions with the “Landing Ice” accretion defined in Appendix C, and with a climb speed of V_{REF} determined in accordance with CS 25.125(b)(2)(ii).

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

(a) *Take-off; landing gear extended.* (See AMC 25.121(a).) In the critical take-off configuration existing along the flight path (between the points at which the aeroplane reaches V_{LOF} and at which the landing gear is fully retracted) and in the configuration used in CS 25.111 but without ground effect, the steady gradient of climb must be positive for two-engined aeroplanes, and not less than 0·3% for three-engined aeroplanes or 0·5% for four-engined aeroplanes, at V_{LOF} and with –

(1) The critical engine inoperative and the remaining engines at the power or thrust available when retraction of the landing gear is begun in accordance with CS 25.111 unless there is a more critical power operating condition existing later along the flight path but before the point at which the landing gear is fully retracted (see AMC 25.121(a)(1)); and

(2) The weight equal to the weight existing when retraction of the landing gear is begun determined under CS 25.111.

(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 CS 25.111 but without ground effect,

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

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

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

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

(i) In non-icing conditions; and

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

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

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

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

(1) The steady gradient of climb may not be less than 1·2% for two-engined aeroplanes, 1·5% for three-engined aeroplanes, and 1·7% for four-engined aeroplanes, at V_{FTO} and with –

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

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

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

(i) In non-icing conditions; and

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

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

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

(d) *Approach.* In a configuration corresponding to the normal all-engines-operating procedure in which V_{SR} for this configuration does not exceed 110% of the V_{SR} for the related all-engines-operating landing configuration:

(1) The steady gradient of climb may not be less than 2·1% for two-engined aeroplanes, 2·4% for three-engined aeroplanes and 2·7% for four-engined aeroplanes, with –

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

(ii) The maximum landing weight;

(iii) A climb speed established in connection with normal landing procedures, but not more than 1·4 VSR; and

(iv) Landing gear retracted.

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

(i) In non-icing conditions; and

(ii) In icing conditions with the Approach Ice accretion defined in Appendix C. The climb speed selected for non-icing conditions may be used if the climb speed for icing conditions, computed in accordance with sub-paragraph (d)(1)(iii) of this paragraph, does not exceed that for non-icing conditions by more than the greater of 5.6 km/h (3 knots) CAS or 3%.

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

(a) For the en-route configuration, the flight paths prescribed in sub-paragraphs (b) and (c) of this paragraph must be determined at each weight, altitude, and ambient temperature, within the operating limits established for the aeroplane. The variation of weight along the flight path, accounting for the progressive consumption of fuel and oil by the operating engines, may be included in the computation. The flight paths must be determined at a selected speed not less than V_{FTO}, with –

(1) The most unfavourable centre of gravity;

(2) The critical engines inoperative;

(3) The remaining engines at the available maximum continuous power or thrust; and

(4) The means for controlling the engine-cooling air supply in the position that provides adequate cooling in the hot-day condition.

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

(1) In non-icing conditions; and

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

(i) A speed of $1.18V_{SR}$ with the "En-route Ice " accretion exceeds the en-route speed selected in non-icing conditions by more than the greater of 5.6 km/h (3 knots) CAS or 3% of V_{SR}, or

(ii) The degradation of the gradient of climb is greater than one-half of the applicable actual-to-net flight path reduction defined in sub-paragraph (b) of this paragraph.

(c) For three- or four-engined aeroplanes, the two-engine-inoperative net flight path data must represent the actual climb performance diminished by a gradient climb of 0·3% for three-engined aeroplanes and 0·5% for four-engined aeroplanes.

[Amdt. No.:25/3]

CS 25.125 Landing

(a) The horizontal distance necessary to land and to come to a complete stop from a point 15 m (50 ft) above the landing surface must be determined (for standard temperatures, at each weight, altitude and wind within the operational limits established by the applicant for the aeroplane):

(1) In non-icing conditions; and

(2) In icing conditions with the "Landing Ice" accretion defined in Appendix C if V_{REF} for icing conditions exceeds V_{REF} for non-icing conditions by more than 9.3 km/h (5 knots) CAS at the maximum landing weight.

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

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

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

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

(A) 1.23 V_{SR0};

(B) V_{MCL} established under CS25.149(f); and

(C) A speed that provides the manoeuvring capability specified in CS25.143(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) 1.23 V_{SR0} with the "Landing Ice" accretion defined in Appendix C if that speed exceeds V_{REF} for non-icing conditions by more than 9.3 km/h (5 knots) CAS; and

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

(3) Changes in configuration, power or thrust, and speed, must be made in accordance with the established procedures for service operation. (See AMC 25.125(b)(3).)

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

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

(c) The landing distance must be determined on a level, smooth, dry, hard-surfaced runway. (See AMC 25.125(c).) In addition –

(1) The pressures on the wheel braking systems may not exceed those specified by the brake manufacturer;

(2) The brakes may not be used so as to cause excessive wear of brakes or tyres (see AMC 25.125(c)(2)); and

(3) Means other than wheel brakes may be used if that means –

(i) Is safe and reliable;

(ii) Is used so that consistent results can be expected in service; and

(iii) Is such that exceptional skill is not required to control the aeroplane.

(d) *Reserved.*

(e) *Reserved.*

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

(g) If any device is used that depends on the operation of any engine, and if the landing distance would be noticeably increased when a landing is made with that engine inoperative, the landing distance must be determined with that engine inoperative unless the use of compensating means will result in a landing distance not more than that with each engine operating.

[Amdt. No.:25/3]

CONTROLLABILITY AND MANOEUVRABILITY

CS 25.143 General

(a) (See AMC 25.143(a).) The aeroplane must be safely controllable and manoeuvrable during –

(1) Take-off;

(2) Climb;

(3) Level flight;

(4) Descent; and

(5) Landing.

(b) (See AMC 25.143(b).) It must be possible to make a smooth transition from one flight condition to any other flight condition without exceptional piloting skill, alertness, or strength, and without danger of exceeding the aeroplane limit-load factor under any probable operating conditions, including –

(1) The sudden failure of the critical engine. (See AMC 25.143(b)(1).)

(2) For aeroplanes with three or more engines, the sudden failure of the second critical engine when the aeroplane is in the en-route, approach, or landing configuration and is trimmed with the critical engine inoperative; and

(3) Configuration changes, including deployment or retraction of deceleration devices.

(c) The aeroplane must be shown to be safely controllable and manoeuvrable with the critical ice accretion appropriate to the phase of flight defined in appendix C, and with the critical engine inoperative and its propeller (if applicable) in the minimum drag position:

(1) At the minimum V_2 for take-off;

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

(3) During an approach and landing.

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

Force, in newton (pounds), applied to the control wheel or rudder pedals	Pitch	Roll	Yaw
For short term application for pitch and roll control – two hands available for control	334 (75)	222 (50)	–
For short term application for pitch and roll control – one hand available for control	222 (50)	111 (25)	–
For short term application for yaw control	–	–	667 (150)
For long term application	44,5 (10)	22 (5)	89 (20)

(e) Approved operating procedures or conventional operating practices must be followed when demonstrating compliance with the control force limitations for short term application that are prescribed in sub-paragraph (d) of this paragraph. The aeroplane must be in trim, or as near to being in trim as practical, in the immediately preceding steady flight condition. For the take-off condition, the aeroplane must be trimmed according to the approved operating procedures.

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

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

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

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

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

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

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

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

(1) Controllability must be demonstrated with the ice accretion described in Appendix C, that is most critical for the particular flight phase.

(2) It must be shown that a push force is required throughout a pushover manoeuvre down to a zero g load factor, or the lowest load factor obtainable if limited by elevator power or other design characteristic of the flight control system. It must be possible to promptly recover from the manoeuvre without exceeding a pull control force of 222 N. (50 lbf); and

(3) Any changes in force that the pilot must apply to the pitch control to maintain speed with increasing sideslip angle must be steadily increasing with no force reversals, unless the change in control force is gradual and easily controllable by the pilot without using exceptional piloting skill, alertness, or strength.

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

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

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

(i) The aeroplane is controllable in a pull-up manoeuvre up to 1.5 g load factor; and

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

[Amdt. No.:25/3]

CS 25.145 Longitudinal control

(a) (See AMC 25.145(a).) It must be possible at any point between the trim speed prescribed in CS 25.103(b)(6) and stall identification (as defined in CS 25.201(d)), to pitch the nose downward so that the acceleration to this selected trim speed is prompt with –

(1) The aeroplane trimmed at the trim speed prescribed in CS 25.103(b)(6);

(2) The landing gear extended;

(3) The wing-flaps (i) retracted and (ii) extended; and

(4) Power (i) off and (ii) at maximum continuous power on the engines.

(b) With the landing gear extended, no change in trim control, or exertion of more than 222 N (50 pounds) control force (representative of the maximum short term force that can be applied readily by one hand) may be required for the following manoeuvres:

(1) With power off, wing-flaps retracted, and the aeroplane trimmed at 1·3 V_{SR_1}, extend the

wing-flaps as rapidly as possible while maintaining the airspeed at approximately 30% above the reference stall speed existing at each instant throughout the manoeuvre. (See AMC 25.145(b)(1), (b)(2) and (b)(3).)

(2) Repeat sub-paragraph (b)(1) of this paragraph except initially extend the wing-flaps and then retract them as rapidly as possible. (See AMC 25.145(b)(2) and AMC 25.145(b)(1), (b)(2) and (b)(3).)

(3) Repeat sub-paragraph (b)(2) of this paragraph except at the go-around power or thrust setting. (See AMC 25.145(b)(1), (b)(2) and (b)(3).)

(4) With power off, wing-flaps retracted and the aeroplane trimmed at 1·3 V_{SR1}, rapidly set go-around power or thrust while maintaining the same airspeed.

(5) Repeat sub-paragraph (b)(4) of this paragraph except with wing-flaps extended.

(6) With power off, wing-flaps extended and the aeroplane trimmed at 1·3 V_{SR1} obtain and maintain airspeeds between V_{SW} and either 1·6 V_{SR1}, or V_{FE}, whichever is the lower.

(c) It must be possible, without exceptional piloting skill, to prevent loss of altitude when complete retraction of the high lift devices from any position is begun during steady, straight, level flight at 1·08 V_{SR1}, for propeller powered aeroplanes or 1·13 V_{SR1}, for turbo-jet powered aeroplanes, with –

(1) Simultaneous movement of the power or thrust controls to the go-around power or thrust setting;

(2) The landing gear extended; and

(3) The critical combinations of landing weights and altitudes.

(d) Revoked

(e) (See AMC 25.145(e).) If gated high-lift device control positions are provided, sub-paragraph (c) of this paragraph applies to retractions of the high-lift devices from any position from the maximum landing position to the first gated position, between gated positions, and from the last gated position to the fully retracted position. The requirements of sub-paragraph (c) of this paragraph also apply to retractions from each approved landing position to the control position(s) associated with the high-lift device configuration(s) used to establish the go-around procedure(s) from that landing position. In addition, the first gated control position from the maximum landing position must correspond with a configuration of the high-lift devices used to establish a go-around procedure from a landing configuration. Each gated control position must require a separate and distinct motion of the control to pass through the gated position and must have features to prevent inadvertent movement of the control through the gated position. It must only be possible to make this separate and distinct motion once the control has reached the gated position.

CS 25.147 Directional and lateral control

(a) *Directional control; general.* (See AMC 25.147(a).) It must be possible, with the wings level, to yaw into the operative engine and to safely make a reasonably sudden change in heading of up to 15º in the direction of the critical inoperative engine. This must be shown at 1·3 V_{SR1}, for heading changes up to 15º (except that the heading change at which the rudder pedal force is 667 N (150 lbf) need not be exceeded), and with –

(1) The critical engine inoperative and its propeller in the minimum drag position;

(2) The power required for level flight at 1.3 V_{SR1}, but not more than maximum continuous power;

(3) The most unfavourable centre of gravity;

(4) Landing gear retracted;

(5) Wing-flaps in the approach position; and

(6) Maximum landing weight.

(b) *Directional control; aeroplanes with four or more engines.* Aeroplanes with four or more engines must meet the requirements of sub-paragraph (a) of this paragraph except that –

(1) The two critical engines must be inoperative with their propellers (if applicable) in the minimum drag position;

(2) Reserved; and

(3) The wing-flaps must be in the most favourable climb position.

(c) *Lateral control; general.* It must be possible to make 20º banked turns, with and against the inoperative engine, from steady flight at a speed equal to 1·3 V_{SR1}, with –

(1) The critical engine inoperative and its propeller (if applicable) in the minimum drag position;

(2) The remaining engines at maximum continuous power;

(3) The most unfavourable centre of gravity;

(4) Landing gear both retracted and extended;

(5) Wing-flaps in the most favourable climb position; and

(6) Maximum take-off weight;

(d) Lateral control; roll capability. With the critical engine inoperative, roll response must allow normal manoeuvres. Lateral control must be sufficient, at the speeds likely to be used with one engine inoperative, to provide a roll rate necessary for safety without excessive control forces or travel. (See AMC 25.147(d).)

(e) *Lateral control; aeroplanes with four or more engines.* Aeroplanes with four or more engines must be able to make 20º banked turns, with and against the inoperative engines, from steady flight at a speed equal to 1·3 V_{SR1}, with maximum continuous power, and with the aeroplane in the configuration prescribed by sub-paragraph (b) of this paragraph.

(f) *Lateral control; all engines operating.* With the engines operating, roll response must allow normal manoeuvres (such as recovery from upsets produced by gusts and the initiation of evasive manoeuvres). There must be enough excess lateral control in sideslips (up to sideslip angles that might be required in normal operation), to allow a limited amount of manoeuvring and to correct for gusts. Lateral control must be enough at any speed up to V_{FC}/M_{FC} to provide a peak roll rate necessary for safety, without excessive control forces or travel. (See AMC 25.147(f).)

CS 25.149 Minimum control speed
(See AMC 25.149)

(a) In establishing the minimum control speeds required by this paragraph, the method used to simulate critical engine failure must represent the most critical mode of powerplant failure with respect to controllability expected in service.

(b) V_{MC} is the calibrated airspeed, at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane with that engine still inoperative, and maintain straight flight with an angle of bank of not more than 5º.

(c) V_{MC} may not exceed 1·13 V_{SR} with –

(1) Maximum available take-off power or thrust on the engines;

(2) The most unfavourable centre of gravity;

(3) The aeroplane trimmed for take-off;

(4) The maximum sea-level take-off weight (or any lesser weight necessary to show V_{MC});

(5) The aeroplane in the most critical take-off configuration existing along the flight path after the aeroplane becomes airborne, except with the landing gear retracted;

(6) The aeroplane airborne and the ground effect negligible; and

(7) If applicable, the propeller of the inoperative engine –

(i) Windmilling;

(ii) In the most probable position for the specific design of the propeller control; or

(iii) Feathered, if the aeroplane has an automatic feathering device acceptable for showing compliance with the climb requirements of CS 25.121.

(d) The rudder forces required to maintain control at V_{MC} may not exceed 667 N (150 lbf) nor may it be necessary to reduce power or thrust of the operative engines. During recovery, the aeroplane may not assume any dangerous attitude or require exceptional piloting skill, alertness, or strength to prevent a heading change of more than 20º.

(e) V_{MCG}, the minimum control speed on the ground, is the calibrated airspeed during the take-off run at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane using the rudder control alone (without the use of nose-wheel steering), as limited by 667 N of force (150 lbf), and the lateral control to the extent of keeping the wings level to enable the take-off to be safely continued using normal piloting skill. In the determination of V_{MCG}, assuming that the path of the aeroplane accelerating with all engines operating is along the centreline of the runway, its path from the point at which the critical engine is made inoperative to the point at which recovery to a direction parallel to the centreline is completed, may not deviate more than 9.1 m (30 ft) laterally from the centreline at any point. V_{MCG} must be established, with –

(1) The aeroplane in each take-off configuration or, at the option of the applicant, in the most critical take-off configuration;

(2) Maximum available take-off power or thrust on the operating engines;

(3) The most unfavourable centre of gravity;

The aeroplane trimmed for take-off; and

(5) The most unfavourable weight in the range of take-off weights. (See AMC 25.149(e).)

(f) (See AMC 25.149 (f)) V_{MCL}, the minimum control speed during approach and landing with all engines operating, is the calibrated airspeed at which, when the critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane with that engine still inoperative, and maintain straight flight with an angle of bank of not more than 5º. V_{MCL} must be established with –

(1) The aeroplane in the most critical configuration (or, at the option of the applicant, each configuration) for approach and landing with all engines operating;

(2) The most unfavourable centre of gravity;

(3) The aeroplane trimmed for approach with all engines operating;

(4) The most unfavourable weight, or, at the option of the applicant, as a function of weight;

(5) For propeller aeroplanes, the propeller of the inoperative engine in the position it achieves without pilot action, assuming the engine fails while at the power or thrust necessary to maintain a 3 degree approach path angle; and

(6) Go-around power or thrust setting on the operating engine(s).

(g) (See AMC 25.149(g)) For aeroplanes with three or more engines, V_{MCL-2}, the minimum control speed during approach and landing with one critical engine inoperative, is the calibrated airspeed at which, when a second critical engine is suddenly made inoperative, it is possible to maintain control of the aeroplane with both engines still inoperative, and maintain straight flight with an angle of bank of not more than 5º. V_{MCL-2} must be established with –

(1) The aeroplane in the most critical configuration (or, at the option of the applicant, each configuration) for approach and landing with one critical engine inoperative;

(2) The most unfavourable centre of gravity;

(3) The aeroplane trimmed for approach with one critical engine inoperative;

(4) The most unfavourable weight, or, at the option of the applicant, as a function of weight;

(5) For propeller aeroplanes, the propeller of the more critical engine in the position it achieves without pilot action, assuming the engine fails while at the power or thrust necessary to maintain a 3 degree approach path angle, and the propeller of the other inoperative engine feathered;

(6) The power or thrust on the operating engine(s) necessary to maintain an approach path angle of 3º when one critical engine is inoperative; and

(7) The power or thrust on the operating engine(s) rapidly changed, immediately after the second critical engine is made inoperative, from the power or thrust prescribed in sub-paragraph (g)(6) of this paragraph to –

(i) Minimum power or thrust; and

(ii) Go-around power or thrust setting.

(h) In demonstrations of V_{MCL} and V_{MCL-2} –

(1) The rudder force may not exceed 667 N (150 lbf);

(2) The aeroplane may not exhibit hazardous flight characteristics or require exceptional piloting skill, alertness or strength;

(3) Lateral control must be sufficient to roll the aeroplane, from an initial condition of steady straight flight, through an angle of 20º in the direction necessary to initiate a turn away from the inoperative engine(s), in not more than 5 seconds (see AMC 25.149(h)(3)); and

(4) For propeller aeroplanes, hazardous flight characteristics must not be exhibited due to any propeller position achieved when the engine fails or during any likely subsequent movements of the engine or propeller controls (see AMC 25.149 (h)(4)).

TRIM

CS 25.161 Trim

(a) *General*. Each aeroplane must meet the trim requirements of this paragraph after being trimmed, and without further pressure upon, or movement of, either the primary controls or their corresponding trim controls by the pilot or the automatic pilot.

(b) *Lateral and directional trim.* The aeroplane must maintain lateral and directional trim with the most adverse lateral displacement of the centre of gravity within the relevant operating limitations, during normally expected conditions of operation (including operation at any speed from 1·3 V_{SR1}, to V_{MO}/M_{MO}).

(c) *Longitudinal trim.* The aeroplane must maintain longitudinal trim during –

(1) A climb with maximum continuous power at a speed not more than 1·3 V_{SR1}, with the landing gear retracted, and the wing-flaps (i) retracted and (ii) in the take-off position;

(2) Either a glide with power off at a speed not more than 1·3 V_{SR1}, or an approach within the normal range of approach speeds appropriate to the weight and configuration with power settings corresponding to a 3º glidepath, whichever is the most severe, with the landing gear extended, the wing-flaps retracted and extended, and with the most unfavourable combination of centre of gravity position and weight approved for landing; and

(3) Level flight at any speed from 1·3 V_{SR1}, to V_{MO}/M_{MO}, with the landing gear and wing-flaps retracted, and from 1·3 V_{SR1} to V_{LE} with the landing gear extended.

(d) *Longitudinal, directional, and lateral trim.* The aeroplane must maintain longitudinal, directional, and lateral trim (and for lateral trim, the angle of bank may not exceed 5º) at 1·3 V_{SR1}, during the climbing flight with –

(1) The critical engine inoperative;

(2) The remaining engines at maximum continuous power; and

(3) The landing gear and wing-flaps retracted.

(e) *Aeroplanes with four or more engines.* Each aeroplane with four or more engines must also maintain trim in rectilinear flight with the most unfavourable centre of gravity and at the climb speed, configuration, and power required by CS 25.123 (a) for the purpose of establishing the en-route flight path with two engines inoperative.

STABILITY

CS 25.171 General

The aeroplane must be longitudinally, directionally and laterally stable in accordance with the provisions of CS 25.173 to 25.177. In addition, suitable stability and control feel (static stability) is required in any condition normally encountered in service, if flight tests show it is necessary for safe operation.

CS 25.173 Static longitudinal stability

Under the conditions specified in CS 25.175, the characteristics of the elevator control forces (including friction) must be as follows:

(a) A pull must be required to obtain and maintain speeds below the specified trim speed, and a push must be required to obtain and maintain speeds above the specified trim speed. This must be shown at any speed that can be obtained except speeds higher than the landing gear or wing flap operating limit speeds or V_{FC}/M_{FC}, whichever is appropriate, or lower than the minimum speed for steady unstalled flight.

(b) The airspeed must return to within 10% of the original trim speed for the climb, approach and landing conditions specified in CS 25.175 (a), (c) and (d), and must return to within 7·5% of the original trim speed for the cruising condition specified in CS 25.175 (b), when the control force is slowly released from any speed within the range specified in sub-paragraph (a) of this paragraph.

(c) The average gradient of the stable slope of the stick force versus speed curve may not be less than 4 N (1 pound) for each 11,2 km/h (6 kt). (See AMC 25.173(c).)

(d) Within the free return speed range specified in sub-paragraph (b) of this paragraph, it is permissible for the aeroplane, without control forces, to stabilise on speeds above or below the desired trim speeds if exceptional attention on the part of the pilot is not required to return to and maintain the desired trim speed and altitude.

CS 25.175 Demonstration of static longitudinal stability

Static longitudinal stability must be shown as follows:

(a) *Climb*. The stick force curve must have a stable slope at speeds between 85% and 115% of the speed at which the aeroplane –

(1) Is trimmed with –

(i) Wing-flaps retracted;

(ii) Landing gear retracted;

(iii) Maximum take-off weight; and

(iv) The maximum power or thrust selected by the applicant as an operating limitation for use during climb; and

(2) Is trimmed at the speed for best rate-of-climb except that the speed need not be less than 1·3 V_{SR1}.

(b) *Cruise*. Static longitudinal stability must be shown in the cruise condition as follows:

(1) With the landing gear retracted at high speed, the stick force curve must have a stable slope at all speeds within a range which is the

greater of 15% of the trim speed plus the resulting free return speed range, or 93 km/h (50 kt) plus the resulting free return speed range, above and below the trim speed (except that the speed range need not include speeds less than 1·3 V_{SR_1} nor speeds greater than V_{FC}/M_{FC}, nor speeds that require a stick force of more than 222 N (50 lbf)), with –

(i) The wing-flaps retracted;

(ii) The centre of gravity in the most adverse position (see CS 25.27);

(iii) The most critical weight between the maximum take-off and maximum landing weights;

(iv) The maximum cruising power selected by the applicant as an operating limitation (see CS 25.1521), except that the power need not exceed that required at V_{MO}/M_{MO}; and

(v) The aeroplane trimmed for level flight with the power required in sub-paragraph (iv) above.

(2) With the landing gear retracted at low speed, the stick force curve must have a stable slope at all speeds within a range which is the greater of 15% of the trim speed plus the resulting free return speed range, or 93 km/h (50 kt) plus the resulting free return speed range, above and below the trim speed (except that the speed range need not include speeds less than 1·3 V_{SR_1} nor speeds greater than the minimum speed of the applicable speed range prescribed in sub-paragraph (b)(1) of this paragraph, nor speeds that require a stick force of more than 222 N (50 lbf)), with –

(i) Wing-flaps, centre of gravity position, and weight as specified in sub-paragraph (1) of this paragraph;

(ii) Power required for level flight at a speed equal to $\frac{V_{MO} + 1{\cdot}3V_{SR1}}{2}$; and

(iii) The aeroplane trimmed for level flight with the power required in sub-paragraph (ii) above.

(3) With the landing gear extended, the stick force curve must have a stable slope at all speeds within a range which is the greater of 15% of the trim speed plus the resulting free return speed range or 93 km/h (50 kt) plus the resulting free return speed range, above and below the trim speed (except that the speed range need not include speeds less than 1·3 V_{SR_1}, nor speeds greater than V_{LE}, nor speeds that require a stick force of more than 222 N (50 lbf)), with –

(i) Wing-flap, centre of gravity position, and weight as specified in sub-paragraph (b)(1) of this paragraph;

(ii) The maximum cruising power selected by the applicant as an operating limitation, except that the power need not exceed that required for level flight at V_{LE}; and

(iii) The aeroplane trimmed for level flight with the power required in sub-paragraph (ii) above.

(c) *Approach.* The stick force curve must have a stable slope at speeds between V_{SW}, and 1·7 V_{SR1} with –

(1) Wing-flaps in the approach position;

(2) Landing gear retracted;

(3) Maximum landing weight; and

(4) The aeroplane trimmed at 1·3 V_{SR1}, with enough power to maintain level flight at this speed.

(d) *Landing*. The stick force curve must have a stable slope and the stick force may not exceed 356 N (80 lbf) at speeds between $V_{SW,}$ and 1·7 V_{SR0} with –

(1) Wing-flaps in the landing position;

(2) Landing gear extended;

(3) Maximum landing weight;

(4) The aeroplane trimmed at 1·3 V_{SR0} with –

(i) Power or thrust off, and

(ii) Power or thrust for level flight.

CS 25.177 Static directional and lateral stability

(a) The static directional stability (as shown by the tendency to recover from a skid with the rudder free) must be positive for any landing gear and flap position and symmetrical power condition, at speeds from 1·13 V_{SR_1}, up to V_{FE}, V_{LE}, or V_{FC}/M_{FC} (as appropriate).

(b) The static lateral stability (as shown by the tendency to raise the low wing in a sideslip with the aileron controls free) for any landing gear and wing-flap position and symmetric power condition, may not be negative at any airspeed (except that speeds higher than V_{FE} need not be considered for wing-flaps extended configurations nor speeds higher than

V_{LE} for landing gear extended configurations) in the following airspeed ranges (see AMC 25.177(b)):

(1) From 1·13 V_{SR_1} to V_{MO}/M_{MO}..

(2) From V_{MO}/M_{MO} to V_{FC}/M_{FC}, unless the divergence is –

(i) Gradual;

(ii) Easily recognisable by the pilot; and

(iii) Easily controllable by the pilot

(c) 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 aileron and 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).)

(d) For sideslip angles greater than those prescribed by sub-paragraph (c) of this paragraph, up to the angle at which full rudder control is used or a rudder control force of 801 N (180 lbf) is obtained, the rudder control forces may not reverse, and increased rudder deflection must be needed for increased angles of sideslip. Compliance with this requirement must be shown using straight, steady sideslips, unless full lateral control input is achieved before reaching either full rudder control input or a rudder control force of 801 N (180 lbf) ; a straight, steady sideslip need not be maintained after achieving full lateral control input. This requirement must be met at all approved landing gear and wing-flap positions for the range of operating speeds and power conditions appropriate to each landing gear and wing-flap position with all engines operating. (See AMC 25.177(d).)

CS 25.181 Dynamic stability
(See AMC 25.181)

(a) Any short period oscillation, not including combined lateral-directional oscillations, occurring between 1·13 V_{SR} and maximum allowable speed appropriate to the configuration of the aeroplane must be heavily damped with the primary controls –

(1) Free; and

(2) In a fixed position.

(b) Any combined lateral-directional oscillations ('Dutch roll') occurring between 1·13 V_{SR} and maximum allowable speed appropriate to the configuration of the aeroplane must be positively damped with controls free, and must be controllable with normal use of the primary controls without requiring exceptional pilot skill.

STALLS

CS 25.201 Stall demonstration

(a) Stalls must be shown in straight flight and in 30º banked turns with –

(1) Power off; and

(2) The power necessary to maintain level flight at 1·5 V_{SR_1} (where V_{SR_1} corresponds to the reference stall speed at maximum landing weight with flaps in the approach position and the landing gear retracted. (See AMC 25.201(a)(2).)

(b) In each condition required by sub-paragraph (a) of this paragraph, it must be possible to meet the applicable requirements of CS25.203 with –

(1) Flaps, landing gear and deceleration devices in any likely combination of positions approved for operation; (See AMC 25.201(b)(1).)

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

(3) The most adverse centre of gravity for recovery; and

(4) The aeroplane trimmed for straight flight at the speed prescribed in CS 25.103 (b)(6).

(c) The following procedures must be used to show compliance with CS 25.203 :

(1) Starting at a speed sufficiently above the stalling 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 0.5 m/s^2 (one knot per second) until the aeroplane is stalled. (See AMC 25.103(c).)

(2) In addition, for turning flight stalls, apply the longitudinal control to achieve airspeed deceleration rates up to 5,6 km/h (3 kt) per second. (See AMC 25.201(c)(2).)

(3) As soon as the aeroplane is stalled, recover by normal recovery techniques.

(d) The 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. (See AMC 25.201 (d).) 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 a 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. (See AMC 25.201(d)(3).)

CS 25.203 Stall characteristics
(See AMC 25.203.)

(a) It must be possible to produce and to correct roll and yaw by unreversed use of aileron and rudder controls, up to the time the aeroplane is stalled. No abnormal nose-up pitching may occur. The longitudinal control force must be positive up to and throughout the stall. In addition, it must be possible to promptly prevent stalling and to recover from a stall by normal use of the controls.

(b) For level wing stalls, the roll occurring between the stall and the completion of the recovery may not exceed approximately 20º.

(c) For turning flight stalls, the action of the aeroplane after the stall may not be so violent or extreme as to make it difficult, with normal piloting skill, to effect a prompt recovery and to regain control of the aeroplane. The maximum bank angle that occurs during the recovery may not exceed –

(1) Approximately 60º in the original direction of the turn, or 30º in the opposite direction, for deceleration rates up to 0.5 m/s^2 (1 knot per second); and

(2) Approximately 90º in the original direction of the turn, or 60º in the opposite direction, for deceleration rates in excess of 0.5 m/s^2 (1 knot per second).

CS 25.207 Stall warning

(a) Stall warning with sufficient margin to prevent inadvertent stalling with the flaps and landing gear in any normal position must be clear and distinctive to the pilot in straight and turning flight.

(b) The warning must be furnished either through the inherent aerodynamic qualities of the aeroplane or by a device that will give clearly distinguishable indications under expected conditions of flight. However, a visual stall warning device that requires the attention of the crew within the cockpit is not acceptable by itself. If a warning device is used, it must provide a warning in each of the aeroplane configurations prescribed in sub-paragraph (a) of this paragraph at the speed prescribed in sub-paragraphs (c) and (d) of this paragraph. Except for the stall warning prescribed in paragraph (h)(2)(ii) of this section, the stall warning for flight in icing conditions prescribed in paragraph (e) of this section must be provided by the same means as the stall warning for flight in non-icing conditions. (See AMC 25.207(b).)

(c) When the speed is reduced at rates not exceeding 0.5 m/s^2 (one knot per second), stall warning must begin, in each normal configuration, at a speed, $V_{SW,}$ exceeding the speed at which the stall is identified in accordance with CS 25.201 (d) by not less than 9.3 km/h (five knots) or five percent CAS, whichever is greater. Once initiated, stall warning must continue until the angle of attack is reduced to approximately that at which stall warning began. (See AMC 25.207(c) and (d)).

(d) In addition to the requirement of sub-paragraph(c) of this paragraph, when the speed is reduced at rates not exceeding 0.5 m/s^2 (one knot per second), in straight flight with engines idling and at the centre-of-gravity position specified in CS 25.103(b)(5), V_{SW}, in each normal configuration, must exceed V_{SR} by not less than 5.6 km/h (three knots) or three percent CAS, whichever is greater. (See AMC 25.207(c) and (d)).

(e) In icing conditions, the stall warning margin in straight and turning flight must be sufficient to allow the pilot to prevent stalling (as defined in CS 25.201(d)) when the pilot starts a recovery manoeuvre not less than three seconds after the onset of stall warning. When demonstrating compliance with this paragraph, the pilot must perform the recovery manoeuvre in the same way as for the airplane in non-icing conditions. Compliance with this requirement must be demonstrated in flight with the speed reduced at rates not exceeding 0.5 m/sec^2 (one knot per second), with –

(1) The more critical of the takeoff ice and final takeoff ice accretions defined in appendix C for each configuration used in the takeoff phase of flight;

(2) The en route ice accretion defined in appendix C for the en route configuration;

(3) The holding ice accretion defined in appendix C for the holding configuration(s);

(4) The approach ice accretion defined in appendix C for the approach configuration(s); and

(5) The landing ice accretion defined in appendix C for the landing and go-around configuration(s).

(f) The stall warning margin must be sufficient in both non-icing and icing conditions to allow the pilot to prevent stalling when the pilot starts a recovery manoeuvre not less than one second after the onset of stall warning in slow-down turns with at least 1·5g load factor normal to the flight path and airspeed deceleration rates of at least 1 m/s^2 (2 knots per second). When demonstrating compliance with this paragraph for icing conditions, the pilot must perform the recovery manoeuvre in the same way as for the airplane in non-icing conditions. Compliance with this requirement must be demonstrated in flight with –

(1) The flaps and landing gear in any normal position;

(2) The aeroplane trimmed for straight flight at a speed of 1.3 V_{SR}; and

(3) The power or thrust necessary to maintain level flight at 1.3 V_{SR}.

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

(h) For flight in icing conditions before the ice protection system has been activated and is performing its intended function, the following requirements apply, with the ice accretion defined in appendix C, part II(e):

(1) If activating the ice protection system depends on the pilot seeing a specified ice accretion on a reference surface (not just the first indication of icing), the requirements of this section apply, except for paragraphs (c) and (d).

(2) For other means of activating the ice protection system, the stall warning margin in straight and turning flight must be sufficient to allow the pilot to prevent stalling without encountering any adverse flight characteristics when the speed is reduced at rates not exceeding 0.5 m/sec^2 (one knot per second) and the pilot performs the recovery manoeuvre in the same way as for flight in non-icing conditions.

(i) If stall warning is provided by the same means as for flight in non-icing conditions, the pilot may not start the recovery manoeuvre earlier than one second after the onset of stall warning.

(ii) If stall warning is provided by a different means than for flight in non-icing conditions, the pilot may not start the recovery manoeuvre earlier than 3 seconds after the onset of stall warning. Also, compliance must be shown with CS 25.203 using the demonstration prescribed by CS 25.201, except that the deceleration rates of CS 25.201(c)(2) need not be demonstrated.

[Amdt. No.:25/3]

GROUND HANDLING CHARACTERISTICS

CS 25.231 Longitudinal stability and control

(a) Aeroplanes may have no uncontrollable tendency to nose over in any reasonably expected operating condition or when rebound occurs during landing or take-off. In addition –

(1) Wheel brakes must operate smoothly and may not cause any undue tendency to nose over; and

(2) If a tail-wheel landing gear is used, it must be possible, during the take-off ground run on concrete, to maintain any attitude up to thrust line level, at 75% of V_{SR_1}.

CS 25.233 Directional stability and control

(a) There may be no uncontrollable ground-looping tendency in 90º cross winds, up to a wind velocity of 37 km/h (20 kt) or 0·2 V_{SR_0}, whichever is greater, except that the wind velocity need not exceed 46 km/h (25 kt) at any speed at which the aeroplane may be expected to be operated on the ground. This may be shown while establishing the 90º cross component of wind velocity required by CS 25.237.

(b) Aeroplanes must be satisfactorily controllable, without exceptional piloting skill or alertness, in power-off landings at normal landing speed, without using brakes or engine power to maintain a straight path. This may be shown during power-off landings made in conjunction with other tests.

(c) The aeroplane must have adequate directional control during taxying. This may be shown during taxying prior to take-offs made in conjunction with other tests.

CS 25.235 Taxying condition

The shock absorbing mechanism may not damage the structure of the aeroplane when the aeroplane is taxied on the roughest ground that may reasonably be expected in normal operation.

CS 25.237 Wind velocities

(a) The following applies:

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

(2) The crosswind component for takeoff established without ice accretions is valid in icing conditions.

(3) The landing crosswind component must be established for:

(i) Non-icing conditions, and

(ii) Icing conditions with the landing ice accretion defined in appendix C.

[Amdt. No.:25/3]

MISCELLANEOUS FLIGHT REQUIREMENTS

CS 25.251 Vibration and buffeting

(a) The aeroplane must be demonstrated in flight to be free from any vibration and buffeting that would prevent continued safe flight in any likely operating condition.

(b) Each part of the aeroplane must be demonstrated in flight to be free from excessive vibration under any appropriate speed and power conditions up to V_{DF}/M_{DF}. The maximum speeds shown must be used in establishing the operating limitations of the aeroplane in accordance with CS 25.1505.

(c) Except as provided in sub-paragraph (d) of this paragraph, there may be no buffeting condition, in normal flight, including configuration changes during cruise, severe enough to interfere with the control of the aeroplane, to cause excessive fatigue to the crew, or to cause structural damage. Stall warning buffeting within these limits is allowable.

(d) There may be no perceptible buffeting condition in the cruise configuration in straight flight at any speed up to V_{MO}/M_{MO}, except that the stall warning buffeting is allowable.

(e) For an aeroplane with M_D greater than 0·6 or with a maximum operating altitude greater than 7620 m (25,000 ft), the positive manoeuvring load factors at which the onset of perceptible buffeting occurs must be determined with the aeroplane in the cruise configuration for the ranges of airspeed or Mach number, weight, and altitude for which the aeroplane is to be certificated. The envelopes of load factor, speed, altitude, and weight must provide a sufficient range of speeds and load factors for normal operations. Probable inadvertent excursions beyond the boundaries of the buffet onset envelopes may not result in unsafe conditions. (See AMC 25.251(e).)

[Amdt. No.:25/1]

CS 25.253 High-speed characteristics

(a) *Speed increase and recovery characteristics.* The following speed increase and recovery characteristics must be met:

(1) Operating conditions and characteristics likely to cause inadvertent speed increases (including upsets in pitch and roll) must be simulated with the aeroplane trimmed at any likely cruise speed up to V_{MO}/M_{MO}. These conditions and characteristics include gust upsets, inadvertent control movements, low stick force gradient in relation to control friction, passenger movement, levelling off from climb, and descent from Mach to air speed limit altitudes.

(2) Allowing for pilot reaction time after effective inherent or artificial speed warning occurs, it must be shown that the aeroplane can be recovered to a normal attitude and its speed reduced to V_{MO}/M_{MO}, without –

(i) Exceptional piloting strength or skill;

(ii) Exceeding V_D/M_D, V_{DF}/M_{DF}, or the structural limitations; and

(iii) Buffeting that would impair the pilot's ability to read the instruments or control the aeroplane for recovery.

(3) With the aeroplane trimmed at any speed up to V_{MO}/M_{MO}, there must be no reversal of the response to control input about any axis at any speed up to V_{DF}/M_{DF}. Any tendency to pitch, roll, or yaw must be mild and readily controllable, using normal piloting techniques. When the aeroplane is trimmed at V_{MO}/M_{MO}, the slope of the elevator control force versus speed curve need not be stable at speeds greater than V_{FC}/M_{FC}, but there must be a push force at all speeds up to V_{DF}/M_{DF} and there must be no sudden or excessive reduction of elevator control force as V_{DF}/M_{DF} is reached.

(4) Adequate roll capability to assure a prompt recovery from a lateral upset condition must be available at any speed up to V_{DF}/M_{DF}. (See AMC 25.253(a)(4).)

(5) *Extension of speedbrakes.* With the aeroplane trimmed at V_{MO}/M_{MO}, extension of the speedbrakes over the available range of movements of the pilots control, at all speeds above V_{MO}/M_{MO}, but not so high that V_{DF}/M_{DF}

would be exceeded during the manoeuvre, must not result in:

(i) An excessive positive load factor when the pilot does not take action to counteract the effects of extension;

(ii) Buffeting that would impair the pilot's ability to read the instruments or control the aeroplane for recovery; or

(iii) A nose-down pitching moment, unless it is small. (See AMC 25.253(a)(5).)

(6) Reserved

(b) *Maximum speed for stability characteristics, V_{FC}/M_{FC}.* V_{FC}/M_{FC} is the maximum speed at which the requirements of CS 25.143(g), 25.147(e), 25.175(b)(1), 25.177(a) through (c), and 25.181 must be met with wing-flaps and landing gear retracted. Except as noted in CS 25.253(c), V_{FC}/M_{FC} may not be less than a speed midway between V_{MO}/M_{MO} and V_{DF}/M_{DF}, except that, for altitudes where Mach Number is the limiting factor, M_{FC} need not exceed the Mach Number at which effective speed warning occurs.

(c) *Maximum speed for stability characteristics in icing conditions*. The maximum speed for stability characteristics with the ice accretions defined in Appendix C, at which the requirements of CS 25.143(g), 25.147(e), 25.175(b)(1), 25.177(a) through (c) and 25.181 must be met, is the lower of:

(1) 556 km/h (300 knots) CAS,

(2) V_{FC}, or

(3) A speed at which it is demonstrated that the airframe will be free of ice accretion due to the effects of increased dynamic pressure.

[Amdt. No.:25/3]

CS 25.255 Out-of-trim characteristics
(See AMC 25.255)

(a) From an initial condition with the aeroplane trimmed at cruise speeds up to V_{MO}/M_{MO}, the aeroplane must have satisfactory manoeuvring stability and controllability with the degree of out-of-trim in both the aeroplane nose-up and nose-down directions, which results from the greater of –

(1) A three-second movement of the longitudinal trim system at its normal rate for the particular flight condition with no aerodynamic load (or an equivalent degree of trim for aeroplanes that do not have a power-operated trim system), except as limited by stops in the trim system, including those required by CS25.655 (b) for adjustable stabilisers; or

(2) The maximum mistrim that can be sustained by the autopilot while maintaining level flight in the high speed cruising condition.

(b) In the out-of-trim condition specified in sub-paragraph (a) of this paragraph, when the normal acceleration is varied from + 1 g to the positive and negative values specified in sub-paragraph (c) of this paragraph –

(1) The stick force vs. g curve must have a positive slope at any speed up to and including V_{FC}/M_{FC}; and

(2) At speeds between V_{FC}/M_{FC} and V_{DF}/M_{DF}, the direction of the primary longitudinal control force may not reverse.

(c) Except as provided in sub-paragraphs (d) and (e) of this paragraph compliance with the provisions of sub-paragraph (a) of this paragraph must be demonstrated in flight over the acceleration range –

(1) –1g to 2·5 g; or

(2) 0 g to 2·0 g, and extrapolating by an acceptable method to – 1 g and 2·5 g.

(d) If the procedure set forth in sub-paragraph (c)(2) of this paragraph is used to demonstrate compliance and marginal conditions exist during flight test with regard to reversal of primary longitudinal control force, flight tests must be accomplished from the normal acceleration at which a marginal condition is found to exist to the applicable limit specified in sub-paragraph (c)(1) of this paragraph.

(e) During flight tests required by sub-paragraph (a) of this paragraph the limit manoeuvring load factors prescribed in CS25.333 (b) and 25.337, and the manoeuvring load factors associated with probable inadvertent excursions beyond the boundaries of the buffet onset envelopes determined under CS 25.251 (e), need not be exceeded. In addition, the entry speeds for flight test demonstrations at normal acceleration values less than 1 g must be limited to the extent necessary to accomplish a recovery without exceeding V_{DF}/M_{DF}.

(f) In the out-of-trim condition specified in sub-paragraph (a) of this paragraph, it must be possible from an overspeed condition at V_{DF}/M_{DF}, to produce at least 1·5 g for recovery by applying not more than 556 N (125 lbf) of longitudinal control force using either the primary longitudinal control alone or the primary longitudinal control and the longitudinal trim system. If the longitudinal trim is used to assist in producing the required load factor, it must be shown at V_{DF}/M_{DF} that the longitudinal trim can be actuated in the aeroplane nose-up direction with the primary surface loaded to correspond to the least of the following aeroplane nose-up control forces:

(1) The maximum control forces expected in service as specified in CS 25.301 and 25.397.

(2) The control force required to produce 1·5 g.

(3) The control force corresponding to buffeting or other phenomena of such intensity that it is a strong deterrent to further application of primary longitudinal control force.

CS–25 BOOK 1

SUBPART C – STRUCTURE

GENERAL

CS 25.301 Loads

(a) Strength requirements are specified in terms of limit loads (the maximum loads to be expected in service) and ultimate loads (limit loads multiplied by prescribed factors of safety). Unless otherwise provided, prescribed loads are limit loads.

(b) Unless otherwise provided the specified air, ground, and water loads must be placed in equilibrium with inertia forces, considering each item of mass in the aeroplane. These loads must be distributed to conservatively approximate or closely represent actual conditions. (See AMC No. 1 to CS 25.301(b).) Methods used to determine load intensities and distribution must be validated by flight load measurement unless the methods used for determining those loading conditions are shown to be reliable. (See AMC No. 2 to CS 25.301(b).)

(c) If deflections under load would significantly change the distribution of external or internal loads, this redistribution must be taken into account.

[Amdt. No.:25/1]

CS 25.302 Interaction of systems and structures

For aeroplanes equipped with systems that affect structural performance, either directly or as a result of a failure or malfunction, the influence of these systems and their failure conditions must be taken into account when showing compliance with the requirements of Subparts C and D. Appendix K of CS-25 must be used to evaluate the structural performance of aeroplanes equipped with these systems.

[Amdt. No.:25/1]

CS 25.303 Factor of safety

Unless otherwise specified, a factor of safety of 1·5 must be applied to the prescribed limit load which are considered external loads on the structure. When loading condition is prescribed in terms of ultimate loads, a factor of safety need not be applied unless otherwise specified.

CS 25.305 Strength and deformation

(a) The structure must be able to support limit loads without detrimental permanent deformation. At any load up to limit loads, the deformation may not interfere with safe operation.

(b) The structure must be able to support ultimate loads without failure for at least 3 seconds. However, when proof of strength is shown by dynamic tests simulating actual load conditions, the 3-second limit does not apply. Static tests conducted to ultimate load must include the ultimate deflections and ultimate deformation induced by the loading. When analytical methods are used to show compliance with the ultimate load strength requirements, it must be shown that –

(1) The effects of deformation are not significant;

2) The deformations involved are fully accounted for in the analysis; or

(3) The methods and assumptions used are sufficient to cover the effects of these deformations.

(c) Where structural flexibility is such that any rate of load application likely to occur in the operating conditions might produce transient stresses appreciably higher than those corresponding to static loads, the effects of this rate of application must be considered.

(d) *Reserved*

(e) The aeroplane must be designed to withstand any vibration and buffeting that might occur in any likely operating condition up to V_D/M_D, including stall and probable inadvertent excursions beyond the boundaries of the buffet onset envelope. This must be shown by analysis, flight tests, or other tests found necessary by the Agency.

(f) Unless shown to be extremely improbable, the aeroplane must be designed to withstand any forced structural vibration resulting from any failure, malfunction or adverse condition in the flight control system. These loads must be treated in accordance with the requirements of CS 25.302.

[Amdt. No.:25/1]

CS 25.307 Proof of structure
(See AMC 25.307)

(a) Compliance with the strength and deformation requirements of this Subpart must be shown for each critical loading condition. Structural analysis may be used only if the structure conforms to that for which experience has shown this method to be reliable. In other cases, substantiating tests must be made to load levels that are sufficient to verify structural behaviour up to loads specified in CS 25.305.

(b) Reserved

(c) Reserved

(d) When static or dynamic tests are used to show compliance with the requirements of CS 25.305 (b) for flight structures, appropriate material correction factors must be applied to the test results, unless the structure, or part thereof, being tested has features such that a number of elements contribute to the total strength of the structure and the failure of one element results in the redistribution of the load through alternate load paths.

[Amdt. No.:25/1]

FLIGHT LOADS

CS 25.321 General

(a) Flight load factors represent the ratio of the aerodynamic force component (acting normal to the assumed longitudinal axis of the aeroplane) to the weight of the aeroplane. A positive load factor is one in which the aerodynamic force acts upward with respect to the aeroplane.

(b) Considering compressibility effects at each speed, compliance with the flight load requirements of this Subpart must be shown –

(1) At each critical altitude within the range of altitudes selected by the applicant;

(2) At each weight from the design minimum weight to the design maximum weight appropriate to each particular flight load condition; and

(3) For each required altitude and weight, for any practicable distribution of disposable load within the operating limitations recorded in the Aeroplane Flight Manual.

(c) Enough points on and within the boundaries of the design envelope must be investigated to ensure that the maximum load for each part of the aeroplane structure is obtained.

(d) The significant forces acting on the aeroplane must be placed in equilibrium in a rational or conservative manner. The linear inertia forces must be considered in equilibrium with the thrust and all aerodynamic loads, while the angular (pitching) inertia forces must be considered in equilibrium with thrust and all aerodynamic moments, including moments due to loads on components such as tail surfaces and nacelles. Critical thrust values in the range from zero to maximum continuous thrust must be considered.

FLIGHT MANOEUVRE AND GUST CONDITIONS

CS 25.331 Symmetric manoeuvring conditions

(a) *Procedure*. For the analysis of the manoeuvring flight conditions specified in sub-paragraphs (b) and (c) of this paragraph, the following provisions apply:

(1) Where sudden displacement of a control is specified, the assumed rate of control surface displacement may not be less than the rate that could be applied by the pilot through the control system.

(2) In determining elevator angles and chordwise load distribution in the manoeuvring conditions of sub-paragraphs (b) and (c) of this paragraph, the effect of corresponding pitching velocities must be taken into account. The in-trim and out-of-trim flight conditions specified in CS 25.255 must be considered.

(b) *Manoeuvring balanced conditions*. Assuming the aeroplane to be in equilibrium with zero pitching acceleration, the manoeuvring conditions A through I on the manoeuvring envelope in CS 25.333 (b) must be investigated.

(c) *Manoeuvring pitching conditions*. The following conditions must be investigated:

(1) *Maximum pitch control displacement at V_A*. The aeroplane is assumed to be flying in steady level flight (point A_1, CS 25.333 (b)) and the cockpit pitch control is suddenly moved to obtain extreme nose up pitching acceleration. In defining the tail load, the response of the aeroplane must be taken into account. Aeroplane loads which occur subsequent to the time when normal acceleration at the c.g. exceeds the positive limit manoeuvring load factor (at point A_2 in CS.333(b)), or the resulting tailplane normal load reaches its maximum, whichever occurs first, need not be considered.

(2) *Checked manoeuvre between V_A and V_D*. Nose up checked pitching manoeuvres must be analysed in which the positive limit load factor prescribed in CS 25.337 is achieved. As a separate condition, nose down checked pitching manoeuvres must be analysed in which a limit load factor of 0 is achieved. In defining the aeroplane loads the cockpit pitch control motions described in sub-paragraphs (i), (ii), (iii) and (iv) of this paragraph must be used:

(i) The aeroplane is assumed to be flying in steady level flight at any speed between V_A and V_D and the cockpit pitch control is moved in accordance with the following formula:

$\delta(t) = \delta_1 \sin(\omega t)$ for $0 \le t \le t_{max}$

where:

δ_1 = the maximum available displacement of the cockpit pitch control in the initial direction, as limited by the control system stops, control surface stops, or by pilot effort in accordance with CS 25.397(b);

$\delta(t)$ = the displacement of the cockpit pitch control as a function of time. In the initial direction $\delta(t)$ is limited to δ_1. In the reverse direction, $\delta(t)$ may be truncated at the maximum available displacement of the cockpit pitch control as limited by the control system stops, control surface stops, or by pilot effort in accordance with CS 25.397(b);

t_{max} = $3\pi/2\omega$;

ω = the circular frequency (radians/second) of the control deflection taken equal to the undamped natural frequency of the short period rigid mode of the aeroplane, with active control system effects included where appropriate; but not less than:

$$\omega = \frac{\pi V}{2V_A}$$ radians per second;

where:

V = the speed of the aeroplane at entry to the manoeuvre.

V_A = the design manoeuvring speed prescribed in CS 25.335(c)

(ii) For nose-up pitching manoeuvres the complete cockpit pitch control displacement history may be scaled down in amplitude to the extent just necessary to ensure that the positive limit load factor prescribed in CS 25.337 is not exceeded. For nose-down pitching manoeuvres the complete cockpit control displacement history may be scaled down in amplitude to the extent just necessary to ensure that the normal acceleration at the c.g. does not go below 0g.

(iii) In addition, for cases where the aeroplane response to the specified cockpit pitch control motion does not achieve the prescribed limit load factors then the following cockpit pitch control motion must be used:

$\delta(t) = \delta_1 \sin(\omega t)$ for $0 \le t \le t_1$

$\delta(t) = \delta_1$ for $t_1 \le t \le t_2$

$\delta(t) = \delta_1 \sin(\omega[t + t_1 - t_2])$ for $t_2 \le t \le t_{max}$

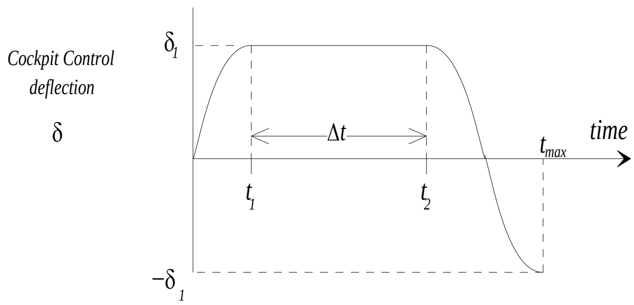
where:

$t_1 = \pi/2\omega$

$t_2 = t_1 + \Delta t$

$t_{max} = t_2 + \pi/\omega$;

Δt = the minimum period of time necessary to allow the prescribed limit load factor to be achieved in the initial direction, but it need not exceed five seconds (see figure below).



(iv) In cases where the cockpit pitch control motion may be affected by inputs from systems (for example, by a stick pusher that can operate at high load factor as well as at 1g) then the effects of those systems must be taken into account.

(v) Aeroplane loads that occur beyond the following times need not be considered:

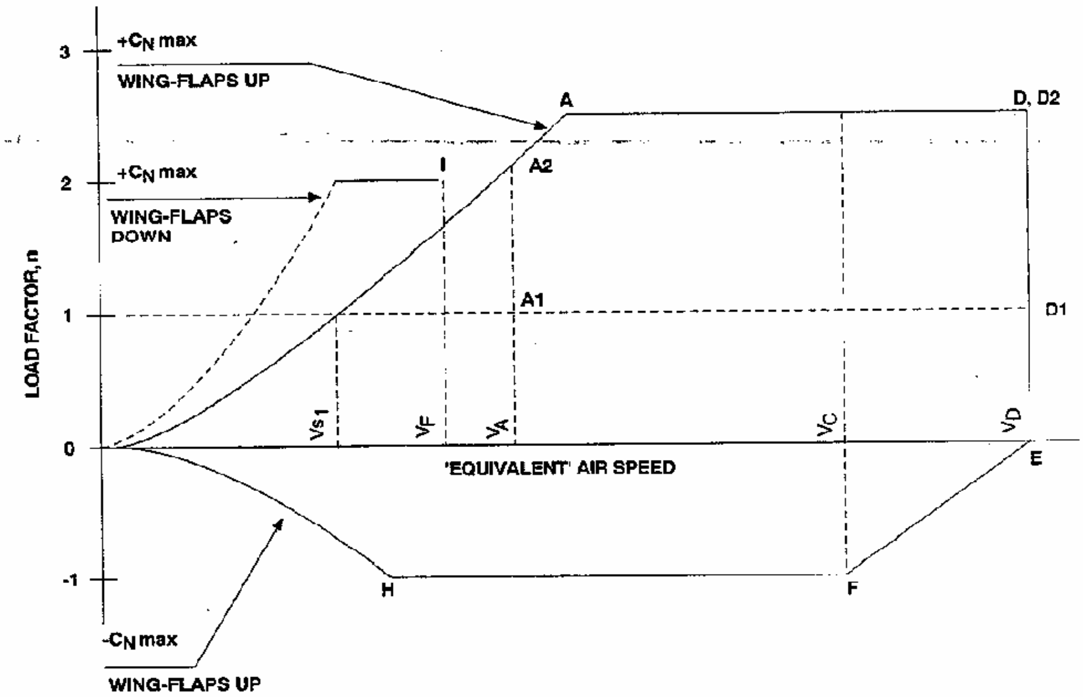
(A) For the nose-up pitching manoeuvre, the time at which the normal acceleration at the c.g. goes below 0g;

(B) For the nose-down pitching manoeuvre, the time at which the normal acceleration at the c.g. goes above the positive limit load factor prescribed in CS 25.337;

(C) t_{max}.

CS 25.333 Flight manoeuvring envelope

(a) *General.* The strength requirements must be met at each combination of airspeed and load factor on and within the boundaries of the representative manoeuvring envelope (V-n diagram) of sub-paragraph (b) of this paragraph. This envelope must also be used in determining the aeroplane structural operating limitations as specified in CS 25.1501.



(b) *Manoeuvring envelope*

CS 25.335 Design airspeeds

The selected design airspeeds are equivalent airspeeds (EAS). Estimated values of V_{S_0} and V_{S_1} must be conservative.

(a) *Design cruising speed, V_C.* For V_C, the following apply:

(1) The minimum value of V_C must be sufficiently greater than V_B to provide for inadvertent speed increases likely to occur as a result of severe atmospheric turbulence.

(2) Except as provided in sub-paragraph 25.335(d)(2), V_C may not be less than V_B + 1·32 U_{ref} (with U_{ref} as specified in sub-paragraph 25.341(a)(5)(i). However, V_C need not exceed the maximum speed in level flight at maximum continuous power for the corresponding altitude.

(3) At altitudes where V_D is limited by Mach number, V_C may be limited to a selected Mach number. (See CS 25.1505.)

(b) *Design dive speed, V_D.* V_D must be selected so that V_C/M_C is not greater than 0·8 V_D/M_D, or so that the minimum speed margin between V_C/M_C and V_D/M_D is the greater of the following values:

(1) From an initial condition of stabilised flight at V_C/M_C, the aeroplane is upset, flown for 20 seconds along a flight path 7·5º below the initial path, and then pulled up at a load factor of 1·5 g (0·5 g acceleration increment). The speed increase occurring in this manoeuvre may be calculated if reliable or conservative aerodynamic data issued. Power as specified in CS 25.175 (b)(1)(iv) is assumed until the pullup is initiated, at which time power reduction and the use of pilot controlled drag devices may be assumed;

(2) The minimum speed margin must be enough to provide for atmospheric variations (such as horizontal gusts, and penetration of jet streams and cold fronts) and for instrument errors and airframe production variations. These factors may be considered on a probability basis. The margin at altitude where M_C is limited by compressibility effects must not be less than 0.07M unless a lower margin is determined using a rational analysis that includes the effects of any automatic systems. In any case, the margin may not be reduced to less than 0.05M. (See AMC 25.335(b)(2))

(c) *Design manoeuvring speed, V_A.* For V_A, the following apply:

(1) V_A may not be less than $V_{S_1}\sqrt{n}$ where –

(i) n is the limit positive manoeuvring load factor at V_C; and

(ii) V_{S_1} is the stalling speed with wing-flaps retracted.

(2) V_A and V_S must be evaluated at the design weight and altitude under consideration.

(3) V_A need not be more than V_C or the speed at which the positive C_{Nmax} curve intersects the positive manoeuvre load factor line, whichever is less.

(d) Design speed for maximum gust intensity, V_B.

(1) V_B may not be less than

$$V_{s1}\left[1+\frac{K_g\, U_{ref}\, V_c\, a}{498w}\right]^{1/2}$$

where –

V_{sl} = the 1-g stalling speed based on C_{NAmax} with the flaps retracted at the particular weight under consideration;

C_{NAmax} = the maximum aeroplane normal force coefficient;

V_c = design cruise speed (knots equivalent airspeed);

U_{ref} = the reference gust velocity (feet per second equivalent airspeed) from CS 25.341(a)(5)(i);

w = average wing loading (pounds per square foot) at the particular weight under consideration.

$$K_g = \frac{.88\mu}{5.3+\mu}$$

$$\mu = \frac{2\,w}{\rho\, cag}$$

ρ = density of air (slugs/ft^3);

c = mean geometric chord of the wing (feet);

g = acceleration due to gravity (ft/sec^2);

a = slope of the aeroplane normal force coefficient curve, C_{NA} per radian;

(2) At altitudes where V_c is limited by Mach number –

(i) V_B may be chosen to provide an optimum margin between low and high speed buffet boundaries; and,

(ii) V_B need not be greater than V_C.

(e) *Design wing-flap speeds, V_F.* For V_F, the following apply:

(1) The design wing-flap speed for each wing-flap position (established in accordance with CS 25.697 (a)) must be sufficiently greater than the operating speed recommended for the corresponding stage of flight (including balked landings) to allow for probable variations in control of airspeed and for transition from one wing-flap position to another.

(2) If an automatic wing-flap positioning or load limiting device is used, the speeds and corresponding wing-flap positions programmed or allowed by the device may be used.

(3) V_F may not be less than –

(i) 1·6 V_{S_1} with the wing-flaps in take-off position at maximum take-off weight;

(ii) 1·8 V_{S_1} with the wing-flaps in approach position at maximum landing weight; and

(iii) 1·8 V_{S_0} with the wing-flaps in landing position at maximum landing weight.

(f) *Design drag device speeds, V_{DD}.* The selected design speed for each drag device must be sufficiently greater than the speed recommended for the operation of the device to allow for probable variations in speed control. For drag devices intended for use in high speed descents, V_{DD} may not be less than V_D. When an automatic drag device positioning or load limiting means is used, the speeds and corresponding drag device positions programmed or allowed by the automatic means must be used for design.

CS 25.337 Limit manoeuvring load factors

(See AMC 25.337)

(a) Except where limited by maximum (static) lift coefficients, the aeroplane is assumed to be subjected to symmetrical manoeuvres resulting in the limit manoeuvring load factors prescribed in this paragraph. Pitching velocities appropriate to the corresponding pull-up and steady turn manoeuvres must be taken into account.

(b) The positive limit manoeuvring load factor 'n' for any speed up to V_D may not be less than $2{\cdot}1 + \left(\frac{24\,000}{W + 10\,000}\right)$ except that 'n' may not be less than 2·5 and need not be greater than 3·8 – where 'W' is the design maximum take-off weight (lb).

(c) The negative limit manoeuvring load factor –

(1) May not be less than –1·0 at speeds up to V_C; and

(2) Must vary linearly with speed from the value at V_C to zero at V_D.

(d) Manoeuvring load factors lower than those specified in this paragraph may be used if the aeroplane has design features that make it impossible to exceed these values in flight.

CS 25.341 Gust and turbulence loads

(See AMC 25.341)

(a) *Discrete Gust Design Criteria.* The aeroplane is assumed to be subjected to symmetrical vertical and lateral gusts in level flight. Limit gust loads must be determined in accordance with the following provisions:

(1) Loads on each part of the structure must be determined by dynamic analysis. The analysis must take into account unsteady aerodynamic characteristics and all significant structural degrees of freedom including rigid body motions.

(2) The shape of the gust must be taken as follows:

$$U = \frac{U_{ds}}{2}\left[1 - \cos\left(\frac{\pi s}{H}\right)\right] \qquad \text{for } 0 \le s \le 2H$$

$$U = 0 \qquad \text{for } s > 2H$$

where –

s = distance penetrated into the gust (metre);

U_{ds} = the design gust velocity in equivalent airspeed specified in sub-paragraph (a) (4) of this paragraph;

H = the gust gradient which is the distance (metre) parallel to the aeroplane's flight path for the gust to reach its peak velocity.

(3) A sufficient number of gust gradient distances in the range 9 m (30 feet) to 107 m (350 feet) must be investigated to find the critical response for each load quantity.

(4) The design gust velocity must be:

$$U_{ds} = U_{ref}\ F_g \left(H/350\right)^{1/6}$$

where –

U_{ref} = the reference gust velocity in equivalent airspeed defined in sub-paragraph (a)(5) of this paragraph;

F_g = the flight profile alleviation factor defined in sub-paragraph (a)(6) of this paragraph.

(5) The following reference gust velocities apply:

(i) At aeroplane speeds between V_B and V_C: Positive and negative gusts with reference gust velocities of 17.07 m/s (56.0 ft/s) EAS must be considered at sea level. The reference gust velocity may be reduced linearly from 17.07 m/s (56.0 ft/s) EAS at sea level to 13.41 m/s (44.0 ft/s) EAS at 4572 m (15 000 ft). The reference gust velocity may be further reduced linearly from 13.41 m/s (44.0 ft/s) EAS at 4572 m (15 000 ft) to 6.36 m/s (20.86 ft/sec) EAS at 18288 m (60 000 ft).

(ii) At the aeroplane design speed V_D: The reference gust velocity must be 0·5 times the value obtained under CS 25.341(a)(5)(i).

(6) The flight profile alleviation factor, F_g, must be increased linearly from the sea level value to a value of 1·0 at the maximum operating altitude defined in CS 25.1527. At sea level, the flight profile alleviation factor is determined by the following equation.

$$F_g = 0{\cdot}5\ (F_{gz} + F_{gm})$$

where –

$$F_{gz} = 1 - \frac{Z_{mo}}{76200}; \quad \left(F_{gz} = 1 - \frac{Z_{mo}}{250\,000}\right)$$

$$F_{gm} = \sqrt{R_2 \operatorname{Tan}\left(\pi R_1/4\right)};$$

$$R_1 = \frac{\text{Maximum Landing Weight}}{\text{Maximum Take-off Weight}};$$

$R_2 = \frac{\text{Maximum Zero Fuel Weight}}{\text{Maximum Take - off Weight}}$;

Z_{mo} maximum operating altitude (metres (feet)) defined in CS 25.1527.

(7) When a stability augmentation system is included in the analysis, the effect of any significant system non-linearities should be accounted for when deriving limit loads from limit gust conditions.

(b) *Continuous Turbulence Design Criteria*. The dynamic response of the aeroplane to vertical and lateral continuous turbulence must be taken into account. The dynamic analysis must take into account unsteady aerodynamic characteristics and all significant structural degrees of freedom including rigid body motions. The limit loads must be determined for all critical altitudes, weights, and weight distributions as specified in CS 25.321(b), and all critical speeds within the ranges indicated in subparagraph (b)(3).

(1) Except as provided in subparagraphs (b)(4) and (b)(5) of this paragraph, the following equation must be used:

$$P_L = P_{L-1g} \pm U_\sigma \bar{A}$$

Where:
P_L = limit load;
P_{L-1g} = steady 1-g load for the condition;
$\bar{A}$ = ratio of root-mean-square incremental load for the condition to root-mean-square turbulence velocity; and
U_σ = limit turbulence intensity in true airspeed, specified in subparagraph (b)(3) of this paragraph.

(2) Values of $\bar{A}$ must be determined according to the following formula:

$$\bar{A} = \sqrt{\int_0^\infty \left|H(\Omega)\right|^2 \Phi_I(\Omega) d\Omega}$$

Where:
$H(\Omega)$ = the frequency response function, determined by dynamic analysis, that relates the loads in the aircraft structure to the atmospheric turbulence; and
$\Phi_I(\Omega)$ = normalised power spectral density of atmospheric turbulence given by:

$$\Phi_I(\Omega) = \frac{L}{\pi} \frac{1 + \frac{8}{3}(1.339\Omega L)^2}{[1 + (1.339\Omega L)^2]^{11/6}}$$

Where:
Ω = reduced frequency, rad/ft; and
L = scale of turbulence = 2,500 ft.

(3) The limit turbulence intensities, U_σ, in m/s (ft/s) true airspeed required for compliance with this paragraph are:

(i) At aeroplane speeds between V_B and V_C:

$$U_\sigma = U_{\sigma ref} F_g$$

Where:
$U_{\sigma ref}$ is the reference turbulence intensity that varies linearly with altitude from 27.43 m/s (90 ft/s) (TAS) at sea level to 24.08 m/s (79 ft/s) (TAS) at 7315 m (24000 ft) and is then constant at 24.08 m/s (79 ft/s) (TAS) up to the altitude of 18288 m (60000 ft); and
F_g is the flight profile alleviation factor defined in subparagraph (a)(6) of this paragraph;

(ii) At speed V_D: U_σ is equal to 1/2 the values obtained under subparagraph (3)(i) of this paragraph.

(iii) At speeds between V_C and V_D: U_σ is equal to a value obtained by linear interpolation.

(iv) At all speeds both positive and negative incremental loads due to continuous turbulence must be considered.

(4) When an automatic system affecting the dynamic response of the aeroplane is included in the analysis, the effects of system non-linearities on loads at the limit load level must be taken into account in a realistic or conservative manner.

(5) If necessary for the assessment of loads on aeroplanes with significant non-linearities, it must be assumed that the turbulence field has a root-mean-square velocity equal to 40 percent of the U_σ values specified in subparagraph (3). The value of limit load is that load with the same probability of exceedance in the turbulence field as $\bar{A} U_\sigma$ of the same load quantity in a linear approximated model.

(c) *Supplementary gust conditions for wing mounted engines*. For aeroplanes equipped with wing mounted engines, the engine mounts, pylons, and wing supporting structure must be designed for the maximum response at the nacelle centre of gravity derived from the following dynamic gust conditions applied to the aeroplane:

(1) A discrete gust determined in accordance with CS 25.341(a) at each angle normal to the flight path, and separately,

(2) A pair of discrete gusts, one vertical and one lateral. The length of each of these gusts must be independently tuned to the maximum response in accordance with CS 25.341(a). The penetration of the aeroplane in the combined gust field and the phasing of the vertical and lateral component gusts must be established to develop the maximum response to the gust pair. In the absence of a more rational analysis, the following formula must be used for each of the maximum engine loads in all six degrees of freedom:

$$P_L = P_{L-1g} \pm 0.85 \sqrt{(L_{Vi}^2+L_{Li}^2)}$$

Where:
P_L = limit load;
P_{L-1g} = steady 1-g load for the condition;
L_V = peak incremental response load due to a vertical gust according to CS 25.341(a); and
L_L = peak incremental response load due to a lateral gust according to CS 25.341(a).

[Amdt. No.:25/1]

CS 25.343 Design fuel and oil loads

(a) The disposable load combinations must include each fuel and oil load in the range from zero fuel and oil to the selected maximum fuel and oil load. A structural reserve fuel condition, not exceeding 45 minutes of fuel under operating conditions in CS 25.1001 (f), may be selected.

(b) If a structural reserve fuel condition is selected, it must be used as the minimum fuel weight condition for showing compliance with the flight load requirements as prescribed in this Subpart. In addition –

(1) The structure must be designed for a condition of zero fuel and oil in the wing at limit loads corresponding to –

(i) A manoeuvring load factor of +2·25; and

(ii) The gust and turbulence conditions of CS 25.341, but assuming 85% of the gust velocities prescribed in CS 25.341(a)(4) and 85% of the turbulence intensities prescribed in CS 25.341(b)(3).

(2) Fatigue evaluation of the structure must account for any increase in operating stresses resulting from the design condition of sub-paragraph (b) (1) of this paragraph; and

(3) The flutter, deformation, and vibration requirements must also be met with zero fuel.

[Amdt. No.:25/1]

CS 25.345 High lift devices

(a) If wing-flaps are to be used during take-off, approach, or landing, at the design flap speeds established for these stages of flight under CS 25.335 (e) and with the wing-flaps in the corresponding positions, the aeroplane is assumed to be subjected to symmetrical manoeuvres and gusts. The resulting limit loads must correspond to the conditions determined as follows:

(1) Manoeuvring to a positive limit load factor of 2·0; and

(2) Positive and negative gusts of 7.62 m/sec (25 ft/sec) EAS acting normal to the flight path in level flight. Gust loads resulting on each part of the structure must be determined by rational analysis. The analysis must take into account the unsteady aerodynamic characteristics and rigid body motions of the aircraft. (See AMC 25.345(a).) The shape of the gust must be as described in CS 25.341(a)(2) except that –

U_{ds} = 7.62 m/sec (25 ft/sec) EAS;
H = 12.5 c; and
c = mean geometric chord of the wing (metres (feet)).

(b) The aeroplane must be designed for the conditions prescribed in sub-paragraph (a) of this paragraph except that the aeroplane load factor need not exceed 1·0, taking into account, as separate conditions, the effects of –

(1) Propeller slipstream corresponding to maximum continuous power at the design flap speeds V_F, and with take-off power at not less than 1·4 times the stalling speed for the particular flap position and associated maximum weight; and

(2) A head-on gust of 7.62m/sec (25 fps) velocity (EAS).

(c) If flaps or other high lift devices are to be used in en-route conditions, and with flaps in the appropriate position at speeds up to the flap design speed chosen for these conditions, the aeroplane is assumed to be subjected to symmetrical manoeuvres and gusts within the range determined by –

(1) Manoeuvring to a positive limit load factor as prescribed in CS 25.337 (b); and

(2) The vertical gust and turbulence conditions prescribed in CS 25.341. (See AMC 25.345(c).)

(d) The aeroplane must be designed for a manoeuvring load factor of 1·5 g at the maximum take-off weight with the wing-flaps and similar high lift devices in the landing configurations.

[Amdt. No.:25/1]

CS 25.349 Rolling conditions

The aeroplane must be designed for loads resulting from the rolling conditions specified in sub-paragraphs (a) and (b) of this paragraph. Unbalanced aerodynamic moments about the centre of gravity must be reacted in a rational or conservative manner, considering the principal masses furnishing the reacting inertia forces.

(a) *Manoeuvring.* The following conditions, speeds, and aileron deflections (except as the deflections may be limited by pilot effort) must be considered in combination with an aeroplane load factor of zero and of two-thirds of the positive manoeuvring factor used in design. In determining the required aileron deflections, the torsional flexibility of the wing must be considered in accordance with CS 25.301 (b):

(1) Conditions corresponding to steady rolling velocities must be investigated. In addition, conditions corresponding to maximum angular acceleration must be investigated for aeroplanes with engines or other weight concentrations outboard of the fuselage. For the angular acceleration conditions, zero rolling velocity may be assumed in the absence of a rational time history investigation of the manoeuvre.

(2) At V_A, a sudden deflection of the aileron to the stop is assumed.

(3) At V_C, the aileron deflection must be that required to produce a rate of roll not less than that obtained in sub-paragraph (a) (2) of this paragraph.

(4) At V_D, the aileron deflection must be that required to produce a rate of roll not less than one-third of that in sub-paragraph (a) (2) of this paragraph.

(b) *Unsymmetrical gusts.* The aeroplane is assumed to be subjected to unsymmetrical vertical gusts in level flight. The resulting limit loads must be determined from either the wing maximum airload derived directly from CS 25.341(a), or the wing maximum airload derived indirectly from the vertical load factor calculated from CS 25.341(a). It must be assumed that 100 percent of the wing airload acts on one side of the aeroplane and 80 percent of the wing airload acts on the other side.

CS 25.351 Yaw manoeuvre conditions

The aeroplane must be designed for loads resulting from the yaw manoeuvre conditions specified in sub-paragraphs (a) through (d) of this paragraph at speeds from V_{MC} to V_D. Unbalanced aerodynamic moments about the centre of gravity must be reacted in a rational or conservative manner considering the aeroplane inertia forces. In computing the tail loads the yawing velocity may be assumed to be zero.

(a) With the aeroplane in unaccelerated flight at zero yaw, it is assumed that the cockpit rudder control is suddenly displaced to achieve the resulting rudder deflection, as limited by:

(1) the control system or control surface stops; or

(2) a limit pilot force of 1335 N (300 lbf) from V_{MC} to V_A and 890 N (200 lbf) from V_C/M_C to V_D/M_D, with a linear variation between V_A and V_C/M_C.

(b) With the cockpit rudder control deflected so as always to maintain the maximum rudder deflection available within the limitations specified in sub-paragraph (a) of this paragraph, it is assumed that the aeroplane yaws to the overswing sideslip angle.

(c) With the aeroplane yawed to the static equilibrium sideslip angle, it is assumed that the cockpit rudder control is held so as to achieve the maximum rudder deflection available within the limitations specified in sub-paragraph (a) of this paragraph.

(d) With the aeroplane yawed to the static equilibrium sideslip angle of sub-paragraph (c) of this paragraph, it is assumed that the cockpit rudder control is suddenly returned to neutral.

SUPPLEMENTARY CONDITIONS

CS 25.361 Engine and APU torque

(a) Each engine mount and its supporting structures must be designed for engine torque effects combined with –

(1) A limit engine torque corresponding to take-off power and propeller speed acting simultaneously with 75% of the limit loads from flight condition A of CS 25.333 (b);

(2) A limit engine torque as specified in sub-paragraph (c) of this paragraph acting simultaneously with the limit loads from flight condition A of CS 25.333 (b); and

(3) For turbo-propeller installations, in addition to the conditions specified in sub-